GE
Grid Solutions

MiCOM P40 Agile

P842

Technical Manual
Mesh Corner Auto-Reclose Relay

Software version: 04
Publication reference: P842/EN M/D11

CONTENTS

SAFETY SECTION

CONTENTS

SS

1. OVERVIEW

This chapter provides information about the safe handling of the equipment. The equipment must be installed properly and handled to maintain it in a safe condition and to keep personnel safe at all times. You must be familiar with information contained in this chapter before unpacking, installing, commissioning, or servicing the equipment.

SS

2. HEALTH AND SAFETY

Personnel associated with the equipment must be familiar with the contents of this Safety Information.

When electrical equipment is in operation, dangerous voltages are present in certain parts of the equipment. Improper use of the equipment and failure to observe warning notices will endanger personnel.

Only qualified personnel may work on or operate the equipment. Qualified personnel are individuals who are:

- familiar with the installation, commissioning, and operation of the equipment and the system to which it is being connected.
- familiar with accepted safety engineering practises and are authorised to energise and de-energise equipment in the correct manner.
- trained in the care and use of safety apparatus in accordance with safety engineering practises
- trained in emergency procedures (first aid).

The documentation provides instructions for installing, commissioning and operating the equipment. It cannot, however cover all conceivable circumstances. In the event of questions or problems, do not take any action without proper authorisation. Please contact your local sales office and request the necessary information.

3. SYMBOLS

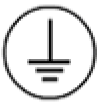
Throughout this manual you will come across the following symbols. You will also see these symbols on parts of the equipment.

Refer to equipment documentation. Failure to do so could result in damage to the equipment

Risk of electric shock

Risk of damage to eyesight

Earth terminal. Note: This symbol may also be used for a protective conductor (earth) terminal if that terminal is part of a terminal block or sub-assembly.



Protective conductor (earth) terminal

Instructions on disposal requirements

The term 'Earth' used in this manual is the direct equivalent of the North American term 'Ground'.

4. INSTALLING, COMMISSIONING AND SERVICING

4.1 Lifting Hazards

Many injuries are caused by:

- Lifting heavy objects
- Lifting things incorrectly
- Pushing or pulling heavy objects
- Using the same muscles repetitively

Plan carefully, identify any possible hazards and determine how best to move the product. Look at other ways of moving the load to avoid manual handling. Use the correct lifting techniques and Personal Protective Equipment (PPE) to reduce the risk of injury.

4.2 Electrical Hazards

All personnel involved in installing, commissioning, or servicing this equipment must be familiar with the correct working procedures.

Consult the equipment documentation before installing, commissioning, or servicing the equipment.

Always use the equipment as specified. Failure to do so will jeopardise the protection provided by the equipment.

Removal of equipment panels or covers may expose hazardous live parts. Do not touch until the electrical power is removed. Take care when there is unlocked access to the rear of the equipment.

Isolate the equipment before working on the terminal strips.

Use a suitable protective barrier for areas with restricted space, where there is a risk of electric shock due to exposed terminals.

Disconnect power before disassembling. Disassembly of the equipment may expose sensitive electronic circuitry. Take suitable precautions against electrostatic voltage discharge (ESD) to avoid damage to the equipment.

NEVER look into optical fibres or optical output connections. Always use optical power meters to determine operation or signal level.

Testing may leave capacitors charged to dangerous voltage levels. Discharge capacitors by reducing test voltages to zero before disconnecting test leads.

Operate the equipment within the specified electrical and environmental limits.

Before cleaning the equipment, ensure that no connections are energised. Use a lint free cloth dampened with clean water.

Contact fingers of test plugs are normally protected by petroleum jelly, which should not be removed.

4.3 UL/CSA/CUL Requirements

The information in this section is applicable only to equipment carrying UL/CSA/CUL markings.

Equipment intended for rack or panel mounting is for use on a flat surface of a Type 1 enclosure, as defined by Underwriters Laboratories (UL).

To maintain compliance with UL and CSA/CUL, install the equipment using UL/CSA-recognised parts for: cables, protective fuses, fuse holders and circuit breakers, insulation crimp terminals, and replacement internal batteries.

4.4 Fusing Requirements

Where UL/CSA listing of the equipment is required for external fuse protection, a UL or CSA Listed fuse must be used for the auxiliary supply. The listed protective fuse type is: Class J time delay fuse, with a maximum current rating of 15 A and a minimum DC rating of 250 V dc (for example type AJT15).

Where UL/CSA listing of the equipment is not required, a high rupture capacity (HRC) fuse type with a maximum current rating of 16 Amps and a minimum dc rating of 250 V dc may be used for the auxiliary supply (for example Red Spot type NIT or TIA).
For P50 models, use a 1A maximum T-type fuse.
For P60 models, use a 4A maximum T-type fuse.

Digital input circuits should be protected by a high rupture capacity NIT or TIA fuse with maximum rating of 16 A. for safety reasons, current transformer circuits must never be fused. Other circuits should be appropriately fused to protect the wire used.

CTs must NOT be fused since open circuiting them may produce lethal hazardous voltages

4.5 Equipment Connections

Terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated.

Tighten M4 clamping screws of heavy duty terminal block connectors to a nominal torque of 1.3 Nm.
Tighten captive screws of terminal blocks to 0.5 Nm minimum and 0.6 Nm maximum.

Always use insulated crimp terminations for voltage and current connections.

Always use the correct crimp terminal and tool according to the wire size.

Watchdog (self-monitoring) contacts are provided to indicate the health of the device on some products. We strongly recommend that you hard wire these contacts into the substation's automation system, for alarm purposes.

4.6 Protection Class 1 Equipment Requirements

Earth the equipment with the supplied PCT (Protective Conductor Terminal).

Do not remove the PCT.

The PCT is sometimes used to terminate cable screens. Always check the PCT’s integrity after adding or removing such earth connections.

Use a locknut or similar mechanism to ensure the integrity of stud-connected PCTs.

The recommended minimum PCT wire size is 2.5 mm² for countries whose mains supply is 230 V (e.g. Europe) and 3.3 mm² for countries whose mains supply is 110 V (e.g. North America). This may be superseded by local or country wiring regulations.
For P60 products, the recommended minimum PCT wire size is 6 mm². See product documentation for details.

The PCT connection must have low-inductance and be as short as possible.

All connections to the equipment must have a defined potential. Connections that are pre-wired, but not used, should be earthed, or connected to a common grouped potential.

4.7 Pre-energisation Checklist

Check voltage rating/polarity (rating label/equipment documentation).

Check CT circuit rating (rating label) and integrity of connections.

Check protective fuse or miniature circuit breaker (MCB) rating.

Check integrity of the PCT connection.

Check voltage and current rating of external wiring, ensuring it is appropriate for the application.

4.8 Peripheral Circuitry

Do not open the secondary circuit of a live CT since the high voltage produced may be lethal to personnel and could damage insulation. Short the secondary of the line CT before opening any connections to it.

For most General Electric equipment with ring-terminal connections, the threaded terminal block for current transformer termination is automatically shorted if the module is removed. Therefore, external shorting of the CTs may not be required. Check the equipment documentation and wiring diagrams first to see if this applies.

Where external components such as resistors or voltage dependent resistors (VDRs) are used, these may present a risk of electric shock or burns if touched.

Take extreme care when using external test blocks and test plugs such as the MMLG, MMLB and P990, as hazardous voltages may be exposed. Ensure that CT shorting links are in place before removing test plugs, to avoid potentially lethal voltages.

4.9 Upgrading/Servicing

Do not insert or withdraw modules, PCBs or expansion boards from the equipment while energised, as this may result in damage to the equipment. Hazardous live voltages would also be exposed, endangering personnel.

Internal modules and assemblies can be heavy and may have sharp edges. Take care when inserting or removing modules into or out of the IED.

5. DECOMMISSIONING AND DISPOSAL

Before decommissioning, completely isolate the equipment power supplies (both poles of any dc supply). The auxiliary supply input may have capacitors in parallel, which may still be charged. To avoid electric shock, discharge the capacitors using the external terminals before decommissioning.

Avoid incineration or disposal to water courses. Dispose of the equipment in a safe, responsible and environmentally friendly manner, and if applicable, in accordance with country-specific regulations.

6. REGULATORY COMPLIANCE

Compliance with the European Commission Directive on EMC and LVD is demonstrated using a technical file.

6.1 EMC Compliance: 2014/30/EU

The product specific Declaration of Conformity (DoC) lists the relevant harmonised standard(s) or conformity assessment used to demonstrate compliance with the EMC directive.

6.2 LVD Compliance: 2014/35/EU

The product specific Declaration of Conformity (DoC) lists the relevant harmonized standard(s) or conformity assessment used to demonstrate compliance with the LVD directive.

Safety related information, such as the installation I overvoltage category, pollution degree and operating temperature ranges are specified in the Technical Data section of the relevant product documentation and/or on the product labelling.

Unless otherwise stated in the Technical Data section of the relevant product documentation, the equipment is intended for indoor use only. Where the equipment is required for use in an outdoor location, it must be mounted in a specific cabinet or housing to provide the equipment with the appropriate level of protection from the expected outdoor environment.

6.3 R&TTE Compliance: 2014/53/EU

Radio and Telecommunications Terminal Equipment (R&TTE) directive 2014/53/EU.

Conformity is demonstrated by compliance to both the EMC directive and the Low Voltage directive, to zero volts.

6.4 UL/CUL Compliance

If marked with this logo, the product is compliant with the requirements of the Canadian and USA Underwriters Laboratories.

The relevant UL file number and ID is shown on the equipment.

6.5 ATEX Compliance: 2014/34/EU

Products marked with the 'explosion protection' Ex symbol (shown in the example, below) are compliant with the ATEX directive. The product specific Declaration of Conformity (DoC) lists the Notified Body, Type Examination Certificate, and relevant harmonized standard or conformity assessment used to demonstrate compliance with the ATEX directive.

The ATEX Equipment Protection level, Equipment group, and Zone definition will be marked on the

product.

For example:

II (2) G

Where:

'II' Equipment Group: Industrial.

'(2)G' High protection equipment category, for control of equipment in gas atmospheres in Zone 1 and 2. This equipment (with parentheses marking around the zone number) is not itself suitable for operation within a potentially explosive atmosphere.

IT

INTRODUCTION

Date:	**2019**
Hardware Suffix:	**B**
Software Version:	**04**

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FIGURES

1. MiCOM DOCUMENTATION STRUCTURE

The manual provides a functional and technical description of the MiCOM P842 distance protection relay and a comprehensive set of instructions for the relay's use and application.

The section contents are summarized below:

P842/EN IT **Introduction**

A guide to the MiCOM P842 Mesh corner relay and the documentation structure. General safety aspects of handling Electronic Equipment is discussed with particular reference to relay safety symbols. Also, a general functional overview of the relay and brief application summary is given.

P842/EN TD **Technical Data**

Technical data including setting ranges, accuracy limits, recommended operating conditions, ratings and performance data. Compliance with norms and international standards is quoted where appropriate.

P842/EN GS **Getting Started**

A guide to the different user interfaces of the protection relay describing how to start using it. This section provides detailed information regarding the communication interfaces of the relay, including a detailed description of how to access the settings database stored within the relay.

P842/EN ST **Settings**

List of all relay settings, including ranges, step sizes and defaults, together with a brief explanation of each setting.

P842/EN OP **Operation**

A comprehensive and detailed functional description of each Functional module and interaction during Autoisolation and DAR sequences.

P842/EN AP **Application Notes**

This section includes a description of a typical application of the P842 to a mesh corner arrangement and typical fault scenarios together with the relay response.

P842/EN PL **Programmable Logic**

Overview of the programmable scheme logic and a description of each logical node. This section includes the factory default (PSL) and an explanation of typical applications.

P842/EN MR **Measurements and Recording**

Detailed description of the relays recording and measurements functions including the configuration of the event and disturbance recorder and measurement functions.

P842/EN FD **Firmware Design**

Overview of the operation of the relay's hardware and software. This section includes information on the self-checking features and diagnostics of the relay.

P842/EN CM **Commissioning**

Instructions on how to commission the relay, comprising checks on the calibration and functionality of the relay.

P842/EN MT **Maintenance**

A general maintenance policy for the relay is outlined.

P842/EN TS **Troubleshooting**

Advice on how to recognize failure modes and the recommended course of action. Includes guidance on whom within General Electric to contact for advice.

P842/EN SC SCADA Communications

This section provides an overview regarding the SCADA communication interfaces of the relay. Detailed protocol mappings, semantics, profiles and interoperability tables are not provided within this manual. Separate documents are available per protocol, available for download from our website.

P842/EN SG Symbols and Glossary

List of common technical abbreviations found within the product documentation.

P842/EN IN Installation

Recommendations on unpacking, handling, inspection and storage of the relay. A guide to the mechanical and electrical installation of the relay is provided, incorporating earthing recommendations. All external wiring connections to the relay are indicated.

P842/EN VH Firmware and Service Manual Version History

History of all hardware and software releases for the product.

2. INTRODUCTION TO MICOM

MiCOM is a comprehensive solution capable of meeting all electricity supply requirements. It comprises a range of components, systems and services from General Electric.

Central to the MiCOM concept is flexibility.

MiCOM provides the ability to define an application solution and, through extensive communication capabilities, integrate it with your power supply control system.

The components within MiCOM are:

- P range protection relays;
- C range control products;
- M range measurement products for accurate metering and monitoring;
- S range versatile PC support and substation control packages.

MiCOM products include extensive facilities for recording information on the state and behavior of the power system using disturbance and fault records. They can also provide measurements of the system at regular intervals to a control center enabling remote monitoring and control to take place.

For up-to-date information on any MiCOM product, visit our website:

www.gegridsolutions.com

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3. PRODUCT SCOPE

The MiCOM P842 Mesh Corner Reclose unit uses high speed peer-peer communication facilities over Ethernet to provide a flexible, distributed scheme for delayed auto-reclose (DAR) and auto-isolation of a mesh bus station

The MiCOM P842 provides for the automatic reclosure of circuit breakers, the automatic isolation of persistently faulted plant and the suppression of ferroresonance, following a fault on the system.

Equipment is provided on the basis of one MCU per mesh corner. Although each MCU is an autonomous unit, inter-unit communication guarantees co-ordinated control of a complete mesh system. This inter-unit communication can be made via Ethernet peer-peer communications or as a traditional hardwired link.

A typical single switch system would require two MCUs; a two switch system, three MCUs, and three and four switch systems, four MCUs.

The P842 provides integrated system check functions for up to two controlled circuit breakers. Two check sync stages are provided that can be used for check sync and system sync closure together with detection of a system split condition.

The P842 is designed using the standard MiCOM hardware and software platform. To assist with the flexible application of the MCU to different plant topology the programmable scheme logic (PSL).

3.1 Functional overview

The MiCOM P842 relay contains a wide variety of control and ancillary functions as summarized below:

Control Functions	Description
Circuit Breaker Function	Up to 2 directly controlled breakers
Feeder Function	Up to 2 feeders connected to the mesh corner
Transformer Function	Up to 3 banked transformers
Ferroresonance suppression	Control up to three banked transformer isolators to suppress resonance
System Checks	2 stages of Sync check including system split alarm
DAR Interlocking	Trip relay reset
Peer to peer communications	Real time goose messaging for up to 32 relays
Ancillary functions	
Measurements	4 Voltage inputs
Event records	500 events
Disturbance records	4 analogue and 32 digital signals
Rear port communications	Courier or IEC60870-5-103

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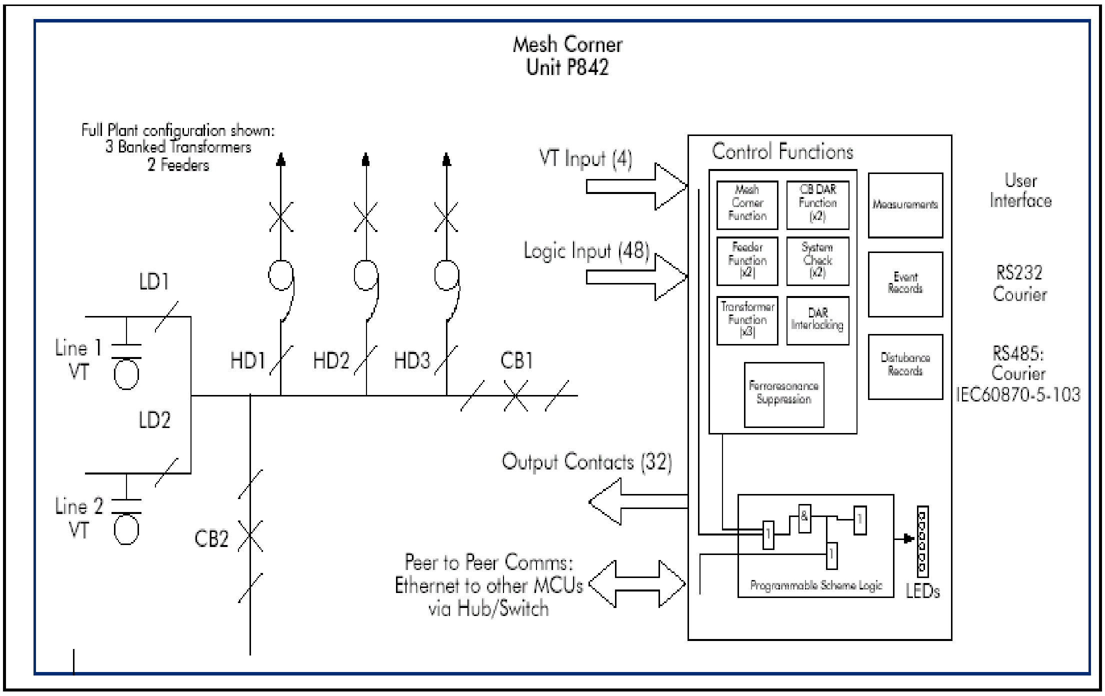

Figure 1: Functional diagram

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3.2 Ordering options

Information Required with MiCOM P842 order

MiCOM P842 Mesh corner reclose relay **P842**

Provides Autoisolation, DAR and

Ferroresonance suppression

Auxiliary Voltage Rating	
24 – 48V dc only	1
48 – 125V dc (30 – 110V ac)	2
110 – 250V dc (100 – 240V ac)	3
Vn rating	
100-120 V ac	1
Hardware options	
Ethernet 10Mbps	5
Ethernet 100Mbps	6
Note: RJ-45 copper connection is always available	
Product Specific	
Version with 48 Inputs and 32 Outputs	A
Protocol Options	
K-Bus/Courier	1
IEC60870-5-103 (EIA 485 or Fiber Optic)	3
Mounting	
Flush/ Panel Mounting	A
19” Rack mounting	B
Language	
English	0
Software Version	
Unless specified the latest version will be delivered	0 4
Settings File	
Default	0
Hardware Suffix	
Original	B

TD

TECHNICAL DATA

Date: **2019**
Hardware Suffix: **B**
Software Version: **04**

TD

Technical Data

Mechanical Specifications

Design

Modular MiCOM Px40 platform relay, available in 80TE (16"), front of panel flush mounting, or 19" rack mounted (ordering options).

Enclosure Protection

Per IEC 60529: 1989
IP 52 Protection (front panel) against dust and dripping water.
IP 30 Protection for sides of the case.
IP 10 Protection for the rear.

Weight

TE: approx. 11 kg

Terminals

AC Current and Voltage Measuring Inputs
Located on heavy duty (black) terminal block:
Threaded M4 terminals, for ring lug connection.
CT inputs are not used.

General Input/Output Terminals
For power supply, opto inputs, output contacts and COM1 rear communications.
Located on general purpose (grey) blocks:
Threaded M4 terminals, for ring lug connection.

Case Protective Earth Connection
Two rear stud connections, threaded M4.
Must be earthed (grounded) for safety, minimum earth wire size $2.5mm^2$.

Front Port Serial PC Interface
EIA(RS)232 DTE, 9 pin D-type female connector.
Courier protocol for interface to MiCOM S1 Agile software.
Isolation to ELV level.
Maximum cable length 15m.

Front Download/Monitor Port
EIA(RS)232, 25 pin D-type female connector.
For firmware downloads.
Isolation to ELV level.

Rear Communications Port
EIA(RS)485 signal levels, two wire
Connections located on general purpose block, M4 screw.
For screened twisted pair cable, multi-drop, 1000m max.
For K-Bus or IEC-870-5-103 protocol (ordering options).
Isolation to SELV level.

UCA2 GOOSE port
Fiber Ethernet connection via RJ-45 copper or 10Mbits/100Mbits (ordering option)

Optional Rear IRIG-B Interface
Currently unavailable

Optional Rear Fiber Connection for SCADA/DCS
BFOC 2.5 - (ST®)-interface for glass fiber, as per IEC 874-10.
850nm short-haul fibers, one Tx and one Rx.

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Ratings

AC Measuring Inputs
Nominal frequency: 50 and 60 Hz (settable)
Operating range: 45 to 65Hz

AC Current
Not applicable

AC Voltage
Nominal voltage (Vn): 100 to 120 V phase-phase.
Nominal burden per phase: < 0.02 VA at 110/√3 V.
Thermal withstand:
continuous 2 Vn
for 10s: 2.6 Vn

Power Supply

Auxiliary Voltage (Vx)
Three ordering options:
(i) Vx: 24 to 48 Vdc
(ii) Vx: 48 to 110 Vdc, and 30 to 100Vac (rms)
(iii) Vx: 110 to 250 Vdc, and 100 to 240Vac (rms)

Operating Range
(i) 19 to 65V (dc only for this variant)
(ii) 37 to 150V (dc), 24 to 110V (ac)
(iii) 87 to 300V (dc), 80 to 265V (ac)
With a tolerable ac ripple of up to 12% for a dc supply, per IEC 60255-11: 1979.

Nominal Burden
Quiescent burden: 12W.
Additions for energized binary inputs/outputs:
Per opto input:
0.09W (24 to 54V),
0.12W (110/125V),

0.19W (220/120V).
Per energized output relay: 0.13W

Power-up Time
Time to power up < 11s.

Power Supply Interruption
Per IEC 60255-11: 1979
The relay will withstand a 20ms interruption in the DC auxiliary supply, without de-energizing.
Per IEC 61000-4-11: 1994
The relay will withstand a 20ms interruption in an AC auxiliary supply, without de-energizing.

Battery Backup
Front panel mounted
Type ½ AA, 3.6V

Field Voltage Output
Regulated 48Vdc
Current limited at 112mA maximum output

Digital (“Opto”) Inputs
Universal opto inputs with programmable voltage thresholds. May be energized from the 48V field voltage, or the external battery supply.
Rated nominal voltage: 24 to 250Vdc
Operating range: 19 to 265Vdc
Withstand: 300Vdc.
Nominal pick-up and reset thresholds:
Pick-up: approx. 75% of battery nominal set,
Reset: approx. 64% of battery nominal set.
Recognition time:
<12ms with half-cycle ac immunity filter on.

Output Contacts

Standard Contacts
General purpose relay outputs for signaling, tripping and alarming:
Rated voltage: 300 V
Continuous current: 10 A
Short-duration current: 30 A for 3s
Making capacity: 250A for 30ms
Breaking capacity:
DC: 50W resistive
DC: 62.5W inductive (L/R = 50ms)
AC: 2500VA resistive (cos ϕ = unity)
AC: 2500VA inductive (cos ϕ = 0.7)
Response to command: < 5ms
Durability:
Loaded contact: 10 000 operations minimum,
Unloaded contact: 100 000 operations minimum.

Watchdog Contacts
Non-programmable contacts for relay healthy/relay fail indication:
Breaking capacity:
DC: 30W resistive
DC: 15W inductive (L/R = 40ms)
AC: 375VA inductive (cos ϕ = 0.7)

IRIG-B Interface
Currently not available

Environmental Conditions

Ambient Temperature Range
Per IEC 60255-6: 1988
Operating temperature range:
-25°C to +55°C (or -13°F to +131°F).
Storage and transit:
-25°C to +70°C (or -13°F to +158°F).

Ambient Humidity Range
Per IEC 60068-2-3: 1969:
56 days at 93% relative humidity and +40°C
Per IEC 60068-2-30: 1980:
Damp heat cyclic, six (12 + 12) hour cycles, 93% RH, +25 to +55°C

Type Tests

Insulation
Per IEC 60255-5: 2000,
Insulation resistance > 100MΩ at 500Vdc
(Using only electronic/brushless insulation tester).

Creepage Distances and Clearances
Per EN 61010-1: 2001
Pollution degree 2,
Overvoltage category III,
Impulse test voltage 5 kV.

High Voltage (Dielectric) Withstand
EIA(RS)232 ports excepted.
(i) Per IEC 60255-5: 2000, 2 kV rms AC, 1 minute:
Between all case terminals connected together, and the case earth.
Also, between all terminals of independent circuits.
1kV rms AC for 1 minute, across open watchdog contacts.
1kV rms AC for 1 minute, across open contacts of changeover output relays.
(ii) Per ANSI/IEEE C37.90-1989 (reaffirmed 1994):
1.5 kV rms AC for 1 minute, across open contacts of changeover output relays.

Impulse Voltage Withstand Test
Per IEC 60255-5: 2000
Front time: 1.2 µs, Time to half-value: 50 µs,
Peak value: 5 kV, 0.5J
Between all terminals, and all terminals and case earth.

Electromagnetic Compatibility (EMC)

1 MHz Burst High Frequency Disturbance Test
Per IEC 60255-22-1: 1988, Class III,
Common-mode test voltage: 2.5 kV,
Differential test voltage: 1.0 kV,
Test duration: 2s, Source impedance: 200Ω
EIA(RS)232 ports excepted.

Immunity to Electrostatic Discharge
Per IEC 60255-22-2: 1996, Class 4,
15kV discharge in air to user interface, display, and exposed metalwork.
Per IEC 60255-22-2: 1996, Class 3,
8kV discharge in air to all communication ports.
6kV point contact discharge to any part of the front of the product.

Electrical Fast Transient or Burst Requirements
IEC 60255-22-4: 2002. Test severity Class III and IV:
Amplitude: 2 kV, burst frequency 5kHz (Class III),
Amplitude: 4 kV, burst frequency 2.5kHz (Class IV).
Applied directly to auxiliary supply and applied to all other inputs. EIA(RS)232 ports excepted.

Surge Withstand Capability
Per IEEE/ANSI C37.90.1: 2002:
4kV fast transient and 2.5kV oscillatory applied common mode and differential mode to opto inputs (filtered), output relays, CTs, VTs, power supply, field voltage.
4kV fast transient and 2.5kV oscillatory applied common mode to communications, IRIG-B.

Surge Immunity Test
EIA(RS)232 ports excepted.
Per IEC 61000-4-5: 2002 Level 4,
Time to half-value: 1.2/50 µs,
Amplitude: 4kV between all groups and case earth,
Amplitude: 2kV between terminals of each group.

Immunity to Radiated Electromagnetic Energy
Per IEC 60255-22-3: 2000, Class III:
Test field strength, frequency band 80 to 1000 MHz:
10 V/m,
Test using AM: 1 kHz / 80%,
Spot tests at 80, 160, 450, 900 MHz
Per IEEE/ANSI C37.90.2: 1995:
25MHz to 1000MHz, zero and 100% square wave modulated.
Field strength of 35V/m.

Radiated Immunity from Digital Communications
Per EN61000-4-3: 2002, Level 4:
Test field strength, frequency band 800 to 960 MHz, and 1.4 to 2.0 GHz:
30 V/m,
Test using AM: 1 kHz / 80%.

Radiated Immunity from Digital Radio Telephones
Per ENV 50204: 1995
10 V/m, 900MHz and 1.89GHz.

Immunity to Conducted Disturbances Induced by Radio Frequency Fields
Per IEC 61000-4-6: 1996, Level 3,
Disturbing test voltage: 10 V

Power Frequency Magnetic Field Immunity
Per IEC 61000-4-8: 1994, Level 5,
100A/m applied continuously,
1000A/m applied for 3s.
Per IEC 61000-4-9: 1993, Level 5,
1000A/m applied in all planes.
Per IEC 61000-4-10: 1993, Level 5,
100A/m applied in all planes at 100kHz/1MHz with a burst duration of 2s.

Conducted Emissions
Per EN 55022: 1998:
0.15 - 0.5MHz, 79dBµV (quasi peak) 66dBµV (average)
0.5 - 30MHz, 73dBµV (quasi peak) 60dBµV (average).

Radiated Emissions
Per EN 55022: 1998:
30 - 230MHz, 40dBµV/m at 10m measurement distance
230 - 1GHz, 47dBµV/m at 10m measurement distance.

EU Directives

EMC Compliance
Per 89/336/EEC:
Compliance to the European Commission Directive on EMC is claimed via the Technical Construction File route. Product Specific Standards were used to establish conformity:
EN50263: 2000

Product Safety
Per 2006/95/EC:
Compliance with European Commission Low Voltage Directive.
Compliance is demonstrated by reference to generic safety standards:
EN61010-1: 2001
EN60950-1: 2002

Mechanical Robustness

Vibration Test
Per IEC 60255-21-1: 1996
Response Class 2
Endurance Class 2

Shock and Bump
Per IEC 60255-21-2: 1995
Shock response Class 2
Shock withstand Class 1
Bump Class 1

Seismic Test
Per IEC 60255-21-3: 1995
Class 2

Timings and Accuracy

Performance Data

Programmable Scheme Logic

Accuracy
Output conditioner timer:
Setting ±20ms or 2%, whichever is greater
Dwell conditioner timer:
Setting ±20ms or 2%, whichever is greater
Pulse conditioner timer:
Setting ±20ms or 2%, whichever is greater

DAR and Check Synchronism

Accuracy
Timers:
Setting ±20ms or 2%, whichever is greater

Under Voltage (Dead Line)

Accuracy

Pick-up: Setting ±2%
Drop-off: 1.02 x setting ±2%
Definite time operation:
±40ms or 2%, whichever is greater
Repeatability: 1%

Over Voltage (Live Line)

Accuracy
Pick-up: Setting ±1%
Drop-off: 0.98 x setting ±2%
Definite time operation:
±40ms or 2%, whichever is greater
Repeatability: 1%

Measurements and Recording Facilities

Accuracy
Voltage: 0.05 to 2Vn
Accuracy: ±1.0% of reading
Phase accuracy: 0° to 360°
Accuracy: ±0.5%
Frequency: 45 to 65Hz
Accuracy: ±0.025Hz

Disturbance Records

Accuracy
Time and date stamping:
±2ms of applied fault/event
Waveshape:
Comparable with applied quantities,
±5% of applied quantities
Trigger positions: ±2%
Record length: 8 records each of 1.8s duration (1.5s at 60Hz)

Reference Conditions

Ambient temperature: 20°C

Frequency Tracking Range

45 to 65Hz

TD

Settings, Measurements and Records List

Settings List

Global Settings (System Data):

Language: English
Frequency: 50/60Hz

Date and Time

Battery Alarm: Disabled/Enabled

Configuration

Setting Group:
Select via Menu
Select via Opto
Active Settings: Group 1/2/3/4
Setting Group 1: Disabled/Enabled
Setting Group 2: Disabled/Enabled
Setting Group 3: Disabled/Enabled
Setting Group 4: Disabled/Enabled
CBs Controlled: 0/1/2
Number of Lines: 0/1/2
No. Transformers: 0/1/2/3
Ferrores Suppr: Disabled/Enabled
Input Labels: Visible/Invisible
Output Labels: Visible/Invisible
CT&VT Ratio: Visible/Invisible
Record Control: Visible/Invisible
Disturb. Recorder: Visible/Invisible
Measure’t Set-up: Visible/Invisible
Comms. Settings: Visible/Invisible
Commission Tests: Visible/Invisible
Setting Values: Primary/Secondary
Control Inputs: Visible/Invisible
Ctrl I/P Config.: Visible/Invisible

CT and VT Ratios

Main VT Primary: 100V...1MV
Main VT Sec'y: 80...140V

Sequence of Event Recorder (Record Control)

Alarm Event: Disabled/Enabled
Relay O/P Event: Disabled/Enabled
Opto Input Event: Disabled/Enabled
General Event: Disabled/Enabled
Maint Rec Event: Disabled/Enabled
Protection Event: Disabled/Enabled
DDB 31 – 0:
(up to):
DDB 1022 – 992:
Binary function link strings, selecting which DDB signals will be stored as events, and which will be filtered out

Oscillography (Disturb Recorder)

Duration: 0.10…10.50s
Trigger Position: 0.0…100.0%
Trigger Mode: Single/Extended
Analog Channel 1:
(up to):
Analog Channel 4:
Disturbance channels selected from:
V1/V2/V3/V4
Digital Input 1:
(up to):
Digital Input 32:
Selected binary channel assignment from any DDB status point within the relay (opto input, output contact, alarms, starts, trips, controls, logic…).
Input 1 Trigger: No Trigger/Trigger
(up to):
Input 32 Trigger: No Trigger/Trigger

Measured Operating Data (Measure't Setup)

Default Display:
Date and Time
Description
Plant Reference
Frequency
Access Level
Local Values: Primary/Secondary
Remote Values: Primary/Secondary

Communications

RP1 Protocol:
Courier
IEC870-5-103
RP1 Address: *(Courier or IEC870-5-103):*
0…255
RP1 InactivTimer: 1…30mins
RP1 Baud Rate: *(IEC870-5-103):*
9600/19200 bits/s
RP1 Parity:
Odd/Even/None
RP1 Meas Period: 1…60s
RP1 PhysicalLink:
RS485
Fiber Optic (IEC870-5-103 only)
K-Bus (Courier only)
RP1 Time Sync: Disabled/Enabled
RP1 CS103Blocking:
Disabled
Monitor Blocking
Command Blocking
RP1 Port Config: *(Courier):*
K Bus
EIA485 (RS485)
RP1 Comms Mode:
IEC60870 FT1.2 Frame
IEC60870 10-Bit Frame

Commission Tests

Monitor Bit 1:
(up to):
Monitor Bit 8:
Binary function link strings, selecting which DDB signals have their status visible in the Commissioning menu, for test purposes
Test Mode:
Disabled
Test Mode
Blocked Contacts
Test Pattern:
Configuration of which output contacts are to be energized when the contact test is applied.

Optocoupled Binary Inputs (Opto Config)

Global threshold:
24-27V
30-34V
48-54V
110-125V
220-250V
Custom
Opto Input 1:
(up to):
Opto Input 48:
Custom options allow independent thresholds to be set per opto, from the same range as above
Characteristics:
Standard 60% - 80%

Control Inputs into PSL (CTRL I/P Config)

Control Input 1: Latched/Pulsed
(up to):
Control Input 32: Latched/Pulsed
Ctrl Command 1:
(up to):
Ctrl Command 32:
SET/RESET

Control Input User Labels (CTRL I/P Labels)

Control Input 1:
(up to):
Control Input 32:
User defined text string to describe the function of the particular control input

Settings In Multiple Groups

Note: All settings here onwards apply for setting groups # = 1 to 4.

Mesh Function

Plant Reference:	Custom name

Feeder # *(# = 1 to 2)*

Plant Reference:	Custom name
Plant Sw. Delay:	0…60s
Pers. ITrip Time:	0…120s
Plant Op. Time:	0…60s
Analog Live Chk:	Disabled/Enabled
Live Line Chk VT:	V1/V2/V3/V4
Line Live Level:	0.0…132V
Plant Serv Status:	Disabled/Enabled
Line Dead Level:	0.0…132V

Transformer # *(# = 1 to 3)*

Plant Reference:	Custom name
Plant Sw. Delay:	0…60s
Plant Op. Time:	0…60s
Plant Serv Status:	Disabled/Enabled

Circuit Breaker # *(# = 1 to 2)*

Plant Reference:	Custom name
Min ISw. Delay:	0…10s
Dead Time:	0…120s
Reclaim Time:	0…60s
Dead Remote Close:	Disabled/Enabled
Dead Local Close:	Disabled/Enabled
Check Sync-Close:	Disabled/Enabled
Check Sync Timeout:	0…300s
Plant Op. Time:	0…60s
Lck. Dropoff Time:	0…60s
Plant Serv Status:	Disabled/Enabled

Ferroresonance Suppresion

Ferro Scheme Lev:	Disabled/F1/F3
Ferror Detect. Time:	0…10s

System Checks

VOLTAGE MONITORS
Live Voltage: 1.0…132.0V
Dead Voltage: 1.0…132.0V

Synchrocheck (Check Synch)

CS1 Status: Disabled/Enabled
CS1 Phase Angle: 5…90°
CS1 Slip Control:
None
Timer
Frequency
Both
CS1 Slip Freq: 0.02…1.00Hz
CS1 Slip Timer: 0.0…99.0s
CS2 Status
(up to):

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CS2 Slip Timer
All settings and options chosen from the same ranges as per the first stage CS1 element.
CS Undervoltage: 10.0…132.0V
CS Overvoltage: 60.0…185.0V
CS Diff Voltage: 1.0…132.0V
CS Voltage Block:
None
Undervoltage
Overvoltage
Differential
UV & OV
UV & DiffV
OV & DiffV
UV, OV & DiffV

System Split

SS Status: Disabled/Enabled
SS Phase Angle: 90…175°
SS Under V Block: Disabled/Enabled
SS Undervoltage: 10.0…132.0V
SS Timer: 0.0…99.0s

Opto Input Labels

Opto Input 1:
(up to):
Opto Input 48:
User defined text string to describe the function of the particular opto input.

Output Labels

Relay 1:
(up to):
Relay 32:
User defined text string to describe the function of the particular relay output contact.

Measurements List

Measurements 1

V1 Magnitude
V1 Phase Angle
V2 Magnitude
V2 Phase Angle
V3 Magnitude
V3 Phase Angle
V4 Magnitude
V4 Phase Angle
Frequency
CB1 C/S Angle
Slip Freq CB1
CB2 C/S Angle
Slip Freq CB2
C/S Remote-Local Ang1
C/S Remote-Local Ang2

GS

GETTING STARTED

Date:	**2019**
Hardware Suffix:	**B**
Software Version:	**04**

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CONTENTS

FIGURES

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1. GETTING STARTED

1.1 User interfaces and menu structure

The settings and functions of the protection relay are available from the front panel keypad and LCD, and through the front and rear communication ports.

1.2 Introduction to the relay

1.2.1 Front panel

The figure below shows the front panel of the relay; the hinged covers at the top and bottom of the relay are shown open. An optional transparent front cover physically protects the front panel. With the cover in place, access to the user interface is possible. Removing the cover allows access to the relay settings and does not compromise the protection of the product from the environment.

When editing relay settings, full access to the relay keypad is needed. To remove the front panel:

1. Open the top and bottom covers, then unclip and remove the transparent cover. If the lower cover is secured with a wire seal, remove the seal.
2. Using the side flanges of the transparent cover, pull the bottom edge away from the relay front panel until it is clear of the seal tab.
3. Move the cover vertically down to release the two fixing lugs from their recesses in the front panel.

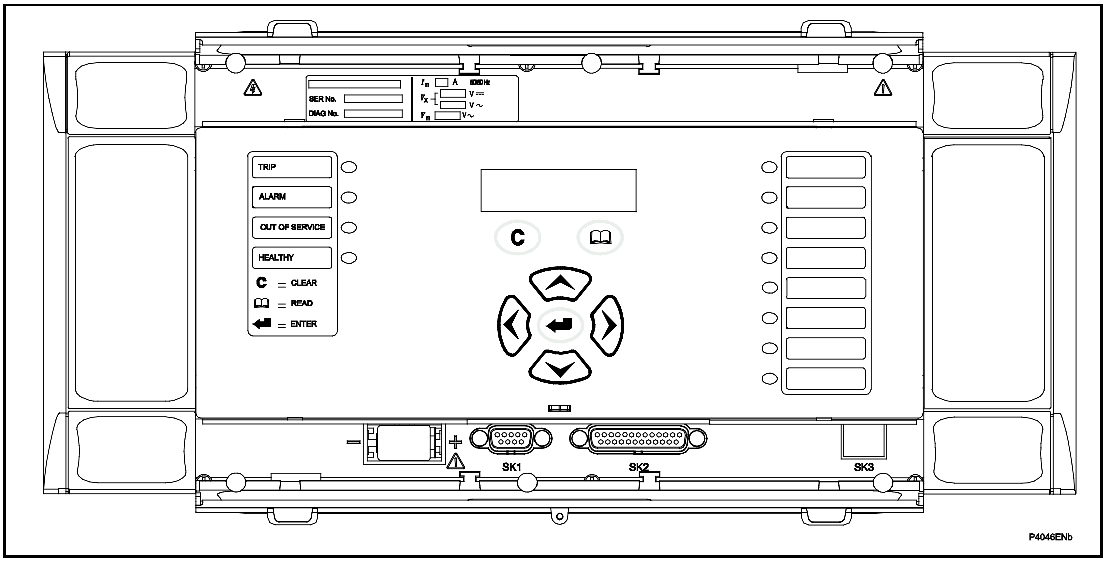

Figure 1: Relay front view

The front panel of the relay includes the following, as indicated in Figure 1:

- a 16-character by 3-line alphanumeric liquid crystal display (LCD)
- a 7-key keypad comprising 4 arrow keys (, , and), an enter key (), a clear key (), a read key ().

1.2.1.1 LED indications

Fixed Function

The four fixed function LEDs on the left-hand side of the front panel are used to indicate the following conditions:

- Trip (Red) LED is not used by default but could be assigned by a user via the PSL.
- Alarm (Yellow) flashes to indicate that the relay has registered an alarm. This may be triggered by an event or maintenance record. The LED will flash until the alarms have been accepted (read), after which the LED will change to constant illumination, and will extinguish, when the alarms have been cleared.
- Out of service (Yellow) indicates that the Mesh Corner autoreclose function is unavailable.

Healthy (Green) indicates that the relay is in correct working order and should be on at all times. It goes OFF if the relay's self-test facilities show there is an error with the relay's hardware or software. The state of the healthy LED is reflected by the watchdog contact at the back of the relay.

Programmable LEDs

There are eight programmable LEDs, suitable for programming alarm indications and the default indications and functions are indicated in the table below.

LED Number	Latched	P842 LED Function Indication
1	No	A/S out of service
2	No	DAR out of service
3	No	FR Function out of service
4	No	Autoswitching in progress
5	No	CB1 Function in service
6	No	Line 1 disconnector is open
7	No	TR1 HV disconector is open
8	No	Not mapped

1.2.2 Relay rear panel

The figure below shows the rear panel of the relay. All voltage signals, digital logic input signals and output contacts are connected at the rear of the relay. Also connected at the rear is the twisted pair wiring for the rear EIA(RS)485 communication port and Ethernet rear communications port with copper or fiber optic connections.

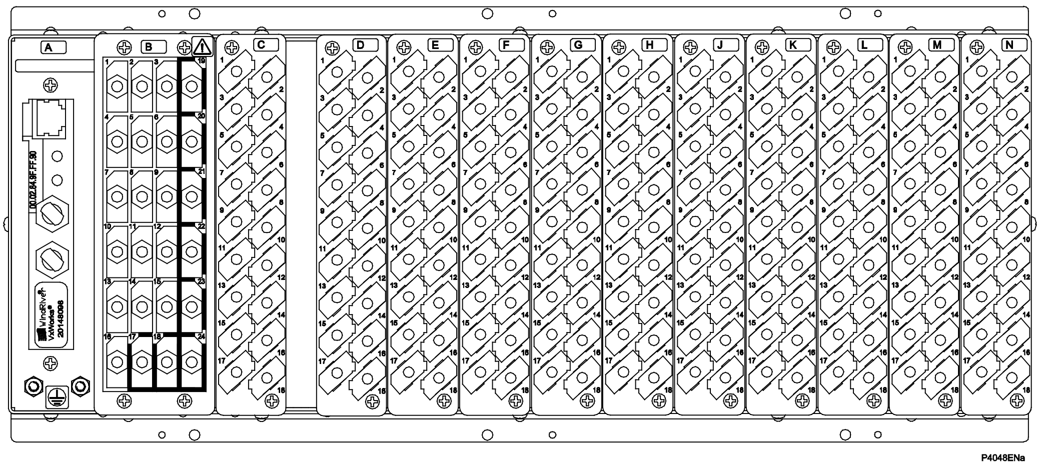

Figure 2: Relay rear view for B-variant

Refer to the wiring diagram in the Installation section for the complete connection details.

1.3 Relay connection and power-up

Before powering-up the relay, confirm that the relay power supply voltage and nominal ac signal magnitudes are appropriate for your application. The relay serial number, and the relay's current and voltage rating, power rating information can be viewed under the top hinged cover. The relay is available in the following auxiliary voltage versions and these are specified in the table below:

Nominal Ranges		Operative dc Range	Operative ac Range
24 - 48V dc		19 to 65V	-
48 - 110V dc	(30 - 100V ac rms) **	37 to 150V	24 to 110V
110 - 250V dc	(100 - 240V ac rms) **	87 to 300V	80 to 265V

** rated for ac or dc operation

Note: The label does not specify the logic input ratings.

The P842 relay has universal opto isolated logic inputs. These can be programmed for the nominal battery voltage of the circuit where they are used. See ‘Universal Opto input’ in the Firmware section for more information on logic input specifications.

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Note: The opto inputs have a maximum input voltage rating of 300 V dc at any setting.

Once the ratings have been verified for the application, connect external power capable of delivering the power requirements specified on the label. Figure 2 indicates the location of the power supply terminals but please refer to the wiring diagrams in the Installation section for complete installation details ensuring that the correct polarities are observed in the case of dc supply.

1.4 Introduction to the user interfaces and settings options

The relay has three user interfaces:

- The front panel using the LCD and keypad
- The front port which supports Courier communication
- The rear port which supports either Courier or IEC 60870-5-103. The protocol for the rear port must be specified when the relay is ordered

The measurement information and relay settings that can be accessed from the three interfaces are summarized in Table 1.

	Keypad/ LCD	Courier	IEC870-5-103
Display & modification of all settings	•	•	
Digital I/O signal status	•	•	•
Display/extraction of measurements	•	•	•
Extraction of disturbance records		•	•
Programmable scheme logic settings		•	
Reset of alarm records	•	•	•
Clear event records	•	•	
Time synchronization		•	•
Control commands	•	•	•

Table 1

1.5 Menu structure

The menu is arranged in a table. Each setting in the menu is referred to as a cell, and each cell in the menu may be accessed by reference to a row and column address. The settings are arranged so that each column contains related settings, for example all of the disturbance recorder settings are contained within the same column. As shown in Figure 3, the top row of each column contains the heading that describes the settings contained within that column. Movement between the columns of the menu can only be made at the column heading level. A complete list of all of the menu settings is given in the Settings chapter.

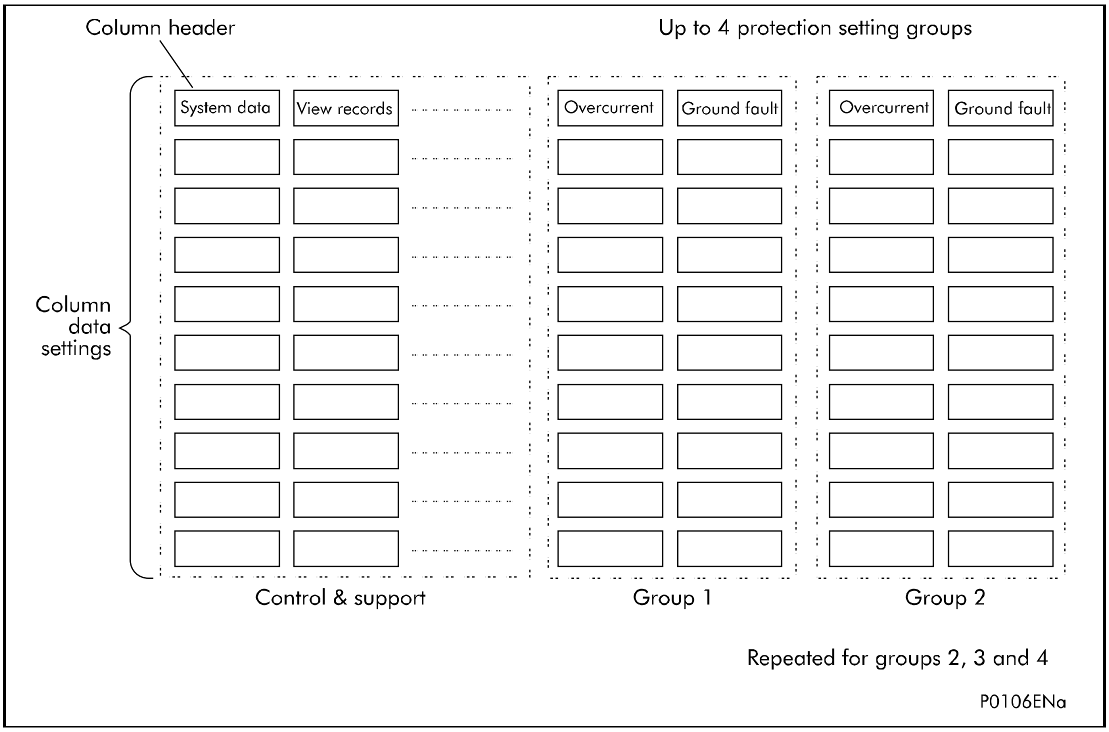

Figure 3: Menu structure

The settings in the menu are in three categories: protection settings, disturbance recorder settings, or control and support (C&S) settings.

New control and support settings are stored and used by the relay immediately after they are entered. New protection settings or disturbance recorder settings are stored in a temporary 'scratchpad'. Once the new settings have been confirmed, the relay activates all the new settings together. This provides extra security so that several setting changes, made in a group of protection settings all take effect at the same time.

1.5.1 Protection settings (mesh corner DAR settings)

The protection as such doesn't exist in P842 but the generic term 'protection' is preserved to be compliant with the MiCOM setting structure. The protection settings include the following items:

- Mesh corner functional blocks settings
- Scheme logic settings
- Check synchronization settings

There are four groups of protection settings, with each group containing the same setting cells. One group of protection settings is selected as the active group and is used by the protection elements.

1.5.2 Disturbance recorder settings

The disturbance recorder settings include the record duration and trigger position, selection of analog and digital signals to record, and the signal sources that trigger the recording.

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1.5.3 Control and support settings

The control and support settings include:

- Relay configuration settings
- CT & VT ratio settings
- Reset LEDs
- Active protection setting group
- Password & language settings
- Communications settings
- Measurement settings
- Event settings
- User interface settings
- Commissioning settings

1.6 Password protection

The menu structure contains three levels of access. The level of access that is enabled determines which of the relay's settings can be changed and is controlled by entry of two different passwords. The levels of access are summarized in Table 2.

Access level	Operations enabled
Level 0 No password required	Read access to all settings, alarms and event records
Level 1 Password 1 or 2 required	As level 0 plus: Control commands. Reset of alarm conditions. Reset LEDs. Clearing of event records.
Level 2 Password 2 required	As level 1 plus: All other settings

Table 2

Each of the two passwords are 4 characters of upper case text. The factory default for both passwords is AAAA. Each password is user-changeable once it has been correctly entered. Entry of the password is achieved either by a prompt when a setting change is attempted, or by moving to the 'Password' cell in the 'System data' column of the menu. The level of access is independently enabled for each interface, that is to say if level 2 access is enabled for the rear communication port, the front panel access will remain at level 0 unless the relevant password is entered at the front panel. The access level enabled by the password entry will time-out independently for each interface after a period of inactivity and revert to the default level. If the passwords are lost an emergency password can be supplied - contact General Electric with the relay's serial number. The current level of access enabled for an interface can be determined by examining the 'Access level' cell in the 'System data' column, the access level for the front panel User Interface (UI), can also be found as one of the default display options.

The relay is supplied with a default access level of 2, such that no password is required to change any of the relay settings. It is also possible to set the default menu access level to either level 0 or level 1, preventing write access to the relay settings without the correct password. The default menu access level is set in the ‘Password control’ cell which is found in the ‘System data’ column of the menu (note that this setting can only be changed when level 2 access is enabled).

1.7 Relay configuration

The relay is a multi-function device that supports numerous different protection, control and communication features. To simplify the setting of the relay, there is a configuration settings column which can be used to enable or disable many of the functions of the relay. The settings associated with any function that is disabled are not shown in the menu. To disable a function change the relevant cell in the ‘Configuration’ column from ‘Enabled’ to ‘Disabled’.

The configuration column controls which of the four protection settings groups is selected as active through the ‘Active settings’ cell. A protection setting group can also be disabled in the configuration column, provided it is not the present active group. Similarly, a disabled setting group cannot be set as the active group.

1.8 Front panel user interface (keypad and LCD)

When the keypad is exposed it provides full access to the menu options of the relay, with the information displayed on the LCD.

The ◄, ►, ▲ and ▼ keys are used for menu navigation and setting value changes. These keys have an auto-repeat function if any of them are held continually pressed. This can be used to speed up both setting value changes and menu navigation; the longer the key is held depressed, the faster the rate of change or movement becomes.

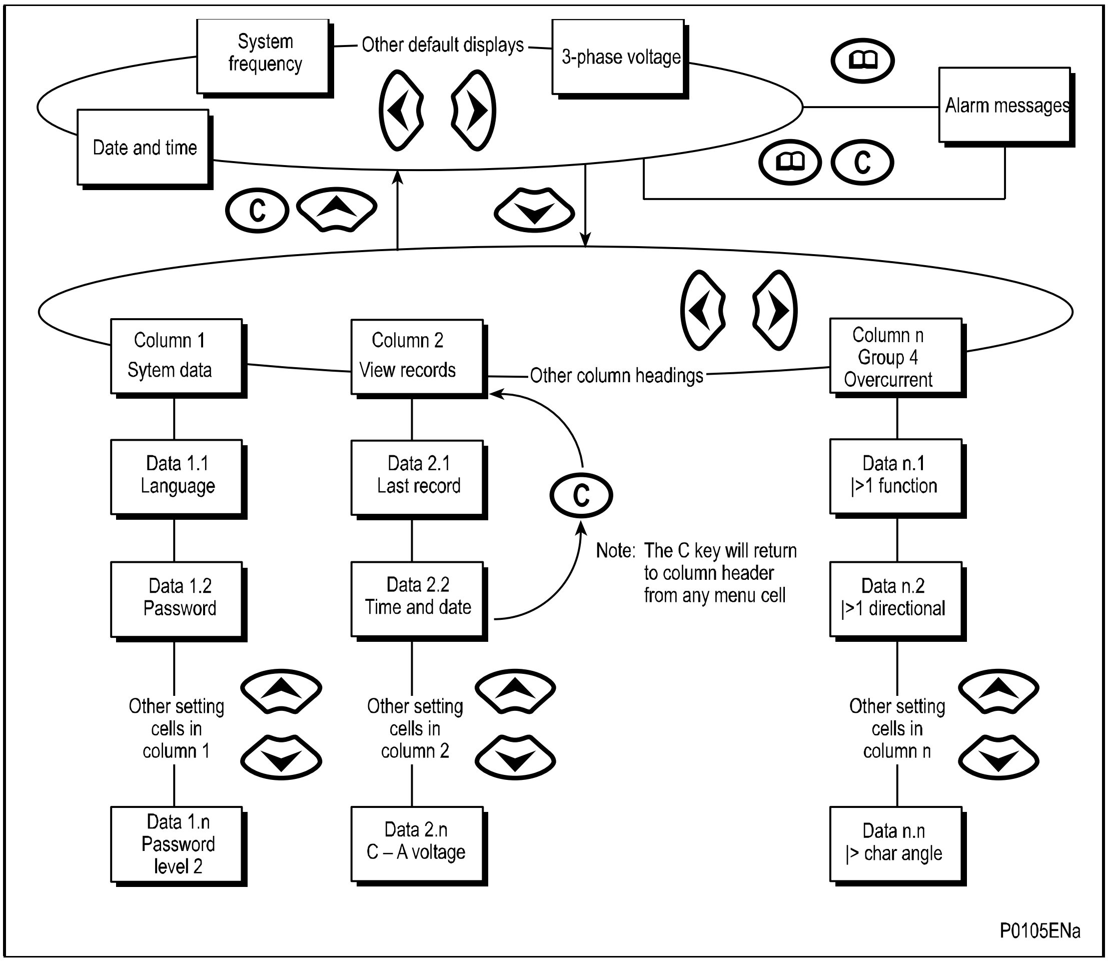

Figure 4: Front panel user interface

1.8.1 Default display and menu time-out

The front panel menu has a default display, the contents of which can be selected from the following options in the 'default display' cell of the 'Measure't. setup' column:

- Date and time
- Relay description (user defined)
- Plant reference (user defined)
- System frequency
- Line voltage
- Access level

From the default display you can view the other default display options using the ◁ and ▷ keys. However, if there is no keypad activity for 15 minutes, the default display reverts to the previous setting and the LCD backlight switches off. Any setting changes that have not been confirmed are lost and the original setting values are maintained.

Whenever there is an uncleared alarm present in the relay (e.g. protection alarm, control alarm etc.) the default display will be replaced by:

Alarms/Faults Present

Enter the menu structure of the relay from the default display, even if the display shows the 'Alarms/Faults present' message.

1.8.2 Password entry

When entry of a password is required the following prompt will appear:

Enter password **** Level 1

Note: The password required to edit the setting is the prompt as shown above.

A flashing cursor will indicate which character field of the password may be changed. Press the △ and ▽ keys to vary each character between A and Z. To move between the character fields of the password, use the ◁ and ▷ keys. The password is confirmed by pressing the enter key ↵. The display will revert to 'Enter Password' if an incorrect password is entered. At this point a message will be displayed indicating whether a correct password has been entered and if so what level of access has been unlocked. If this level is sufficient to edit the selected setting then the display will return to the setting page to allow the edit to continue. If the correct level of password has not been entered then the password prompt page will be returned to. To escape from this prompt press the clear key Ⓒ. Alternatively, the password can be entered using the 'Password' cell of the 'System data' column.

For the front panel user interface the password protected access will revert to the default access level after a keypad inactivity time-out of 15 minutes. It is possible to manually reset the password protection to the default level by moving to the 'Password' menu cell in the 'System data' column and pressing the clear key Ⓒ instead of entering a password.

1.8.3 Reading and clearing of alarm messages

The presence of one or more alarm messages will be indicated by the default display and by the yellow alarm LED flashing. The alarm messages can either be self-resetting or latched, in which case they must be cleared manually. To view the alarm messages press the read key . When all alarms have been viewed, but not cleared, the alarm LED will change from flashing to constant illumination and the latest record will be displayed (if there is one). To scroll through the pages of this use the key. When all pages of the record have been viewed, the following prompt will appear:

Press clear to reset alarms

To clear all alarm messages press ; to return to the alarms/faults present display and leave the alarms uncleared, press . Depending on the password configuration settings, it may be necessary to enter a password before the alarm messages can be cleared (see section on password entry). When the alarms have been cleared the yellow alarm LED will extinguish.

1.8.4 Setting changes

To change the value of a setting, first navigate the menu to display the relevant cell. To change the cell value press the enter key , which will bring up a flashing cursor on the LCD to indicate that the value can be changed. This will only happen if the appropriate password has been entered, otherwise the prompt to enter a password will appear. The setting value can then be changed by pressing the or keys. If the setting to be changed is a binary value or a text string, the required bit or character to be changed must first be selected using the and keys. When the desired new value has been reached it is confirmed as the new setting value by pressing . Alternatively, the new value will be discarded either if the clear button is pressed or if the menu time-out occurs.

For protection group settings and disturbance recorder settings, the changes must be confirmed before they are used by the relay. To do this, when all required changes have been entered, return to the column heading level and press the key. Prior to returning to the default display the following prompt will be given:

Update settings? Enter or clear

Pressing will result in the new settings being adopted, pressing will cause the relay to discard the newly entered values. It should be noted that, the setting values will also be discarded if the menu time out occurs before the setting changes have been confirmed. Control and support settings will be updated immediately after they are entered, without the 'Update settings?' prompt.

1.9 Front communication port user interface

The front communication port is provided by a 9-pin female D-type connector located under the bottom hinged cover. It provides EIA(RS)232 serial data communication and is intended for use with a PC locally to the relay (up to 15m distance) as shown in Figure 5. This port supports the Courier communication protocol only. Courier is the communication language developed by us to allow communication with its range of protection relays. The front port is intended for use with the relay settings program S1 Agile which runs on Windows™ 2000, Vista, XP or Windows 7.

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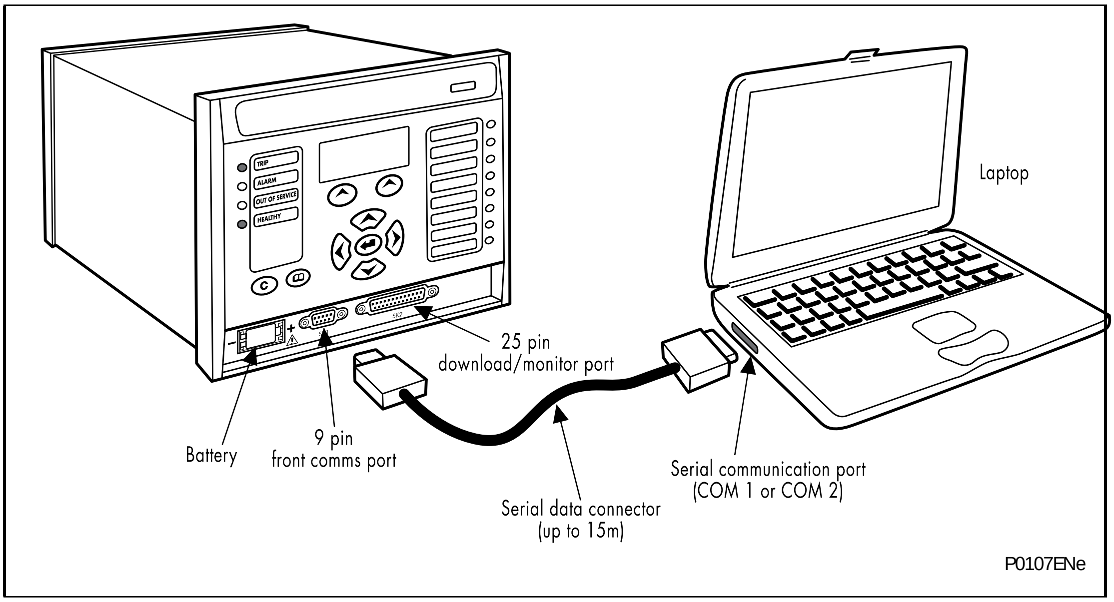

Figure 5: Front port connection

The relay is a Data Communication Equipment (DCE) device with the following pin connections on the 9-pin front port.

Pin number	Description
2	Tx Transmit data
3	Rx Receive data
5	0 V Zero volts common

None of the other pins are connected in the relay. The relay should be connected to the serial port of a PC, usually called COM1 or COM2. PCs are normally Data Terminal Equipment (DTE) devices which have a serial port pin connection as below (if in doubt check your PC manual):

Pin number	25-way	9-way	Description
2	3	2	x Receive data
3	2	3	Tx Transmit data
5	7	5	0 V Zero volts common

For successful data communication, connect the Tx pin on the relay to the Rx pin on the PC, and the Rx pin on the relay to the Tx pin on the PC, as shown in Figure 6. Normally a straight-through serial cable is required, connecting pin 2 to pin 2, pin 3 to pin 3, and pin 5 to pin 5.

Note: A common cause of difficulty with serial data communication is connecting Tx to Tx and Rx to Rx. This could happen if a cross-over serial cable is used, connecting pin 2 to pin 3, and pin 3 to pin 2, or if the PC has the same pin configuration as the relay.

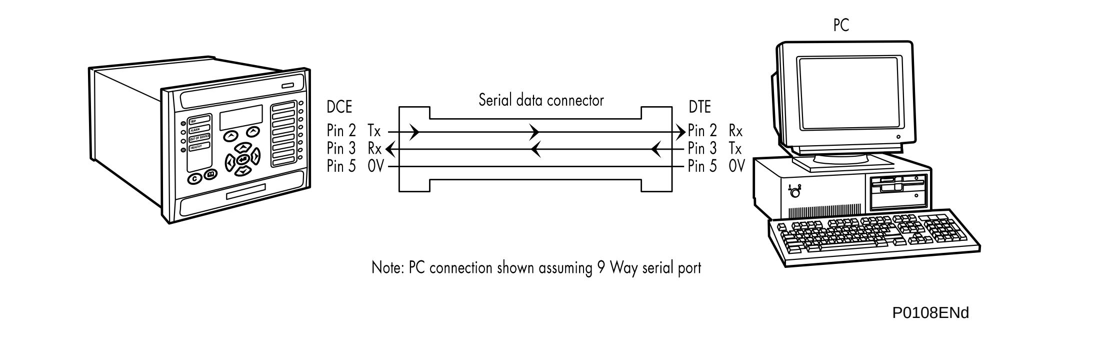

Figure 6: PC – relay signal connection

Once the physical connection from the relay to the PC is made, the PC's communication settings must be configured to match those of the relay. The relay's communication settings for the front port are fixed as shown in the table below:

Protocol	Courier
Baud rate	19,200 bits/s
Courier address	1
Message format	11 bit - 1 start bit, 8 data bits, 1 parity bit (even parity), 1 stop bit

If there is no communication using the front port for 15 minutes, any password access level that has been enabled is cancelled.

1.9.1 Front courier port

The front EIA(RS)232[1] 9 pin port supports the Courier protocol for one to one communication. It is designed for use during installation and commissioning or maintenance and is not suitable for permanent connection. Since this interface is not used to link the relay to a substation communication system, the following features of Courier are not used:

Automatic Extraction of Event Records:

- Courier Status byte does not support the Event flag
- Send Event/Accept Event commands are not implemented

Automatic Extraction of Disturbance Records:

- Courier Status byte does not support the Disturbance flag

Busy Response Layer:

- Courier Status byte does not support the Busy flag, the only response to a request will be the final data

Fixed Address:

- The address of the front courier port is always 1, the Change Device address command is not supported.

Fixed Baud Rate:

- 19200 bps

Note: Although automatic extraction of event and disturbance records is not supported, this data can be manually accessed using the front port.

[1] This port is actually compliant to EIA(RS)574; the 9-pin version of EIA(RS)232, see www.tiaonline.org.

1.10 S1 Agile relay communications basics

The EIA(RS)232 front communication port is intended for use with the relay settings program S1 Agile. This program runs on Windows^{TM} 2000, XP, Vista or Windows 7 and is the universal IED Support Software used for direct access to all stored data in any IED.

S1 Agile provides full access to:

- Px40, Modulex series, K series, L series relays
- MiCOM Mx20 measurements units

1.10.1 PC requirements

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The following minimum requirements must be met for the S1 Agile software to properly work on a PC.

- IBM computer or 100% compatible,
- WindowsTM 98 or NT 4.0 (Not WindowsTM 95)
- Pentium II 300 Mhz minimum,
- Screen VGA 256 colours minimum,
- Resolution 640 x 400 minimum (1024 x 768 recommended),
- 48Mb RAM minimum,
- 500Mb free on computer hard-disk.

1.10.2 Connecting to the P842 relay using S1 Agile

This section is intended as a quick start guide to using S1 Agile and assumes you have a copy installed on your PC. See the *S1 Agile program online help* or 'MiCOM P40 Agile Modular and Compact Ranges, Settings Application Software User Guide', P40-M&CR-UG for more detailed information.

1. Make sure the EIA(RS)232 serial cable is properly connected between the port on the front panel of the relay and the PC. See section 1.9.
2. Start S1 Agile and click the **Quick Connect** tab and select **Create a New System**.
3. Check the **Path to System file** is correct, then enter the name of the system in the Name field. If you need to add a brief description of the system, use the **Comment** field.
4. Click **OK**.
5. Select the device type.
6. Select the communications port.
7. Once connected, select the language for the settings file, the device name, then click **Finish**. The configuration is updated.
8. In the **Agile Explorer** window, select **Device > Supervise Device…** to control the relay directly.

1.10.3 Off-line use of S1 Agile

S1 Agile can also be used as an off-line tool to prepare settings, without access to the relay.

1. If creating a new system, in the Agile Explorer, select **create new** system. Then right-click the new system and select **New substation**.
2. Right-click the new substation and select **New voltage level**.
3. Then right-click the new voltage level and select **New bay**.
4. Then right-click the new bay and select **New device**.
   You can add a device at any level, whether it is a system, substation, voltage or bay.
5. Select a device type from the list, then enter the relay type, such as P645. Click **Next.**
6. Enter the full model number and click **Next**.
7. Select the **Language** and **Model**, then click **Next**.
8. Enter a unique device name, then click **Finish**.
9. Right-click the **Settings** folder and select **New File**. A default file 000 is added.
10. Right-click file **000** and select click **Open**. You can then edit the settings. See the *S1 Agile program online help* for more information.

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SETTINGS

Date:	**2019**
Hardware Suffix:	**B**
Software Version:	**04**

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1. SETTINGS

The MiCOM P842 must be configured to the system and application using appropriate settings. In this chapter settings are described in sequence: protection settings, control and configuration settings and the disturbance recorder settings. The relay is supplied with a factory-set configuration of default settings.

1.1 Relay settings configuration

The relay is a multi-function device that supports control and communication features. To simplify the setting of the relay, there is a configuration settings column which can be used to enable or disable many of the functions of the relay. The settings associated with any disabled function are not shown in the menu. To disable a function change the relevant cell in the 'Configuration' column from 'Enabled' to 'Disabled'.

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The configuration column controls which of the four protection settings groups is selected as active through the 'Active settings' cell. A protection setting group can also be disabled in the configuration column, provided it is not the present active group. Similarly, a disabled setting group cannot be set as the active group.

The column also allows all of the setting values in one group of protection settings to be copied to another group.

To do this set the 'Copy from' cell to the protection setting group to be copied, then set the 'copy to' cell to the protection group where the copy is to be placed. The copied settings are initially placed in the temporary scratchpad and will only be used by the relay following confirmation.

Menu Text	Default Setting	Available Settings
Restore Defaults	No Operation	No Operation All Settings Setting Group 1 Setting Group 2 Setting Group 3 Setting Group 4
Setting to restore a setting group to factory default settings.		
Setting Group	Select via Menu	Select via Menu Select via Optos
Allows setting group changes to be initiated via Opto Input or via Menu.		
Active Settings	Group 1	Group 1, Group 2, Group 3, Group 4
Selects the active setting group.		
Save Changes	No Operation	No Operation, Save, Abort
Saves all relay settings.		
Copy from	Group 1	Group 1, 2, 3 or 4
Allows displayed settings to be copied from a selected setting group.		
Copy to	No Operation	No Operation Group 1, 2, 3 or 4
Allows displayed settings to be copied to a selected setting group (ready to paste).		
Setting Group 1	Enabled	Enabled or Disabled
If the setting group is disabled from the configuration, then all associated settings and signals are hidden, with the exception of this setting (paste).		
Setting Group 2 (as above)	Disabled	Enabled or Disabled
Setting Group 3 (as above)	Disabled	Enabled or Disabled

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Menu Text	Default Setting	Available Settings
Setting Group 4 (as above)	Disabled	Enabled or Disabled
CBs Controlled	1	0, 1 or 2
To set number of directly controlled circuit breakers.		
Number of Lines	1	0, 1 or 2
To set number of lines connected to a corner		
No. Transformers	1	0, 1, 2 or 3
To set number of transformers banked to a corner		
Ferrores Suppr	Disabled	Enabled or Disabled
To enable (activate) or disable (turn off) the Ferroresonance suppression. By default, F3 flapping scheme is used in the PSL.		
Input Labels	Visible	Invisible or Visible
Sets the Input Labels menu visible further on in the relay settings menu.		
Output Labels	Visible	Invisible or Visible
Sets the Output Labels menu visible further on in the relay settings menu.		
CT & VT Ratios	Visible	Invisible or Visible
Sets the Voltage Transformer Ratios menu visible further on in the relay settings menu.		
Record Control	Invisible	Invisible or Visible
Sets the Record Control menu visible further on in the relay settings menu.		
Disturb. Recorder	Invisible	Invisible or Visible
Sets the Disturbance Recorder menu visible further on in the relay settings menu.		
Measure't. Set-up	Invisible	Invisible or Visible
Sets the Measurement Setup menu visible further on in the relay settings menu.		
Comms. Settings	Visible	Invisible or Visible
Sets the Communications Settings menu visible further on in the relay settings menu. These are the settings associated with the 2nd rear communications ports.		
Commission Tests	Visible	Invisible or Visible
Sets the Commissioning Tests menu visible further on in the relay settings menu.		
Setting Values	Primary	Primary or Secondary
This affects all settings that are dependent upon VT ratio's. All subsequent settings input must be based in terms of this reference.		
Control Inputs	Visible	Invisible or Visible
Activates the Control Input status and operation menu further on in the relay setting menu.		
Ctrl I/P Config.	Visible	Invisible or Visible
Sets the Control Input Configuration menu visible further on in the relay setting menu.		

1.1.1 Default settings restore

To restore the default values to the settings in any settings group, set the ‘restore defaults’ cell to the relevant group number. Alternatively, set the ‘restore defaults’ cell to ‘all settings’ to restore the default values to all of the relay’s settings, not just the particular groups’ settings. The default settings are initially placed in the scratchpad and are only used by the relay after they have been confirmed.

Note: Restoring defaults to all settings includes the rear communication port settings may result in communication via the rear port being disrupted if the new (default) settings do not match those of the master station.

1.2 GROUP_X settings

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The group settings include all the following items that become active once enabled in the configuration column of the relay menu database:

- Mesh Corner Function settings
- Feeder Function settings
- Transformer Function settings
- Circuit Breaker Function settings
- Circuit Breaker System Check setting
- Input/ Output Labels
- Programmable Scheme Logic (PSL)

There are four groups of settings, with each group containing the same setting cells. One group of protection settings is selected as the active group and is used for the Autoisolation and DAR. The settings for group 1 is shown. The settings are discussed in the same order in which they are displayed in the menu.

1.2.1 Mesh corner function

The column “GROUP x MESH FUNCTION” is used to label (name) the Mesh corner.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Plant Reference	Mesh Corner	16 characters custom name		
Defines custom name for Mesh corner				

1.2.2 Feeder 1 function

The column “GROUP x FEEDER 1” is used to set parameters for Feeder 1 module as follows:

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Plant Reference	Feeder 1	16 characters custom name		
Defines custom name for Feeder 1				
Plant Sw. Delay	10s	0s	60s	1s
The time delay between initiation and Line 1 disconnector opening				
Pers. ITrip Time	60s	0s	120s	1s
The time delay timer initiated by the inter-trip signal coming from remote end. If the intertrip signal persists for more then the above time delay, the Line 1 disconnector will be opened and mesh breaker reclosed.				

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Plant Op. Time	60s	0s	60s	1s
The time delay during which Line 1 disconnector is expected to open. If the time window is exceeded without successful Line 1 disconnector opening, the reclosure of the associated breaker will be locked out.				
Analog Live Chk	Enabled	Enabled or Disabled		
Analogue signal, representing line voltage, used for System Check. If set Enabled, this signal will confirm external voltage ring measurement, thus adding more security into corner voltage measurement, providing that the Line 1 disconnector is closed. When set Disabled, measured input will be ignored. Note: when CB Controlled = 2 is set, the setting must be Disabled and voltage input re-wired.				
Live Line Chk VT	Use V3	Use V1 or V2 or V3 or V4		
Assignment of the Line 1 voltage to one of 4 possible voltage channels: V1 or V2 or V3 or V4. Normally, line voltage for Line 1 would be assigned to V3 (as per default) and for Line 2 (if exists) to V4. Note that the assignment will be invisible if Analog Live Chk is Disabled.				
Line Live Level	30V	0V	132V	0.5V
Line 1 voltage magnitude setting. If Line 1 voltage exceeds the threshold, the Line 1 voltage is considered present. Note that this setting will be invisible if Analogue Live Chk is Disabled				
Plant Serv Stat.	Enabled	Enabled or Disabled		
The setting that indicates that the Line 1 is in/out of service. This setting is to accommodate maintenance work, where signals coming from the Line 1 out of service such as disconector position etc, will be ignored. Setting Enable corresponds to Line 1 in service.				
Line Dead Level	20V	0V	132V	0.5V
Line 1 voltage magnitude setting. If Line 1 voltage drops below the threshold, the Line 1 voltage is considered absent. Note that this setting will be invisible if Analogue Live Chk is Disabled				

Note: By default, only one feeder is enabled. If the second feeder is connected to the mesh and set under Configuration column, the similar setting as above will become visible.

1.2.3 Transformer 1 function

The column “GROUP x TRANSFORMER 1” is used to set parameters for Transformer 1 module as follows:

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Plant Reference	Transformer 1	16 characters custom name		
Defines custom name for Transformer 1				
Plant Sw. Delay	10s	0s	60s	1s
The time delay between opening/closing initiation and transformer disconnector opening/closing command.				
Plant Op. Time	60s	0s	60s	1s

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Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
The time delay during which transformer's disconnector is expected to either open or close. If the time is exceeded and transformer line disconnector remains in the previous position, the reclosure of the associated breakers will be locked out.				
Plant Serv Stat.	Enabled	Enabled or Disabled		
The setting that indicates that the Transformer 1 is in/out of service. This setting is to accommodate maintenance work, where signals coming from the Transformer 1 being out of service such as disconector position etc, will be ignored. Setting Enable corresponds to Transformer 1 in service.				

Note: By default, only one Transformer is enabled. If two or three transformers are connected to the mesh corner and set under Configuration column, the similar setting as above will become visible.

1.2.4 Circuit breaker 1 function

The column "GROUP x CIRCUIT BREAKER1" is used to set parameters for Circuit breaker 1 module as follows:

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Plant Reference	Circuit Breaker1	16 characters custom name		
Defines custom name for Circuit Breaker 1				
Min ISw. Delay	5s	0s	10s	1s
The time delay between closing two breakers. The timer prevents the closure of one or more breakers at the same time. This may happen when, for example, Line 1 is charged by closing X120 breaker. Breaker X420 would tend to close immediately, since Dead time setting doesn't apply to the breaker X420 in Check Sync mode.				
Dead Time	10s	0s	120s	1s
The time delay between clearing fault (protection reset) and the command for circuit breaker to close. Normally, the MCU with the shortest Dead Time in predetermined sequence closes first.				
Reclaim Time	20s	0s	60s	1s
The time window following a mesh circuit breaker reclosure, during which any fault on a circuit connected to either of the adjacent mesh corners or on either of the mesh corners themselves, is treated as a permanent fault (second fault). If the second fault is on a feeder or transformer circuit, the circuit disconnector is autoisolated before the mesh circuit breakers are reclosed. If the second fault is on one of the mesh corners, then all circuit disconnectors on the faulted mesh corner are autoisolated, and the associated mesh circuit breakers are locked out.				
Dead RemoteClose	Enabled	Enabled or Disabled		
Setting that initiates CB 1 closure after Dead Time, providing that is enabled and that Volts on bus and no volts on line condition is satisfied.				
Dead LocalClose	Enabled	Enabled or Disabled		
Setting that initiates CB 1 closure after Dead Time, providing that is enabled and that volts on line and no volts on bus condition is satisfied.				
Check-Sync Close	Enabled	Enabled or Disabled		

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Setting that initiates CB closure, providing that is enabled and that the voltages at both side of the breaker are in synchronism.				
Chk-Sync Timeout	30s	0s	300s	10s
The time window, initiated by Check Sync request, during which the two voltages are expected to be in 'In Sync' position. If Chk_Sync Timeout expired without Check Sync condition being satisfied, the reclose of the breaker that requested Check Sync will be lock-out.				
Plant Op. Time	60s	0s	60s	1s
The time delay during which CB1 closure is expected to be completed. If the time window is exceeded without successful CB1 closure, the CB1 will be locked out.				
Lck. Dropoff Time	2s	0s	60s	1s
The time delay after which the lock out will be reset for CB1 breaker. This time will be initiated when lock out condition(s), that generated reclosure lock out, are removed. .				
Plant Serv Stat.	Enabled	Enabled or Disabled		
The setting that indicates that CB1 is in/out of service. This setting is to accommodate maintenance work, where signals coming from the CB1 out of service such as disconector position etc, will be ignored. Setting Enable corresponds to CB1 in service.				

Note: By default, only one CB is directly controlled. If the second breaker is directly controlled by the same MCU, the similar setting as above for CB2 will become visible.

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1.2.5 Ferroresonance suppresion function

The column "GROUP x FERRORES SUPPR" is used to set parameters for Ferroresonance suppression scheme as follows:

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Ferro Scheme Lev	Disabled	Alarm Only F1/ Flapping F3/ Disabled		
The setting defines the control logic for Ferroresonance condition. When set to 'Alarm Only F1', no ferroresonance suppression would occur, only alarm will be issued upon ferroresonance detection and 'Ferroresonance Detection Time delay. When set to 'Flapping F3' the opening and closing of Transformer(s) disconnectors will be performed after ferroresonance detection and 'Ferroresonance Detection Time delay. . This scheme is supported by default PSL. When set 'Disabled' no action upon ferroresonance detection will occur.				
Ferror Detect Tim	2s	0s	10s	1s
Time delay after which 'Alarm Only F1' or 'Flapping F3' will be executed.				

1.2.6 System checks (check sync. function)

The MiCOM P842 has a two stage Check Synchronization function that can be set independently.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
VOLTAGE MONITORING				
Live Voltage	32V	1V	132V	0.5V
Sets the minimum voltage threshold above which a line or bus is to be recognized as being ‘Live’.				
Dead Voltage	13V	1V	132V	0.5V
Sets the voltage threshold below which a line or bus to be recognized as being ‘Dead’.				
CHECK SYNC.				
CS1 Status	Enabled	Enabled or Disabled		
Setting to enable or disable the first stage check sync. element.				
CS1 Phase Angle	20°	5°	90°	1°
Sets the maximum phase angle difference between the line and bus voltage for the first stage check sync. element phase angle criteria to be satisfied.				
CS1 Slip Control	Frequency	Frequency/Both/Timer/None		
Setting that determines whether slip control is by slip frequency only, frequency + timer or timer only criteria to satisfy the first stage check sync. conditions. If slip control by timer or frequency + timer is selected, the combination of phase angle and timer settings determines an effective maximum slip frequency, calculated as: $\frac{2 \times A}{T \times 360}$ Hz. for Check Sync. 1, or where A = Phase angle setting (°) T = Slip timer setting (seconds)				
CS1 Slip Freq.	50mHz	20mHz	1Hz	10mHz
Sets the maximum frequency difference between the line and bus voltage for the first stage check sync. element slip frequency to be satisfied.				
CS1 Slip Timer	1s	0s	99s	0.01s
Minimum operating time-delay setting for the first stage check sync. element. This setting is visible only when CS1 Slip Control is set to ‘Timer’ or ‘Both’.				
CS2 Status	Enabled	Enabled or Disabled		
Setting to enable or disable the second stage check sync. element.				
CS2 Phase Angle	20°	5°	90°	1°
Sets the maximum phase angle difference between the line and bus voltage for the second stage check sync. element phase angle criteria to be satisfied.				
CS2 Slip Control	Frequency	Frequency/Both/Timer/None		

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Menu Text	Default Setting	Setting Range Min.	Setting Range Max.	Step Size
Setting that determines whether slip control is by slip frequency only, frequency + timer or timer only criteria to satisfy the CS1 conditions. If Slip Control by Timer or Frequency + Timer is selected, the combination of Phase Angle and Timer settings determines an effective maximum slip frequency, calculated as: $\frac{A}{T \times 360}$ Hz. for Check Sync. 2, or where A = Phase angle setting (°) T = Slip timer setting (seconds) Unlike Check Sync. 1, Check Sync. 2 only permits closure for decreasing angles of slip, therefore the circuit breaker should always close within the limits defined by Check Sync. 2.				
CS2 Slip Freq.	50mHz	20mHz	1Hz	10mHz
Slip frequency setting for the second stage check sync. element.				
CS2 Slip Timer	1s	0s	99s	0.01s
Setting for the second stage Check Sync. slip timer.				
CS Undervoltage	54V	10V	132V	0.5V
Sets an undervoltage threshold above which the line and bus voltage must be to satisfy the Check Sync. condition if selected in the 'CS Voltage Block' cell.				
CS Overvoltage	130V	50V	132V	0.5V
Sets an overvoltage threshold above below which the line and bus voltage must be to satisfy the Check Sync. condition if selected in the 'CS Voltage Block' cell.				
CS Diff. Voltage	6.5V	1V	132V	0.5V
Sets the voltage magnitude threshold between the line and bus volts below that the line and bus voltage difference must be to satisfy the Check Sync. condition if selected in the 'CS Voltage Block' cell.				
CS Voltage Block	V<	V< / V> / Vdiff.> / V< and V> / V< and Vdiff> / V> and Vdiff> / V< V> and Vdiff> / None		
Selects whether an undervoltage, overvoltage and voltage difference thresholds for the line and bus voltages must be satisfied in order for the Check Sync. conditions to be satisfied.				
SYSTEM SPLIT				
SS Status	Enabled	Enabled or Disabled		
Setting to enable or disable the system split function - to detect a line and bus which are not possible to synchronize.				
SS Phase Angle	120°	90°	175°	1°
Sets the maximum phase angle difference between the line and bus voltage, which must be exceeded, for the System Split condition to be satisfied.				
SS Under V Block	Enabled	Enabled or Disabled		
Activates and undervoltage block criteria				
SS Undervoltage	54V	10V	132V	0.5V
Sets an undervoltage threshold above which the line and bus voltage must be to satisfy the System Split condition.				

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
SS Timer	1s	0s	99s	0.01s
The System Split output remains set for as long as the System Split criteria are true, or for a minimum period equal to the System Split Timer setting, whichever is longer.				

1.2.7 Input labels

The column "GROUP x INPUT LABELS" is used to individually label each opto input that is available in the relay. The text is restricted to 16 characters and is available if 'Input Labels' are set visible under CONFIGURATION column.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Opto Input 1	Input L1	16 characters custom name		
Label for Opto Input 1				
Opto Input x	Input Lx	16 characters custom name		
Label for Opto Inputs x= 2-48				

1.2.8 Output labels

The column "GROUP x OUTPUT LABELS" is used to individually label each output relay that is available in the relay. The text is restricted to 16 characters and is available if 'Output Labels' are set visible under CONFIGURATION column.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Relay 1	Output R1	16 characters custom name		
Label for output relay 1				
Relay x	Output Rx	16 characters custom name		
Label for output relay x= 2 -32.				

1.3 Control and support settings

The control and support settings are part of the main menu and are used to configure the relays global configuration. It includes submenu settings as below:

- Relay function configuration settings
- VT ratio settings
- Active setting group
- Password & language settings
- Communications settings
- Measurement settings
- Event & fault record settings
- User interface settings
- Commissioning settings

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1.3.1 System data

This menu provides information for the device and general status of the relay.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Language	English			
The default language used by the device. Selectable as English, French, German, Spanish.				
Password	****			
Device default password.				
Sys. Fn. Links	0			1
Setting to allow the fixed function trip LED to be self resetting (set to 1 to extinguish the LED after a period of healthy restoration of load current).				
Description	MESH CORNER UNIT			
16 character relay description. Can be edited.				
Plant Reference	MiCOM			
Associated plant description and can be edited.				
Model Number	P842???????????			
Relay model number. This display cannot be altered.				
Serial Number	123456A			
Relay model number. This display cannot be altered.				
Frequency	50 Hz	50Hz or 60Hz		
Relay set frequency. Settable either 50 or 60Hz				
Comms. Level 2				
Displays the conformance of the relay to the Courier Level 2 comms.				
Relay Address 1	255	0	255	1
Sets the first rear port relay address.				
Plant Status	0000000000000010			
Displays the circuit breaker plant status.				
Control Status	0000000000000000			
Not used.				
Active Group	1	1	4	1
Displays the active settings group.				
CB Trip/Close	No Operation			
Supports trip and close commands if enabled in the Circuit Breaker Control menu.				
Software Ref. 1	P842____A1_050_A			
Displays the relay software version including protocol and relay model.				
Opto I/P Status 1	00000000000000000000000000000000			
Display the status of the first 32 opto inputs				
Relay O/P Status 1	00000000000000000000000000000000			
Displays the status of all 32 output relays				
Alarm Status 1	00000000000000000000000000000000			

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
32 bit field gives status of first 32 alarms. Includes fixed and user settable alarms.				
Opto I/P Status 1	00000000000000000000000000000000			
Duplicate of Opto I/P Status 1 above (to preserve Courier data base compatibility)				
Opto I/P Status 2	0000000000000000			
Display the status of the remaining 16 opto inputs				
Relay O/P Status 1	00000000000000000000000000000000			
Duplicate of Relay O/P Status 1 above (to preserve Courier data base compatibility)				
Alarm Status 1	00000000000000000000000000000000			
Duplicate of Alarm Status 1 above (to preserve Courier data base compatibility)				
Alarm Status 2	00000000000000000000000000000000			
Next 32 alarm status defined.				
Alarm Status 3	00000000000000000000000000000000			
Next 32 alarm status defined.				
Access Level	2			
Displays the current access level. Level 0 - No password required - Read access to all settings, alarms, event records and fault records Level 1 - Password 1 or 2 required - As level 0 plus: Control commands, e.g. circuit breaker open/close Reset of fault and alarm conditions, Reset LEDs Clearing of event and fault records Level 2 - Password 2 required - As level 1 plus: All other settings				
Password Control	2			1
Sets the menu access level for the relay. This setting can only be changed when level 2 access is enabled.				
Password Level 1	****			
Allows user to change password level 1.				
Password Level 2	****			
Allows user to change password level 2.				

1.3.2 Date and time

Displays the date and time as well as the battery condition.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Date/Time	Data			
Displays the relay's current date and time.				
Battery Status	Data			
Displays whether the battery is healthy or not.				
Battery Alarm	Enabled	Enabled or Disabled		
Setting that determines whether an unhealthy relay battery condition is alarmed or not.				

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1.3.3 VT ratios

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Main VT Primary	110.0 V	100V	1000 kV	1
Sets the main voltage transformer input primary voltage.				
Main VT Sec'y	110.0 V	80V	140V	1
Sets the main voltage transformer input secondary voltage.				

1.3.4 Record control

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It is possible to disable the reporting of events from all interfaces that supports setting changes. The settings that control the various types of events are in the Record Control column. The effect of setting each to disabled is as follows:

Menu Text	Default Setting	Available Settings
Alarm Event	Enabled	Enabled or Disabled
Disabling this setting means that all the occurrences that produce an alarm will result in no event being generated.		
Relay O/P Event	Enabled	Enabled or Disabled
Disabling this setting means that no event will be generated for any change in logic input state.		
Opto Input Event	Enabled	Enabled or Disabled
Disabling this setting means that no event will be generated for any change in logic input state.		
General Event	Enabled	Enabled or Disabled
Disabling this setting means that no General Events will be generated		
Maint. Rec. Event	Enabled	Enabled or Disabled
Disabling this setting means that no event will be generated for any occurrence that produces a maintenance record.		
Protection Event	Enabled	Enabled or Disabled
Disabling this setting means that any operation of protection elements will not be logged as an event.		
DDB 31 - 0	11111111111111111111111111111111	
Chooses whether any individual DDBs should be deselected as a stored event, by setting the relevant bit to "0" (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.		
Up to… DDB 992 - 1022	11111111111111111111111111111111	
As above, for all DDBs through to 1022		

1.3.5 Measurements

Menu Text	Default Settings	Available settings
MEASUREMENT SETUP		
Default Display	Description	Description/Plant Reference/ Frequency/Access Level/Date and Time
This setting can be used to select the default display from a range of options, note that it is also possible to view the other default displays whilst at the default level using the ←and → keys. However once the 15 minute timeout elapses the default display will revert to that selected by this setting.		
Local Values	Primary	Primary/Secondary
This setting controls whether measured values via the front panel user interface and the front courier port are displayed as primary or secondary quantities.		
Remote Values	Primary	Primary/Secondary
This setting controls whether measured values via the rear communication port are displayed as primary or secondary quantities.		

1.3.6 Communications settings

The communications settings apply to the rear communications ports only and will depend upon the particular protocol being used. Further details are given in the SCADA communications section (P842/EN SC).

1.3.6.1 Communications settings for courier protocol

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
COMMUNICATIONS				
RP1 Protocol	Courier			
Indicates the communications protocol that will be used on the rear communications port.				
RP1 Remote Address	255	0	255	1
This cell sets the unique address for the relay such that only one relay is accessed by master station software.				
RP1 Inactivity Timer	15 mins.	1 mins.	30 mins.	1 min.
This cell controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including resetting any password access that was enabled.				
RP1 Physical Link	Copper	Copper, Fiber Optic or KBus		
This cell defines whether an electrical EIA(RS)485, fiber optic or KBus connection is being used for communication between the master station and relay. If ‘Fiber Optic’ is selected, the optional fiber optic communications board will be required.				
RP1 Port Config.	KBus	KBus or EIA(RS)485		
This cell defines whether an electrical KBus or EIA(RS)485 is being used for communication between the master station and relay.				
RP1 Comms. Mode	IEC60870 FT1.2 Frame	IEC60870 FT1.2 Frame or 10-Bit No Parity		
The choice is either IEC60870 FT1.2 for normal operation with 11-bit modems, or 10-bit no parity.				

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Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
RP1 Baud Rate	19200 bits/s	9600 bits/s, 19200 bits/s or 38400 bits/s		
This cell controls the communication speed between relay and master station. It is important that both relay and master station are set at the same speed setting.				

1.3.6.2 Communications settings for IEC60870-5-103 protocol

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Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
COMMUNICATIONS				
RP1 Protocol	IEC60870-5-103			
Indicates the communications protocol that will be used on the rear communications port.				
RP1 Address	1	0	247	1
This cell sets the unique address for the relay such that only one relay is accessed by master station software.				
RP1 Inactivity Timer	15 mins.	1 min.	30 mins.	1 min.
This cell controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including resetting any password access that was enabled.				
RP1 Baud Rate	19200 bits/s	9600 bits/s or 19200 bits/s		
This cell controls the communication speed between relay and master station. It is important that both relay and master station are set at the same speed setting.				
RP1 Measure't. Period	15s	1s	60s	1s
This cell controls the time interval that the relay will use between sending measurement data to the master station.				
RP1 Physical Link	Copper	Copper or Fiber Optic		
This cell defines whether an electrical EIA(RS) 485 or fiber optic connection is being used for communication between the master station and relay. If 'Fiber Optic' is selected, the optional fiber optic communications board will be required.				
RP1 CS103 Blocking	Disabled	Disabled, Monitor Blocking, or Command Blocking		
There are three settings associated with this cell: Disabled - No blocking selected. Monitor Blocking - When the monitor blocking DDB Signal is active high, either by energizing an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the relay returns a "termination of general interrogation" message to the master station. Command Blocking - When the command blocking DDB signal is active high, either by energizing an opto input or control input, all remote commands will be ignored (i.e. CB Trip/Close, change setting group etc.). When in this mode the relay returns a "negative acknowledgement of command" message to the master station.				

1.3.7 Commissioning tests

There are menu cells which allow the status of the opto-isolated inputs, output relay contacts, internal digital data bus (DDB) signals and user-programmable LEDs to be monitored. Additionally, there are cells to test the operation of the output contacts and user-programmable LEDs.

Menu Text	Default Setting	Available Settings
COMMISSION TESTS		
Opto I/P Status 1	00000000000000000000000000000000	
This menu cell displays the status of the first 32 opto-isolated inputs as a binary string, a ‘1’ indicating an energized opto-isolated input and a ‘0’ a de-energized one		
Opto I/P Status 2	0000000000000000	
This menu cell displays the status of the remaining 16 opto-isolated inputs as a binary string, a ‘1’ indicating an energized opto-isolated input and a ‘0’ a de-energized one		
Relay O/P Status 1	00000000000000000000000000000000	
This menu cell displays the status of 32 digital data bus (DDB) signals that result in energization of the available output relays as a binary string, a ‘1’ indicating an operated state and ‘0’ a non-operated state. When the ‘Test Mode’ cell is set to ‘Enabled’ the ‘Relay O/P Status’ cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.		
Test Port Status	00000000	
This menu cell displays the status of the eight digital data bus (DDB) signals that have been allocated in the ‘Monitor Bit’ cells.		
Monitor Bit 1	64	0 to 1022 See PSL section for details of digital data bus signals
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.		
Monitor Bit 8	71	0 to 1022
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.		
Test Mode	Disabled	Disabled, Test Mode, Contacts Blocked
The Test Mode menu cell is used to allow secondary injection testing to be performed on the relay without operation of the trip contacts. It also enables a facility to directly test the output contacts by applying menu controlled test signals. To select test mode the Test Mode menu cell should be set to ‘Test Mode’, which takes the relay out of service and blocks operation of output contacts and maintenance, counters. It also causes an alarm condition to be recorded and the yellow ‘Out of Service’ LED to illuminate and an alarm message ‘Prot’n. Disabled’ is given. This also in IEC60870-5-103 builds changes the Cause of Transmission, COT, to Test Mode. To enable testing of output contacts the Test Mode cell should be set to Contacts Blocked. This blocks the output relays from operating the contacts and enables the test pattern and contact test functions which can be used to manually operate the output contacts. Once testing is complete the cell must be set back to ‘Disabled’ to restore the relay back to service.		
Test Pattern	00000000000000000000000000000000	0 = Not Operated 1 = Operated
This cell is used to select the output relay contacts that will be tested when the ‘Contact Test’ cell is set to ‘Apply Test’.		

ST

Menu Text	Default Setting	Available Settings
Contact Test	No Operation	No Operation, Apply Test, Remove Test
When the ‘Apply Test’ command in this cell is issued the contacts set for operation (set to ‘1’) in the ‘Test Pattern’ cell change state. After the test has been applied the command text on the LCD will change to ‘No Operation’ and the contacts will remain in the Test State until reset issuing the ‘Remove Test’ command. The command text on the LCD will again revert to ‘No Operation’ after the ‘Remove Test’ command has been issued. Note: When the ‘Test Mode’ cell is set to ‘Enabled’ the ‘Relay O/P Status’ cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.		
Test LEDs	No Operation	No Operation Apply Test
When the ‘Apply Test’ command in this cell is issued the eighteen user-programmable LEDs will illuminate for approximately 2 seconds before they extinguish and the command text on the LCD reverts to ‘No Operation’.		
Test Auto Reclose	No Operation	
Standard MiCOM feature but not applicable in P842.		
DDB 31 - 0	00000000000000000000001000000000	
Displays the status of DDB signals 0-31.		
… DDB 32 - 1022	00000000000000000000000000000000	
... For monitoring all DDB signals up to 1022		

1.3.8 Opto configuration

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
OPTO CONFIG.				
Global Nominal V	24 - 27	24 - 27, 30 - 34, 48 - 54, 110 - 125, 220 - 250, Custom		
Sets the nominal battery voltage for all opto inputs by selecting one of the five standard ratings in the Global Nominal V settings. If Custom is selected then each opto input can individually be set to a nominal voltage value.				
Opto Input 1	24 - 27	24 - 27, 30 - 34, 48 - 54, 110 - 125, 220 - 250		
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting.				
Opto Input 2 - 48	24 - 27	24 - 27, 30 - 34, 48 - 54, 110 - 125, 220 - 250		
Each out of 48 opto input can individually be set to a nominal voltage value if custom is selected for the global setting.				

1.3.9 Control inputs

The control inputs function as software switches that can be set or reset either locally or remotely. These inputs can be used to trigger any function that they are connected to as part of the PSL. The setting is not visible if ‘Control Inputs’ are set invisible under the CONFIGURATION column.

Menu Text	Default Setting	Setting Range	Step Size
CONTROL INPUTS			
Ctrl I/P Status	00000000000000000000000000000000		
Cell that is used to set (1) and reset (0) the selected Control Input by simply scrolling and changing the status of selected bits. This command will be then recognized and executed in the PSL. Alternatively, each of the 32 Control input can also be set and reset using the individual menu setting cells as follows:			
Control Input 1	No Operation	No Operation or Set or Reset	
Setting to allow Control Inputs 1 Set/ Reset.			
Control Input 2 to 32	No Operation	No Operation or Set or Reset	
Cell as for Control Input 1			

1.3.10 Control input configuration

Menu Text	Default Setting	Setting Range	Step Size
CTRL I/P CONFIG.			
Control Input 1	Latched	Latched, Pulsed	
Configures the control inputs as either ‘latched’ or ‘pulsed’. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10ms after the set command is given and will then reset automatically (i.e. no reset command required) .			
Control Input 2 to 32	Latched	Latched, Pulsed	
Configures the control inputs as either ‘latched’ or ‘pulsed’.			

1.4 Disturbance recorder settings (Oscillography)

The disturbance recorder settings include the record duration and trigger position, selection of analog and digital signals to record, and the signal sources that trigger the recording.

The "DISTURBANCE RECORDER" menu column is shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
DISTURB. RECORDER				
Duration	1.5s	0.1s	10.5s	0.01s
This sets the overall recording time.				
Trigger Position	33.3%	0	100%	0.1%
This sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 1.5s with the trigger point being at 33.3% of this, giving 0.5s pre-fault and 1s post fault recording times.				
Trigger Mode	Single	Single or Extended		
If set to single mode, if a further trigger occurs whilst a recording is taking place, the recorder will ignore the trigger. However, if this has been set to "Extended", the post trigger timer will be reset to zero, thereby extending the recording time.				

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Analog. Channel 1	VA	V1, V2, V3, V4		
Selects any available analog input to be assigned to this channel.				
Analog. Channel 2	VB	As above		
Analog. Channel 3	VC	As above		
Analog. Channel 4	IA	As above		
Digital Inputs 1 to 32	Relays 1 to 14 and Opto's 1 to 17	Any O/P Contact, Any Opto Inputs, or Internal Digital Signals		
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal relay digital signals, such as protection starts, LEDs etc.				
Inputs 1 to 32 Trigger	No Trigger except Dedicated Relay 3 operation which is set to Trigger L/H	No Trigger, Trigger L/H, Trigger H/L		
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				

OP

OPERATION

Date: **2019**
Hardware Suffix: **B**
Software Version: **04**

CONTENTS

OP

FIGURES

1. INTRODUCTION

The aim of this document is to explain the operation of the P842 mesh corner auto-reclose device in detail. It includes a short overview and definition of the autoswitching sequences for each functional block using a description and comprehensive State Charts. These will contribute to an in-depth understanding of the product and consequently assist in creating and testing the autoswitching schemes.

Note: All the state charts are drawn using standard UML state chart syntax - for a description of this please refer to the Glossary SG Section.

1.1 Product overview

The P842 is designed specifically for autoswitching of Mesh corners and Single-switch arrangements with up to two feeders and up to three banked transformers including autoisolation function. This product meets the requirement specified within the relevant NGTS standards. The relay provides the real time UCA2 GOOSE communications via Ethernet board, thus reducing the wiring and associated costs.

The figures below show the P842 application to 4 switch mesh and single switch sub-station configurations.

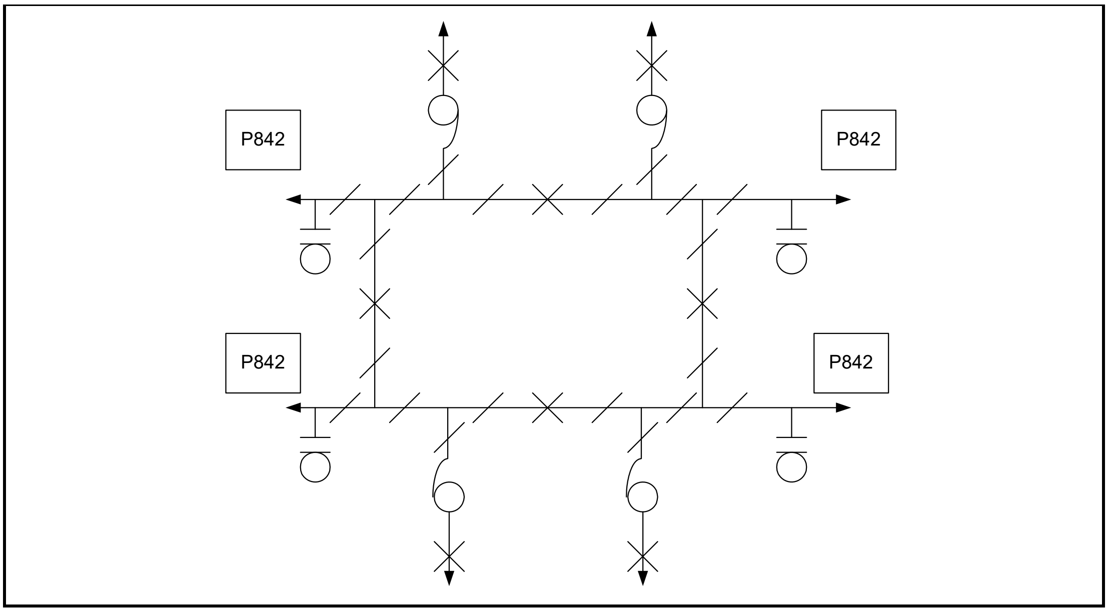

Figure 1: Four switch configuration

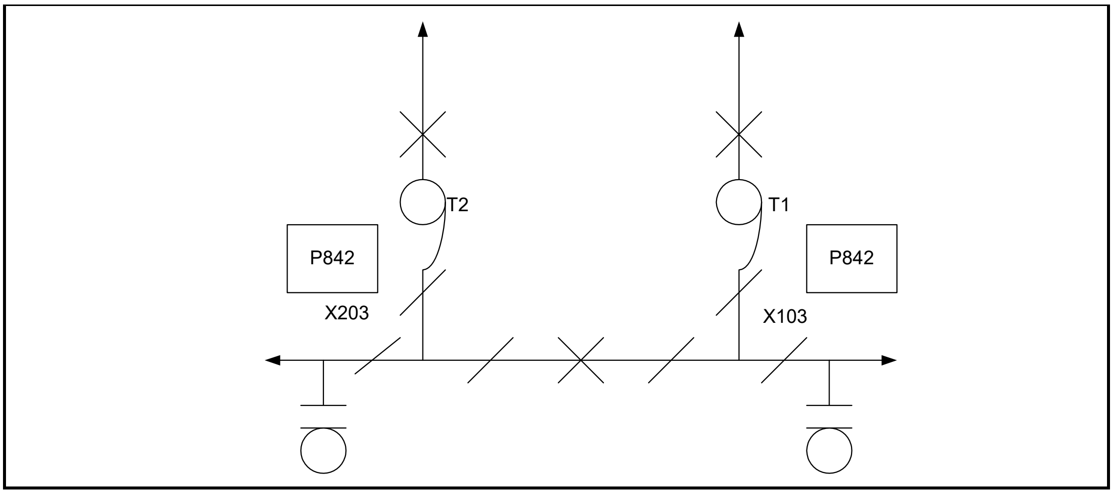

Figure 2: Single switch configuration

P842 can also be used for other mesh configurations, for more details refer to the Applications chapter.

The P842 provides no protection functionality; it is responsible for reclosing of the mesh breakers following a trip and plant isolation using the disconnectors. It also incorporates system checks before breaker closure by measuring a single phase voltage either side of the associated circuit breakers.

The P842 responds to faults detected by the following protection equipment:

- Mesh corner protection
- HV Line/Cable protection
- Transformer protection

The behavior of the relay under the various fault scenarios is defined within this document. This behavior is based on that specified by NGTS Standards.

In addition to this the P842 provides Ferroresonance suppression, when required.

At present, Manual closure and Ferroresonance detection are not provided by the relay.

2. RELAY FUNCTIONAL ARCHITECTURE

2.1 Functional blocks

The P842 relay is split into logical functional blocks, some of them multiplied, to allow maximum flexibility for different applications. Functional blocks included within P842 are:

- Mesh Corner function (MC)
- Mesh Circuit Breaker function (CB) x 2
- System Checks (CB) x 2
- Mesh Feeder function (FD) x 2
- Mesh Transformer function (TX) x 3
- Ferroresonance Suppresion (FR) x 3

To allow maximum flexibility to different plant configurations the logical blocks above are interconnected via user available DDB signals in the programmable logic (PSL). This design allows a very low level of access to the relay and, as a consequence, easy determination which Block doesn't perform towards a user expectation and "fault finding" which could be a result of conflict in settings or PSL or for any other reason. This split into functional blocks is helpful to users with limited experience in Automatic reclosing.

The relay provides facilities to monitor all logic input signals to the scheme. This includes physical opto inputs, control inputs and GOOSE signals from the peer-peer scheme. If modifications to the default PSL are needed it is possible to monitor the status of all the internal scheme logic signals using the Commissioning section of the relay's menu. To verify the correct operation of the external wiring to the relay facilities are provided to permit operation of the relay output contacts.

The P842 device provides 32 output contacts and 48 opto inputs. The status information between the mesh units are passed via Ethernet connection. Application of the device to certain plant configurations may be constrained by the available physical I/O - see P842 AP chapter for more information.

2.2 Signal types

The signal types indicated within the functional block descriptions are also described in the P842 PL sections. They are as follows:

Status Input

Input from external equipment/plant mapped from opto inputs

Control Input

Pulsed command input (L/H transition 2 second pulse) from opto or communications.

Status Output

Signal from relay to external plant/protection equipment.

Indication

Status indication via contact, programmable LED and communications.

Alarm

As indication which is also indicated via relay front panel as an alarm.

Internal signal

These are signals that may not appear as an input or an output from the P842 but pass information between the functional blocks.

3. AUTOSWITCHING REQUIREMENTS

3.1 Latching logic for protection trips

Before any autoswitching sequence starts (subject to service state), the protection must first operate and clear the fault. It is usual in a mesh corner scheme for the protection trip signals to be latched for a period of time to delay the start of the auto-reclose and co-ordinate the reclosure at each end of the transmission line.

The P842 can be applied to a scheme with individual latched trip relays for each protection device or a common latching trip relay. In the second case it is necessary for the individual trip signals to be latched within the P842 and held until the common latched trip resets. The logic to permit this application is indicated in Figure 3. The outputs from this logic will be used as inputs into the Mesh corner, Feeder and Transformer functions in addition to the trip relay reset logic.

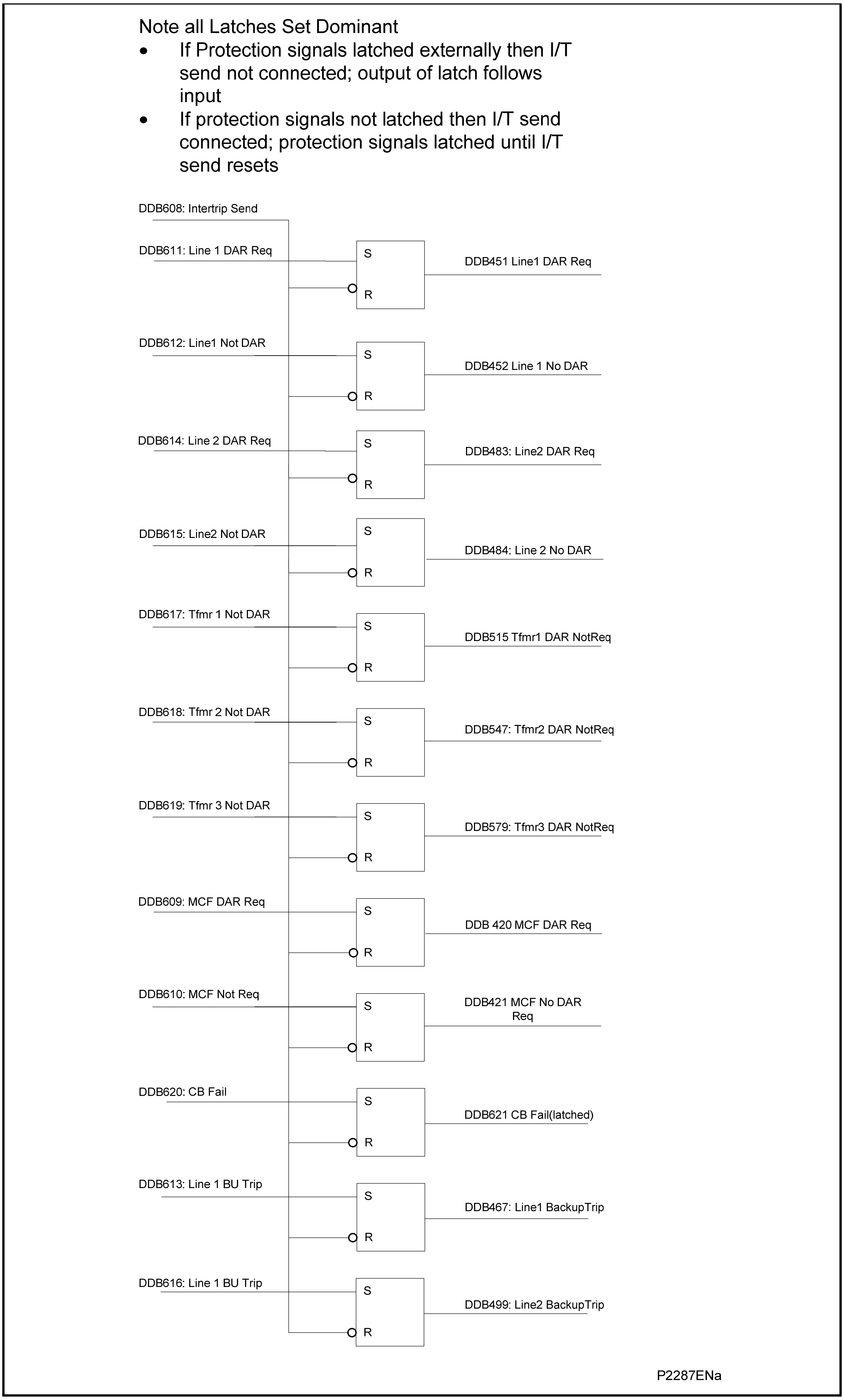

Figure 3: Latching logic for protection signals

3.2 Automatic switching

The purpose of autoswitching is to isolate the faulted part of the plant and to restore the supply for the remaining system. Like tripping, the auto-isolation is always 3 phase.

The functional blocks referenced above constitute the mesh corner device and are described within this document. A scenario could be when multiple control actions result from more than one functional block simultaneously. If this happens any conflict is resolved using the following priorities:

- Lockout DAR will take priority over Start DAR
- Open disconnector will take priority over no disconnector operation.

3.3 DAR

Delay auto-reclose (DAR) is an attempt to re-close mesh breakers following the successful fault clearance. The reclosure is always 3ph and time delayed, typically in seconds.

The P842 will provide DAR for up to two mesh circuit breakers; the DAR for the LV circuit breakers is contained within a separate device. The P842 provides control signals to initiate or inhibit the LV DAR.

Where isolation of Feeders/Transformers is required then this isolation must be completed prior to reclosure of any circuit breakers.

All mesh HV circuit breaker reclosures must be separated by a user settable minimum interswitch time (nominally 5s).

If a mesh breaker reclosure that is ready to close is inhibited, then reclosure of any other ready HV CB will be attempted.

3.4 Plant isolation

The P842 provides facilities to control the motor-driven isolators for all plant connected to the corner (Feeders and Transformers).

Three isolated contacts are needed for control of an isolator and the overriding of the interlock. The P842 provides the contacts allocated using the PSL. If the number of plant items on the corner is high and there are insufficient output contacts on the P842 then auxiliary relays may be used to provide the duplicated contacts.

Each function block provides a user settable time delay between the initiating signal and the start of the isolation sequence (Plant switching delay).

Before plant isolation occurs all local and remote DAR sequences must be inhibited, and any other specified interlock conditions have been met.

Once started the plant isolation sequence is cancelled either by successful completion of the isolation or by the timeout of the Plant Operation Timer.

If the switching requirements specify that the plant isolation must be achieved before the DAR can be started and isolation is either not possible or fails then the DAR sequences will be locked out.

3.5 Sizing requirement

See the P842 AP section.

3.6 Plant layout topology

It is possible to configure the number of plant items and topology using the relay interfaces. The PSL facility is then used to customize the I/O to plant items.

The voltage selection for the P842 checksync inputs is made externally. However, it is possible to select the A and B inputs for each check sync function using internal logic signals that can be accessed from the PSL. This will permit internal voltage selection to permit flexible application of the device. However, this method does not provide voltage selection for other devices that may require it.

4. MESH CORNER FUNCTION

This is the general control module for the corner, which provides control inputs for enabling/disabling the auto-switching for the corner and associated HV and LV circuit breakers. It also directly responds to operation of the mesh corner protection, controlling auto-isolation and DAR depending on the nature of the fault and the status of the plant prior to the fault.

The number of Feeders (0 to 2) and Transformers (0 to 3) connected to the mesh corner are settable under the Configuration column. The mesh corner function does not provide a plant switching delay setting as the switching delay is implemented within the function controlling the plant item (Feeder or Transformer)

The mesh corner can be labeled using up to 16 character string.

4.1 Inputs and outputs

Note: For a detailed description of the MC Inputs and outputs refer to the P842 PL section.

Inputs	Description	Type
Auto-switch In	Selects auto-switching in service for the corner, feeder and transformer functions	Control Input
Auto-switch Out	De-Selects auto-switching service for the corner, feeder and transformer functions	Control Input
DAR In Service	Select DAR in service for CBs connected to the corner	Control input
DAR Out of Service	Select DAR out of service for CBs connected to corner	Control input
DAR Required	From mesh corner protection, open disconnectors and initiate mesh DAR	Status input
DAR Not required	From mesh corner protection, open disconnectors and lockout DAR	Status input
Inhibit DAR	Input to inhibit mesh and LV DAR	Status Input
Lockout DAR	Input to lockout mesh and LV DAR	Status Input

Outputs	Description	Type
Auto-switch in service	Auto-switching enabled	Indication
Auto switch out of service	Auto-switching disabled	Indication
Auto-switch in progress	This indication is asserted when a DAR or Plant isolation sequence has been started and it reset on completion	Indication
Start HV DAR	Output to Mesh CB	Status Output
Inhibit HV DAR	Output to Mesh CB	Status Output
Lockout HV DAR	Output to Mesh CB	Status Output
Start LV DAR	Output to LV DAR	Status Output
Inhibit LV DAR	Output to LV DAR	Status Output
Lockout LV DAR	Output to LV DAR	Status Output
Open Line Isolator 1 Req	Output to Feeder function	Internal signal
Open Line Isolator 2 Req	Output to Feeder function	Internal signal
Open Transformer Isolator 1 Req	Output to Transformer function	Internal signal
Open Transformer Isolator 2 Req	Output to Transformer function	Internal signal
Open Transformer Isolator 3 Req	Output to Transformer function	Internal signal

4.2 Operation

- The module is placed into a ‘Faulty’ state if the input ‘Function Faulty’ is set. In this state all switching and DAR functions are out of service. The Indications Auto Switching out of service and DAR out of service indicates this. In this state the switching functions within the module are inhibited. The other functional descriptions within this section assume the module is in the healthy state.

- If the control to input ‘Auto switch out of service’ has been received, then the indication autoswitch out of service is asserted. In this state the indication DAR out of service is also asserted. In this state it is possible to start any plant isolation or DAR sequences on any of the associated plant. If any isolation or DAR sequences have been started they will be halted.
- On power up the function will start in the state Auto switch out of service until the criteria for moving to the autoswitch in service have been met.
- When in the state auto-switching in service (set via the control auto-switching in service) it is possible to perform the plant isolation for the Feeder and Transformers. However, the DAR functions will be blocked until the control DAR in service has been received.
- When in the ‘DAR in service’ state, both auto isolation and DAR will operate according to the function table shown below. In summary, any mesh fault will cause all plant connected to the corner to be isolated. Both the HV and LV DAR will be locked out with the single exception if no isolators are open, no reclaim timers are running and the initiation is DAR Required.

Input/ Event	Line Disconnector		Transformer HV Disconnector		Mesh HV CB	Transformer LV CB
	Position	Action	Position	Action	Action	Action
Mesh Corner Fault - No DAR Reqd.	Closed	Open	Closed	Open	Lockout DAR	Lockout DAR
	Closed	Open	Open	None	Lockout DAR	Lockout DAR
	Open	None	Closed	Open	Lockout DAR	Lockout DAR
	Open	None	Open	None	Lockout DAR	Lockout DAR
Mesh Corner Fault - DAR Reqd.	Closed	None	Closed	Open	DAR	Lockout DAR
	Closed	Open	Open	None	Lockout DAR	Lockout DAR
	Open	None	Closed	Open	Lockout DAR	Lockout DAR
	Open	None	Open	None	Lockout DAR	Lockout DAR

Table 1: Automatic switching requirements table for: mesh corner function
(Reclaim Timer Not Running)

Input/ Event	Line Disconnector		Transformer HV Disconnector		Mesh HV CB	Transformer LV CB
	Position	Action	Position	Action	Action	Action
Mesh Corner Fault - No DAR Reqd.	Closed	Open	Closed	Open	Lockout DAR	Lockout DAR
	Closed	Open	Open	None	Lockout DAR	Lockout DAR
	Open	None	Closed	Open	Lockout DAR	Lockout DAR
	Open	None	Open	None	Lockout DAR	Lockout DAR
Mesh Corner Fault - DAR Reqd.	Closed	Open	Closed	Open	Lockout DAR	Lockout DAR
	Closed	Open	Open	None	Lockout DAR	Lockout DAR
	Open	None	Closed	Open	Lockout DAR	Lockout DAR
	Open	None	Open	None	Lockout DAR	Lockout DAR

Table 2: Automatic switching requirements table for: mesh corner function
(Reclaim Timer Running)

- The status and control of the line and transformer disconnectors can be accessed using the Feeder and Transformer functions. They cannot be accessed using the mesh function. it is necessary to perform a delayed reclose this is achieved via the mesh breaker function and the LV DAR outputs.
- The mesh corner function provides two status inputs ‘Lockout DAR’ and ‘Inhibit DAR’; these when asserted will cause all associated HV and LV DAR to be locked out or inhibited respectively.

The detailed operation of the MC Function block is shown in the State Charts that are split via 4 concurrent state machines for clarity:

Figure 4: Mesh Status: Manages the In/Out switching of the Mesh Corner Unit.

Figure 5: Mesh DAR Interface: Handles the signals from the mesh corner protection and DAR initiation and lockout.

Figure 6: Transformer Disconnector Logic: Determines Transformer isolation for mesh corner faults.

Figure 7: Line Disconnector Logic: Determines Line isolation for mesh corner faults.

Note: The indication signal MCF Switch InProg (DDB430) is set if any of the transformer or line disconnector logic blocks is currently isolating and is reset when all isolation is complete.

The interface between MC Function and other Function Blocks is realized via PSL.

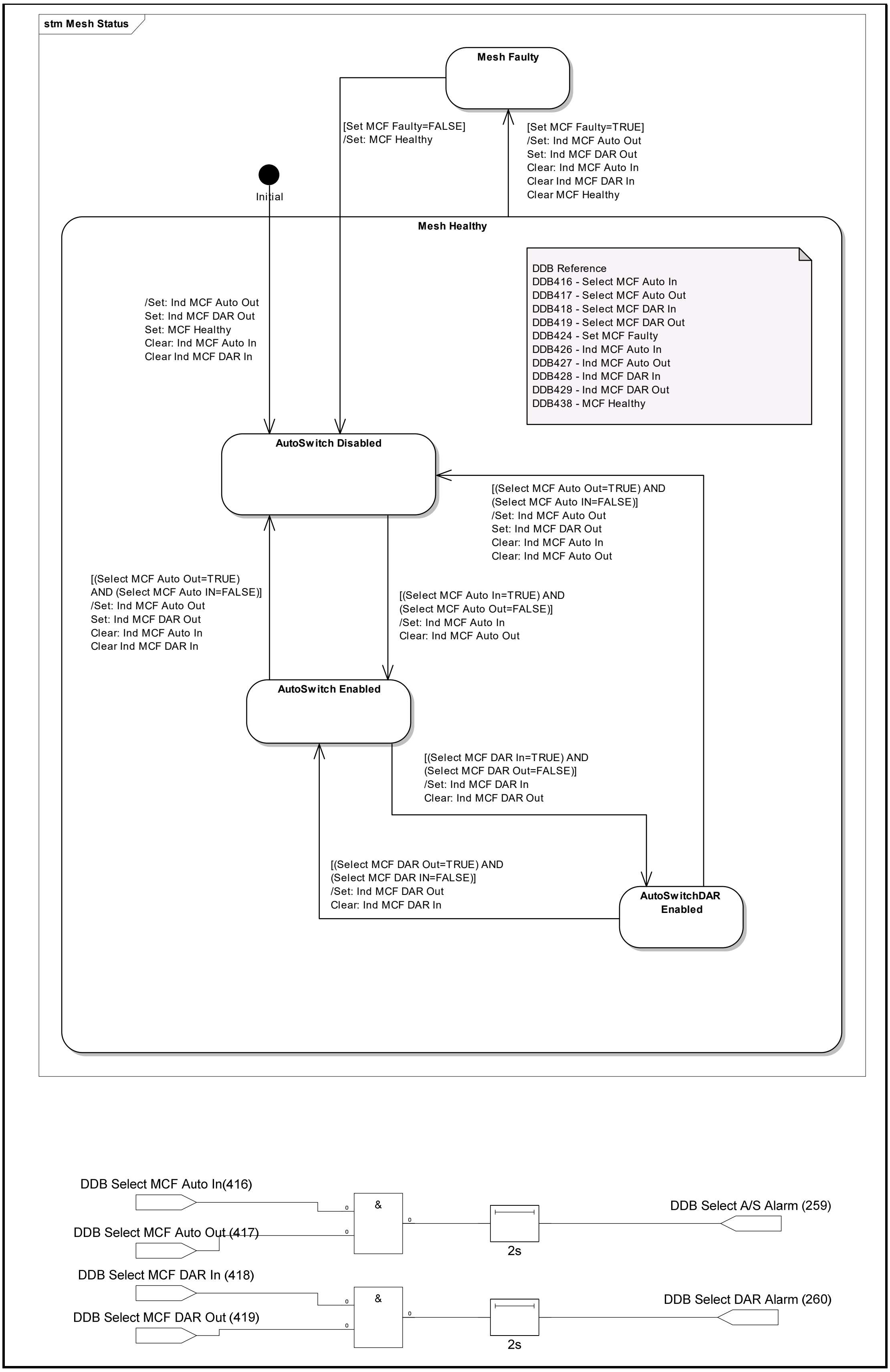

Figure 4: Mesh corner function - mesh status state chart and alarm

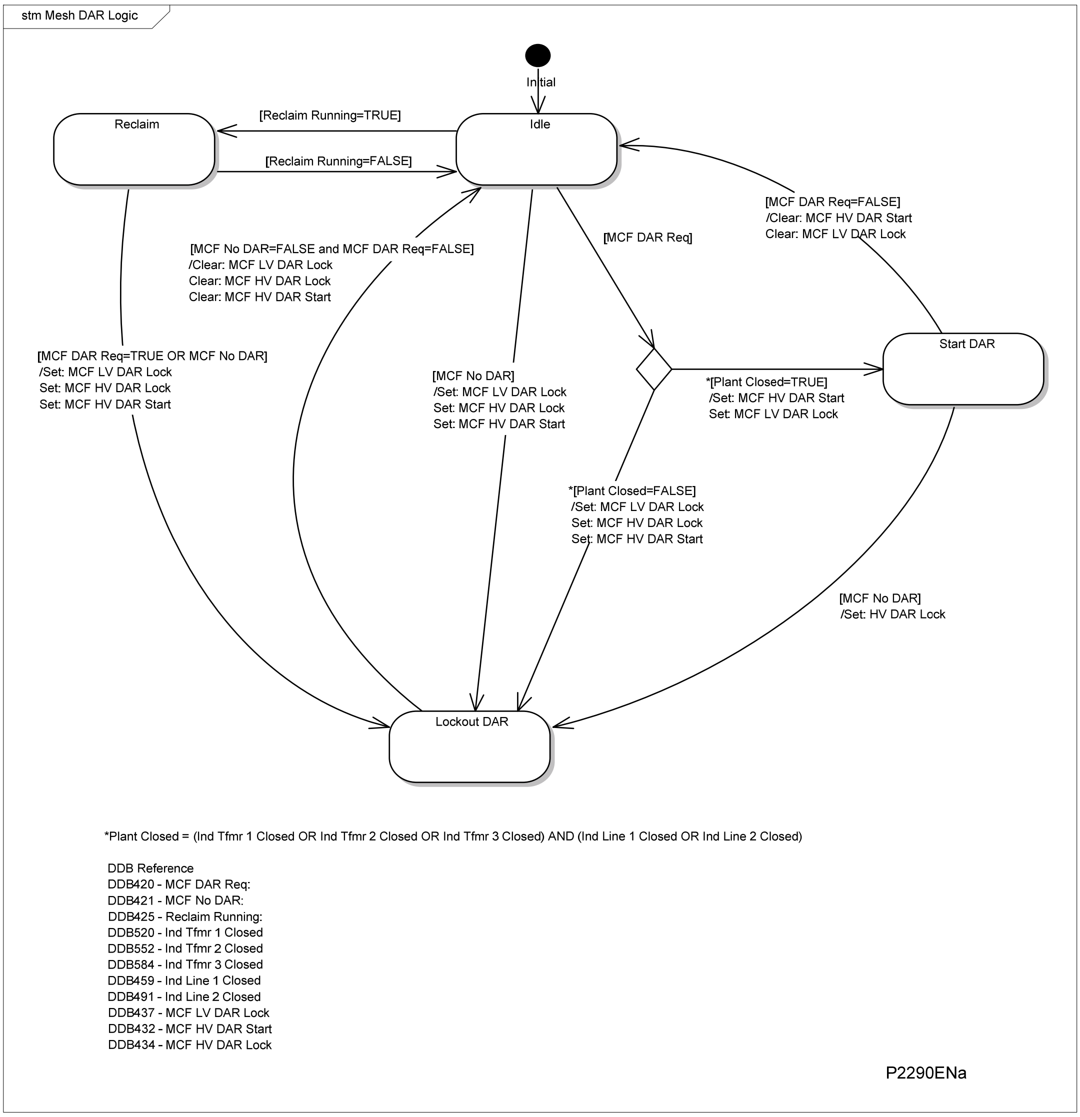

Figure 5: Mesh corner function – DAR interface

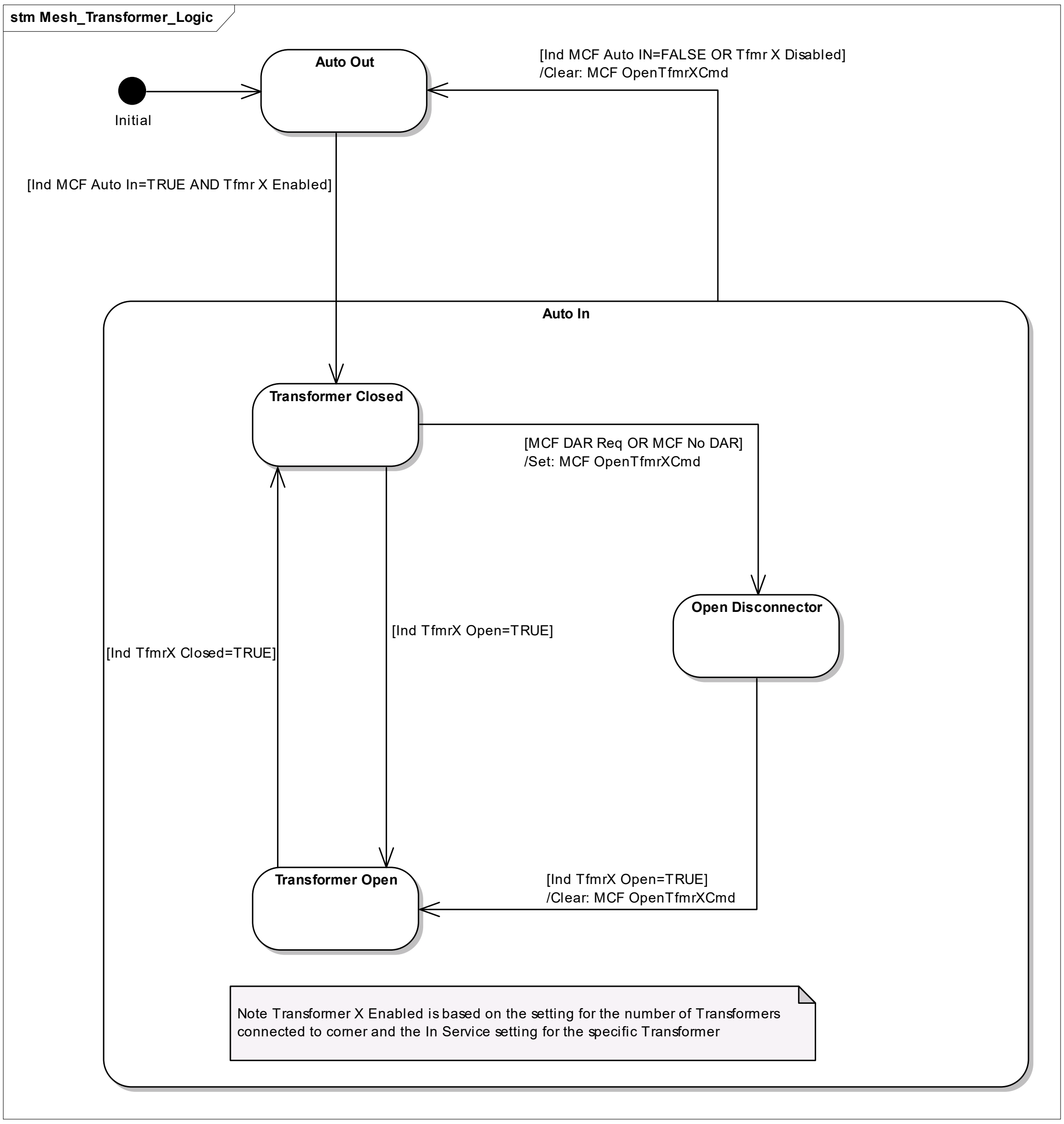

Figure 6: Mesh corner function – transformer disconnector logic

DDB Reference	Transformer 1	Transformer 2	Transformer 3
Ind TfmrX Closed	533	565	597
Ind TfmrX Open	534	566	598
MCF OpenTfmrX Cmd	441	442	443

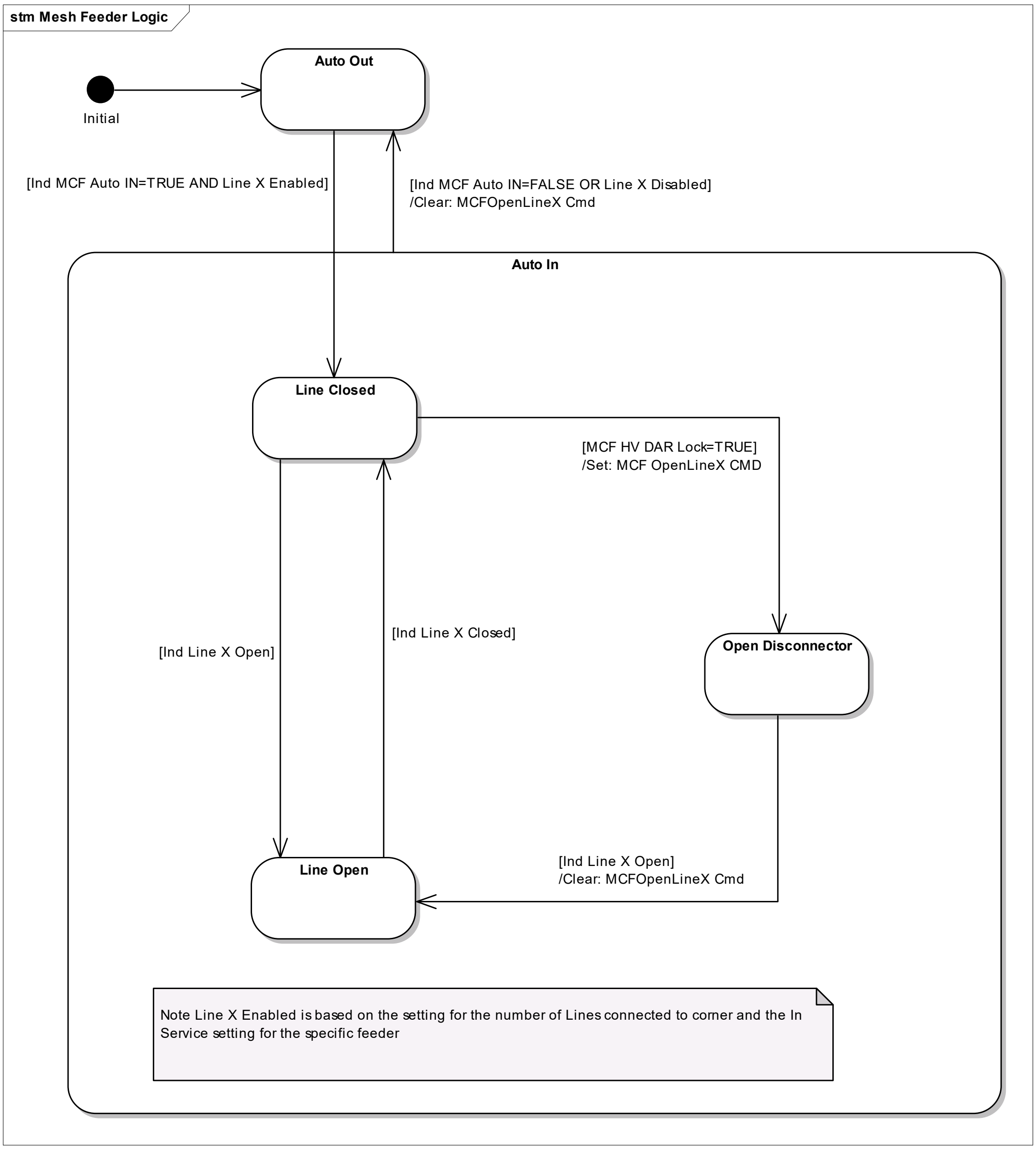

Figure 7: Mesh corner function – feeder disconnector logic

DDB Reference	Feeder 1	Feeder 2
Ind LineX Closed	469	501
Ind LineX Open	470	502
MCF OpenLineX Cmd	439	440

5. FEEDER FUNCTION

The Feeder function is associated with the Line (Feeder) connected to the corner and permits isolation of the Feeder. The P842 provides 2 independent Feeder functions permitting the relay to be applied on a corner with either 0, 1 or 2 connected Feeders. Each Feeder could be labeled using up to 16 character string

Note: If both circuit breaker functions are enabled then all four voltage inputs will be used for check sync; no spare voltage inputs will be available for the line voltage check. In this case the local side live indication from the check sync is used to inhibit the line isolator opening for a live line.

5.1 Inputs and outputs

Note: For a detailed description of the Feeder Inputs and outputs refer to the P842 PL chapter.

Inputs	Description	Type
Disconnector Open	Line disconnector position	Status Input
Disconnector Closed	Line disconnector position	Status Input
Inhibit Disconnector	Input to delay opening of disconnector	Status Input
DAR Required	From Feeder prot	Status Input
DAR Not required	From Feeder prot	Status Input
Open Disconnector Request	From other MCU modules	Internal Signal
Close Disconnector Request	From other MCU modules	Internal Signal
Intertrip Received	Feeder Intertrip	Status Input
Auto-switch in service	From Mesh Function	Internal Signal
DAR In service	From Mesh Function	Internal Signal
Live Line	From system checks in CB function	Internal Signal
Reclaim Timer running	On either adjacent CB	Internal Signal
Feeder function Fault	Puts Module into Faulty state	Internal Signal
Line Voltage Input	Line voltage input	Analogue voltage

Outputs	Description	Type
Open Disconnector Command	Output to Plant	Status Output
Close disconnector command	Output to Plant	Status Output
Disconnector Status Alarm	Indication	Status Output
Start DAR	Output to HV and LV DAR	Status Output
Inhibit DAR	Output to HV and LV DAR	Status Output
Lockout DAR	Output to HV and LV DAR	Status Output
Function Healthy	Indicates healthy state	Status Output

5.2 Operation

The Feeder function is associated with a Feeder (Line) connected to the mesh corner. It responds to faults detected by the Feeder protection controlling isolation of the Feeder and initiation of DAR if required.

- The function has two main states Faulty and Healthy. The transition to the faulty state occurs when the input Function Faulty is set. When in the Faulty state the check on the isolator position is executed and the outputs set accordingly. However, no switching operations are executed in this state.
- The Feeder function is controlled by the mesh corner function with repeats of the controls to Enable/Disable Auto-Switching. This allows the following three modes to be selected:
- Auto-Switching and DAR Disabled – in this state the module will make no response to an initiation signal from the Feeder protection.

- Auto-switching Enabled and DAR Disabled – in this state the auto-isolation of the plant will occur as defined in the Table below. However, the DAR will not be started for a fault detected.
- Auto-switching enabled and DAR Enabled – in this state auto-isolation and DAR will take place depending on the nature of the trigger and the plant status.

The following table indicates the response of the module to the trigger conditions under the various underlining states. It is assumed that the function is in the healthy state and that both auto-switching and DAR are enabled.

Trigger	Line	Reclaim	Action
Feeder Fault DAR Req	Closed	No	Start DAR
	Open	No	Lockout DAR
	Closed	Yes	Open Disconnector then start DAR
	Open	Yes	Lockout DAR
Feeder Fault – No DAR	Closed	No	Open Disconnector then start DAR
	Open	No	Lockout DAR
	Closed	Yes	Open Disconnector then start DAR
	Open	Yes	Lockout DAR
Feeder Intertrip	Closed	No	Start DAR
	Open	No	Lockout DAR
	Closed	Yes	Start DAR
	Open	Yes	Lockout DAR
Feeder Persistent intertrip	Closed	No	Open Disconnector then start DAR
	Open	No	Lockout DAR
	Closed	Yes	Open Disconnector then start DAR
	Open	Yes	Lockout DAR

The detailed operation of the Feeder Function block is shown in the State Charts in figures 8 to 11. The P842 relay must perform and match the signals state, providing that the applied conditions are true. The interface between Feeder Function and other Function Blocks is done through PSL.

The feeder function can be split into four function blocks each of which is represented by a state diagram:

Figure 8: Feeder Status: Monitor the Feeder disconnector position status

Figure 9: Feeder Live: Perform the voltage monitoring for the line

Figure 10: Feeder DAR Interface: Respond to Feeder protection signals

Figure 11: Feeder Auto-Switching: Manages the switching logic for the disconnector

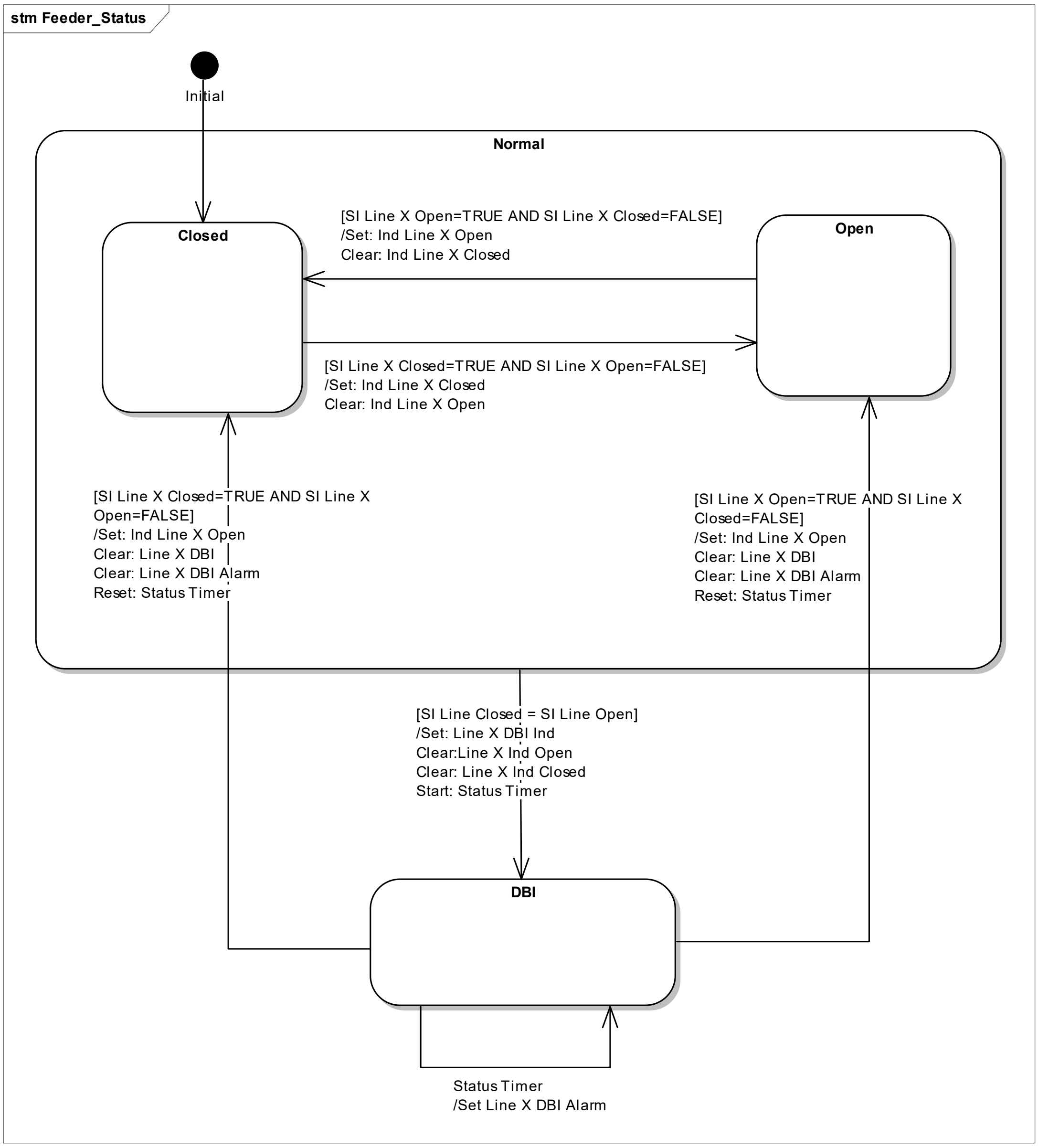

Figure 8: Feeder function feeder status- state chart

DDB Reference	Feeder 1	Feeder 2
SI Line X Open	449	481
SI Line X Closed	448	480
Line X DBI	466	498
Line X DBI Alarm	261	262
Ind LineX Closed	469	501
Ind LineX Open	470	502
MCF OpenLineX Cmd	439	440

Note: DBI (Don't believe it) inconsistent double point status

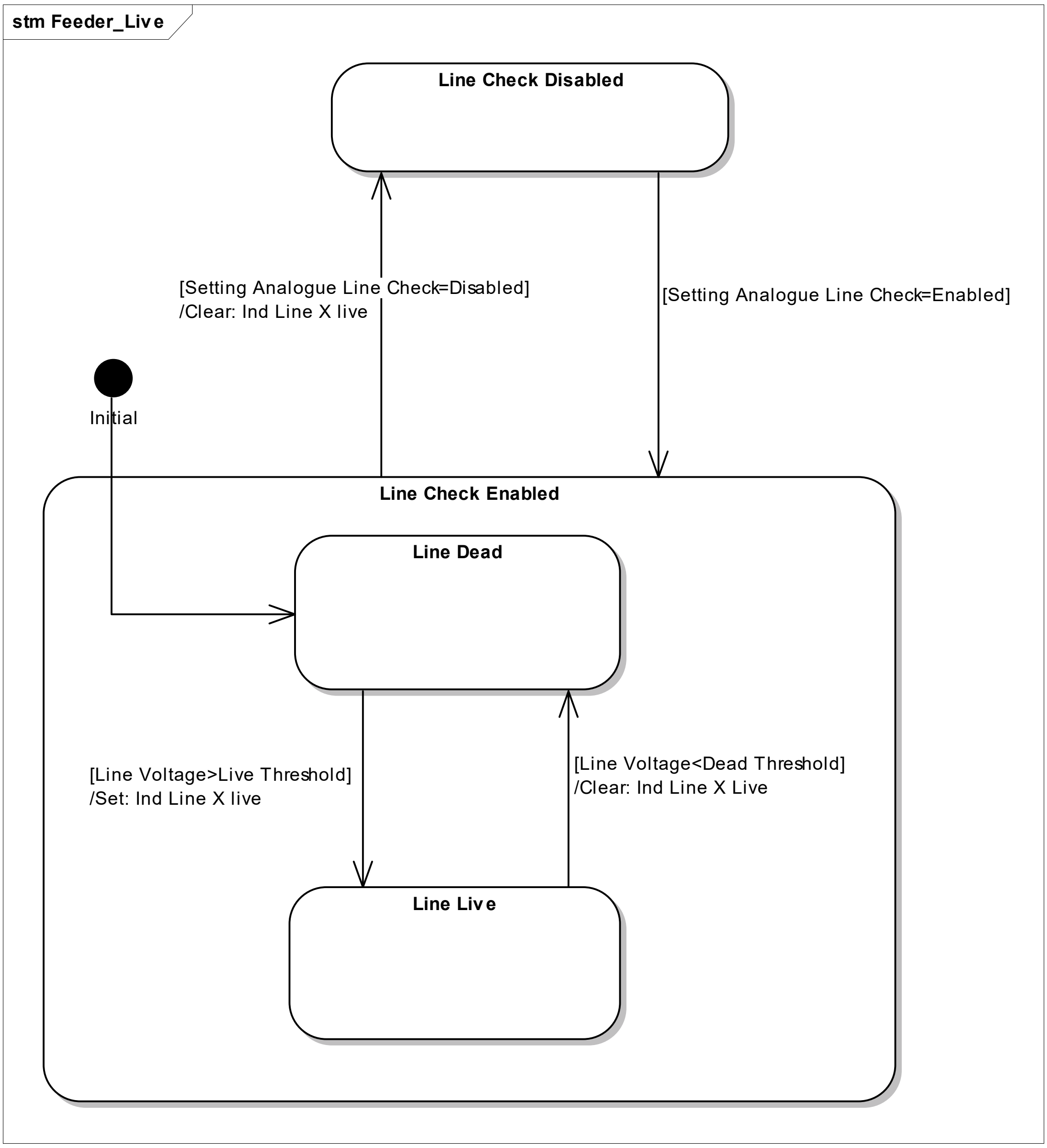

Figure 9: Feeder function feeder live- state chart

DDB Reference	Feeder 1	Feeder 2
Ind Line X Live	456	488

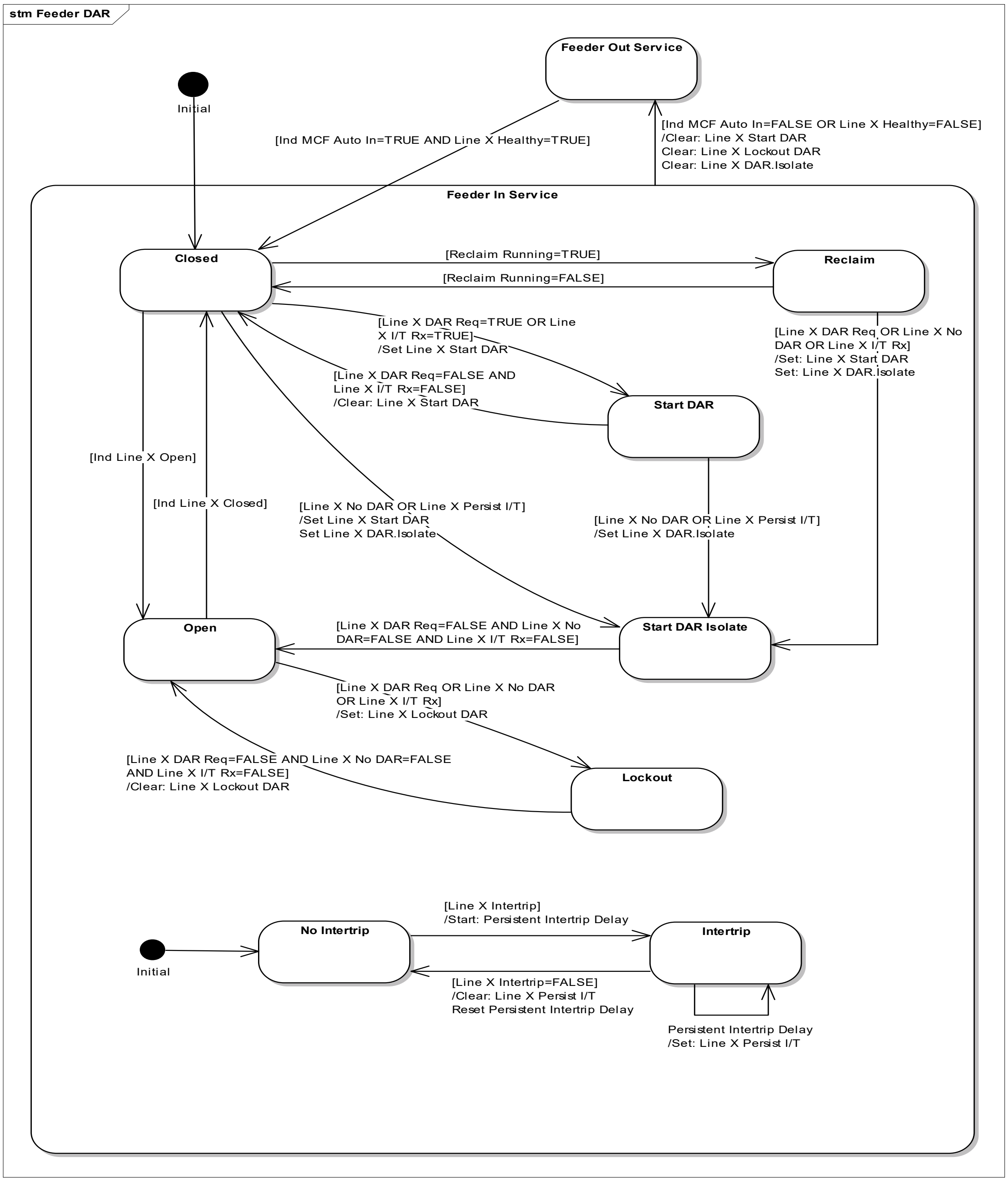

Figure 10: Feeder function DAR interface- state chart

DDB Reference	Feeder 1	Feeder 2
Ind LineX Closed	469	501
Ind LineX Open	470	502
Line X DAR Req	451	483
Line X No DAR	452	484
Line X Intertrip	455	487
Line X Persist I/T	458	490
Line X Lockout DAR	464	496
Reclaim Running	425	

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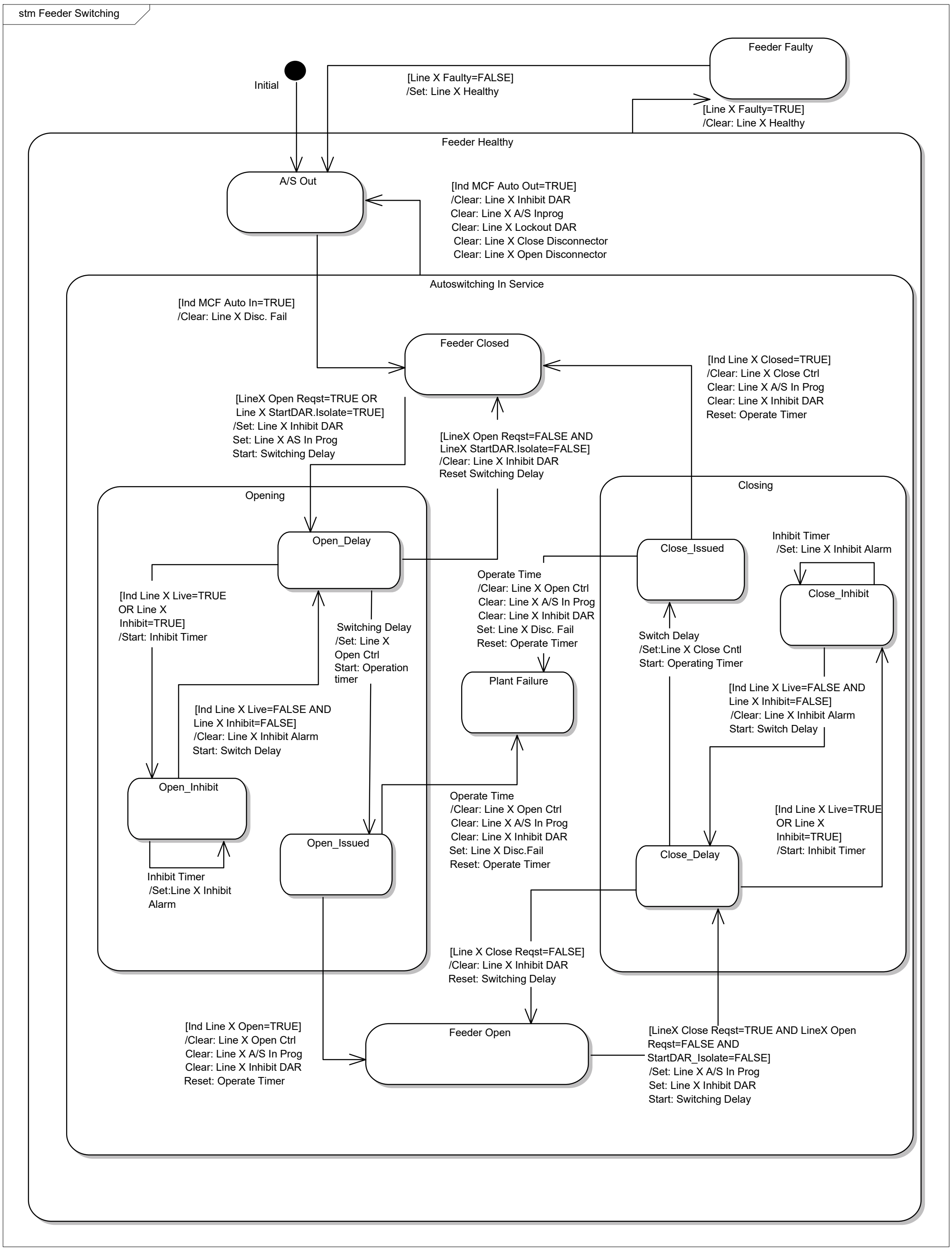

Figure 11: Feeder function disconnector switching- state chart

DDB Reference	Feeder 1	Feeder 2
Line X Faulty	457	489
Line X Healthy	465	497
Line X Disc. Fail	268	269
SI Line X Inhibit	450	482
Line X Inhibit Alarm	282	283
Line X Inhibit DAR	463	495
Line X A/S In Prog	468	500
Line X Open Reqst	453	485
Line X Close Reqst	454	486
Line X Open Ctrl	460	492
Line X Close Ctrl	461	493

DDB Reference	Feeder 1	Feeder 2
Ind MCF Auto In	426	

6. TRANSFORMER FUNCTION

The P842 provides 3 independent Transformer functions allowing the relay to be applied on a corner with either 0, 1, 2 or 3 connected transformers. Each Transformer can be labeled using up to 16 character string.

6.1 Inputs and outputs

Note: For a detailed description of the Transformer Inputs and outputs refer to the P842 PL section.

Inputs	Note	Type
Disconnector Open	Plant status	Status Input
Disconnector Closed	Plant status	Status Input
Inhibit Disconnector	Plant interlocks	Status Input
DAR Not required	From Transformer prot	Status Input
Open Disconnector Request	From other MCU modules	Internal Signal
Close Disconnector Request	From other MCU modules	Internal Signal
Auto-switch in service	From Mesh Function	Internal Signal
DAR In service	From Mesh Function	Internal Signal
Live Line	Used to block isolator operating if corner is live	Internal Signal
Reclaim Timer running	From adjacent CBs	Internal Signal
Transformer function Fault	Puts Module into Faulty state	Internal Signal

Outputs		
Open Disconnector Command	Output to Plant	Status Output
Close Disconnector command	Output to Plant	Status Output
Disconnector position	Indication	Indication
Disconnector Status Alarm	Indication	Indication
Start LV DAR	Output to LV DAR	Internal Signal
Lockout LV DAR	Output to LV DAR	Internal Signal
Start HV DAR	Output to HV DAR	Internal Signal
Lockout HV DAR	Output to HV DAR	Internal Signal
Function Healthy	Indicates healthy state	Internal Signal

6.2 Operation

The Transformer function is associated with a Transformer connected to the mesh corner. It responds to faults detected by the transformer protection controlling isolation of the plant and initiation of DAR if required.

- The function has two main states Faulty and Healthy; the transition to the faulty state occurs when the input Function Faulty is set. When in the Faulty state the check on the isolator position is executed and the outputs set accordingly. However, no switching operations are executed while in this state.
- The state of the transformer isolator is monitored by the transformer function and the position indicated to other MCU modules. If the dual point status input is invalid then the disconnector status alarm is set.
- The Transformer function is controlled by the mesh corner function with repeats of the controls to Enable/Disable Auto-Switching and DAR. This allows the following three modes to be selected:
- Auto-Switching and DAR Disabled – in this state the module will make no response to an initiation signal from the Feeder protection.
- Auto-switching Enabled and DAR Disabled – in this state the auto-isolation of the plant will occur as defined in the Table below. However, the DAR will not be started for a fault detected.

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- Auto-switching enabled and DAR Enabled – in this state auto-isolation and DAR will take place depending on the nature of the trigger and the plant status.

The following table indicates the response of the module to the trigger. It assumes that the function is in the healthy state and that both auto-switching and DAR are enabled.

Trigger	Disconnector	Reclaim	Action
Transformer Fault – No DAR	Closed	No	Open Disconnector, Start Mesh DAR + Lockout LV DAR
	Open	No	Lockout Mesh + LV DAR
	Closed	Yes	Open Disconnector, Start Mesh DAR + Lockout LV DAR
	Open	Yes	Lockout Mesh + LV DAR

The detailed operation of the Transformer Function block is shown in the State Charts in the figures below. The interface between Feeder Function and other Function Blocks is done through the PSL.

The transformer function can be split into three function blocks, each block is represented by a state diagram:

Figure 12: Transformer Status: Monitor the Transformer disconnector position status

Figure 13: Transformer DAR Interface: Respond to Transformer protection signals

Figure 14: Transformer Auto-Switching: Manages the switching logic for the disconnector

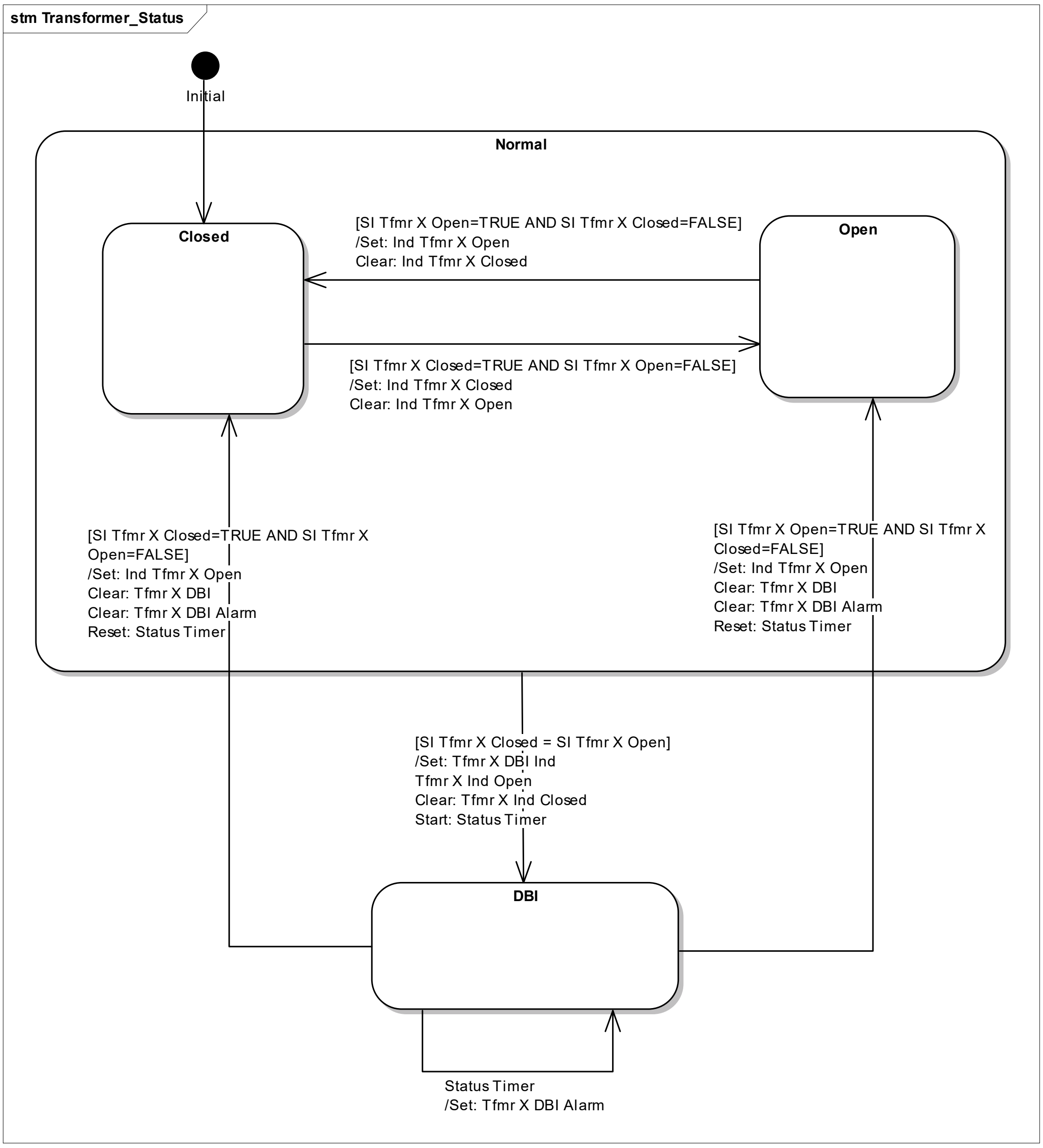

Figure 12: Transformer function - disconnector status

DDB Reference	Transformer 1	Transformer 2	Transformer 3
SI Tfmr X Open	513	545	577
SI Tfmr X Closed	512	544	576
Tfmr X DBI	531	563	595
Tfmr X DBI Alarm	263	264	265
Ind TfmrX Closed	533	565	597
Ind TfmrX Open	534	566	598

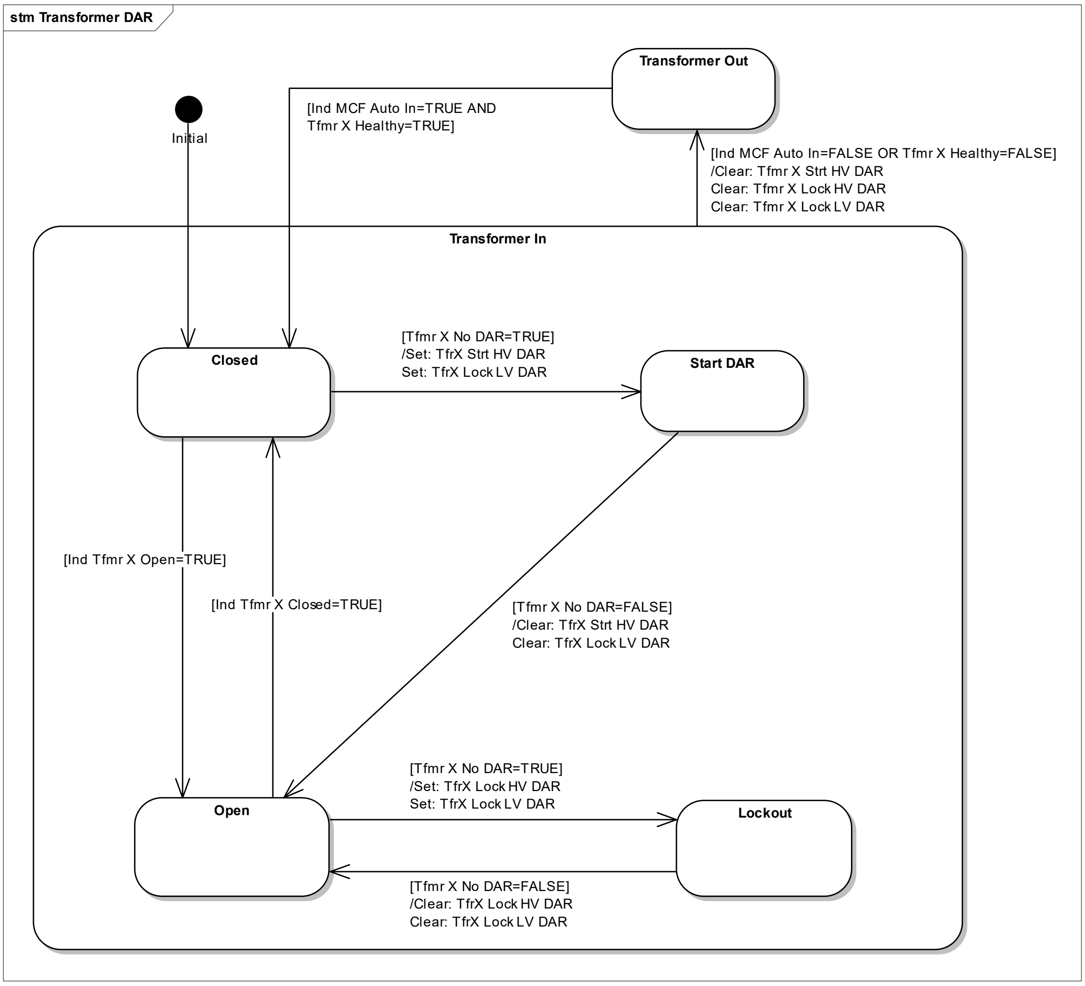

Figure 13: Transformer function – DAR interface

DDB Reference	Transformer 1	Transformer 2	Transformer 3
Tfmr X Healthy	526	558	590
Tfmr X No DAR	515	547	579
Tfmr X Strt HV DAR	528	560	592
Tfmr X Lock LV DAR	529	561	593
Tfmr X Lock HV DAR	530	562	594
Ind TfmrX Closed	533	565	597
Ind TfmrX Open	534	566	598

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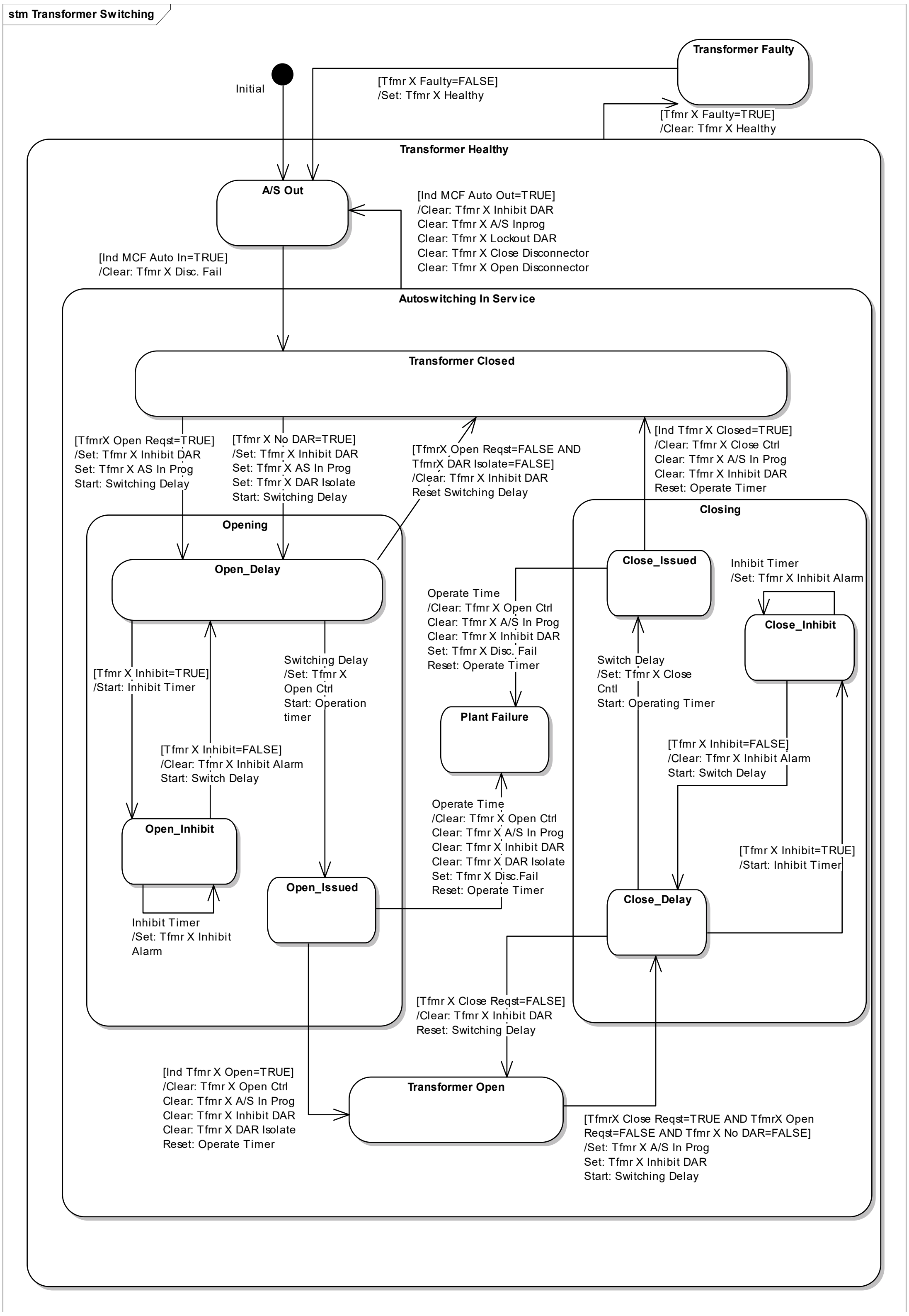

Figure 14: Transformer function - disconnector switching

DDB Reference	Transformer 1	Transformer 2	Transformer 3
Tfmr X Faulty	519	551	583
Tfmr X Healthy	526	558	590
Tfmr X No DAR	515	547	579
Tfmr X Open Reqst	516	548	580
Tfmr X Cls Reqst	517	549	581
SI Tfmr X Inhibit	514	546	578

DDB Reference	Transformer 1	Transformer 2	Transformer 3
Tfmr X Inhibit DAR	524	556	588
Tfmr X A/S In Prog	532	564	596
Ind TfmrX Closed	533	565	597
Ind TfmrX Open	534	566	598
Tfmr X Close Ctrl	522	554	586
Tfmr X Open Ctrl	521	553	585
Tfmr X Disc.Fail	270	271	272
TR X Inhibit Alarm	279	280	281

7. CB FUNCTION

The CB function allows control and monitoring of the circuit breaker adjacent to the corner. The P842 supports either one or two CB functions to be enabled allowing application to a single or four-switch mesh. The two CB Functions, when set, are independent and run in parallel. The circuit breaker function is controlled by signals initiated from within the same or another mesh corner unit. This allows application of the relay to a four switch mesh scheme using four P842 relays. Each P842 will only control one mesh CB directly.

7.1 Inputs and outputs

Note: For a detailed description of the Circuit Breaker Inputs and outputs refer to the P842 PL section.

Mesh Breaker and DAR

Inputs	Description	Type
Circuit Breaker Open	Breaker position	Status Input
Circuit Breaker Closed	Breaker position	Status Input
Start DAR	From other MCU modules	Internal signal
Inhibit DAR	From other MCU modules	Internal signal
Lockout DAR	From other MCU modules	Internal signal
No DAR		Status Input
Sequential disconnector position	Status input	
Auto-switch in service	From Mesh Function	Internal signal
DAR In service	From Mesh Function	Internal signal
In sync	From CB system checks	Internal signal
CB Function function Fault	Puts Module into Faulty state	
CB Local Inhibit	External inhibit due to low air pressure etc	Status Input

Outputs		
DAR In service	Indication	
DAR out of service	Indication	
Close CB	Output to Plant	
Open CB	Output to Plant	
CB Status Alarm	Indication	
Check sync	Output to LV DAR	
Function Healthy	Indicates healthy state	
Inhibit Sequential Isolation	Prevents opening of breaker sequential isolators	

7.2 Operation

The CB function provides a multishot auto-reclose facility for the breaker. Depending on the type of fault one reclose shot will be attempted. If a second trip occurs on reclosure then the DAR will be locked out. There is no sequence count within the DAR function, the lockout is set by the other mesh corner modules depending on the state of the system when the fault occurs.

- The DAR function for each circuit breaker can be individually configured as 'In' or 'Out' of service, dependent on a double point control input.
- If there is a discrepancy between the DAR In/Out input and/or the CB status inputs then an alarm will be raised.
- The CB function will start in the Healthy State; when the input CB Function fault is raised then the function is placed into the faulty state. The outputs Function faulty and DAR Out of Service will be set and switching operations disabled. The functions to check the state of the control inputs and status inputs will be executed. The CB Function response specified below assumes the function is in the healthy state.

7.2.1 DAR out of service

- When the DAR function is reset or powered up it will enter the state DAR Out of Service.
- When the control input DAR Out is set any pre-existing DAR sequences will be cancelled and the DAR function will enter the state DAR Out of Service.
- While in the operational state DAR Out of Service you will not be able to start or complete a DAR sequence.
- While in the state DAR Out of Service the indication DAR Out will be set.
- While in the state DAR out of Service Sequential Isolation will not be inhibited.
- An overview of the DAR operation is summarized in figure 15.

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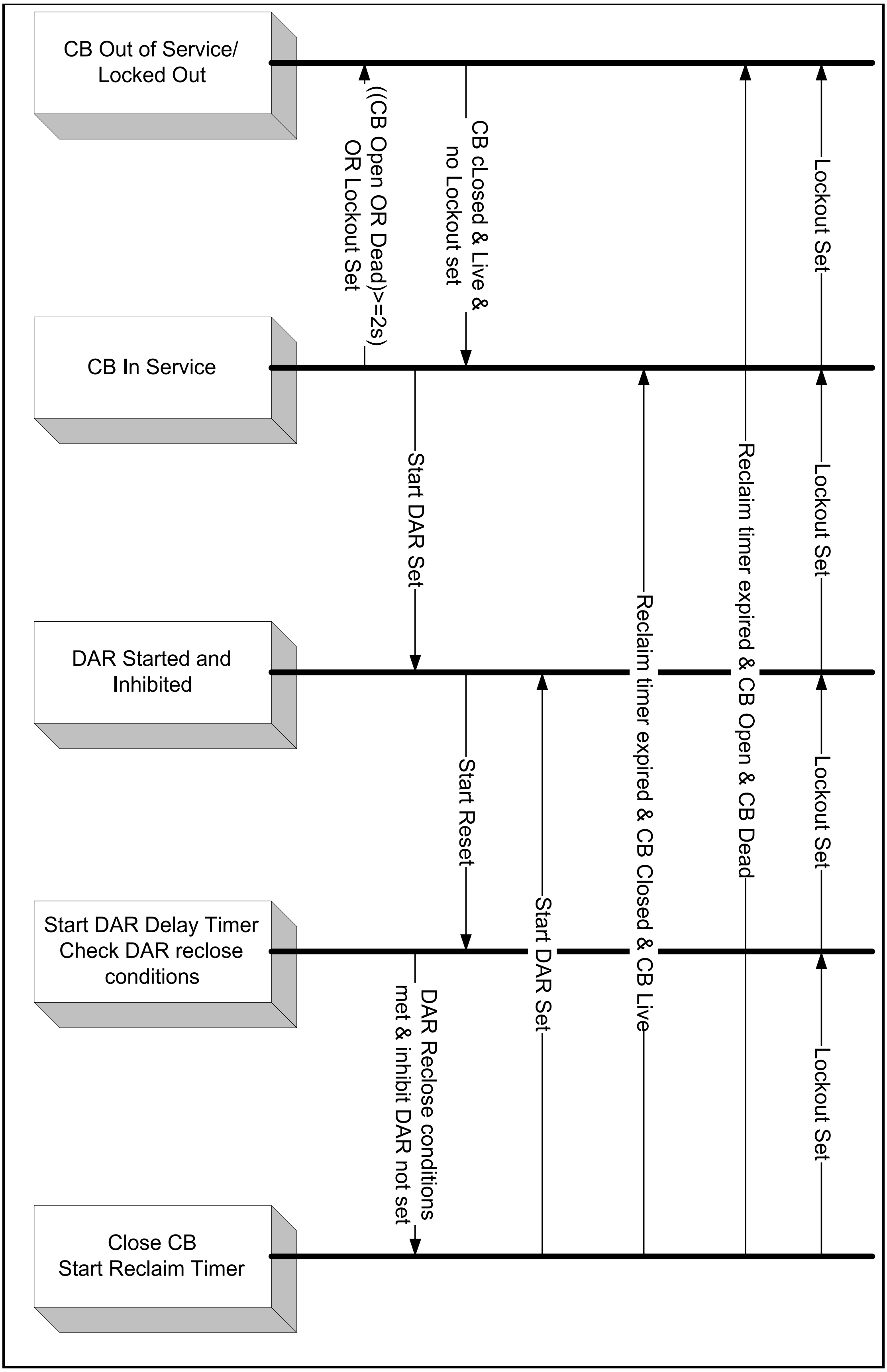

Figure 15: DAR overview state diagram

7.2.2 DAR in service

When the control input DAR In is set the DAR function enters the operational state DAR in Service.

While in the state DAR In Service the indication DAR In will be set.

7.2.3 DAR in progress

Once a DAR sequence has been started and until the DAR sequences have completed or been reset the indication DAR in Progress will be set.

7.2.4 Check DAR reclose conditions

With reference to the DAR sequence detailed in Figure 7, when the DAR sequence reaches the operational state Start DAR delay Timer and Check DAR Reclose Conditions, the CB will be closed when the Conditions for Reclosure have been met.

7.2.5 Prevention of simultaneous CB operations

All CB switching operations are separated by the minimum switching delay so it is necessary to co-ordinate the switching actions of all four mesh corner units. When one unit is ready to close its breaker then all other CB functions are inhibited until the CB has operated and the minimum switching delay time has elapsed.

7.2.6 Sequential isolation

While a DAR sequence is in progress sequential isolation of the associated circuit breaker will be inhibited until the DAR sequence has been completed or Locked out.

Ref Reclose Mode	**Conditions for Reclosure**						
	Mode Selected (Yes/No)	**Minimum Inter-switch delay timer**	**Sync**	**DAR Delay Timer**	**CB Side “A” Volts**	**CB Side “B” Volts**	**Start DAR & Inhibit DAR**
Check Sync Close	Yes	Expired	In sync	Don’t Care	Live	Live	Not Set
Dead Side “A” Close	Yes	Expired	Not in sync	Expired	Dead	Live	Not Set
Dead Side “B” Close	Yes	Expired	Not in Sync	Expired	Live	Dead	Not Set
Close after time delay	Yes	Expired	In sync OR Not in Sync	Expired	Live OR Dead	Live OR Dead	Not Set

Table 3 : DAR reclosure conditions

The detailed operation of the CB Function block is shown in the State Charts in figures 17-18. The P842 relay must perform and match the signals state providing that the applied conditions are true. The interface between the CB Function and other Function Blocks is done through the PSL. The CB function is split into three key areas, each of which is documented using a state chart. They are as follows:

Figure 16: CB Status – Includes several small state charts to manage the status of the circuit breaker.

Figure 17: CB DAR Logic – The main DAR logic for the circuit breaker control.

Figure 18: CB Token Logic – Implements the token system used to prevent simultaneous closure of mesh circuit breakers.

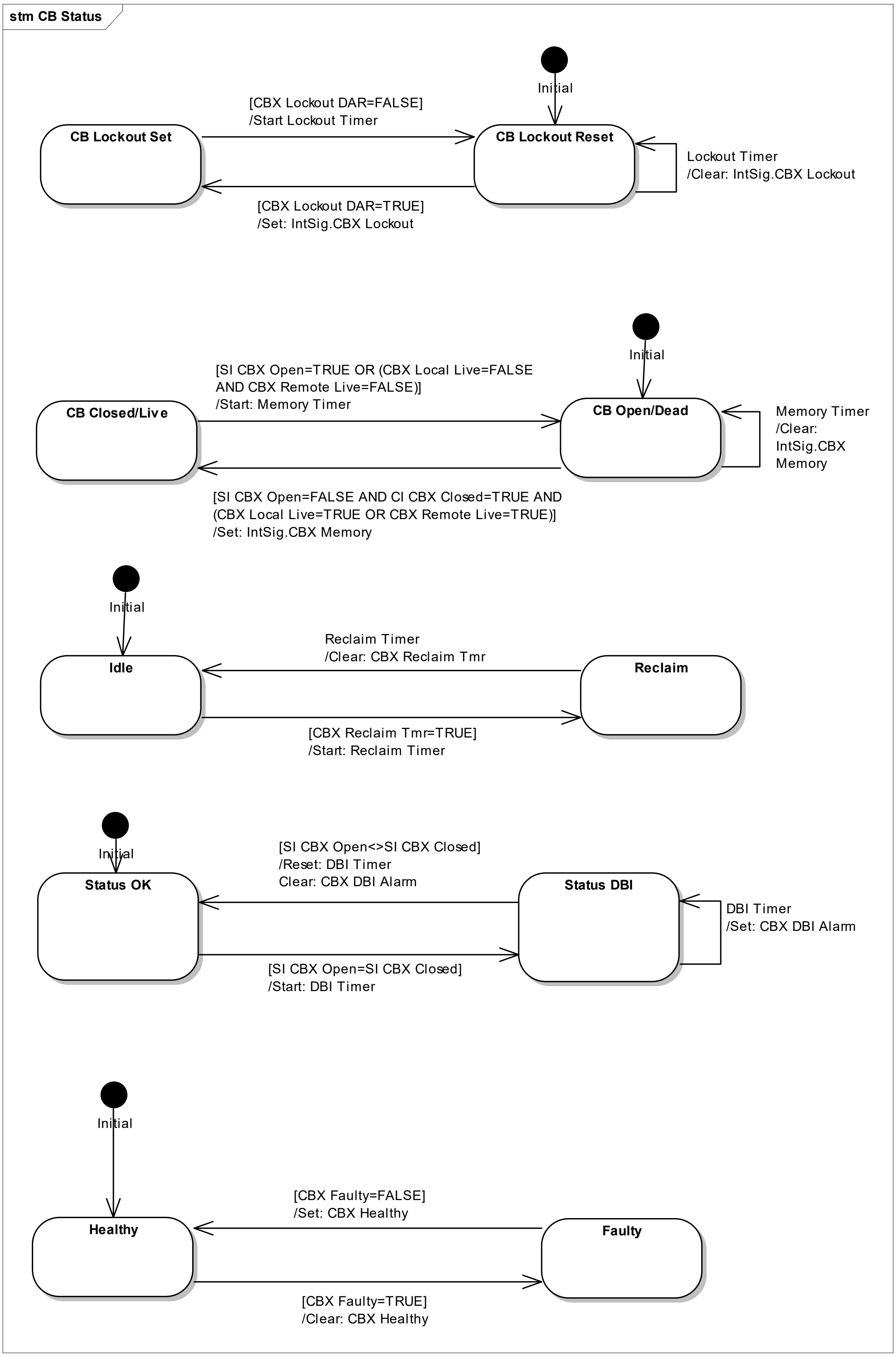

Figure 16: CB function – CB status state chart

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DDB Reference	Circuit Breaker 1	Circuit Breaker 2
CB X Lockout DAR	678	710
SI CBX Open	674	706
SI CBX Closed	675	707
CBX Local Live	647	663
CBX Remote Live	649	665
CBX Reclaim Tmr	702	734
CBX DBI Alarm	266	267
CBX Faulty	683	715
CBX Healthy	682	714

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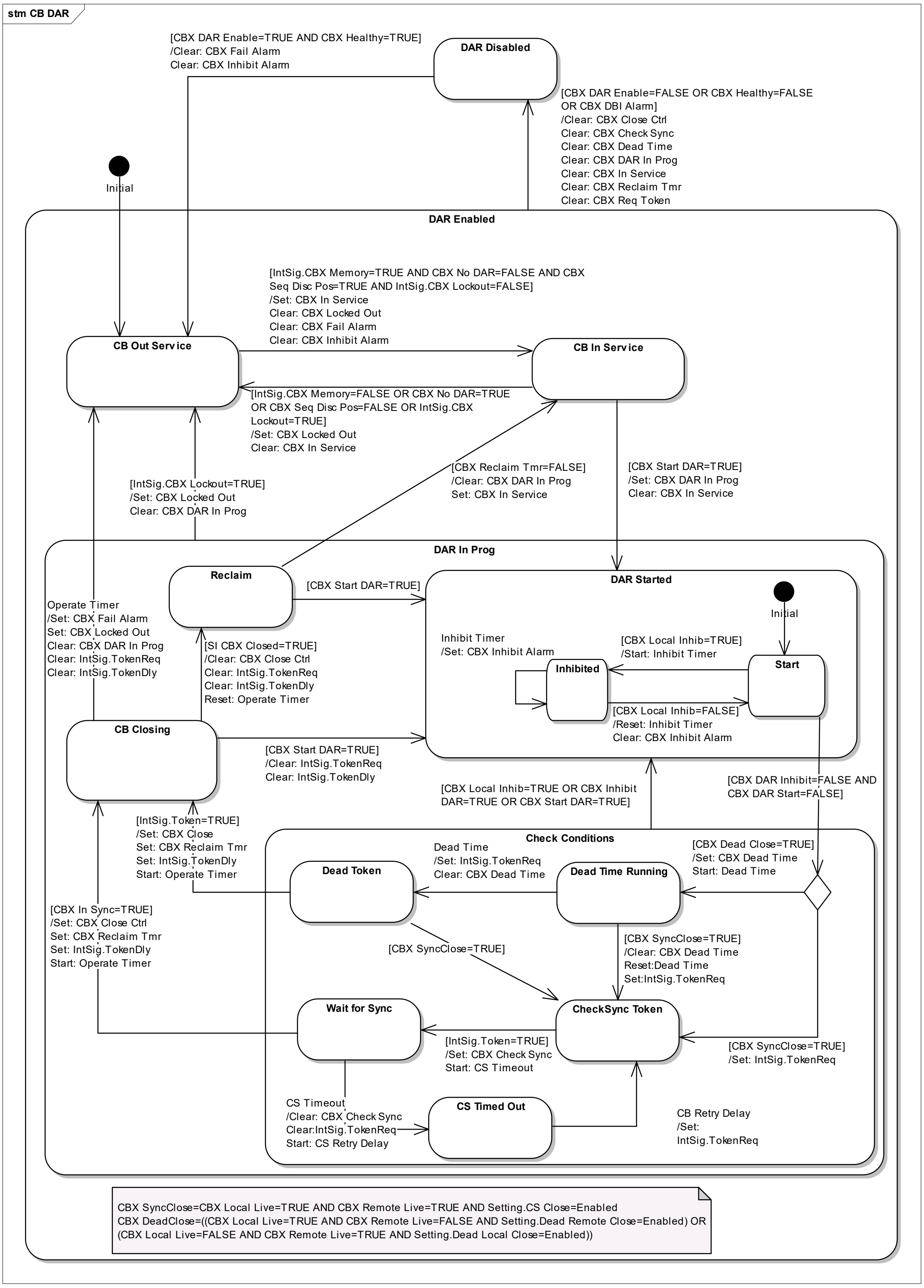

Figure 17: CB function – CB DAR logic state chart

DDB Reference	Circuit Breaker 1	Circuit Breaker 2
CBX Start Dar	676	708
CBX Inhibit Dar	677	709
CBX No Dar	679	711
CBX Seq Disc Pos	680	712
CBX In Sync	681	713
CBX DAR In Prog	684	716
CB1 Close Ctrl	689	721
CB1 Local Inhib	690	722
CB1 Check Sync	691	723

DDB Reference	Circuit Breaker 1	Circuit Breaker 2
CB1 Dead Time	692	724
CB1 Inh Seq Disc	693	725
CB1 In Service	694	726
CB1 Locked Out	695	727

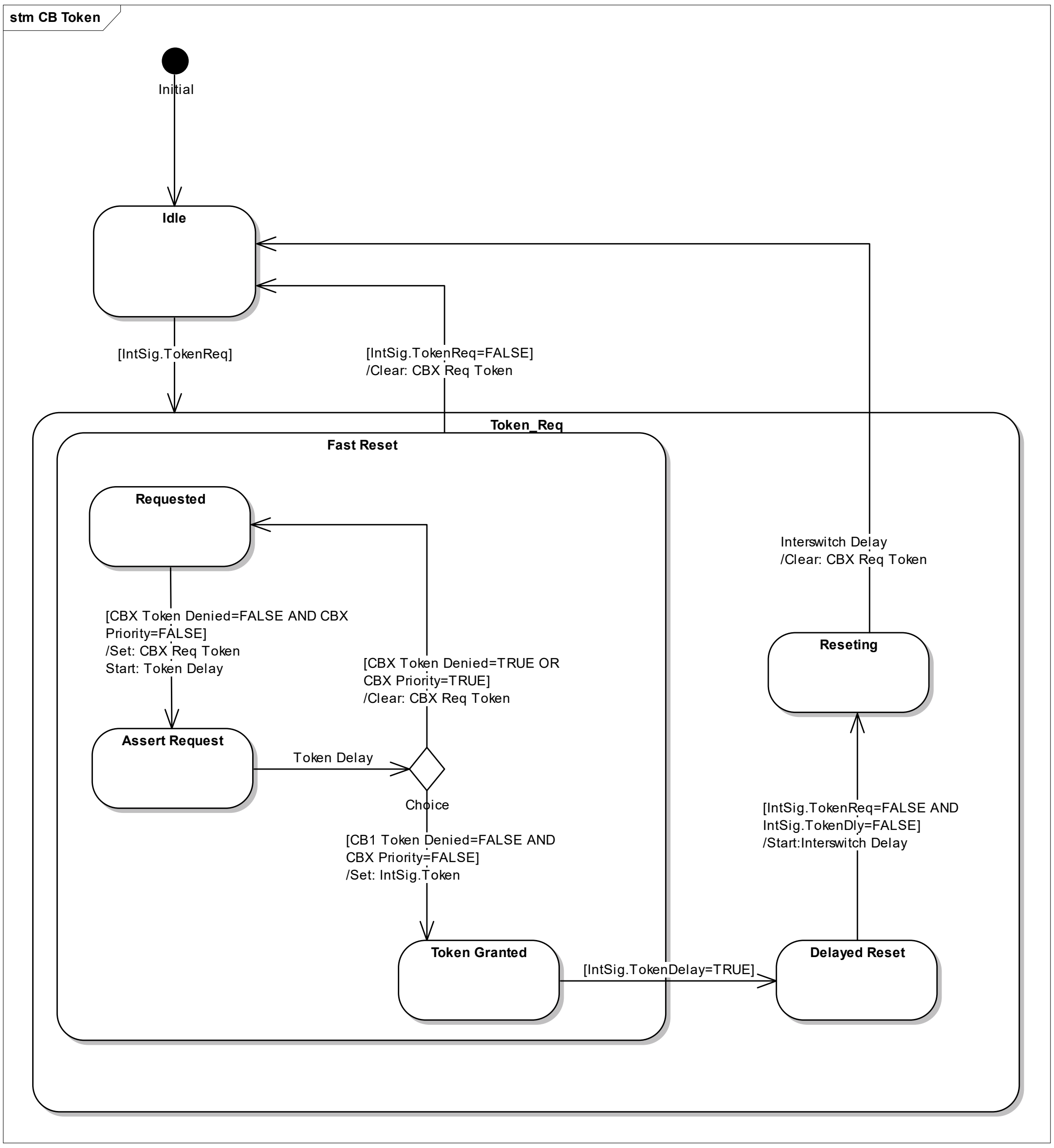

Figure 18: CB function – CB token logic state chart

DDB Reference	Circuit Breaker 1	Circuit Breaker 2
CBX Req Token	685	717
CBX Token Denied	686	718
CBX Priority	687	719

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8. LV DAR INTERFACE

The P842 does not implement an LV DAR function but it does provide an interface to the equipment. This will generally be interfaced to the LV DAR using physical contacts from the P842. The logic to define this interface will be implemented through the PSL using the signals available from the in-built function blocks.

Outputs
Start LV DAR
Inhibit LV DAR
Lockout LV DAR

9. SYSTEM CHECKS

The check synchronism function is associated with the CB function. The relay provides two independent Check-sync functions. The check sync functionality provides for the following facilities:

- Two independent stages of check sync
- System split indication
- Live/Dead Line and Bus signals

9.1 Inputs and outputs

There are four independent analogue voltage inputs suitable for phase to ground or phase to phase connection. The voltages are connected to the external voltage ring.

Note: For a detailed description of the System-Check signals refer to the P842 PL section. The settings are shown in the P842 ST section.

Inputs	Type	Description
Voltage Selector A1		Control Input
Voltage Selector A2		Control Input
Voltage Selector B1		Control Input
Voltage Selector B2		Control Input
Stage 1 Enable		Control Input
Stage 1 Block		Control Input
Stage 2 Enable		Control Input
Stage 2 Block		Control Input

Outputs		
System Checks Active		Status Indication
Stage 1 Sys Check OK		Status Indication
Stage 2 Sys Check OK		Status Indication
System Split Indication		Status Indication
Side A Live		Status Indication
Side A Dead		Status Indication
Side B Live		Status Indication
Side B Dead		Status Indication

9.2 Operation

To ensure flexibility of the checksync function it is possible to configure the A/B voltage inputs from the four VT inputs using logic signals from the DDB. By default the voltages are allocated to fixed inputs allowing an external voltage selection scheme to be used.

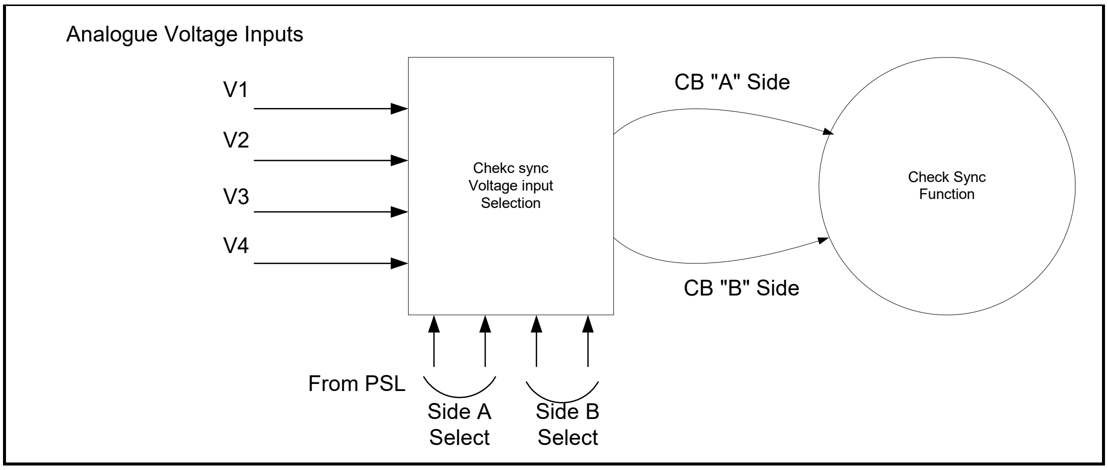

Figure 19: Voltage mapping for system check function

The following diagram provides an overview of the check sync functionality:

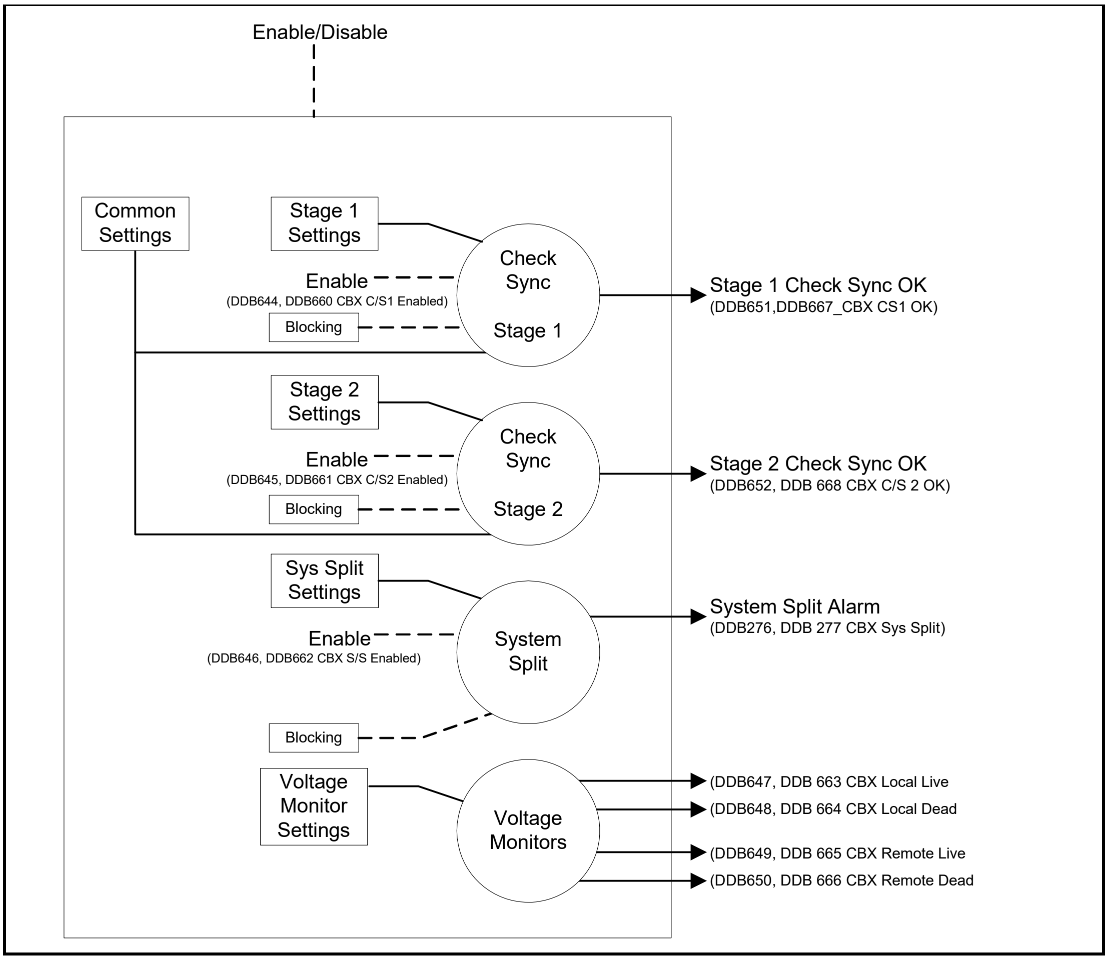

Figure 20: System check functionality

The function provides two independent stages of Check-sync for the circuit breaker.

- A system split detection is also provided; the output signal can be used for indication purposes or for control/blocking of the reclose.
- The system split indication is raised when the two voltages are out of phase by more than the angle setting.

- Two stages of check sync are provided; the same settings are provided independently for each stage. This allows one stage to be used for check sync and the other applied as System sync.
- All outputs from the checksync function including system split and the voltage monitor signals are available as signals for the programmable logic of the relay. In this way they can be used as required for auto-closure of the breaker.
- The check sync element can be blocked by any combination of the following voltage criteria:
    - Under voltage
    - Overvoltage
    - Differential voltage
- The check sync element will be blocked if the slip frequency exceeds the user setting.
- The check sync provides a voltage monitoring function, which indicates the Live/Dead status of each side of the circuit breaker.

10. FERRORESONANCE SUPPRESSION (SCHEME F3)

10.1 Inputs and outputs

Note: For a detailed description of the Ferroresonance Inputs and outputs refer to the P842 PL chapter.

Inputs	Description
Scheme In	Control Input
Scheme Out	Control Input
Ferroresonance Detected	Status Input
Start	Control Input
Lockout	Control Input
HV Disconnector Position	From other MCU modules
Local interlocks	Status Input
Reset Scheme	Control Input
Scheme Faulty	Puts scheme into faulty state

Outputs	
Ferroresonance alarm	Indication
Ferroresonance scheme Healthy	Indication
Configuration alarm	Indication
Scheme in Service	Indication
Scheme out of Service	
Inhibit local/Remote DAR	
Switching in Progress	
Open disconnector	
Close disconnector	

10.2 Operation

10.2.1 Suppression schemes

The Ferroresonance suppression module is designed to implement the F3 scheme using the default PSL. However, it should be possible to customize this to provide the other standard NGC schemes (F1, F2A, F2B and F4) by modifying the PSL.

- Scheme F1: Ferroresonance suppression should be set to Alarm only (F1).
- Scheme F2A/F2B: As above with Ferroresonance alarm configured to Lockout/Inhibit DAR using PSL.
- Scheme F3: Both Ferroresonance suppression should be set to transformer flapping (F3). The PSL will be used to connect the control to the transformer disconnector.
- Scheme F4: As for scheme F3, however the Ferroresonance will be suppressed by control of the earth switch. The same switching sequence is used however, the output will be used to close the earth switch instead of opening the disconnector and vica versa.

10.2.2 Alarm indication

With Ferroresonance suppression enabled then the function will respond to the signal Ferroresonance detected after the time delay (Ferroresonance Detection Time) the Ferroresonance alarm shall be set.

The Ferroresonance alarm resets instantly once the Ferroresonance detected signal resets.

10.2.3 Scheme healthy/faulty

When the input scheme faulty is energized the Ferroresonance detection scheme is disabled and no outputs (with the exception of the configuration alarm) are generated.

10.2.4 Flapping scheme out of service

When the double point control is used to take the scheme out of service the indication 'Scheme out' is asserted and any scheme operations are prevented. If the device is running a flapping sequence it will be cancelled.

10.2.5 Flapping sequence

With the scheme in service and the Ferroresonance alarm asserted, the receipt of the Start signal will cause the start of the flapping sequence (state prepare to open HV disconnector).

For the flapping sequence to run the input Local interlocks and the lockout need to be reset.

10.2.6 Prepare to open HV disconnector

When the prepare to open disconnector has started the switching delay timer should be started.

When the switching delay timer has expired the scheme will move to the state Open HV disconnector.

10.2.7 Open HV disconnector

While in this state the output Open HV disconnector will be set

Once the disconnector opens then the transition to HV disconnector open occurs.

10.2.8 HV disconnector open

On entry to this state the switching delay timer starts.

When the switching delay timer elapses the transition to the state Close HV disconnector occurs.

10.2.9 Close HV disconnector

On entry to this state the output close HV disconnector is set

When the confirmation of the closure of the HV disconnector is received the transition to the state flapping scheme reset occurs. If the conditions to allow the transition to Prepare to open HV disconnector are present the flapping of the disconnector will continue.

10.2.10 Reset scheme

The flapping scheme can be reset at any point in the sequence by either energisation of the Scheme reset input, a Lockout being set or by the Local interlocks being reset.

The detailed operation of the F3 Ferroresonance suppression is shown in the State Chart in figures 21-22. The P842 relay must perform and match the signals state as per figures 21-22, providing that the applied conditions are true. The interface between the Ferroresonance Function and other Function Blocks is done through the PSL.

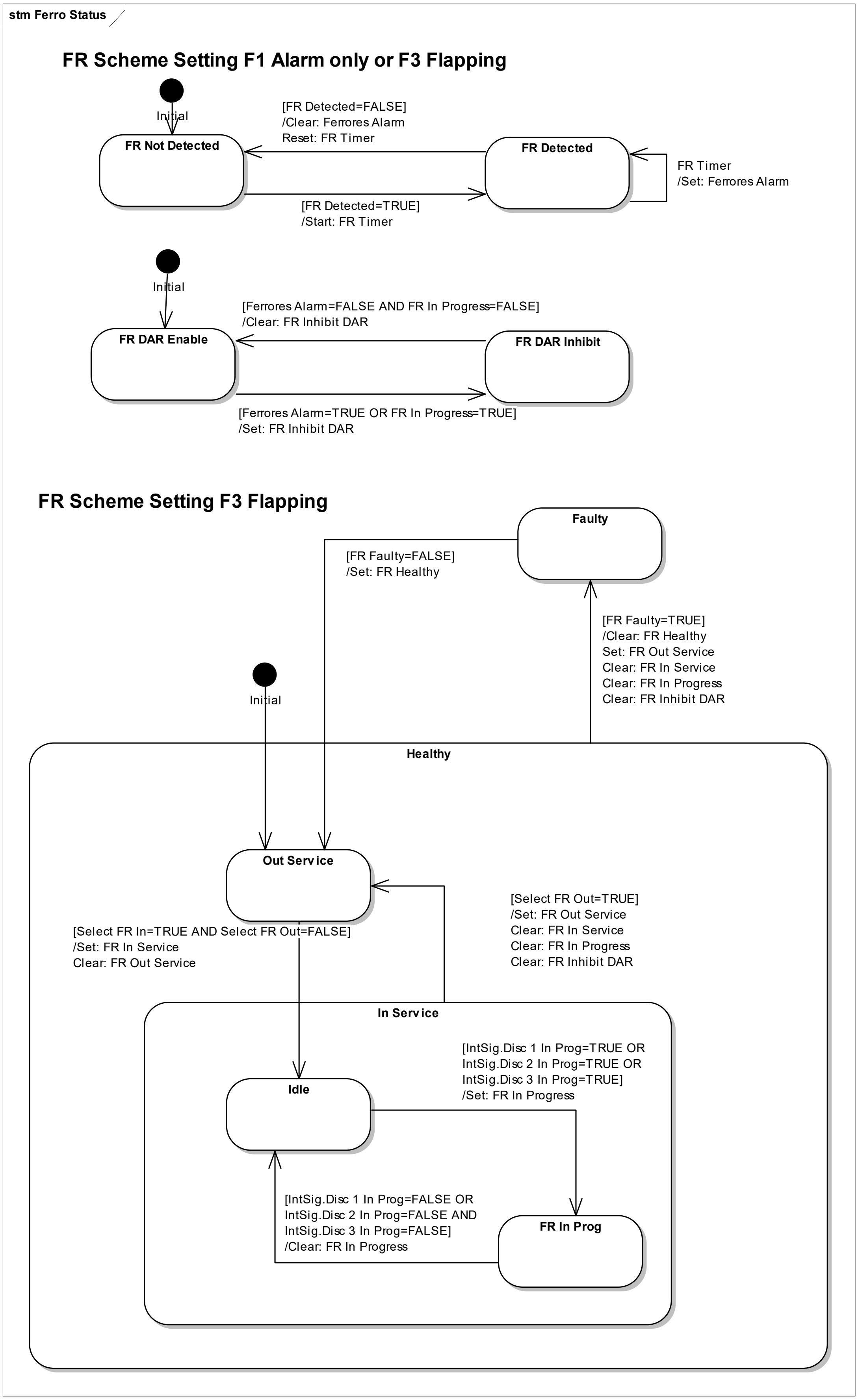

Figure 21: Ferroresonance status - state chart

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DDB Reference	
Select FR In	736
Select FR Out	737
FR Detected	738
FR Start	739
FR Lockout	740
Reset FR	742
FR Faulty	743
FR Healthy	745
FR In Service	746
FR Out Service	747
FR Inhibit DAR	748
FR In Progress	749

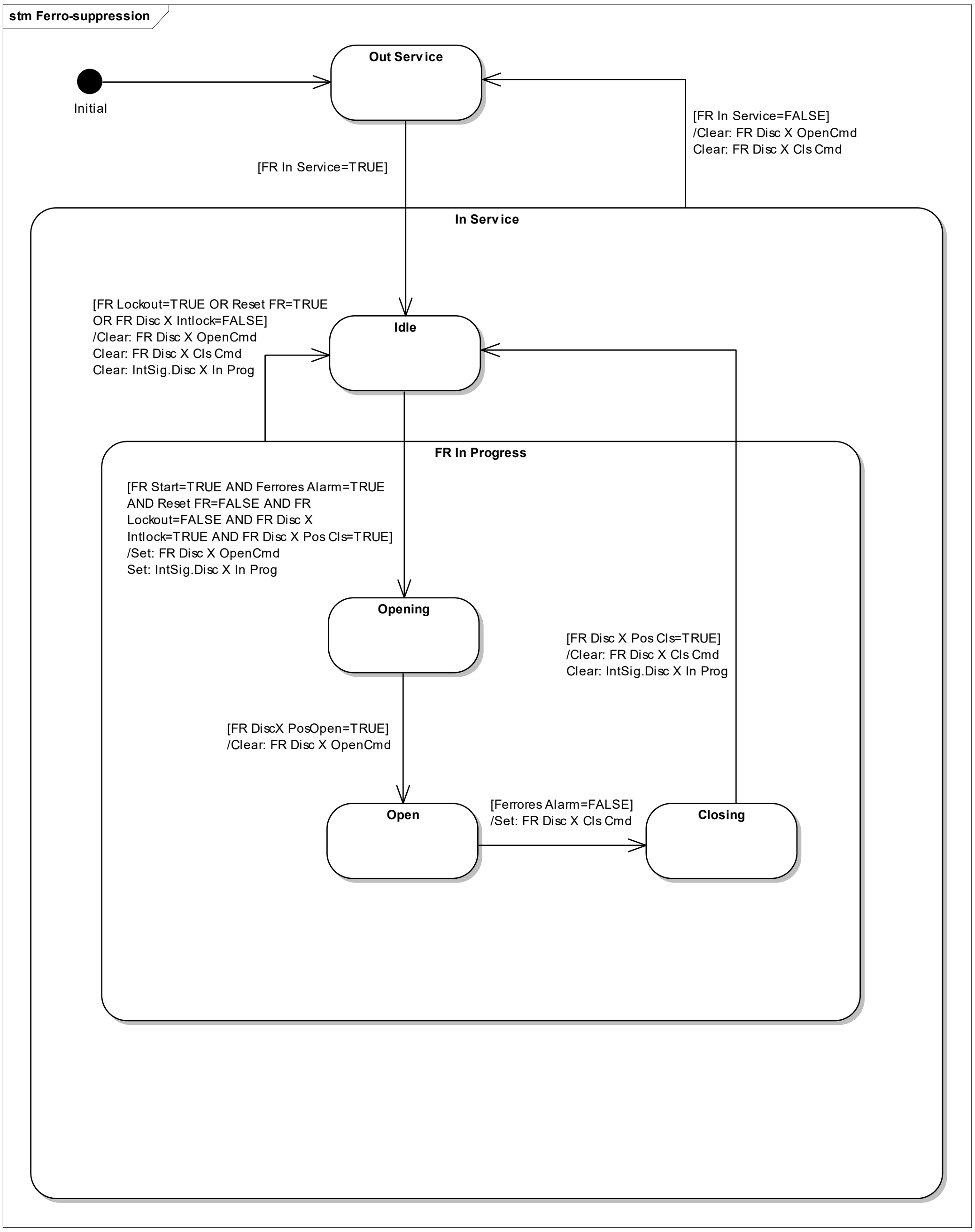

Figure 22: Ferroresonance F3 flapping scheme - state chart

DDB Reference	Disconnector 1	Disconnector 2	Disconnector 3
FR Disc1 Intlock	750	754	758
FR Disc1 OpenCmd	751	755	759
FR Disc1 Cls Cmd	752	756	760
FR Disc1 Pos Cls	753	757	761
FR Disc1 PosOpen	762	763	764

The above state diagram shows the flapping logic for a single transformer disconnector. Up to three instances of the above logic can exist based on the number of transformers enabled in the P842 settings. The signal number for each instance of the scheme are indicated below.

Note: The disconnector status and close/open commands must be connected to the transformer via the programmable logic. This allows for customization of the flapping scheme. Also, the Ferroresonance flapping logic does not include a switching delay as this is implemented within the transformer switching logic.

11. FERRORESONANCE DETECTION

Ferroresonance detection is not included in the P842. The relay accepts an external signal via opto inputs.

12. TRIP CIRCUIT RESET

The P842 includes the logic for the automatic reset of an external latched trip relay. The logic below is used for cases where individual latching trip relays are used. In other case, for example Warley, where a single latching Intertrip send relay is used then the reset logic will be implemented using the PSL feature for flexibility. While the trip relay is latched then both local and remote DAR sequenced are inhibited. The reset of the trip is subject to the logic specified below.

12.1 Reset time

The fixed logic trip relay reset scheme does not provide settable timers. There are two different timers available in the PSL:

- Short Reset delay 0 to 200s step 1s, default setting 10s
- Long Reset delay 0 to 200s step 1s, default setting 120s

12.2 Operation

The trip reset logic assumes a single latched trip relay rather than separate latch relays for each protection function. The following reset criteria for each trip have been implemented:

CB Fail Trip – Reset after 120s

Feeder Trip (DAR Required) – Reset after 10s (No CB Fail, No Ferroresonance, No Isolator DBI, Line Isolator closed)

Feeder Trip (DAR Required) – Reset after 120s (No CB Fail, No Ferroresonance, No Isolator DBI)

Feeder Trip (DAR Not Required) – Reset after 120s (No CB Fail, No Ferroresonance, No Isolator DBI)

Intertrip – Reset after 10s (No CB Fail, No Ferroresonance, No Isolator DBI)

Transformer Trip – Reset after 10s (No CB Fail, No Ferroresonance, No Isolator DBI, Transformer isolator open)

Mesh Trip (DAR Required) - Reset after 10s (No CB Fail, No Ferroresonance, No Isolator DBI, all Transformer isolators open)

Mesh Trip (DAR Not Required) – Reset after 120s (No CB Fail, No Ferroresonance, No Isolator DBI)

The trip relay can be reset manually using a push button. This can be routed through the P842 to record the event.

The following diagram shows the logical implementation of the above requirements. It has been drawn for a single Feeder and Transformer configured for the corner, however, the implementation provides for up to three transformers and two Feeders on the corner.

Note: The reset occurs when the last protection element resets, providing that there is more than one latched trip.

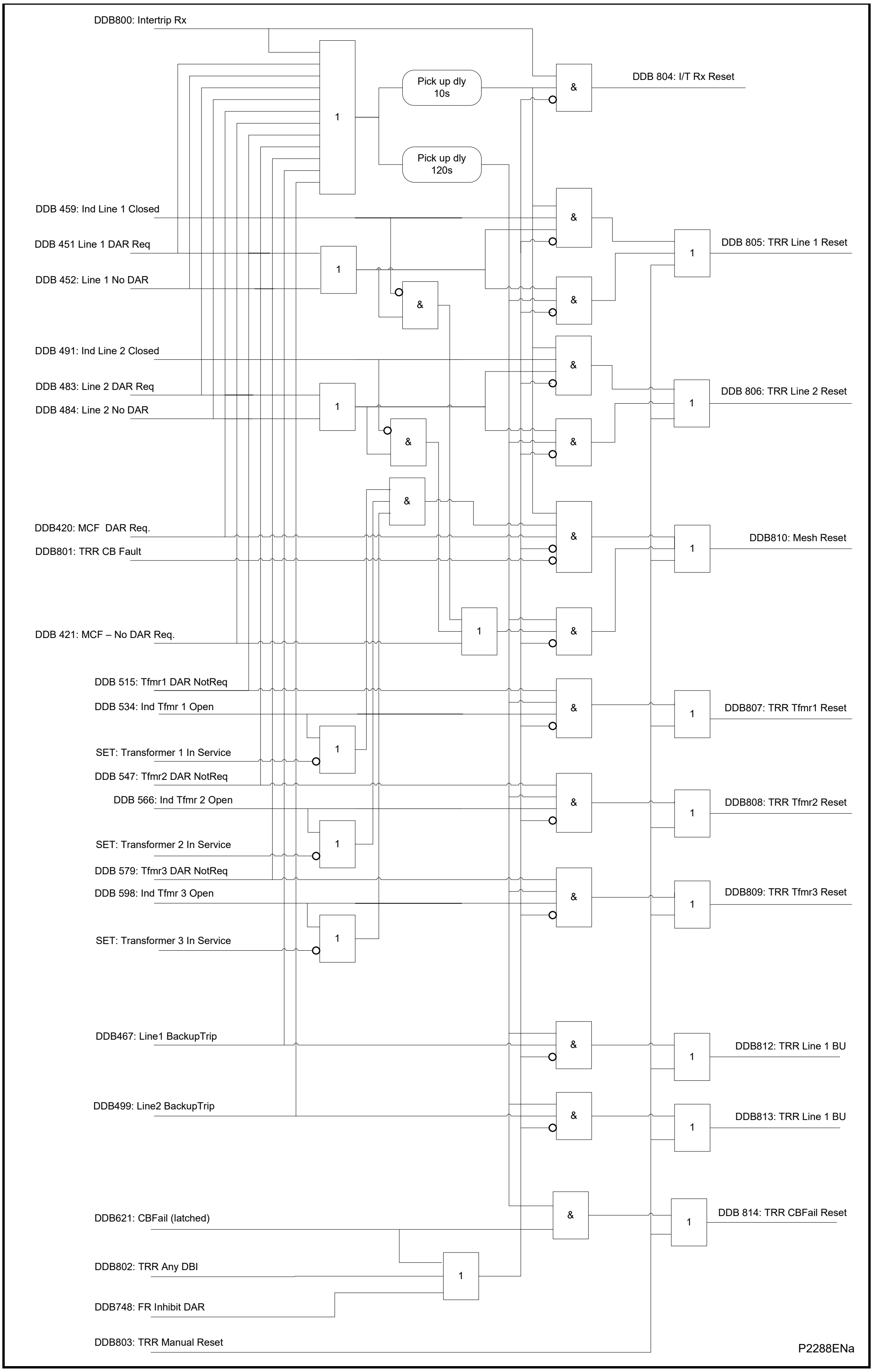

Figure 23: Trip relay reset logic

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13. PSL

The 4 switch mesh will require 4 x P842. These are located on each corner. The default PSL developed provides for connections to a single Feeder and two transformers connected to the corner.

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APPLICATION NOTES

Date:	**2019**
Hardware Suffix:	**B**
Software Version:	**04**

AP

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(AP) 6-

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FIGURES

1. INTRODUCTION

The P842 is designed for Automatic and Manual switching of mainly 4 Switch Mesh and single switch configurations, it does not include any protection functions. This document covers:

- Flexible configuration
- DAR (Delayed Auto-reclose)
- Auto-isolation
- Ferroresonance suppression
- Peer to peer communications and PSL
- Comprehensive diagnostics and commissioning aids
- Typical faults and P842 response

To assist in the understanding of a typical application of the P842 to a mesh corner arrangement typical fault scenarios together with the response of the relay are presented in Section 8.

Note: I/O connections for application of the P842 to a mesh corner with 1 Feeder and two banked transformer connected to the corner are shown in the P842/EN PL/A11 section. In this application it is assumed that each P842 will provide direct control of a single circuit breaker (the other adjacent CB being controlled by the adjacent P842).

This section outlines the main aspects of P842 applications. Due to the complexity of auto switching in 4 and single switch applications this Application Guide will not cover every application that can occur. However, the most common cases are considered and explained. For specific applications, contact General Electric.

2. FLEXIBLE CONFIGURATIONS

The P842 has a high level of flexibility and will accommodate most plant configurations.

P842 can be applied for Automatic switching to:

- Single switch system
- 2 switch system
- 3 switch system
- 4 Switch Mesh

P842 relays can also accommodate more complex schemes where the number of corners/ breakers exceeds four. The maximum number of relays that can be connected to the scheme via GOOSE communications is 32, providing that each P842 relay hardware requirement is not exceeded.

Note: Logic signals are mainly passed between adjacent P842 relays. Only a limited number of signals, such as prevention of closing more than one breaker at a time, are transmitted between all P842 units. As a result up to 32 P842's could work in an integrated autoswitching scheme, leading them to accommodate any existing scheme in practice.

The variation of typical switching arrangements is shown in Figure 1 below.

For Single switch arrangements, two P842 relays are required, as shown in Figure 1A. This accommodates the number of lines and banked transformers connected to the corners, and Ferroresonance suppression at each side of the breaker.

For extended single switch applications, two P842 relays are needed, as shown in Figure 1B and 1C below, where CB's could be on feeder or transformer side.

For a fully equipped 2 switch arrangement, three P842 relays are required, as in Figure 1D.

For 3 switch and 4 switch applications, four P842 are needed, as presented in Figures 1F and 1E below.

Peer to peer status relaying via UCA2 GOOSE (via either fiber or copper ethernet) allows different schemes to function with reduced hardwired connections between the relays.

The number of circuit breakers, lines and transformers to be controlled are included in the settings of each relay, so allowing a scheme of 2 or more relays to be suitably configured.

The basic "configuration" settings for each relay are:

- Number of connected feeders: 0, 1 or 2
- Number of banked transformers: 0, 1, 2, or 3
- Number of directly controlled circuit breakers: 0, 1 or 2

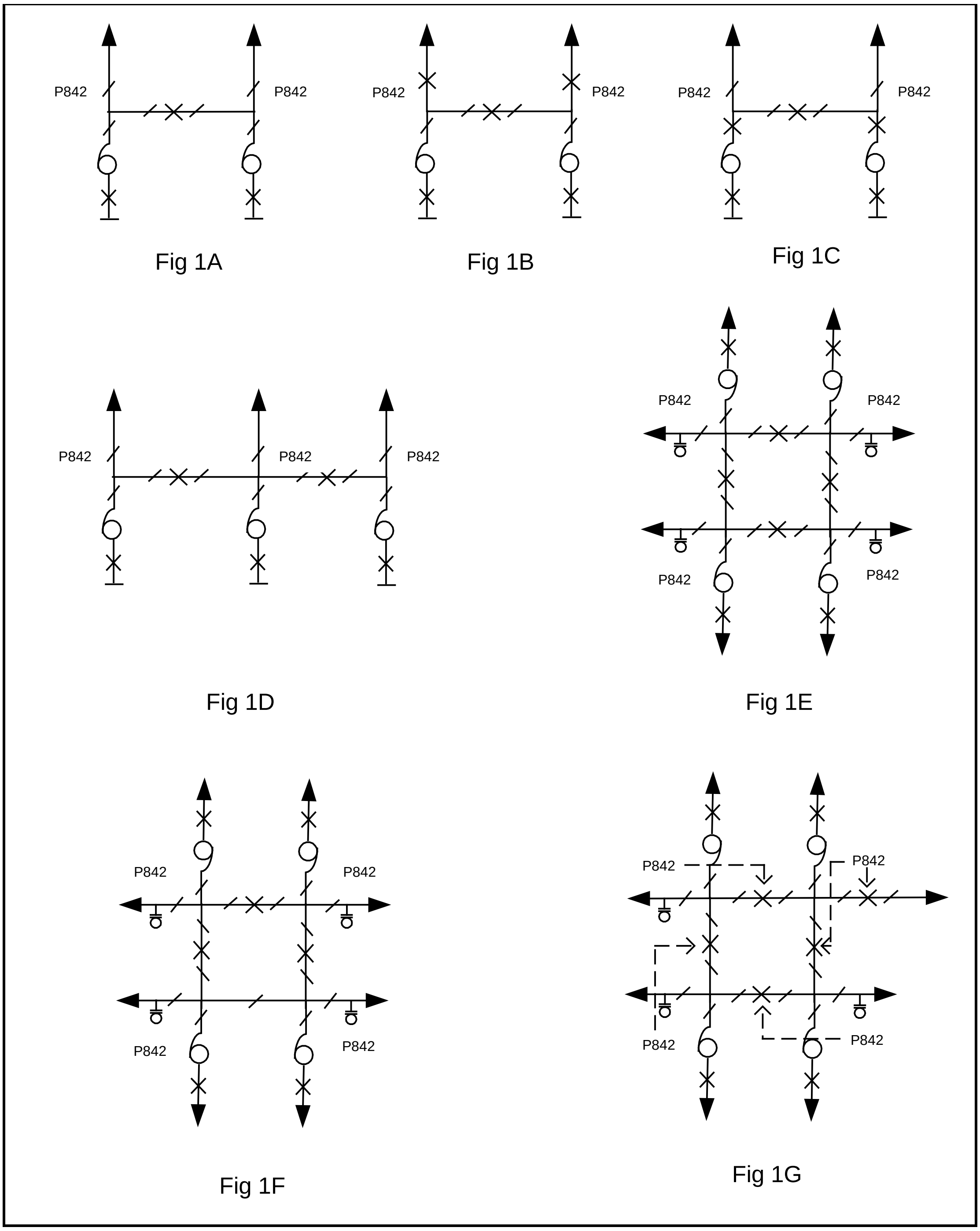

Figure 1: Number of P842 relays required for different switching arrangements

Settings for all three parameters are available in the P842/EN ST/A11 section.

Typical relay settings for the main arrangements are considered below:

- Figure 1A – each P842 controls directly or indirectly one, shared breaker. A user can assign CB auxiliaries to one P842 unit only, say to one being located at the left mesh. In that case, the CB setting for the left P842 unit will be 1. For any fault on the left mesh corner, the breaker will be directly controlled by the associated P842. If in this arrangement a fault appears on the right mesh, the P842 located at the right mesh, with the setting of CB=0, will perform DAR (subject to setting) and indirectly control the breaker by UCA2 GOOSE signaling to the "CBs controlled" function in the P842 on the left side of the scheme. Alternatively, it is possible to connect the auxiliaries and control circuit of the breaker to both P842's, in which case each P842 will have an equal setting CBs controlled=1, and will directly control the shared CB. The first arrangement makes less use of the relays physical I/O and simplifies plant wiring.

However, the advantage of such a scheme would be independent from the peer to peer communications, provided that the other signals important for the scheme to run independently, such as reclaim time sent to the adjacent MCU, are also hard-wired.

- Figures 1B & C – each P842 controls associated mesh corner and the mid breaker is shared. Left P842 unit, for instance, could be wired to the auxiliaries of the left line breaker (Fig 1C) and mid breaker, thus providing the direct CB controls for both breakers with setting CBs controlled=2. The remaining P842, located on the right mesh side will be wired to the line breaker and set to directly control only right hand breaker (CBs controlled=1). The above setting would be applicable if the number of lines and banked transformers at the right mesh exceeds the number of connected lines and transformers at the left mesh. If the number of the lines and transformers are not critical or if the ferroresonance suppression is not required, the number of controlled CB at each mesh side could be set to 2. This assumes that the auxiliaries of the middle breaker are connected to both P842 units.
- Figure 1D – Normally, two P842 located at each side directly control one breaker each (CBs controlled=1 on both P842's), while the P842 in the middle indirectly controls both breakers (setting CBs controlled=0). The variations in setting are possible if the number of connected lines/ transformers at one end, for example, are high or where ferroresonance effects are experienced.
- Figure 1E - Normally, each P842 controls one breaker (default settings).
- Figure 1F - Similarly to Figure 1E, the only difference to 4 switch mesh is that one breaker is replaced by a bypass disconnector. For such 3 switch configuration, 4 P842 units are needed.
- Figure 1G - Variations are possible in line with what has already been said above. In some cases, as illustrated in Figure 1F above, the P842 with its flexible application would allow for the mesh scheme to be extended. Note that P842, located in the upper right corner, directly controls two breakers and has setting CBs controlled=2, whilst the remaining three P842 units directly control one associated breaker (CBs controlled=1).

2.1 Constraints on the application of P842

The P842 software will provide for flexible applications with up to:

- 2 Feeders
- 3 Banked transformers (including Ferroresonance suppression)
- 2 breakers (including System Checks)

A P842 relay, occupying a full 19' rack with 4 VT inputs, 48 opto inputs and 32 output relays can support the application as above but some functions may require contacts to be multiplied using external auxiliary relays. The allocation of the relay physical I/O will also be influenced by the interface to a control system. If commands and relay status are communicated to the relay via communications more I/O can be used for plant interfacing.

Without the use of contact multipliers, P842, in hardware terms, can support up to:

- 1 line, 3 transformers, CBs controlled=1, no ferroresonance suppression
- 1 line, 2 transformers, CBs controlled=1, ferroresonance suppression
- 1 line, 1 transformers, CBs controlled=2, ferroresonance suppression

The above table provides a rough guide to the capability of the P842; this will depend on the exact scheme requirements and the interface to the SCADA.

3. AUTO-ISOLATION

Auto-isolation is automatic isolation of a faulted part of the electrical network after the circuit has been tripped, thus securing the maximum level of network interconnection by reclosing the remaining, healthy parts and restoring the power supply. To perform Auto-isolation, motor driven disconnectors are required.

P842 DAR supports only systems with 3 phase tripping. The Auto-isolation would normally be performed in highly interconnected electrical networks where system stability is not an issue.

P842 provides an auto-isolation for up to two feeders and three banked transformers connected to a Mesh corner.

Transformer disconnectors will be opened immediately after clearing a transformer fault, providing that the AUTOSWITCHING IN SERVICE was set. If AUTOSWITCHING OUT OF SERVICE is set, two adjacent Mesh circuit breakers and LV breakers will lock out and transformer disconnector will remain closed.

Line disconnectors will be opened immediately after clearing line fault depending on the initiating fault condition and the transient/permanent nature of the fault. If Auto-isolation was unsuccessful for any reason, the circuit breakers on both HV and LV sides will be locked out.

4. DAR

Delayed auto-reclose (DAR) will depend on two different factors as follows:

- P842 settings
- The type and location of the fault, where DAR may or may not be required

4.1 P842 controls

P842 controls consist of:

- Autoswitching in/out of service
- DAR in/out of service

These controls are implemented as signals within the relay logic and can be operated either by the relay opto inputs or through the control inputs from the relay menu/communication interfaces. Mapping of the optos/control inputs to the control signals is achieved through the Programmable Scheme Logic. By default this allows either optos or the control inputs to be used.

Note: These control are edge triggered and should not be set continuously.

The control AUTOSWITCHING OUT OF SERVICE forces DAR OUT OF SERVICE. Therefore, the following three service states are available:

1. AUTOSWITCHING IN SERVICE/ DAR IN SERVICE
(P842 action = auto-isolation provided, DAR provided

2. AUTOSWITCHING IN SERVICE/ DAR OUT OF SERVICE
P842 action = auto-isolation provided, no DAR)

3. AUTOSWITCHING OUT OF SERVICE/ DAR OUT OF SERVICE
(P842 action = no auto-isolation, no DAR

Term ‘service state’ instead of setting is used to reflect more accurately the relay operating mode since the above three possible operating states are combination of settings and control signals.

On relay energisation, AUTOSWITCHING OUT OF SERVICE and DAR OUT OF SERVICE (State 1) will be set.

Note: DAR In/Out control is applied to both circuit breakers adjacent to the corner.

4.2 Protection interface

The P842 is designed to receive protection tripping inputs from three types of protection associated with the mesh corner:

- Mesh corner busbar protection
- Feeder protection
- Transformer protection

Depending on the protection input, the relay service state and the operation of the reclaim timer on the adjacent circuit breakers the P842 will perform any auto-isolation of the plant disconnectors and reclosure of the breakers as required.

The P842 will also perform the logic associated with the reset of the latching relays associated with the protection relays and ferroresonance suppression.

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4.2.1 Mesh corner protection

The P842 accepts two inputs from the mesh corner protection:

- DAR Required
- DAR Not Required

In the case of a DAR Not Required the busbar fault is considered to be permanent; the P842 will isolate any Feeders and Transformers connected to the corner and Lockout reclosure of the adjacent mesh circuit breakers.

In the case of a DAR Required the P842 will isolate all transformers connected to the corner and then attempt to reclose the adjacent circuit breakers. However, under the following circumstances isolation of the corner and lockout of the two breakers will occur:

- If the reclaim timer is running on either adjacent breaker (indicating closure onto a permanent fault).
- If there are either no feeders or transformers currently connected to the corner
- If a mesh corner fault also occurs on an adjacent corner

4.2.2 Feeder protection

The P842 accepts three inputs from the Feeder protection:

- DAR Required
- DAR Not Required
- Intertrip Receive

On DAR Required, the P842 relay will leave the feeder connected to the corner and attempt to reclose the adjacent mesh breakers. However, if the reclaim timer is running indicating reclosure onto a fault then the Feeder will be isolated prior to the closure of the mesh breakers.

On receipt of the signal DAR Not Required, the P842 will always open the Feeder disconnector prior to the reclosure of the corner.

If an intertrip is received, then one of two actions may be taken. When the intertrip signal is received for less than the duration of persistent intertrip timer then the corner will be reclosed with the line connected. However, if the duration of the signal is greater than the persistent intertrip timer (this is a signal from the remote end of the line not to reclose the Feeder) the line will be isolated prior to reclosure of the corner.

4.2.3 Transformer protection

A single input only is received from the Transformer protection DAR Not Required; on receipt of this signal the P842 will isolate the transformer and then reclose the mesh corner.

4.2.4 Interface to LV DAR

DAR for the LV circuit breakers will be contained within a separate device. P842 will provide control signals for co-ordination with the LV DAR.

4.2.5 Control of disconnectors

Plant voltage transformers, connected to the plain feeders, cables or hybrid connections, are monitored and used for reference. The operation of the disconnectors is interlocked by both external inhibits and by monitoring of the live/dead status of the disconnector. The P842 continuously monitors the disconnector status; in the case of invalid status of the disconnector or failure to operate then an alarm will be raised and the autoswitching on the corner will automatically be taken out of service.

5. FERRORESONANCE SUPPRESSION

A Ferroresonance phenomenon can be experienced when the circuit is tripped either manually or by protection. A tripped overhead line will remain connected to one or more banked transformers, since there is no circuit breaker in between. In such an event, the mutual coupling from the parallel line being in service, if it runs on the same pylons or in close proximity for at least 15km, will support the Ferroresonance in the electrically isolated line-transformer circuit as presented in figure 2 below.

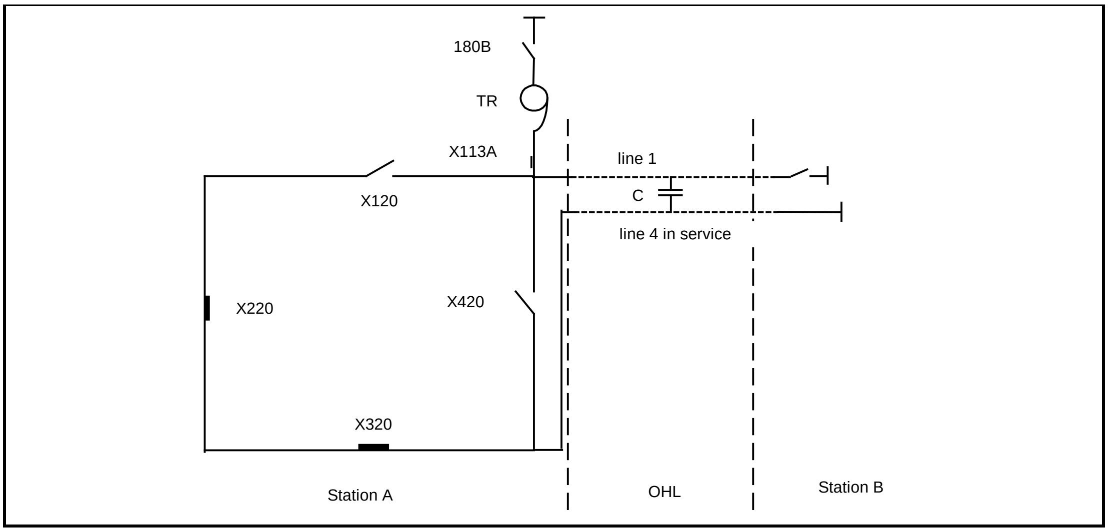

Figure 2: Typical scenario for ferroresonance occurrence

The isolated line1- TR circuit will have:

Voltage distribution per phase: (+1; -0.5; -0.5) or (+1; -1; 0)

Voltage magnitude: 1pu at 50Hz; 0.33pu at 16.67Hz; 0.2 pu at 10Hz etc.

If not removed prolonged Ferroresonance can damage the power transformer. Any reclosure during the presence of a Ferroresonance condition is dangerous and could damage plant isolation as the voltages are not sinusoidal at unpredictable angle and magnitude.

The P842 does not include a facility to detect the Ferroresonance condition on the system. This must be achieved using an external device. It does, however, provide control logic to implement a Ferroresonance suppression scheme.

The Ferroresonance suppression is achieved by:

- Opening and, after suitable time delay, closing transformer(s) disconnectors to disconnect line-transformer oscillatory circuit
- Closing and opening earth disconnectors to discharge an accumulated energy in line-transformer section

The default PSL will support transformer disconnectors flapping. It is possible thorough the PSL, using the same outputs, to change the functionality and control earth switches.

> **Note:** Opening and closing the transformer's disconnectors is the preferred option since the breaking capacity for earth switches may cause a problem. Similarly, opening and closing of line disconnector would be easier and would require less I/O but the breaking capacity of a line disconnector is usually low, particularly when more transformers are banked. The maximum number of transformer disconnectors or earth disconnectors is limited to 3.

During the operation of Ferroresonance flapping logic reclosing of the local HV/LV circuit breakers and remote circuit breaker is inhibited. The inhibit for the remote circuit breaker is implemented by preventing the intertrip send relay from resetting until the Ferroresonance condition has been cleared.

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6. UCA 2 GOOSE PEER TO PEER COMMUNICATIONS AND PSL

The peer-peer communication scheme is implemented over Ethernet communications using the GOOSE (Generic Object Orientated Sub-Station Event) facility defined within the UCA2 and allows the communications in real time. The mapping of GOOSE signals is done through the Programmable Scheme Logic (PSL). For more details refer to the P842/EN PL/A11 section.

The P842 default PSL scheme is developed for 4 Switch-single CBs controlled and Single switch arrangements. It also includes auto-isolation for 1 feeder and 2 banked transformers and Ferroresonance suppression controlling 2 transformer disconnectors. It is necessary for the PSL to be modified to provide for a different network topology or adaptions of the scheme logic.

7. COMPREHENSIVE DIAGNOSTICS AND COMMISSIONING AIDS

The P842 relay is split into logical functional blocks, some of them multiplied, to allow maximum flexibility for different applications.

These logical blocks are interconnected via user available DDB signals. This design allows a very low level of access to the relay. As a consequence, easy determination which block doesn’t perform towards a user expectation and “fault finding” which could be a result of conflict in settings or PSL or for any other reason. This split into functional blocks is very helpful to users with less experience in Automatic reclosing.

The relay provides facilities to monitor all logic input signals to the scheme including physical opto inputs, control inputs and GOOSE signals from the peer-peer scheme. To help the design of an auto-reclose scheme, particularly those which require modifications to the default PSL, it is possible to monitor the status of all of the internal scheme logic signals via the Commissioning chapter of the relay menu – see also P842/EN CM/A11.

8. TYPICAL FAULTS AND P842 RESPONSE

8.1 Topology

Four-switch mesh layout is presented in Figure 3 below. For simplicity, one line and one transformer feeder or transformer are connected to mesh corner 1 (MC1). If more lines and transformers are connected to the corner, they will respond in the same way if a fault has occurred on them, with the following exceptions:

- For the transient bus bar mesh corner fault, when DAR is required, all banked transformers will be isolated
- For the bus bar fault, when DAR is not required, all lines and banked transformers will be isolated
- For the persistent bus bar fault, DAR required, all transformers and all lines (after unsuccessful closure attempt) will be isolated

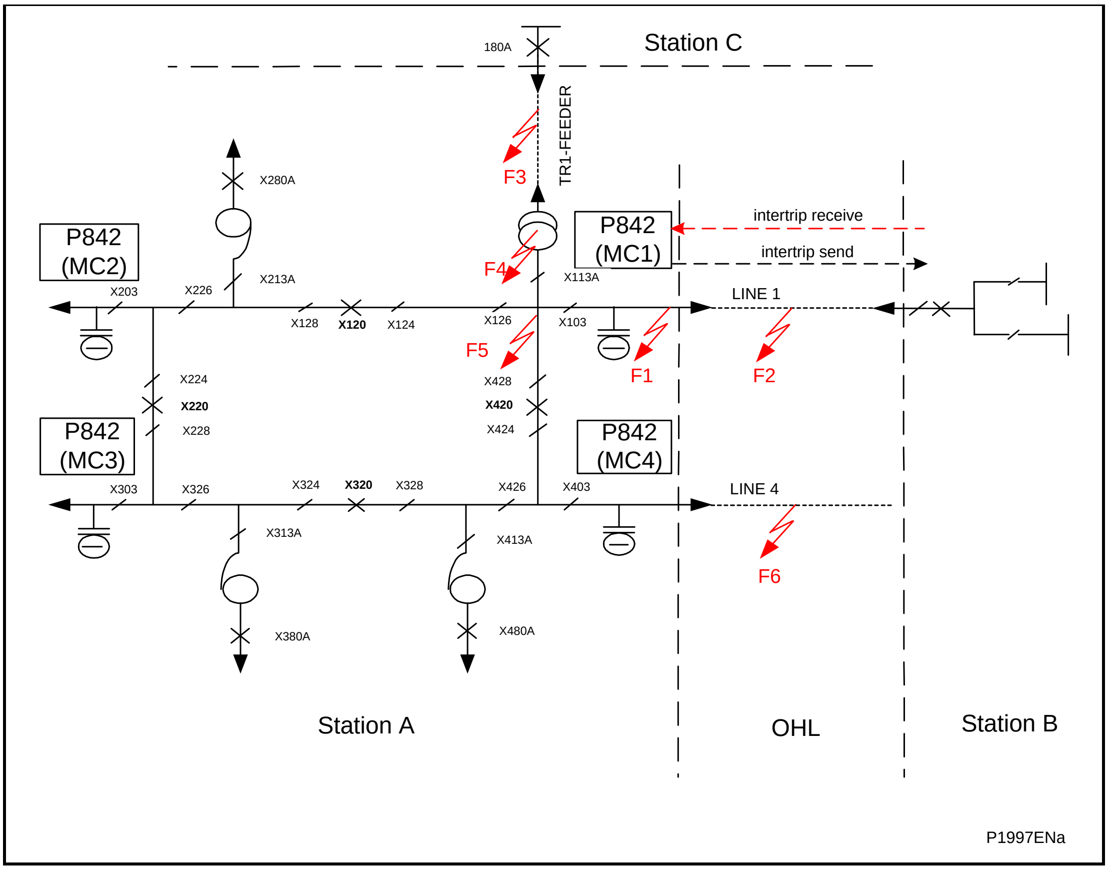

Figure 3: Typical faults in four switch mesh configuration

8.2 Applied faults:

Several typical faults are considered as follows:

- F1- fault on cable section or cable, DAR not required, local end recloses first
- F2- transient fault on overhead line, DAR required, remote end recloses first
- F2- persistent fault on overhead line, DAR required, local end recloses first
- TRANSIENT INTERTRIP – received from the remote end, remote end recloses first
- PERSISTENT INTERTRIP – received from the remote end
- F3- fault on feeder section of transformer feeder, DAR required, HV end recloses first
- F4- fault on transformer, DAR not required, HV end recloses first

- F5- Bus bar transient fault, DAR required (subject to utility practice), local end recloses first
- F5- Bus bar persistent fault, DAR required (subject to utility practice), local end recloses first
- F5- Bus bar fault, DAR not required
- EVOLVING FAULT – F2 transient fault followed up by F6 transient fault during X120 Dead Time, DAR required, local ends reclose first, X420 Dead Time >X320 Dead Time >X120 Dead Time, no Ferroresonance condition detected at either corner
- FERRORESONANCE DETECTED, F2 fault, DAR required, Ferroresonance suppression in service, local end recloses first
- FERRORESONANCE DETECTED, F2 fault, DAR required, Ferroresonance suppression out of service

8.3 P842 settings:

The following P842 settings at MCU1 is assumed:

- AUTOSWITCHING IN SERVICE
- CB controlled=1
- X120 Dead time < X420 Dead time

8.4 Definition of terms:

<EVENT> SIGNAL	- defines event external to the MCU1 which may affect its operation
MCU	- defines data communication between MCUs or between the and other interface units
EVENT‘START’	- defines the boundary of MCU activity
LV service.	- defines the initial conditions as being: all mesh breakers, all breakers and all plant disconnectors are closed and in
TOKEN	- confirmation of priority for CB closing, i.e. no higher priority CB closing has been asserted.

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8.5 Sequence of events:

8.5.1 F1 fault, DAR not required, local end recloses first

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
X103 OPENS
X120 RECLOSES DEAD LINE CHARGING LINE 1
X420 RECLOSES WITH CHECK SYNC
LV BREAKERS RECLOSE
PLANT OPERATION IN DETAILS
‘START’
<LINE 1 PROTECTION OPERATES>
<LINE 1 INTERTRIP SENT>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD

SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
SIGNAL X120 & X420 INHIBITED TO COMMON MCUs
SIGNAL OPEN X103
FEEDER PLANT SW DELAY TIME ELAPSED
<X103 OPENS>
SIGNAL X120 & X420 NOT INHIBITED TO COMMON MCUs
<LINE 1 PROTECTION RESETS>
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL REQUEST TOKEN FROM X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X120
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FROM X120
SIGNAL END OF X120 RECLAIM TIME
SIGNAL REQUEST TOKEN FROM X420
SIGNAL REQUEST CHECK SYNC FOR X420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X420
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420
<X420 CLOSES>
SIGNAL RESET TOKEN FROM X420
SIGNAL END OF X420 RECLAIM TIME
AUTO-SWITCHING COMPLETE

8.5.2 F2 transient fault, DAR required, remote end recloses first

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
LINE 1 CHARGED FROM REMOTE END
X120 RECLOSES WITH CHECK SYNC
X420 RECLOSES WITH CHECK SYNC
LV BREAKER RECLOSES
PLANT OPERATION IN DETAILS
‘START’
<LINE 1 PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
<LINE 1 PROTECTION RESETS>
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL REQUEST TOKEN FROM X120
REQUEST CHECK SYNC FOR X 120
SIGNAL IN SYNC X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X120
<X120 CLOSES>
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
SIGNAL RESET TOKEN FROM X120
SIGNAL END OF X120 RECLAIM TIME
SIGNAL REQUEST TOKEN FROM X420
SIGNAL REQUEST CHECK SYNC FOR X420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X420
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420

<X420 CLOSES>
SIGNAL RESET TOKEN FROM X420
SIGNAL END OF X420 RECLAIM TIME
AUTO-SWITCHING COMPLETE

8.5.3 F2 persistent fault, DAR required, local end recloses first

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
X120 RECLOSES DEAD LINE CHARGING LINE 1
X120 TRIPS
X103 OPENS
X120 RECLOSES DEAD LINE CHARGING LINE 1
X420 RECLOSES WITH CHECK SYNC
LV BREAKERS RECLOSE
PLANT OPERATION IN DETAILS
‘START’
<LINE 1 PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
<LINE 1 PROTECTION RESETS>
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL REQUEST TOKEN FROM X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FROM X120
SIGNAL REQUEST TOKEN FROM X420
<LINE 1 PROTECTION OPERATES>
<LINE 1 INTERTRIP SENT>
<X120 TRIPS>

SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
SIGNAL X120 & X420 INHIBITED TO COMMON MCSu
SIGNAL END OF X120 RECLAIM TIME
SIGNAL OPEN X103
FEEDER PLANT SW DELAY TIME ELAPSED
<X103 OPENS>
<LINE 1 PROTECTION RESET>
SIGNAL X120 & X420 NOT INHIBITED TO COMMON MCUs
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL REQUEST TOKEN FROM X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FROM X120
SIGNAL END OF X120 RECLAIM TIME
SIGNAL REQUEST TOKEN FROM X420
SIGNAL REQUEST CHECK SYNC FOR X420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X420
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420
<X420 CLOSES>
SIGNAL RESET TOKEN FROM X420
SIGNAL END OF X420 RECLAIM TIME
AUTO-SWITCHING COMPLETE

8.5.4 Transient intertrip received from the remote end, remote end recloses first

Note: Intertrip, coming from a remote end as a consequence of the transformer fault at the remote end, is cleared in less than set time indicating that the isolator on the remote side is successfully opened. Therefore, DAR will be completed at local end. Transient received intertrip is normally generated from either remote line protection or remote transformer protection or remote transformer feeder protection or remote busbar protection.

The sequence of events would be the same as for the transient F2 fault, detailed above, with the following differences:

LINE 1 Protection operates = Line 1 Intertrip receive operates

LINE 1 Protection reset = Line 1 Intertrip receive reset

Persistence intertrip received from the remote end.

Note: Intertrip, coming from a remote end as a consequence of the transformer fault at the remote end, is maintained for more than set time indicating that the isolator on the remote side has not been successfully opened. Therefore, DAR at the local end is not applicable, isolator x103 must be opened and mesh restored. Persistent received intertrip is normally generated from either remote transformer protection or remote transformer feeder protection or remote busbar protection).

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
X103 OPENS
X120 RECLOSES DEAD LINE CHARGING LINE 1
X420 RECLOSES WITH CHECK SYNC
LV BREAKERS RECLOSE
PLANT OPERATION IN DETAILS
‘START’
<LINE 1 INTERTRIP RECEIVE OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
<LINE 1 INTERTRIP RECEIVE MAINTAINED>
SIGNAL X120 & X420 INHIBITED TO COMMON MCUs
SIGNAL OPEN X103
FEEDER PLANT SW DELAY TIME ELAPSED
<X103 OPENS>
SIGNAL X120 & X420 NOT INHIBITED TO COMMON MCUs
<LINE 1 INTERTRIP RECEIVE RESETS>
SIGNAL TRIP RELAY RESET TO LV BREAKERS

SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL REQUEST TOKEN FROM X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X120
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FROM X120
SIGNAL END OF X120 RECLAIM TIME
SIGNAL REQUEST TOKEN FROM X420
SIGNAL REQUEST CHECK SYNC FOR X420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X420
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420
<X420 CLOSES>
SIGNAL RESET TOKEN FROM X420
SIGNAL END OF X420 RECLAIM TIME
AUTO-SWITCHING COMPLETE

AP

8.5.5 F3 fault, DAR required, local HV end recloses first

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
X120 RECLOSES DEAD LINE CHARGING LINE 1
X420 RECLOSES WITH CHECK SYNC
LV BREAKER RECLOSES
PLANT OPERATION IN DETAILS
‘START’
<TR1-FEEDER PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
<TR1-FEEDER PROTECTION RESETS>

SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL REQUEST TOKEN FROM X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FROM X120
SIGNAL END OF X120 RECLAIM TIME
SIGNAL REQUEST TOKEN FROM X420
SIGNAL REQUEST CHECK SYNC FOR X420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X420
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420
<X420 CLOSES>
SIGNAL RESET TOKEN FROM X420
SIGNAL END OF X420 RECLAIM TIME
AUTO-SWITCHING COMPLETE

AP

8.5.6 F4 fault, DAR not required, local HV end recloses first

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
X113A OPENS
X120 RECLOSES DEAD LINE CHARGING LINE 1
X420 RECLOSES WITH CHECK SYNC
LV BREAKER (X180A) STAYS OPEN
PLANT OPERATION IN DETAILS
‘START’
<TRANSFORMER TR1 PROTECTION OPERATES>
<LINE 1 INTERTRIP SENT>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT

SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
SIGNAL X120 & X420 INHIBITED TO COMMON MCUs
SIGNAL OPEN X113A
TRANSFORMER PLANT SW DELAY TIME ELAPSED
<X113A OPENS>
SIGNAL X120 & X420 NOT INHIBITED TO COMMON MCUs
<TRANSFORMER TR-1 PROTECTION RESETS>
SIGNAL X120 & X420 NOT INHIBITED
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL REQUEST TOKEN FOR X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X120
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FOR X120
SIGNAL END OF X120 RECLAIM TIME
SIGNAL REQUEST TOKEN FOR X420
SIGNAL REQUEST CHECK SYNC FOR X420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X420
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420
<X420 CLOSES>
SIGNAL RESET TOKEN FOR X420
SIGNAL END OF X420 RECLAIM TIME
AUTO-SWITCHING COMPLETE

8.5.7 F5 transient fault, DAR required, local end recloses first

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
X113A OPENS
X120 RECLOSES DEAD LINE CHARGING LINE 1
X420 RECLOSES WITH CHECK SYNC
PLANT OPERATION IN DETAILS
‘START’
<MESH CORNER PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
SIGNAL X120 AND X420 INHIBITED TO COMMON MCUs
SIGNAL OPEN X113A
TRANSFORMER PLANT SW DELAY TIME ELAPSED
<X113A OPENS>
<MESH CORNER PROTECTION RESETS>
SIGNAL X120 AND X420 NOT INHIBITED
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL REQUEST TOKEN FOR X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X120
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FOR X120
SIGNAL END OF X120 RECLAIM TIME
SIGNAL REQUEST TOKEN FOR X420
SIGNAL REQUEST CHECK SYNC FOR X420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU

AP

SIGNAL CLOSE X420
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420
<X420 CLOSES>
SIGNAL RESET TOKEN FOR X420
SIGNAL END OF X420 RECLAIM TIME
AUTO-SWITCHING COMPLETE

8.5.8 F5 persistent fault, DAR required, local end recloses first

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
X113 OPENS
X120 RECLOSES DEAD LINE CHARGING LINE 1
X120 TRIPS
X103 OPENS
X120, X420 & LV BREAKERS LOCKED OUT
PLANT OPERATION IN DETAILS
‘START’
<MESH CORNER PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
SIGNAL X120 AND X420 INHIBITED TO COMMON MCUs
SIGNAL OPEN X113A
TRANSFORMER PLANT SW DELAY TIME ELAPSED
<X113A OPENS>
<MESH CORNER PROTECTION RESETS>
SIGNAL X120 AND X420 NOT INHIBITED
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL REQUEST TOKEN FOR X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X120
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE

SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
<MESH CORNER PROTECTION OPERATES>
<X120 TRIPS>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
SIGNAL RECLOSE LOCKOUT LV BREAKERS
SIGNAL X120 & X420 LOCKED OUT TO ADJECENT MCUs
SIGNAL RESTORE SEQUENTIAL ISOLATION TO X420
SIGNAL OPEN X103
FEEDER PLANT SW DELAY TIME ELAPSED
<X103 OPENS>
<MESH CORNER PROTECTION RESETS>
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
AUTO-SWITCHING COMPLETE

AP

8.5.9 F5 fault, DAR not required

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
X103 & X113A OPEN
X120, X420 & LV BREAKERS LOCKED OUT
PLANT OPERATION IN DETAILS
‘START’
<MESH CORNER PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL RECLOSE LOCKOUT LV BREAKERS
SIGNAL X120 & X420 LOCKED OUT TO ADJECENT MCUs
AUTOSWITCHING IN PROGRESS
SIGNAL OPEN X103
FEEDER PLANT SW DELAY TIME ELAPSED
<X103 OPENS>
SIGNAL OPEN X113A
TRANSFORMER PLANT SW DELAY TIME ELAPSED
<X113A OPENS>

<MESH CORNER PROTECTION RESETS>
AUTO-SWITCHING COMPLETE
SIGNAL X120, X420 AND LV BREAKER LOCKOUT RESET

8.5.10 Evolving fault: F2 transient fault followed by F6 transient fault during x120 dead time, DAR required, local ends reclose first, x420 dead time > x320 dead time > x120 dead time, no Ferroresonance condition detected on either corner.

PLANT OPERATION SUMMARY
X120, X420, X180A BREAKERS TRIP
X320, X480A TRIP
X120 RECLOSES DEAD LINE CHARGING LINE 1
X320 RECLOSES DEAD LINE CHARGING LINE 4
X420 RECLOSES WITH CHECK SYNC
LV BREAKERS RECLOSE
PLANT OPERATION IN DETAILS
‘START’
<LINE 1 PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO X180A BREAKER
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS-MCU1
<LINE 1 PROTECTION RESETS>
SIGNAL TRIP RELAY RESET TO X180A BREAKER
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
<LINE 4 PROTECTION OPERATES>
<X320 TRIPS>
SIGNAL LINE 4 DEAD
SIGNAL X320 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X320 & X420
SIGNAL TRIP RELAY OPERATED TO X480A BREAKER
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS-MCU4
<LINE 4 PROTECTION RESETS>
SIGNAL TRIP RELAY RESET TO X480A BREAKER
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
REQUEST TOKEN FOR X 120

SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FOR X120
SIGNAL REQUEST TOKEN FOR X320
SIGNAL X320 RECLAIM TIME TO COMMON MCU
SIGNAL RESTORE SEQUENTIAL ISOL. TO X320
<X320 CLOSES>
SIGNAL LINE 4 LIVE
SIGNAL X320 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS (MCU2) PRESENT
SIGNAL RESET TOKEN FOR X320
AUTO-SWITCHING COMPLETE-MCU4
SIGNAL REQUEST TOKEN FOR X420
REQUEST CHECK SYNC FOR X 420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X420
<X420 CLOSES>
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420
SIGNAL RESET TOKEN FOR X420
SIGNAL END OF X420 RECLAIM TIME
AUTO-SWITCHING COMPLETE-MCU1

AP

8.5.11 Ferroresonance: F2 fault, DAR required, Ferroresonance suppression out of service

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
FERRORESONANCE DETECTED
X120, X420 & LV BREAKERS LOCKED OUT
PLANT OPERATION IN DETAILS
‘START’
<LINE 1 PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS

SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
<FERRORESONANCE DETECTED>
SIGNAL RECLOSE LOCKOUT LV BREAKERS
SIGNAL X120 & X420 LOCKED OUT TO ADJECENT MCUs
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120 & X420
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
AUTO-SWITCHING COMPLETE
<FERRORESONANCE NOT DETECTED> (after some time)
SIGNAL X120, X420 AND LV BREAKER LOCKOUTS RESET

8.5.12 Ferroresonance: F2 fault, DAR required, Ferroresonance suppression in service, local end recloses first.

PLANT OPERATION SUMMARY
X120, X420, LV BREAKERS TRIP
FERRORESONANCE DETECTED
X113A OPENS
X113A CLOSES
X120 RECLOSES DEAD LINE CHARGING LINE 1
X420 RECLOSES WITH CHECK SYNC
LV BREAKERS RECLOSE
PLANT OPERATION IN DETAILS
‘START’
<LINE 1 PROTECTION OPERATES>
<X120 & X420 TRIP>
SIGNAL LINE 1 DEAD
SIGNAL X120 LOCAL VOLTS NOT PRESENT
SIGNAL X420 LOCAL VOLTS NOT PRESENT
SIGNAL INHIBIT SEQUENTIAL ISOL.TO X120 & X420
SIGNAL TRIP RELAY OPERATED TO LV BREAKERS
SIGNAL TRIP RELAY OPERATED TO ADJACENT MCUs
AUTOSWITCHING IN PROGRESS
<FERRORESONANCE DETECTED>
SIGNAL INHIBIT TRIP RELAY RESET
SIGNAL X120 AND X420 INHIBITED TO COMMON MCUs
SIGNAL OPEN X113A
TRANSFORMER PLANT SW DELAY TIME ELAPSED
<X113A OPENS>
<FERRORESONANCE NOT DETECTED>
SIGNAL CLOSE X113A
TRANSFORMER PLANT SW DELAY TIME ELAPSED

AP

<X113A CLOSES>
SIGNAL RELEASE TRIP RELAY RESET
<LINE 1 PROTECTION RESETS>
SIGNAL X120 AND X420 NOT INHIBITED TO COMMON MCUs
SIGNAL TRIP RELAY RESET TO LV BREAKERS
SIGNAL TRIP RELAY RESET TO ADJACENT MCUs
WAIT X120 DEAD TIME
SIGNAL REQUEST TOKEN FOR X120
SIGNAL X120 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X120
SIGNAL RESTORE SEQUENTIAL ISOL. TO X120
<X120 CLOSES>
SIGNAL LINE 1 LIVE
SIGNAL LINE 1 LIVE
SIGNAL X120 LOCAL VOLTS PRESENT
SIGNAL X420 LOCAL VOLTS PRESENT
SIGNAL RESET TOKEN FOR X120
SIGNAL END OF X120 RECLAIM TIME
SIGNAL REQUEST TOKEN FOR X420
SIGNAL REQUEST CHECK SYNC FOR X420
SIGNAL IN SYNC X420
SIGNAL X420 RECLAIM TIME TO COMMON MCU
SIGNAL CLOSE X420
SIGNAL RESTORE SEQUENTIAL ISOL. TO X420
<X420 CLOSES>
SIGNAL RESET TOKEN FOR X420
SIGNAL END OF X420 RECLAIM TIME

PROGRAMMABLE LOGIC

PL

Date: **2019**

Hardware Suffix: **B**

Software Version: **04**

CONTENTS

(PL) 7-

PL

1. PROGRAMMABLE LOGIC

1.1 Overview

The purpose of the programmable scheme logic (PSL) is to allow the relay user to configure an individual protection scheme to suit their own particular application. This is achieved through the use of programmable logic gates and delay timers.

The input to the PSL is any combination of the status of opto inputs. It is also used to assign the mapping of functions to the opto inputs and output contacts, the outputs of the protection elements, e.g. protection starts and trips, and the outputs of the fixed protection scheme logic. The fixed scheme logic provides the relay's standard protection schemes.

The PSL itself consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay, and/or to condition the logic outputs, e.g. to create a pulse of fixed duration on the output regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

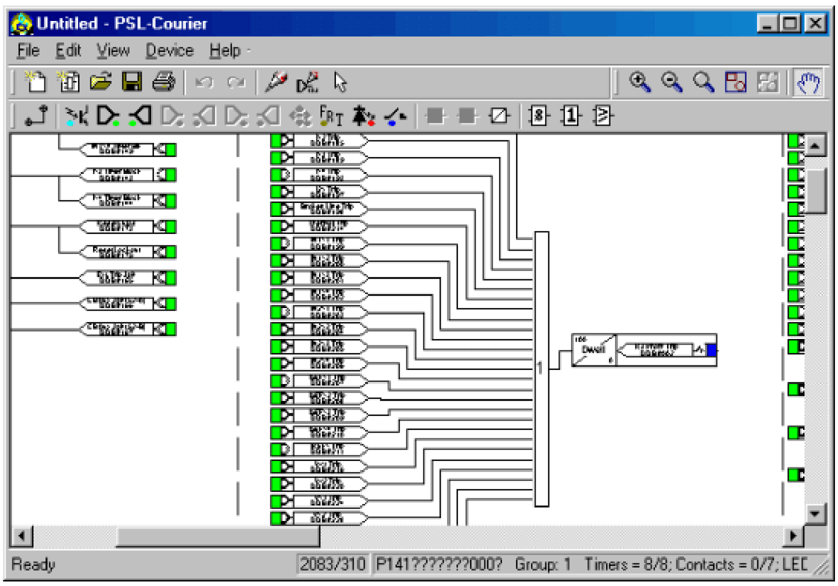
The execution of the PSL logic is event driven; the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals or a trip output from a protection element. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL; even with large, complex PSL schemes the relay trip time will not lengthen.

This system provides flexibility for the user to create their own scheme logic design. However, it also means that the PSL can be configured into a very complex system, hence setting of the PSL is implemented through the PC support package S1 Agile.

1.2 S1 Agile Px40 PSL editor

To access the Px40 PSL Editor menu click on

The PSL Editor module enables you to connect to any MiCOM device front port, retrieve and edit its Programmable Scheme Logic files and send the modified file back to a MiCOM Px40 device.



S0059ENa

1.3 How to use MiCOM Px40 PSL editor

With the MiCOM Px40 PSL Module you can:

- Start a new PSL diagram
- Extract a PSL file from a MiCOM Px40 IED
- Open a diagram from a PSL file
- Add logic components to a PSL file
- Move components in a PSL file
- Edit link of a PSL file
- Add link to a PSL file
- Highlight path in a PSL file
- Use a conditioner output to control logic
- Download PSL file to a MiCOM Px40 IED
- Print PSL files

See the S1 Agile program online help or ‘MiCOM P40 Agile Modular and Compact Ranges, Settings Application Software User Guide’, P40-M&CR-UG for more detailed information on how to use these functions.

1.4 Warnings

PL

Before the scheme is sent to the relay checks are done. Various warning messages may be displayed as a result of these checks.

The Editor first reads in the model number of the connected relay, and then compares it with the stored model number. A "wildcard" comparison is employed. If a model mismatch occurs then a warning will be generated before sending commences. Both the stored model number and that read-in from the relay are displayed along with the warning; the onus is on you to decide if the settings to be sent are compatible with the connected relay. Wrongly ignoring the warning could lead to undesired behavior in the relay.

If there are any potential problems of an obvious nature then a list will be generated. The types of potential problems that the program attempts to detect are:

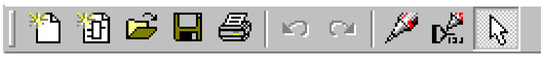
- One or more gates, LED signals, contact signals, and/or timers have their outputs linked directly back to their inputs. An erroneous link of this sort could lock up the relay or cause other more subtle problems to arise.
- Inputs To Trigger (ITT) exceeds the number of inputs. A programmable gate has its ITT value set to greater than the number of actual inputs; the gate can never activate. Note that there is no lower ITT value check. A 0-value does not generate a warning.
- Too many gates. There is a theoretical upper limit of 256 gates in a scheme, but the practical limit is determined by the complexity of the logic. In practice the scheme would have to be very complex, and this error is unlikely to occur.
- Too many links. There is no fixed upper limit to the number of links in a scheme. However, as with the maximum number of gates, the practical limit is determined by the complexity of the logic. In practice the scheme would have to be very complex, and this error is unlikely to occur.

1.5 Toolbar and commands

There are a number of toolbars available for easy navigation and editing of PSL.

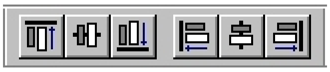
1.5.1 Standard tools

- For file management and printing.



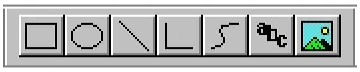
1.5.2 Alignment tools

- To snap logic elements into horizontally or vertically aligned groupings.



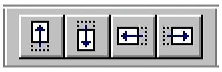
1.5.3 Drawing tools

- To add text comments and other annotations, for easier reading of PSL schemes.



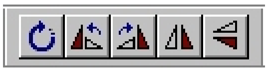
1.5.4 Nudge tools

- To move logic elements.



1.5.5 Rotation tools

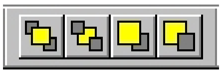
- Tools to spin, mirror and flip.



PL

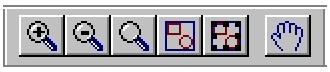
1.5.6 Structure tools

- To change the stacking order of logic components.



1.5.7 Zoom and pan tools

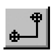
- For scaling the displayed screen size, viewing the entire PSL, or zooming to a selection.



1.5.8 Logic symbols

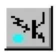
This toolbar provides icons to place each type of logic element into the scheme diagram. Not all elements are available in all devices. Icons will only be displayed for those elements available in the selected device.

Link



Create a link between two logic symbols.

Opto Signal



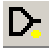
Create an opto signal.

Input Signal 

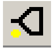
Create an input signal.

Output Signal 

Create an output signal.

GOOSE In 

Create an input signal to logic to receive a UCA2.0 GOOSE message transmitted from another IED.

GOOSE Out 

Create an output signal from logic to transmit a UCA2.0 GOOSE message to another IED.

Control In 

Create an input signal to logic that can be operated from an external command.

Trigger Signal 

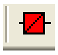
Create a fault record trigger.

LED Signal 

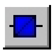
Create an LED input signal that repeats the status of LED.

Contact Signal 

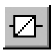
Create a contact signal.

LED Conditioner 

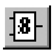
Create an LED conditioner.

Contact Conditioner 

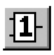
Create a contact conditioner.

Timer 

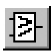
Create a timer.

AND Gate 

Create an AND Gate.

OR Gate 

Create an OR Gate.

Programmable Gate 

Create a programmable gate.

1.6 PSL logic signals properties

The logic signal toolbar is used for the selection of logic signals.

Performing a right-mouse click on any logic signal will open a context sensitive menu and one of the options for certain logic elements is the **Properties…** command. Selecting the Properties option will open a Component Properties window, the format of which will vary according to the logic signal selected.

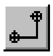
Properties of each logic signal, including the Component Properties windows, are shown in the following sub-sections:

Signal properties menu

The **Signals List** tab is used for the selection of logic signals.

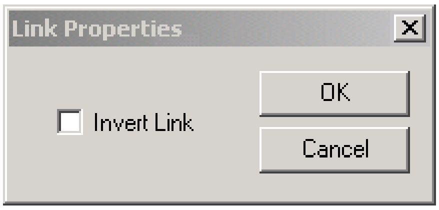
The signals listed will be appropriate to the type of logic symbol being added to the diagram. They will be of one of the following types:

1.6.1 Link properties



Links form the logical link between the output of a signal, gate or condition and the input to any element.

Any link that is connected to the input of a gate can be inverted via its properties window. An inverted link is indicated with a “bubble” on the input to the gate. It is not possible to invert a link that is not connected to the input of a gate.



Links can only be started from the output of a signal, gate, or conditioner, and can only be ended on an input to any element.

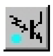
Since signals can only be either an input or an output then the concept is somewhat different. To follow the convention adopted for gates and conditioners, input signals are connected from the left and output signals to the right. The Editor will automatically enforce this convention.

A link attempt will be refused where one or more rules would otherwise be broken. A link will be refused for the following reasons:

- An attempt to connect to a signal that is already driven. The cause of the refusal may not be obvious, since the signal symbol may appear elsewhere in the diagram. Use “Highlight a Path” to find the other signal.
- An attempt is made to repeat a link between two symbols. The cause of the refusal may not be obvious, since the existing link may be represented elsewhere in the diagram.

1.6.2 Opto signal properties

Opto Signal



Each opto input can be selected and used for programming in PSL. Activation of the opto input will drive an associated DDB signal.

For example, activating opto input L1 will assert DDB 064 in the PSL.

1.6.3 Input signal properties

Input Signal

Relay logic functions provide logic output signals that can be used for programming in PSL. Depending on the relay functionality, operation of an active relay function will drive an associated DDB signal in PSL.

For example, DDB 749 will be asserted in the PSL if the Ferroresonance is in progress.

1.6.4 Output signal properties

Output Signal

Relay logic functions provide logic input signals that can be used for programming in PSL. Depending on the relay functionality, activation of the output signal will drive an associated DDB signal in PSL and cause an associated response to the relay function

For example, if DDB 681 is asserted in the PSL, the relay will indicate that CB 1 is in synchronism.

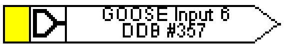
1.6.5 GOOSE input signal properties

GOOSE In

The Programmable Scheme Logic interfaces with the GOOSE Scheme Logic (S1 Agile user's manual) by means of 32 Virtual inputs. The Virtual Inputs can be used in much the same way as the Opto Input signals.

The logic that drives each of the Virtual Inputs is contained within the relay's GOOSE Scheme Logic file. It is possible to map any number of bit-pairs, from any enrolled device, using logic gates onto a Virtual Input (S1 Agile user's manual for more details).

For example, DDB 357 will be asserted in PSL should virtual input 6 and its associated bit pair operate.



1.6.6 GOOSE output signal properties

GOOSE Out

The Programmable Scheme Logic interfaces with the GOOSE Scheme Logic by means of 32 Virtual outputs.

It is possible to map virtual outputs to bit-pairs for transmitting to any enrolled devices.

For example, if DDB 388 is asserted in PSL, Virtual Output 5 and its associated bit-pair mappings will operate.

1.6.7 Control in signal properties

Control In

There are 32 control inputs which can be activated via the relay menu or via rear communications. Depending on the programmed setting i.e. latched or pulsed, an associated DDB signal will be activated in PSL when a control input is operated.

For example, operate control input 1 to assert DDB 320 in the PSL.

1.6.8 LED signal properties

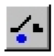
LED

All programmable LEDs will drive associated DDB signal when the LED is activated.

For example, DDB 128 will be asserted when LED 1 is activated.

1.6.9 Contact signal properties

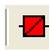
Contact Signal



All relay output contacts will drive associated DDB signal when the output contact is activated.

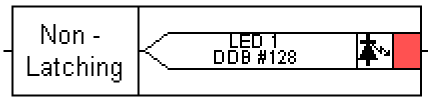
For example, DDB 013 will be asserted when output R14 is activated.

1.6.10 LED conditioner properties



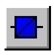
LED Conditioner

1. Select the **LED name** from the list (only shown when inserting a new symbol).



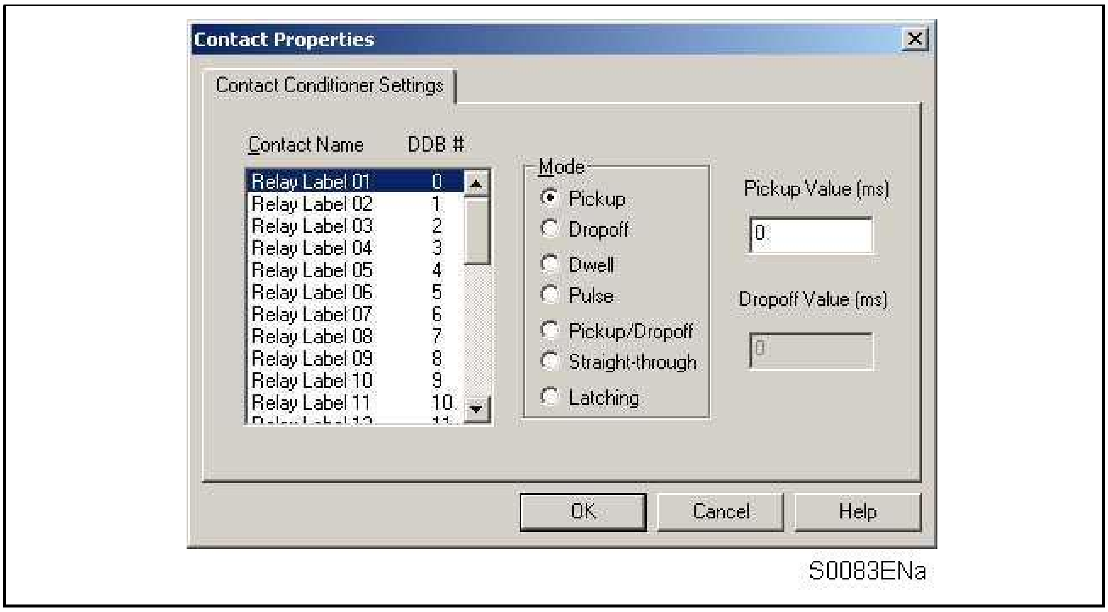
2. Configure the LED output to be latching or non-latching.

1.6.11 Contact conditioner properties



Each contact can be conditioned with an associated timer that can be selected for pick up, drop off, dwell, pulse, pick-up/drop-off, straight-through, or latching operation. "Straight-through" means it is not conditioned in any way whereas "latching" is used to create a sealed-in or lockout type function.

PL



1. Select the contact **name** from the **Contact Name** list (only shown when inserting a new symbol).
2. Choose the conditioner type required in the **Mode** tick list.
3. Set the **Pick-up** Time (in milliseconds), if required.
4. Set the **Drop-off** Time (in milliseconds), if required.

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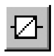
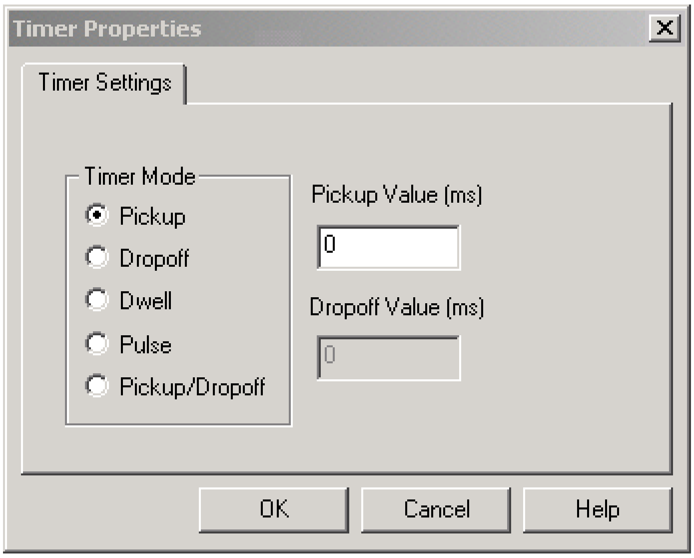
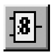
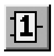
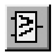
1.6.12 Timer properties



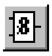
Each timer can be selected for pick up, drop off, dwell, pulse or pick-up/drop-off operation.

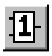


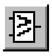
1. Choose the operation mode from the **Timer Mode** tick list.
2. Set the Pick-up Time (in milliseconds), if required.
3. Set the Drop-off Time (in milliseconds), if required.

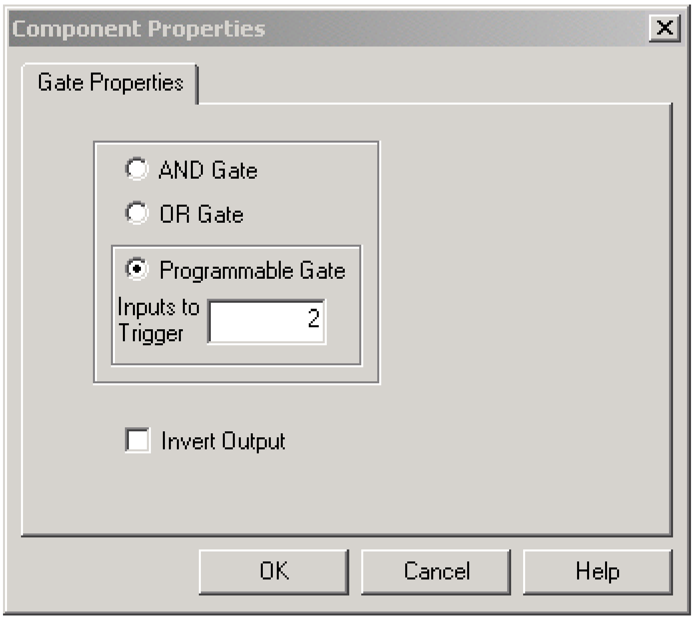
1.6.13 Gate properties  or  or 

A Gate may be an AND, OR, or programmable gate.

An **AND** gate  requires that all inputs are TRUE for the output to be TRUE.

An **OR** gate  requires that one or more input is TRUE for the output to be TRUE.

A **Programmable** gate  requires that the number of inputs that are TRUE is equal to or greater than its ‘Inputs to Trigger’ setting for the output to be TRUE.



4. Select the Gate type AND, OR, or Programmable.
5. Set the number of inputs to trigger when Programmable is selected.
6. Select if the output of the gate should be inverted using the Invert Output check box. An inverted output is indicated with a "bubble" on the gate output.

PL

1.7 Description of logic nodes

DDB No.	English Text	Source	Description
0	Output Label 1 (Setting)	Output conditioner	Assignment of signal to drive output Relay 1
31	Output Label 32 (Setting)	Output conditioner	Assignment of signal to drive output Relay 32
32 - 63			Unused
64	Opto Label 1(Setting)	Opto Input	From opto input 1- when opto energized (used for setting group changes)
65	Opto Label 2(Setting)	Opto Input	From opto input 2- when opto energized (used for setting group changes)
111	Opto Label 48 (Setting)	Opto Input	From opto input 48 - when opto energized
112 - 127			Unused
128	LED1	Output conditioner	Programmable LED 1 is energized
135	LED8	Output conditioner	Programmable LED 8 is energized
137 - 143			Unused
144	LED Cond IN 1	PSL	Input to LED1 Output Condition
151	LED Cond IN 8	PSL	Input to LED8 Output Condition
152	LED Cond IN 9	Internal signal driven from PSL	Input to Trip LED
153 - 159			Unused
160	Relay Cond 1	PSL	Input to Relay 1 Output Conditioner
191	Relay Cond 32	PSL	Input to Relay 32 Output Conditioner
192 - 223			Unused
224	Timer in 1	PSL	Input to Auxiliary Timer 1
239	Timer in 16	PSL	Input to Auxiliary Timer 16
240	Timer out 1	Auxiliary Timer	Output from Auxiliary Timer 1
255	Timer out 16	Auxiliary Timer	Output from Auxiliary Timer 16
256	SG-opto Invalid	Group Selection	Setting group selection opto inputs have detected an invalid (disabled) settings group
257	Prot'n Disabled	Commissioning Test	Protection disabled - typically out of service due to test mode
258	F out of Range	Frequency Tracking	Frequency Out of Range Alarm
259	Select A/S Alarm	MC function	Invalid control state alarm
260	Select DAR Alarm	MC function	Invalid control state alarm
261	Line 1 DBI Alarm	Feeder 1 function	Line 1 disconnector position status alarm
263	TR1 DBI Alarm	Transformer 1 Function	Transformer 1 disconnector position status alarm
266	CB1 DBI Alarm	CB 1 Function	Circuit breaker 1 position status alarm
268	Line1 Disc. Fail	Feeder 1 function	Line 1 disconnector fail to respond to control request
270	Tr1 Disc. Fail Alarm	Transformer 1 Function	TR1 disconnector fail to respond to control request
273	CB1 Fail alarm	CB 1 Function	CB1 fail to respond to control request
275	Ferrores alarm	From external device	Ferroresonance detection alarm
276	CB1 Sys Split	CB 1 Function	CB1 System Split alarm
278	Select F/R alarm	FR Function	Invalid Control state alarm
279	TR1 Inhibit alarm	Transformer 1 Function	TR1 disconnector control inhibited
282	Line1 Inhibit alarm	Feeder 1 Function	Line 1 disconnecto control inhibited
284	CB1 Inhibit alarm	CB 1 Function	CB1 DAR control inhibited
286	MC DAR Inhibit alarm	MC Function	Mesh corner DAR control inhibited
287	User Alarm 1	PSL	Triggers User Alarm 1 message to be alarmed on LCD display (self-resetting)
313	User Alarm 27	PSL	Triggers User Alarm 27 message to be alarmed on LCD display (self-resetting)
314 - 319			Unused
320	Control Input 1	Control Input Command	Control Input 1 - for SCADA and menu commands into PSL
351	Control Input 32	Control Input Command	Control Input 32 - for SCADA and menu commands into PSL
352	GOOSE Input 1	Control Input Command	Real time signal input driven by GOOSE Output 1 via Ethernet

DDB No.	English Text	Source	Description
383	GOOSE Input 32	Control Input Command	Real time signal input driven by GOOSE Output 32 via Ethernet
384	GOOSE Output 1	PSL	Real time output signal driven from PSL and routed via Ethernet
415	GOOSE Output 32	PSL	Real time output signal driven from PSL and routed via Ethernet
416	Select MCF Auto In	PSL	Pulse controlled input to select Autoswitching in service on associated mesh corner, feeder and transformer functions
417	Select MCF Auto Out	PSL	Pulse controlled input to de-select Autoswitching in service on associated mesh corner, feeder and transformer functions
418	Select MCF DAR In	PSL	Pulse controlled input that accepts requests for the operational state 'DAR In' to be selected (providing that associated mesh corner function(s) are in the operational state Auto-Switching in Service. Autoswitching in service on associated mesh corner, feeder and transformer functions
419	Select MCF DAR Out	PSL	Pulse controlled input that accepts requests for the operational state 'DAR Out' to be selected
420	MCF DAR Req.	MCF	Status input that accepts signals from protections associated with a mesh corner to initiate mesh corner DAR (Start DAR) and opening of all associated Transformer HV disconnectors
421	MCF No DAR Req.	MCF	Status input that accepts signals from protections associated with a mesh corner, lockout mash corner and associated LV DAR and initiates opening of all associated Transformer HV and Line disconnectors
422	MCF DAR Inhibit	PSL	Status input that accepts signals to delay all mesh corner and associated LV DAR
423	MCF DAR Lockout	PSL	Status input that accepts Lockout signals to cancel all mesh corner and associated LV DAR sequences
424	Set MCF Faulty	PSL	Internal signal that sets Mesh corner function into Faulty State
425	Reclaim Running	PSL	Internal signal that starts upon circuit breaker re-closure. Will force DAR Inhibit and open line disconnector under fault
426	Ind MCF Auto In	MC function	Indication that associated mesh corner, feeder and transformer functions are active
427	Ind MCF Auto Out	MC function	Indication that associated mesh corner, feeder and transformer functions are inactive
428	Ind MCF DAR In	MC function	Indication that operational state 'DAR In' is active
429	Ind MCF DAR Out	MC function	Indication that operational state 'DAR Out' is active, either as a result of DAR Out being selected or an associated mesh corner function being in the state Automatic Switching Out of Service
430	MCF Switch inProg	MC function	Indication that DAR and/or plant disconnector switching sequence has been initiated and remain set until the switching sequence has been completed or cancelled.
431	MCF Switch Finish	MC function	Signal not used
432	MCF HV DAR Start	MC function	This output when set shall provide a Start DAR signal for the associated HV DAR
433	MCF HV DAR Inhib	MC function	This output when set shall delay DAR on HV breakers
434	MCF HV DAR Lock	MC function	This output when set shall cancel DAR on HV breakers
435	MCF LV DAR Start	MC function	This output when set shall provide a Start DAR signal for the associated LV DAR

DDB No.	English Text	Source	Description
436	MCF LV DAR Inhib	MC function	This output when set shall delay DAR on LV breakers
437	MCF LV DAR Lock	MC function	This output when set shall cancel DAR on LV breakers
438	MCF Healthy	MC function	Indication that Mesh Corner Function is in healthy state
439	MCFOpenLine1 Cmd	MC Function	Output signal to Feeder 1 function to open Line disconnector
441	MCFOpenTfmr1 Cmd	MC Function	Output signal to Transformer 1 function to open HV disaconnector
444 - 447			Unused
448	SI Line1 Closed	PSL	Status Input from closed Line 1 disconnector
449	SI Line1 Open	PSL	Status Input from open Line 1 disconnector
450	SI Line1 Inhibit	PSL	This input when set shall delay opening of the Line 1 disconnector
451	Line1 DAR Req	Prot. Latching logic	This input shall accept signals from the Line 1 protection to Start DAR on associated mesh corner and LV circuit breakers
452	Line1 No DAR	Prot. Latching logic	This input shall accept signals from the Line 1 protection to initiate opening of the Line 1 disconnector and to Start DAR on associated mesh corner and LV circuit breakers
453	Line1 Open Reqst	PSL	Input from other functions within the MCU to initiate opening of the Line 1 disconnector
454	Line1 Cls Reqst	PSL	Input from other functions within the MCU to initiate closing of the Line 1 disconnector
455	Line1 Intertrip	PSL	This input accepts signals from Line 1 intertrip receive channels to Start DAR on associated mesh corner and LV circuit breakers. (see also 458)
456	Ind Line1 Live	Feeder 1 Function	Indication that Live 1 is live based on analogue voltage measurement
457	Ind Line1 Faulty	Feeder 1 function	Indication that Feeder 1 function is faulty
458	Line1 Persist I/T	Feeder 1 function	Indication from the Feeder function that the intertrip receive input has been high for a period of time greater that the set persistent intertrip delay time. In this case the Line 1 disconnector shall be open prior to DAR reclosure of the associated mesh corner and LV circuit breaker
459	Ind Line1 Closed	Feeder 1 Function	Indication of Line 1 disconnector position
460	Line1 Open Ctrl	Feeder 1 function	Control output to initiate opening of Line 1 disconnector. The output is also used to bypass plant interlocks
461	Line1 Close Ctrl	Feeder 1 function	Control output to initiate closing of Line 1 disconnector
462	Line1 Start DAR	Feeder 1 Function	Output signal to Mesh CBs
463	Line1 Inhibit DAR	Feeder 1 Function	Output signal to Mesh CBs to delay DAR
464	Line1 Lockout DAR	Feeder 1 Function	Output signal to Mesh CBs to lockout
465	Line1 Healthy	Feeder 1 Function	Feeder 1 Function is healthy and operational
466	Line1 DBI Ind	Feeder 1 Function	Instantaneous Indication of simultaneous open and close Line 1 disconnector position
467	Line1 Backup Trip	Prot. Latching Logic	Back up feeder 1 trip used in DAR interlocking logic
468	Line1 AS InProg	Feeder 1 Function	Indication that Line 1disconnector opening has been started and has not yet been completed or cancelled
469	Ind Line1 Closed	Feeder 1 Function	Indication that Line 1 is closed (based on status inputs)
470	Ind Line1 Open	Feeder 1 Function	Indication that Line 1 is open (based on status inputs)
471 - 479			Unused
480 - 502	Feeder 2 - as per Feeder 1 above		

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DDB No.	English Text	Source	Description
503 - 511			Unused
512	SI Tfmr1 Closed	PSL	Status Input from closed Transformer 1 disconnector
513	SI Tfmr1 Open	PSL	Status Input from open Transformer 1 disconnector
514	SI Tfmr1 Inhibit	PSL	This input when set shall delay opening of Transformer 1 disconnector
515	Tfmr1 DAR NotReq	Prot. Latching logic	This signal shall accept signals from Transformer 1 protection to initiate opening of the TR1 HV disconnector. Start DAR on associated mesh corner circuit breakers and lockout TR1 LV DAR
516	Tfmr1 Open Reqst	PSL	Input from other functions within the MCU to initiate opening of the Transformer 1 disconnector
517	Tfmr1 Cls Reqst	PSL	Input from other functions within the MCU to initiate closing of the Transformer 1 disconnector
518	Ind Tfmr1 Live	Transformer 1 Function	Indication of TR 1 disconnector position
519	Ind Tfmr1 Faulty	Transformer 1 Function	Indication that TR 1 function is faulty
520	Tfmr1 Closed Ind	Transformer 1 Function	Indication that TR 1 HV disconnectors are closed
521	Tfmr1 Open Ctrl	Transformer 1 Function	Control output to initiate opening of TR1 disconnector. The output is also used to bypass plant interlocks.
522	Tfmr1 Close Ctrl	Transformer 1 Function	Control output to initiate closing of TR 1 disconnector
523			Unused
524	Tfmr1 Inhibit DAR	Transformer 1 Function	Output signal to delay DAR until auto-switching is complete
525			Unused
526	Tfmr1 Healthy	Transformer 1 Function	Status signal that TR 1 function is in healthy state
527			Unused
528	Tf1r Strt HV DAR	Transformer 1 Function	Output to Start HV DAR
529	Tfr1 Lock LV DAR	Transformer 1 Function	Output to Lockout LV DAR
530	Tfr1 Lock HV DAR	Transformer 1 Function	Output to Lockout HV DAR
531	Tfr1 DBI Ind	Transformer 1 Function	Instantaneous Indication of simultaneous open and close TR 1 disconnector position
532	Tfmr1 AS InProg	Transformer 1 Function	Indication that TR1 disconnector opening has been successfully initiated
533	Ind Tfmr1 Closed	Transformer 1 Function	Indication that TR 1 disconnector is closed
534	Ind Tfmr1 Open	Transformer 1 Function	Indication that TR 1 disconnector is open
535 - 543			Unused
544 - 566	Transformer 2 - as per Transformer 1 above		
567 - 575			Unused
576 - 598	Transformer 3 - as per Transformer 1 above		
599 - 607			Unused
608	Intertrip Send	PSL	Input signals from external latched intertrip send; used to maintain latched protection signals within P842
609	MCF DAR Req	PSL	Input from MC protection DAR Required
610	MCF No DAR Req	PSL	Input from MC protection DAR Not required
611	Line1 DAR Req	PSL	Input from Line 1 protection DAR Required
612	Line1 Not DAR	PSL	Latched input from Line 1 protection DAR Not Required
613	Line1 BU Trip	PSL	Input from Line 1 BU protections for DAR Interlocking logic
614 - 616	Feeder 2 - as per Feeder 1 above (611-613)		
617	Tfmr1 Not DAR	PSL	Input from TR 1protection DAR Not Required
620	CB Fail	PSL	Input from CB Fail
621	CB Fail (latched)	CB Function	Latched CB Fail signal (held until intertrip send resets)
622 - 639			Unused

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DDB No.	English Text	Source	Description
640	CB1 V Select A1	PSL	Control input to select CB1 A (local) voltage from 4 voltage analogue inputs using PSL
641	CB1 V Select A2	PSL	Control input to select CB1 A (local) voltage from 4 voltage analogue inputs using PSL
642	CB1 V Select B1	PSL	Control input to select CB1 B (remote) voltage from 4 voltage analogue inputs using PSL
643	CB1 V Select B2	PSL	Control input to select CB1 B (remote) voltage from 4 voltage analogue inputs using PSL
644	CB1 C/S1 Enabled	PSL	Input signal that enables Check synch for CB1
645	CB1 C/S2 Enabled	PSL	Input signal that enables System synch check for CB1
646	CB1 S/S Enabled	PSL	Input signal that enables System split detection across CB1
647	CB1 Local Live	System-Check Function	Indication that local CB1 A voltage is above the live setting
648	CB1 Local Dead	System-Check Function	Indication that indicates that local CB1 A voltage is below the dead setting
649	CB1 Remote Live	System-Check Function	Indication that indicates that remote CB1 B voltage is above the live setting
650	CB1 Remote Dead	System-Check Function	Indication that indicates that remote CB1 B voltage is below the setting
651	CB1 C/S1 Ok	System-Check Function	Indication that first stage Check sync conditions for CB1 are met
652	CB1 C/S2 Ok	System-Check Function	Indication that second stage Check conditions (System sync) for CB1 are met
653 - 655			Unused
656 - 668	CB 2 - as per CB1 above (640-652)		
669 - 671			Unused
672	CB1 DAR Enable	PSL	Input to enable DAR for CB1
673			Unused
674	SI CB1 Open	PSL	Status Input that CB1 is open
675	SI CB1 Closed	PSL	Status input that CB1 is closed
676	CB1 Start Dar	PSL	This input when set high will start the DAR sequence on CB1; however the sequence cannot proceed until this signals resets
677	CB1 Inhibit Dar	PSL	When this input is set, CB1 DAR will be delayed
678	CB1 Lockout Dar	PSL	This input shall accept signal to cancel the DAR sequence on CB1
679	CB1No Dar	PSL	When this input is set, a DAR sequence for CB1 cannot started. Once started, a DAR sequence can not be stopped by this input
680	CB1 Seq Disc Pos	PSL	This input shall be set when CB1 sequential disconnectors are closed. This signal must be set for a DAR sequence to be started; however once started the DAR sequence will not be cancelled by a change in this signal
681	CB1 In Sync	PSL	This input shall accept a signal that indicates that the voltage synchronism conditions across the CB1 meet the requirements for CB1 closure
682	CB1 Healthy	CB 1 Function	Indication that the CB 1 function is in the healthy state
683	CB1 Faulty	PSL	Input to place the CB 1 Function into the faulty state, the CB healthy output will reset and a DAR sequence cannot be started
684	CB1 DAR In Prog	CB 1 Function	This output indicates that CB1 DAR sequence has been started and will terminate once the DAR sequence has been completed or cancelled
685	CB1 Req Token	CB1 Function	Request from CB1 to proceed with closure; used to prevent simultaneous closing of mesh breakers
686	CB1 Token Denied	PSL	This signal when set shall delay CB1 Request Token and thus CB 1 closure until it resets

DDB No.	English Text	Source	Description
687	CB1 Priority	PSL	Priority input from CB1 used to arbitrate order of closure for mesh breakers
688			Unused
689	CB1 Close Ctrl	CB1 Function	This output shall generate a signal to close CB1
690	CB1 Local Inhib	PSL	External input from CB1 that inhibits breaker operation due to insufficient energy
691	CB1 Check Sync	CB1 Function	This output shall be set while the voltage synchronism conditions of the CB1 are being checked
692	CB1 Dead Time	CB1 Function	This output indicates the dead time is running for CB1
693	CB1 Inh Seq Disc	CB1 Function	This output shall be set when sequential isolation of CB1 is to be inhibited while a DAR sequence is in progress
694	CB1 In Service	CB1 Function	Indication that CB1 is Closed and Live
695	CB1 Locked Out	CB1 Function	Indication that CB1 DAR is open or dead with no DAR in progress, or is not able to commence a DAR sequence
696 - 701			Unused
702	CB1 Reclaim Tmr	CB1 Function	Time window that starts with re-closure command during which any fault will be considered as permanent. This signal is sent to adjacent Mesh corners units
703			Unused
704-735	CB 2 - as per CB1 above (672-703)		
736	Select FR In	PSL	Control to switch Ferroresonance scheme in service
737	Select FR Out	PSL	Control to switch Ferroresonance scheme out of service
738	FR Detected	PSL	Input from external ferroresonance detection device
739	FR Start	PSL	Input to start the ferroresonance flapping sequence
740	FR Lockout	PSL	Input to lockout the ferroresonance flapping sequence
742	Reset FR	PSL	Input to reset the ferroresonance flapping sequence
743	FR Faulty	PSL	Input to force the ferreresonance scheme into the faulty state
745	FR Healthy	FR Function	Indication that FR Scheme is in the healthy state
746	FR In Service	FR Function	Output that indicates that Ferroresonance Scheme is in Service
747	FR Out Service	FR Function	Output that indicates that Ferroresonance Scheme is out of Service
748	FR Inhibit DAR	FR Function	This output will be set when local and remote DAR sequences need to be inhibited
749	FR In Progress	FR Function	Output that indicates that FR scheme is in progress
750	FR Disc 1 Intlock	FR Function	This input shall be set while the interlock conditions to open and close the HV Disconnector are met
751	FR Disc 1 OpenCmd	FR Function	A control output to initiate opening of TR 1 HV disconnector
752	FR Disc 1 Cls Cmd	FR Function	A control output to initiate closure of TR 1 HV disconnector
753	FR Disc 1 Pos Cls	PSL	This input shall accept a signal to indicate that the TR 1 HV disconnector is Closed
762	FR Disc 1 PosOpen	PSL	This input shall accept a signal to indicate that the TR 1 HV disconnector is Open

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DDB No.	English Text	Source	Description
754 - 764	FR Disconnectors 2 and 3 - as per FR disconnector 1 above (750 - 764)		
765 - 768			Unused
769	Test Mode	PSL	This signal when set places the relay into test mode, messages sent via CS103 will be flagged as test
770 - 781			Unused
782	CS103 Block	PSL	This signal when set blocks the sending and receiving of messages via the CS103 interface
782	CS103 CMD Block	PSL	This signal when set prevents the relays from responding to commands issued via the CS103 interface. Messages will continue to be issued via this interface
784 - 799			Unused
800	Intertrip Rx	PSL	This input shall accept Intertrip signal from remote end
801	TRR CB Fault	PSL	This input shall reset Mesh Trip and I/T Send
802	TRR Any DBI	PSL	This input shall reset any Trip and I/T Send
803	TRR Manual Reset	PSL	External Manual Reset command
804	TRR Manual Reset	Trip Relay Reset Logic	Manual Trip Reset input command
805	TRR I/T Rx Reset	Trip Relay Reset Logic	Intertrip Rx Trip Reset output signal
806	TRR Line1 Reset	Trip Relay Reset Logic	Line 1 Main Trip Reset output signal
806	TRR Line2 Reset	Trip Relay Reset Logic	Line 2 Main Trip Reset output signal
807	TRR Tfmr1 Reset	Trip Relay Reset Logic	TR 1 Trip Reset output signal
808	TRR Tfmr2 Reset	Trip Relay Reset Logic	TR 2 Trip Reset output signal
809	TRR Tfmr3 Reset	Trip Relay Reset Logic	TR 3 Trip Reset output signal
810	TRR Mesh Reset	Trip Relay Reset Logic	Mesh Trip Reset output signal
811	TRR I/T Tx Reset	Trip Relay Reset Logic	I/T Send Reset output signal - set when all Reset outputs reset
812	TRR Line1 BU	Trip Relay Reset Logic	Line 1 BU Trip Reset output signal
813	TRR Line2 BU	Trip Relay Reset Logic	Line 2 BU Trip Reset output signal
814	TRR CBFail Reset	Trip Relay Reset Logic	CBFail Trip Reset output signal
815 - 831			Unused
832	Battery Fail	Self monitoring	Front panel miniature battery failure - either battery removed from slot, or low voltage
833	Field Volts Fail	Self monitoring	48V Field Voltage Failure
834			Unused
835	GOOSE IED Absent	Network Interface card support	One or several of the enrolled devices for the GOOSE peer-peer communications cannot be detected
836	NIC Not Fitted	Network Interface card support	The relay is unable to detect the Network Interface Card (Ethernet interface)
837	NIC No Response	Network Interface card support	The relay has detected the Network interface Card is fitted but is unable to communicate with the card
838	NIC Fatal Error	Network Interface card support	The Network Interface Card has indicated that a Fatal software error has occurred
839	NIC Soft. Reload	Network Interface card support	The Network interface card has been placed into software download mode
840	Bad TCP/IP Cfg.	Network Interface card support	The relay address settings for the TCP (Transmission Control Protocol/Internet Protocol) are invalid
841	Bad OSI Config.	Network Interface card support	The configuration settings for OSI (Open Systems Interconnection)
842	NIC Link Fail	Network Interface card support	The Network Interface Card has not detected a physical Ethernet link
843	NIC SW Mis-Match	Network Interface card support	The software version of the Network Interface Card does not match that of the main processor card
844	IP Addr Conflict	Network Interface card support	The IP address configured for the Network Interface card is not unique on the local network

DDB No.	English Text	Source	Description
845 - 1022			Unused

1.8 Factory default programmable scheme logic

The following section details the default settings of the PSL.

Note: The default PSL has been implemented for the P842xxxAxxxxxxB with 48 inputs and 32 outputs.

1.9 Logic input mapping

The default mappings for each of the opto-isolated inputs are as shown in the following table:

Opto-Input Number	P842 Relay Text	Function
1	L1 AutoSwitch In	Auto-switch In
2	L2 AutoSwitchOut	Auto switch Out
3	L3 DAR In	DAR In
4	L4 DAR Out	DAR Out
5	L5 MC DAR Req	DAR Required
6	L6 MC Not DAR	DAR Not required
7	L7 MC InhibitDAR	Inhibit DAR
8	L8CBFail Lockout	Global Lockout (From CB Fail)
9	L9 Line 1 Open	Disconnector Open
10	L10 Line1 Closed	Disconnector Closed
11	L11 InhibitLine1	Inhibit Disconnector
12	L12 Ln1 DAR Req	DAR Required
13	L13 Ln1 Not DAR	DAR Not required
14	L14 Ln1 I/T Rx	Intertrip Rx
15	L15 MC Lockout	Corner Lockout DAR
16	L16 Ln1 I/T Tx	Intertrip Tx auxiliary
17	L17 Unused	Spare
18	L18 Unused	Spare
19	L19 Unused	Spare
20	L20 Unused	Spare
21	L21 Trfmr1 Open	Disconnector Open
22	L22 Trfmr1Closed	Disconnector Closed
23	L23 Inhibit Tfr1	Inhibit Disconnector
24	L24 Tfr1 Not DAR	DAR Not required (Isolate Transformer)
25	L25 Unused	Spare
26	L26 Unused	Spare
27	L27 Unused	Spare
28	L28 Unused	Spare
29	L29 CB1 Open	CB Open
30	L30 CB1 Closed	CB Closed
31	L31 Inhibit CB1	Inhibit DAR
32	L32 Lockout CB1	Lockout DAR
33	L33 No DAR CB1	No DAR
34	L34 CB1 Seq Disc	Seq Disc Position
35	L35 Stub Bus	Spare
36	L36 Unused	Spare
37	L37 Unused	Spare
38	L38 Unused	Spare
39	L39 Unused	Spare
40	L40 Unused	Spare
41	L41 Ferrores In	Ferroresonance in

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Opto-Input Number	P842 Relay Text	Function
42	L42 Ferrores Out	Ferroresonance out
43	L43 FR Detect	Ferroresonance detect
44	L44 FR Start	Ferroresonance start
45	L45 FR Lockout	Ferroresonance lockout
46	L46 FR Interlock	Ferroresonance local interlock
47	L47 FR Cancel	FR Reset/Cancel
48	L48 TRR Reset	DAR Interlock Reset

Note: If the "Setting Group" cell in the "CONFIGURATION" column is set to "Select via Opto", the opto's that are used for changing setting groups are always opto's 1 and 2. This mapping is effectively hardwired and does not therefore need to be mapped within the PSL.

1.10 Relay output contact mapping

The default mappings for each of the relay output contacts are as shown in the following table:

Relay Contact Number	P842 Relay Text	P842 Relay Conditioner	Function
1	R1 Unused	Not mapped	
2	R2 Unused	Not mapped	
3	R3 I/T Rx Reset	Straight	I/T Receive reset
4	R4 FR Close Tfr1	Straight	Reclose TR1 disconnector command
5	R5 FR Close Tfr1	Straight	Reclose TR1 disconnector command
6	R6 FR Det. I/M	Straight	Indication of FR condition being detected by external device
7	R7 Echo I/T Tx1	Straight	Echo received I/T signal
8	R8 Echo I/T Tx1	Straight	Echo received I/T signal
9	R9 Tfr1 Open	Straight	Command to open Line 1 disconnector
10	R10 Tfr1 Open	Straight	Command to open Line 1 disconnector
11	R11 Tfr1Overide	Straight	TR 1 override
12	R12 I/T Tx Reset	Straight	I/T Send reset
13	R13 I/T Tx Reset	Straight	I/T Send reset
14	R14 CB1 Close	Straight	CB1 close command
15	R15 CB1 Close	Straight	CB1 close command
16	R16 CB1 Inh Iso	Straight	Inhibit CB1 sequential disconnectors
17	R17 Unused	Straight	Spare
18	R18 Sys Split Al	Straight	Indication of CB1 System Split
19	R19 Open Line 1	Straight	Command to open Line 1 disconnector
20	R20 Open Line 1	Straight	Command to open Line 1 disconnector
21	R21 Open Line 1	Straight	Command to open Line 1 disconnector
22	R22 FR InProgres	Straight	FR in progress indication
23	R23 LVDARLockout	Straight	Command to lockout LV DAR
24	R24 FR Detected	Straight	FR detected
25	R25 LVDARInhibit	Straight	Inhibit LV DAR command
26	R26 A/S Inhibit Alrm	Straight	Inhibit Autoswitching alarm
27	R27A/S InProgres	Straight	Indication of Autoswitching in progress
28	R28 A/S Complete	Straight	Indication of Autoswitching being completed
29	R29 Start LV DAR	Straight	Start LV DAR command
30	R30 PlantStat. Al	Straight	Plant DBI alarm
31	R31 AutoSwch Out	Straight	Autoswitching disabled
32	R32 DAR Out	Straight	DAR disabled

Note: Unlike other MiCOM relays, Relay 3 is not connected to the trip LED since P842 has no built in protections. Consequently, Fault recorded signal is not available in the PSL.

1.11 Programmable LED output mapping

The default mappings for each of the programmable LEDs are as shown in the following table:

LED Number	LED Input Connection/Text	Latched	P842 LED Function Indication
1	LED 1 Red	No	A/S out of service
2	LED 2 Red	No	DAR out of service
3	LED 3 Red	No	FR Function out of service
4	LED 4 Red	No	Autoswitching in progress
5	LED 5 Red	No	CB1 Function in service
6	LED 6 Red	No	Line 1 disconnector is open
7	LED 7 Grn.	No	TR1 HV disconector is open
8	LED 8 Red	No	Not mapped

1.12 PSL DATA column

The MiCOM P842 relay contains a PSL DATA column that can be used to track PSL modifications. A total of 12 cells are contained in the PSL DATA column, 3 for each setting group. The function for each cell is shown below:

Grp. PSL Ref.	When downloading a PSL to the relay, the user will be prompted to enter which group the PSL is for and a reference identifier. The first 32 characters of the reference ID will be displayed in this cell. The ◁ and ▷ keys can be used to scroll through 32 characters as only 16 can be displayed at any one time.
18 Nov 2004 08:59:32.047	This cell displays the date and time when the PSL was down loaded to the relay.
Grp. 1 PSL ID - 2062813232	This is a unique number for the PSL that has been entered. Any change in the PSL will result in a different number being displayed.

Note: The above cells are repeated for each setting group.

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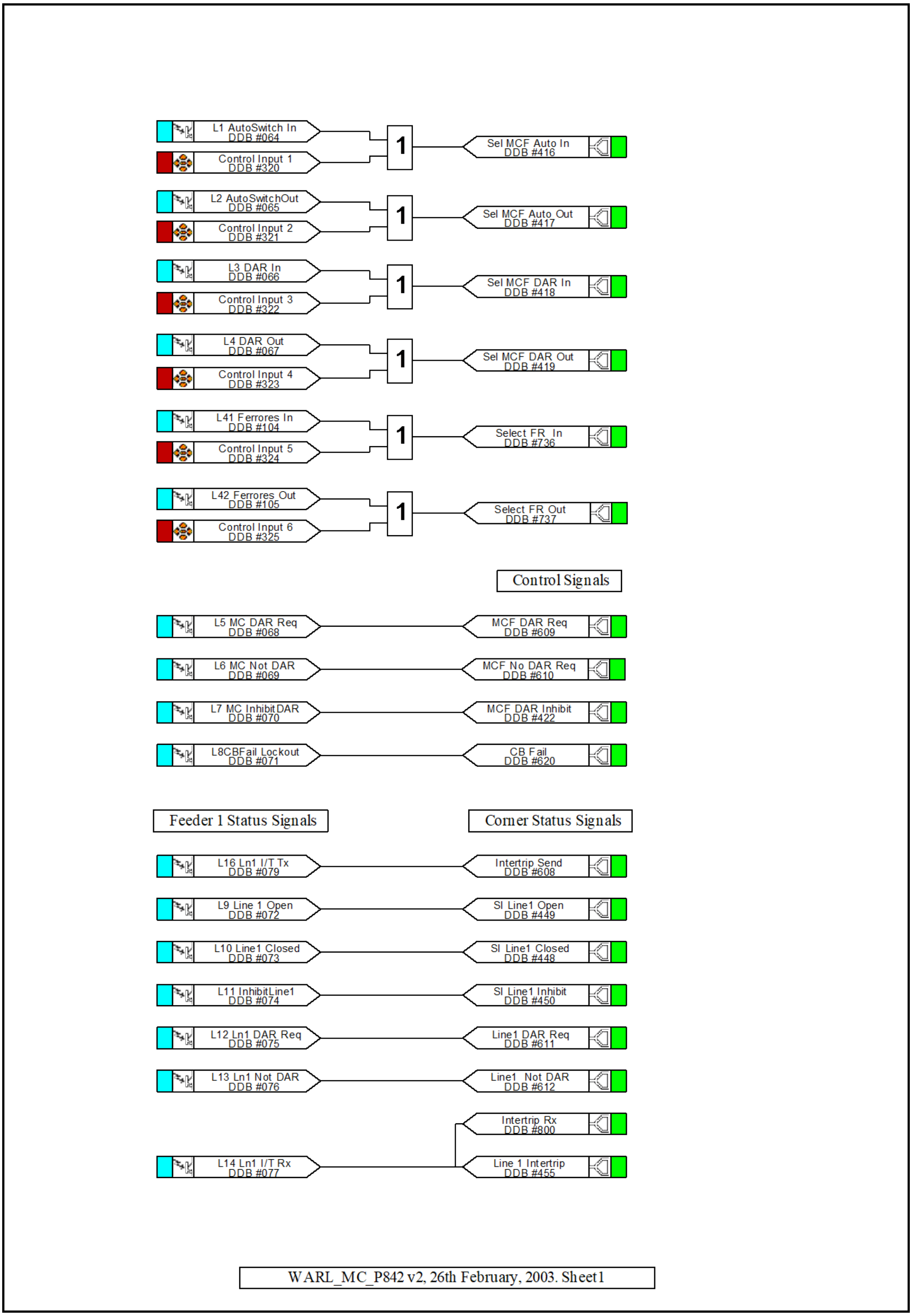
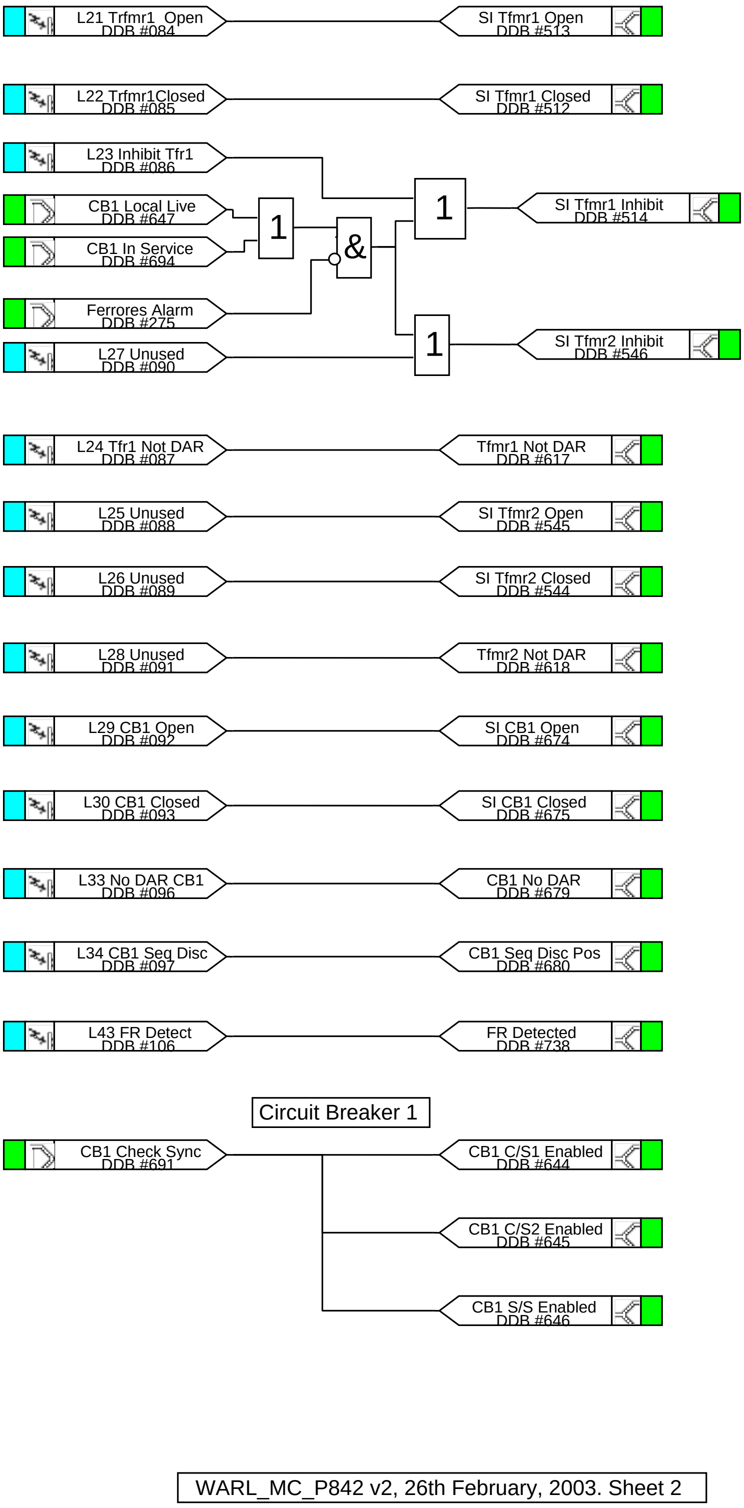
MiCOM P842 PROGRAMMABLE SCHEME LOGIC

Opto Input Mappings




L21 Trfmr1 Open
DDB #084
SI Tfmr1 Open
DDB #513
L22 Trfmr1Closed
DDB #085
SI Tfmr1 Closed
DDB #512
L23 Inhibit Tfr1
DDB #086
CB1 Local Live
DDB #647
CB1 In Service
DDB #694
Ferrores Alarm
DDB #275
L27 Unused
DDB #090
1
&
1
1
SI Tfmr1 Inhibit
DDB #514
SI Tfmr2 Inhibit
DDB #546
L24 Tfr1 Not DAR
DDB #087
Tfmr1 Not DAR
DDB #617
L25 Unused
DDB #088
SI Tfmr2 Open
DDB #545
L26 Unused
DDB #089
SI Tfmr2 Closed
DDB #544
L28 Unused
DDB #091
Tfmr2 Not DAR
DDB #618
L29 CB1 Open
DDB #092
SI CB1 Open
DDB #674
L30 CB1 Closed
DDB #093
SI CB1 Closed
DDB #675
L33 No DAR CB1
DDB #096
CB1 No DAR
DDB #679
L34 CB1 Seq Disc
DDB #097
CB1 Seq Disc Pos
DDB #680
L43 FR Detect
DDB #106
FR Detected
DDB #738
Circuit Breaker 1
CB1 Check Sync
DDB #691
CB1 C/S1 Enabled
DDB #644
CB1 C/S2 Enabled
DDB #645
CB1 S/S Enabled
DDB #646
WARL_MC_P842 v2, 26th February, 2003. Sheet 2

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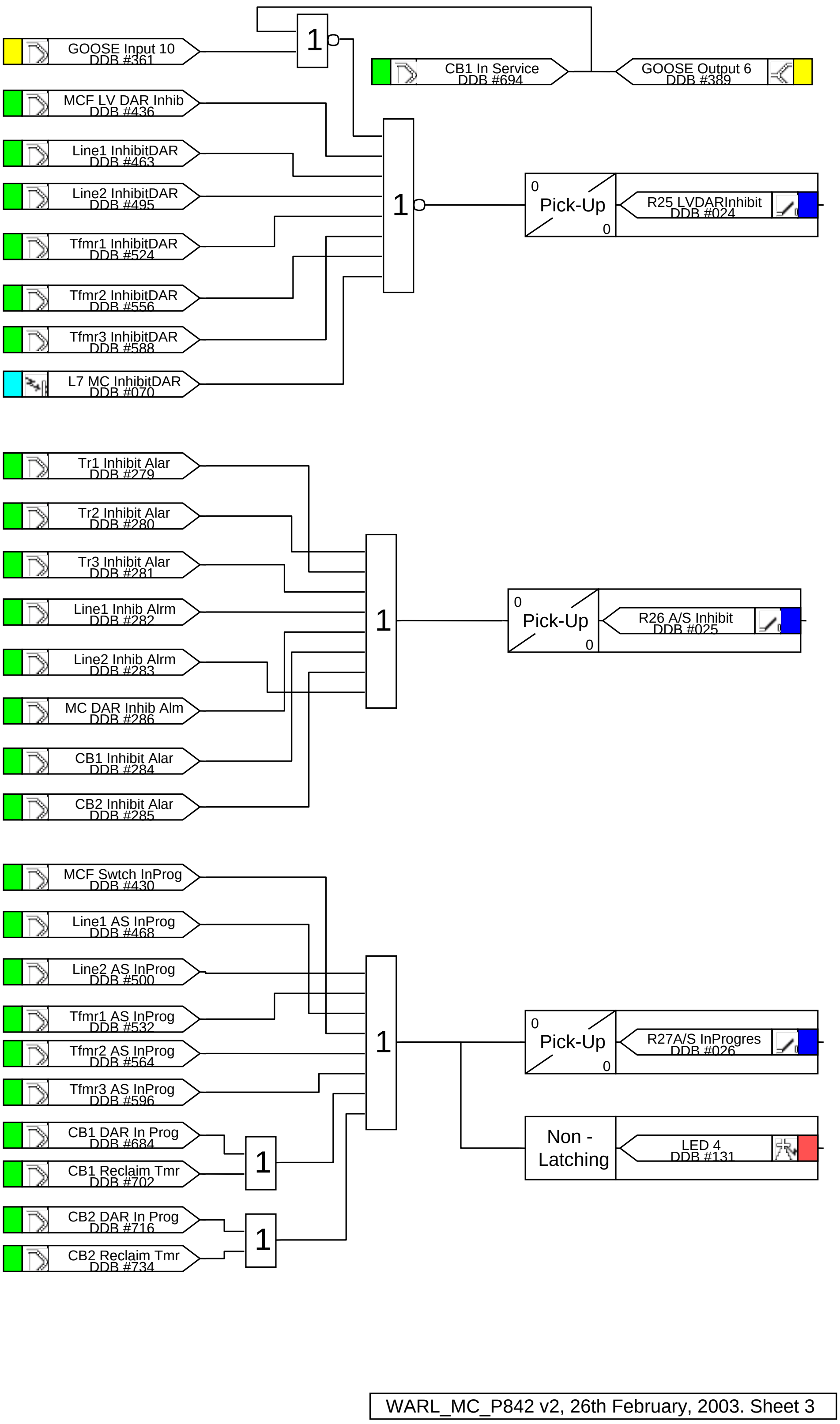
Output Relay Mappings



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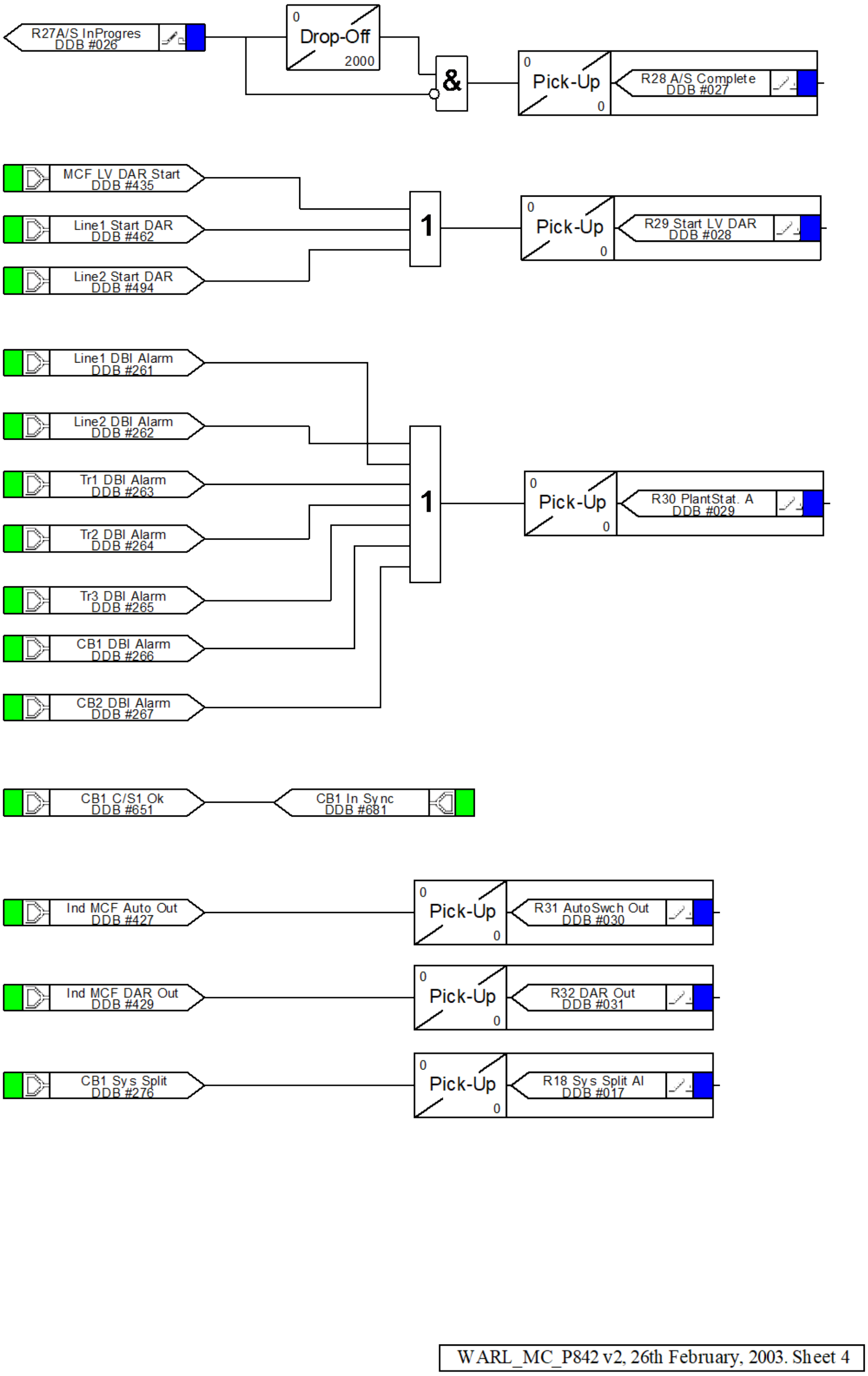
R27A/S InProgres
DDB #026
Drop-Off
0
2000
&
Pick-Up
0
0
R28 A/S Complete
DDB #027
MCF LV DAR Start
DDB #435
Line1 Start DAR
DDB #462
Line2 Start DAR
DDB #494
1
R29 Start LV DAR
DDB #028
Line1 DBI Alarm
DDB #261
Line2 DBI Alarm
DDB #262
Tr1 DBI Alarm
DDB #263
Tr2 DBI Alarm
DDB #264
Tr3 DBI Alarm
DDB #265
CB1 DBI Alarm
DDB #266
CB2 DBI Alarm
DDB #267
R30 PlantStat. A
DDB #029
CB1 C/S1 Ok
DDB #651
CB1 In Sync
DDB #681
Ind MCF Auto Out
DDB #427
R31 AutoSwch Out
DDB #030
Ind MCF DAR Out
DDB #429
R32 DAR Out
DDB #031
CB1 Sys Split
DDB #276
R18 Sys Split Al
DDB #017
WARL_MC_P842 v2, 26th February, 2003. Sheet 4

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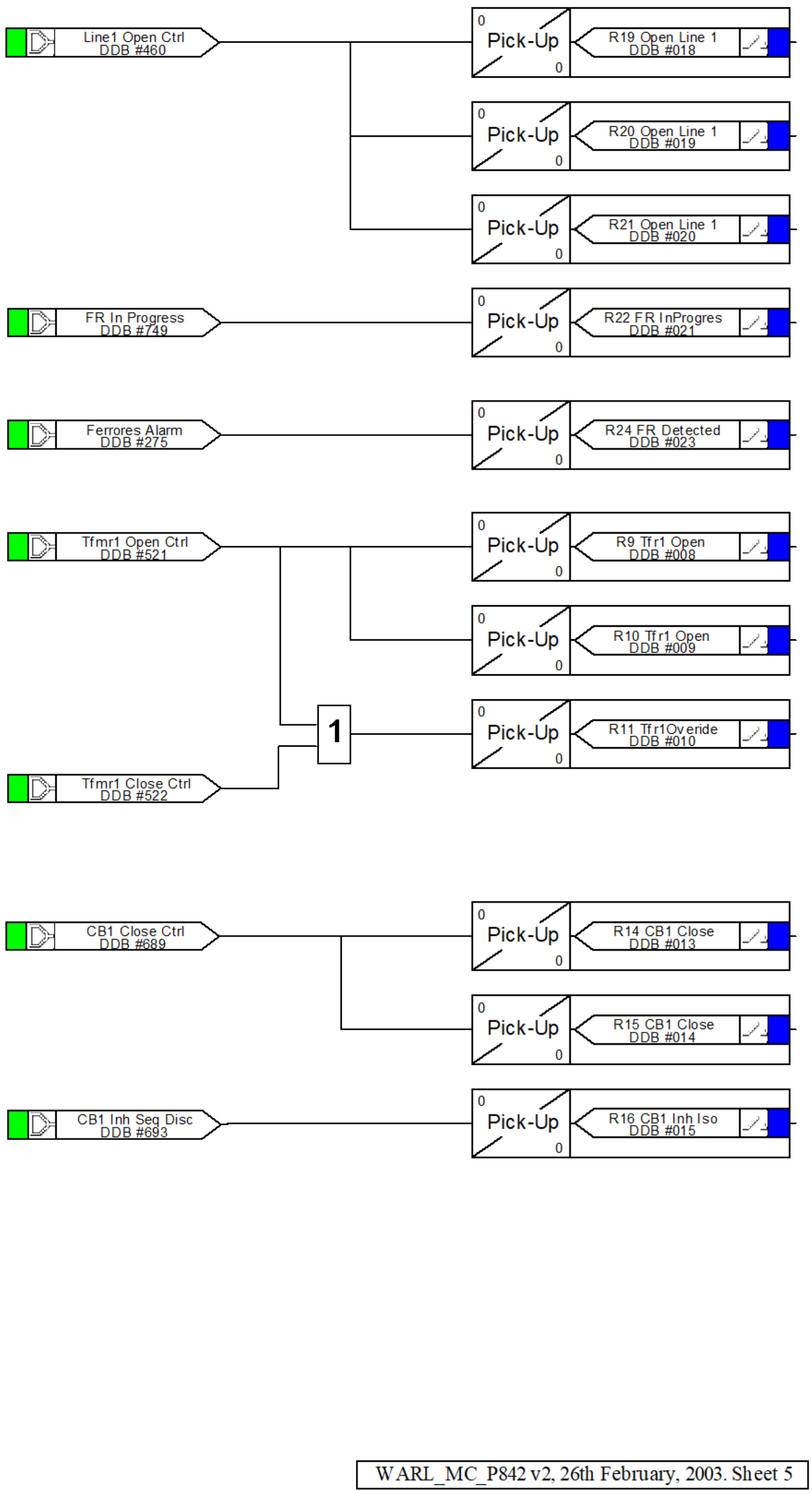
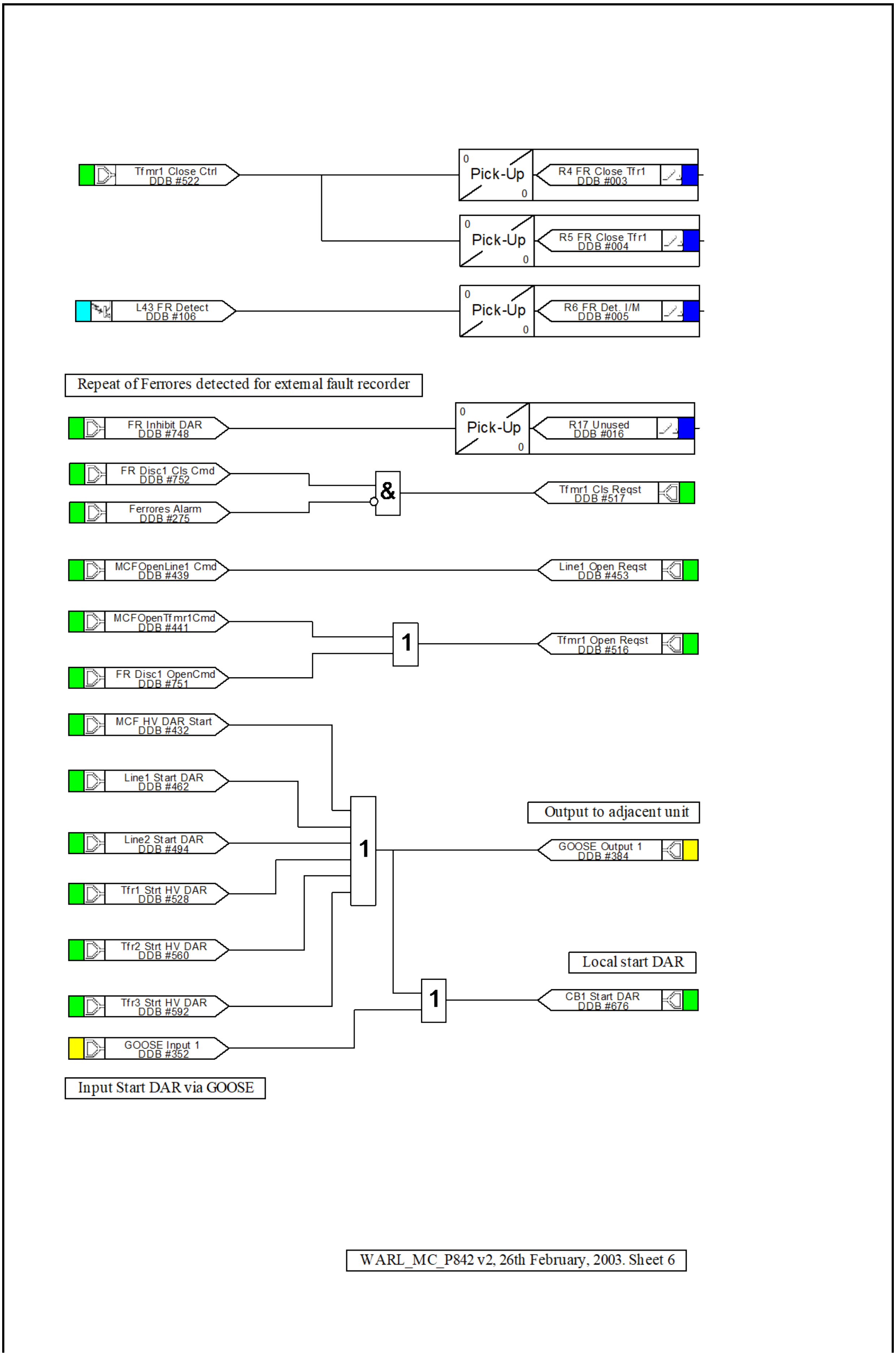
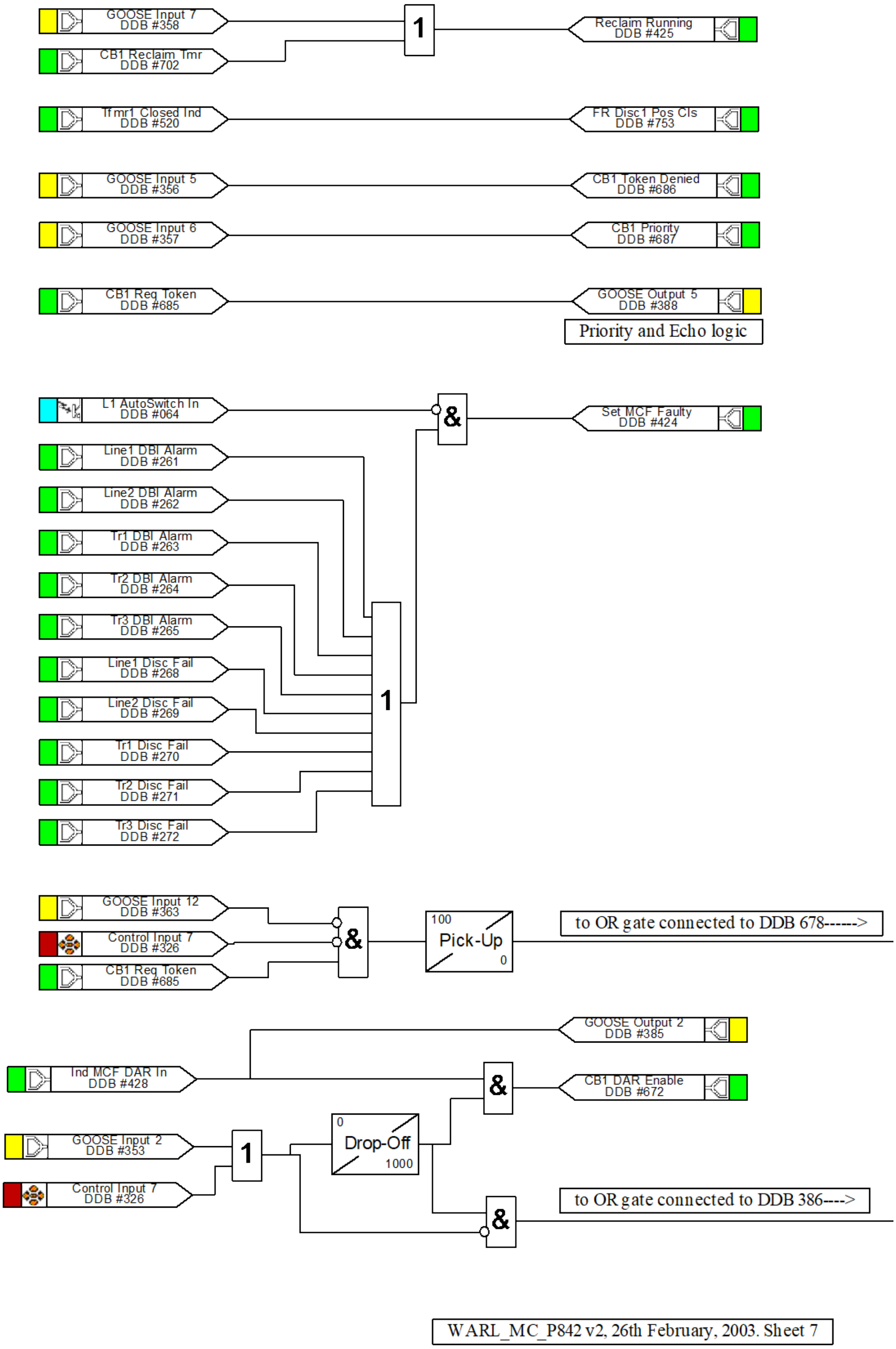
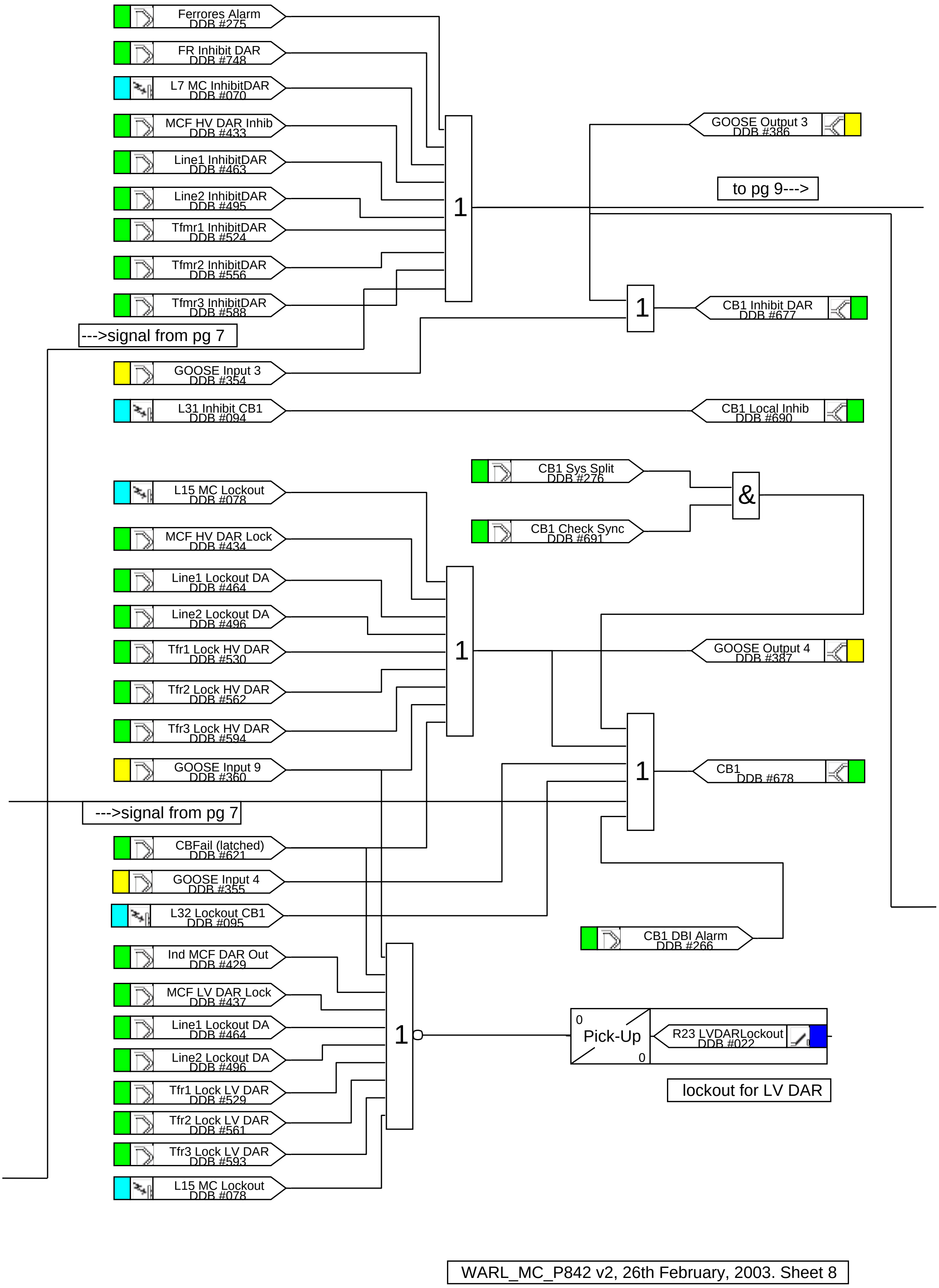

Line1 Open Ctrl DDB #460
FR In Progress DDB #749
Ferrores Alarm DDB #275
Tfmr1 Open Ctrl DDB #521
Tfmr1 Close Ctrl DDB #522
CB1 Close Ctrl DDB #689
CB1 Inh Seq Disc DDB #693
1
Pick-Up
R19 Open Line 1 DDB #018
R20 Open Line 1 DDB #019
R21 Open Line 1 DDB #020
R22 FR InProgres DDB #021
R24 FR Detected DDB #023
R9 Tfr1 Open DDB #008
R10 Tfr1 Open DDB #009
R11 Tfr1Overide DDB #010
R14 CB1 Close DDB #013
R15 CB1 Close DDB #014
R16 CB1 Inh Iso DDB #015
WARL_MC_P842 v2, 26th February, 2003. Sheet 5

Function Blocks Interface Logic




GOOSE Input 7
DDB #358
CB1 Reclaim Tmr
DDB #702
1
Reclaim Running
DDB #425
Tfmr1 Closed Ind
DDB #520
FR Disc1 Pos Cls
DDB #753
GOOSE Input 5
DDB #356
CB1 Token Denied
DDB #686
GOOSE Input 6
DDB #357
CB1 Priority
DDB #687
CB1 Req Token
DDB #685
GOOSE Output 5
DDB #388
Priority and Echo logic
L1 AutoSwitch In
DDB #064
&
Set MCF Faulty
DDB #424
Line1 DBI Alarm
DDB #261
Line2 DBI Alarm
DDB #262
Tr1 DBI Alarm
DDB #263
Tr2 DBI Alarm
DDB #264
Tr3 DBI Alarm
DDB #265
Line1 Disc Fail
DDB #268
Line2 Disc Fail
DDB #269
Tr1 Disc Fail
DDB #270
Tr2 Disc Fail
DDB #271
Tr3 Disc Fail
DDB #272
1
GOOSE Input 12
DDB #363
Control Input 7
DDB #326
CB1 Req Token
DDB #685
&
100
Pick-Up
0
to OR gate connected to DDB 678------>
GOOSE Output 2
DDB #385
Ind MCF DAR In
DDB #428
&
CB1 DAR Enable
DDB #672
GOOSE Input 2
DDB #353
Control Input 7
DDB #326
1
0
Drop-Off
1000
&
to OR gate connected to DDB 386---->
WARL_MC_P842 v2, 26th February, 2003. Sheet 7


Ferrores Alarm
DDB #275
FR Inhibit DAR
DDB #748
L7 MC InhibitDAR
DDB #070
MCF HV DAR Inhib
DDB #433
Line1 InhibitDAR
DDB #463
Line2 InhibitDAR
DDB #495
Tfmr1 InhibitDAR
DDB #524
Tfmr2 InhibitDAR
DDB #556
Tfmr3 InhibitDAR
DDB #588
--->signal from pg 7
GOOSE Input 3
DDB #354
L31 Inhibit CB1
DDB #094
1
GOOSE Output 3
DDB #386
to pg 9--->
1
CB1 Inhibit DAR
DDB #677
CB1 Local Inhib
DDB #690
CB1 Sys Split
DDB #276
CB1 Check Sync
DDB #691
&
L15 MC Lockout
DDB #078
MCF HV DAR Lock
DDB #434
Line1 Lockout DA
DDB #464
Line2 Lockout DA
DDB #496
Tfr1 Lock HV DAR
DDB #530
Tfr2 Lock HV DAR
DDB #562
Tfr3 Lock HV DAR
DDB #594
GOOSE Input 9
DDB #360
1
GOOSE Output 4
DDB #387
1
CB1
DDB #678
--->signal from pg 7
CBFail (latched)
DDB #621
GOOSE Input 4
DDB #355
L32 Lockout CB1
DDB #095
CB1 DBI Alarm
DDB #266
Ind MCF DAR Out
DDB #429
MCF LV DAR Lock
DDB #437
Line1 Lockout DA
DDB #464
Line2 Lockout DA
DDB #496
Tfr1 Lock LV DAR
DDB #529
Tfr2 Lock LV DAR
DDB #561
Tfr3 Lock LV DAR
DDB #593
L15 MC Lockout
DDB #078
1
0
Pick-Up
0
R23 LVDARLockout
DDB #022
lockout for LV DAR
WARL_MC_P842 v2, 26th February, 2003. Sheet 8

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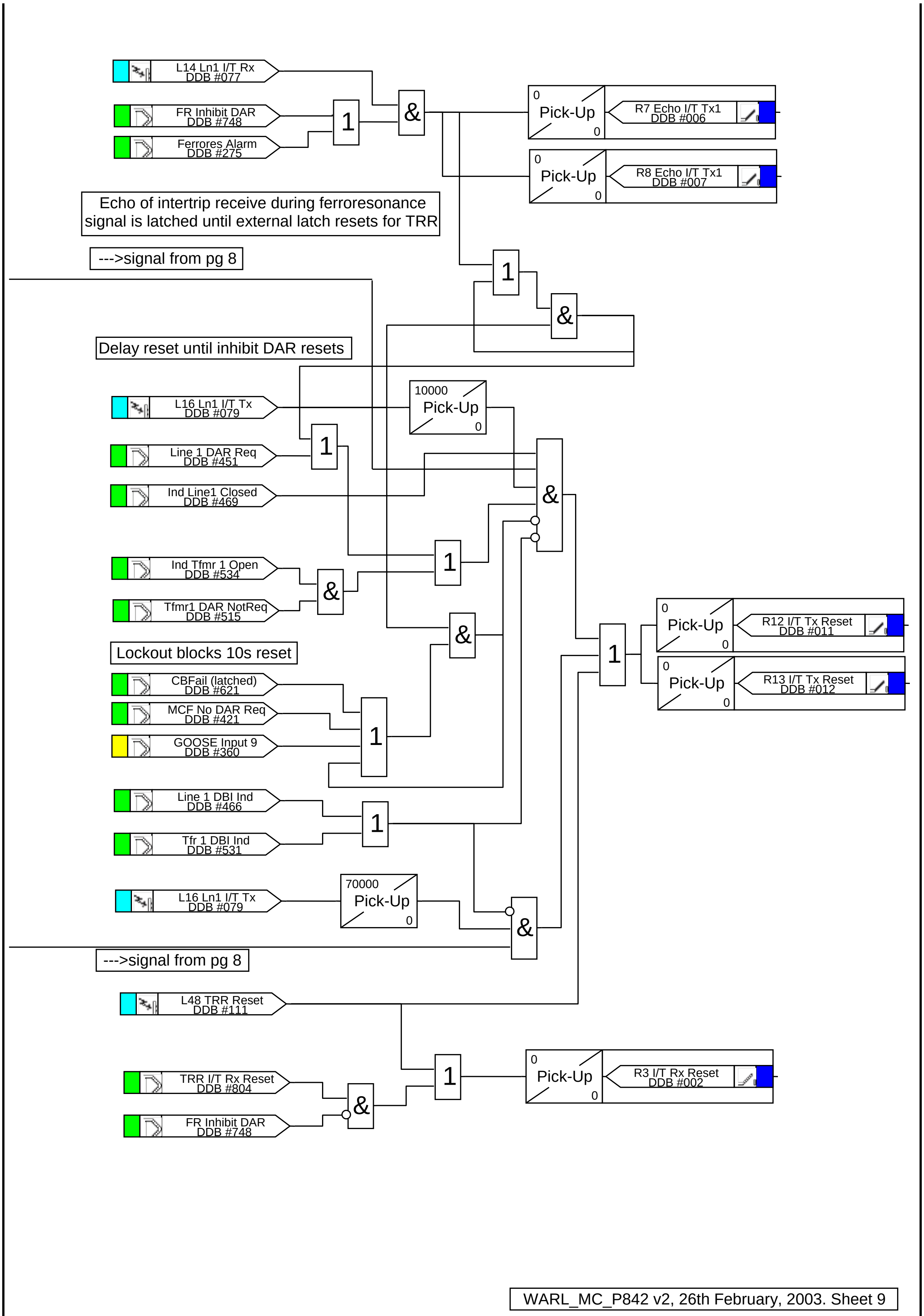
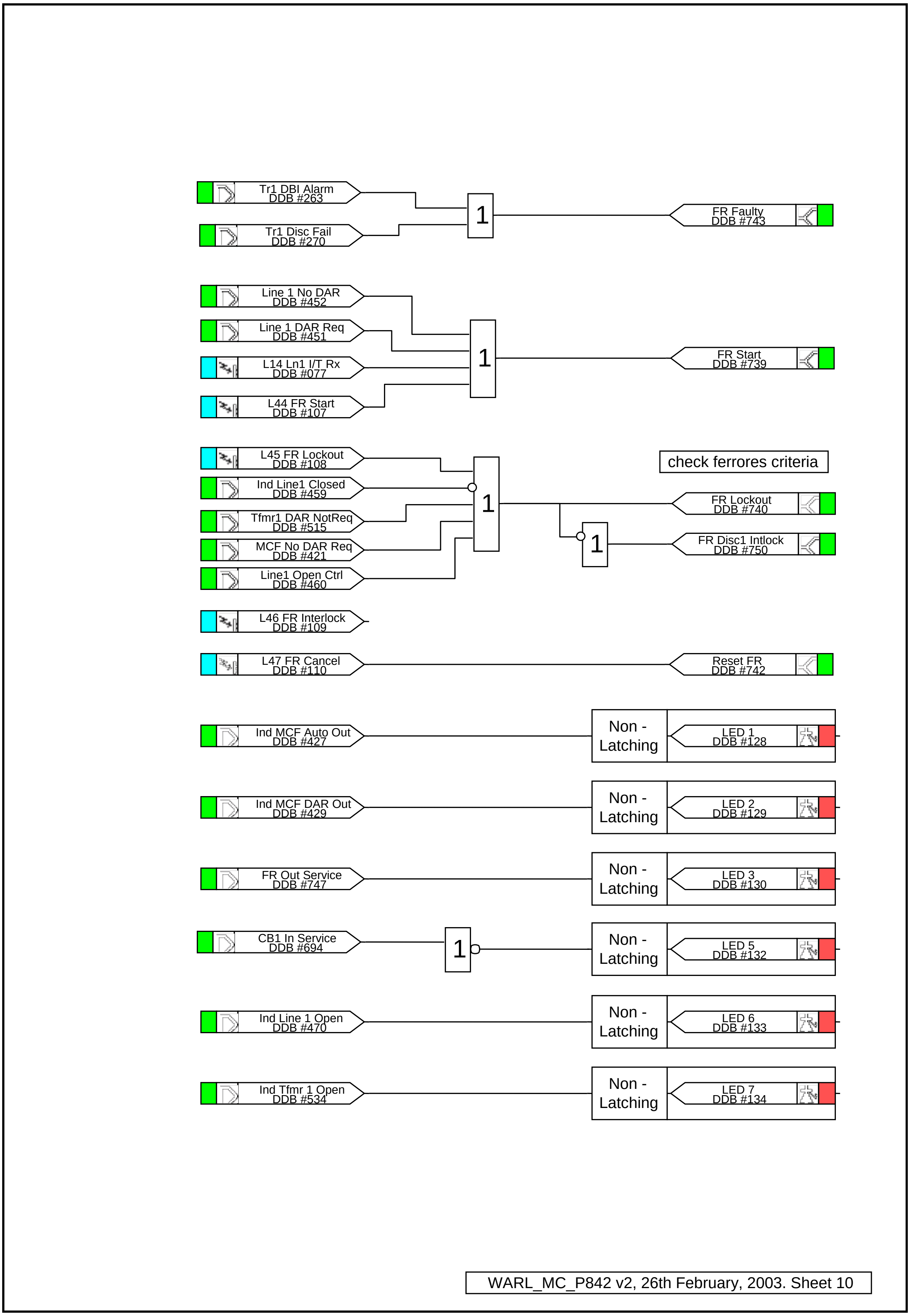

L14 Ln1 I/T Rx
DDB #077
FR Inhibit DAR
DDB #748
Ferrores Alarm
DDB #275
Pick-Up
R7 Echo I/T Tx1
DDB #006
R8 Echo I/T Tx1
DDB #007
Echo of intertrip receive during ferroresonance signal is latched until external latch resets for TRR
--->signal from pg 8
Delay reset until inhibit DAR resets
L16 Ln1 I/T Tx
DDB #079
10000
Line 1 DAR Req
DDB #451
Ind Line1 Closed
DDB #469
Ind Tfmr 1 Open
DDB #534
Tfmr1 DAR NotReq
DDB #515
Lockout blocks 10s reset
CBFail (latched)
DDB #621
MCF No DAR Req
DDB #421
GOOSE Input 9
DDB #360
Line 1 DBI Ind
DDB #466
Tfr 1 DBI Ind
DDB #531
R12 I/T Tx Reset
DDB #011
R13 I/T Tx Reset
DDB #012
70000
--->signal from pg 8
L48 TRR Reset
DDB #111
TRR I/T Rx Reset
DDB #804
FR Inhibit DAR
DDB #748
R3 I/T Rx Reset
DDB #002
WARL_MC_P842 v2, 26th February, 2003. Sheet 9

LED Mappings



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MEASUREMENTS AND RECORDING

MR

Date: **2019**

Hardware Suffix: **B**

Software Version: **04**

MR

CONTENTS

(MR) 8-

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1. MEASUREMENTS AND RECORDING

1.1 Introduction

The P842 is equipped with integral measurements, event and disturbance recording facilities suitable for analysis of complex system disturbances.

The relay is flexible enough to allow for the programming of these facilities to specific user application requirements and are discussed below.

1.2 Event & fault records

The relay records and time tags up to 512 events and stores them in non-volatile (battery backed up) memory. This enables the system operator to establish the sequence of events that happened in the relay following a particular power system condition or switching sequence. When the available space is exhausted, the oldest event is automatically overwritten by the new one.

The real time clock in the relay provides the time tag to each event, to a resolution of 1ms.

The event records are available for viewing either through the frontplate LCD or remotely through the communications ports (courier versions only).

Local viewing on the LCD is achieved in the menu column entitled "VIEW RECORDS". This column allows viewing of event, fault and maintenance records and is shown in the following table:

VIEW RECORDS	
LCD Reference	**Description**
Select Event	Setting range from 0 to 511. This selects the required event record from the possible 512 that may be stored. A value of 0 corresponds to the latest event and so on.
Time & Date	Time & Date Stamp for the event given by the internal Real Time Clock.
Event Text	Up to 32 Character description of the Event refer to following sections).
Event Value	Up to 32 Bit Binary Flag or integer representative of the Event (refer to following sections).
Select Maint.	Setting range from 0 to 4. This selects the required maintenance report from the possible 5 that may be stored. A value of 0 corresponds to the latest report and so on.
Maint. Text	Up to 16 Character description of the occurrence (refer to following sections).
Maint. Type/Main Data	These cells are numbers representative of the occurrence. They form a specific error code which should be quoted in any related correspondence to Report Data.
Reset Indication	Either Yes or No. This serves to reset the trip LED indications provided that the relevant protection element has reset.

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For extraction from a remote source via communications, refer to the SCADA Communications chapter (P842/EN SC), where the procedure is fully explained.

1.2.1 Types of event

An event may be a change of state of a control input or output relay, an alarm condition, setting change etc. The following sections show the various items that constitute an event:

1.2.1.1 Change of state of opto-isolated inputs

If one or more of the opto (logic) inputs has changed state since the last time the protection algorithm ran, the new status is logged as an event. When this event is selected on the LCD, three applicable cells will become visible as shown below:

Time & date of event
“LOGIC INPUTS 1”
“Event Value 0101010101010101”

The Event Value is an 8, 12, 16 or 24-bit word showing the status of the opto inputs, where the least significant bit (extreme right) corresponds to opto input 1 etc. The same information is present if the event is extracted and viewed via PC.

1.2.1.2 Change of state of one or more output relay contacts

If one or more of the output relay contacts have changed state since the last time the protection algorithm ran, then the new status is logged as an event. When this event is selected on the LCD, three applicable cells will become visible as shown below:

Time & date of event
“OUTPUT CONTACTS 1”
“Event Value 010101010101010101010”

The Event Value is an 8, 12, 16, 24 or 32 bit word showing the status of the output contacts, where the least significant bit (extreme right) corresponds to output contact 1 etc. The same information is present if the event is extracted and viewed using a PC.

1.2.1.3 Relay alarm conditions

Any alarm conditions generated by the relays are logged as individual events. The following table shows examples of some of the alarm conditions and how they appear in the event list:

Alarm Condition	Event Text	Event Value
Battery Fail	Battery Fail ON/OFF	Bit position 0 in 32 bit field
Field Voltage Fail	Field Volt Fail ON/OFF	Bit position 1 in 32 bit field
Setting Group via Opto Invalid	Setting Grp. Invalid ON/OFF	Bit position 2 in 32 bit field
Protection Disabled	Prot’n. Disabled ON/OFF	Bit position 3 in 32 bit field
Frequency out of Range	Freq. out of Range ON/OFF	Bit position 4 in 32 bit field
VTS Alarm	VT Fail Alarm ON/OFF	Bit position 5 in 32 bit field

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The table above shows the abbreviated description given to the various alarm conditions and also a corresponding value between 0 and 31. This value is added to each alarm event in a similar way to the input and output events previously described. It is used by the event extraction software, such as S1 Agile, to identify the alarm and is therefore invisible if the event is viewed on the LCD. Either ON or OFF is shown after the description to signify whether the particular condition has become operated or has reset.

1.2.1.4 General events

A number of events come under the heading of 'General Events', as shown below:

Nature of Event	Displayed Text in Event Record	Displayed Value
Level 1 password modified, either from user interface, front or rear port.	PW1 modified UI, F, R or R2	0 UI=6, F=11, R=16, R2=38

A complete list of the 'General Events' is given in the Relay Menu Database, which is a separate document.

1.2.1.5 Maintenance reports

Internal failures detected by the self-monitoring circuitry, such as watchdog failure or field voltage failure are logged in a maintenance report. The maintenance report holds up to 5 such 'events' and is accessed from the "Select Report" cell at the bottom of the "VIEW RECORDS" column.

Each entry consists of a self explanatory text string and a 'Type' and 'Data' cell, which is explained in the menu extract at the beginning of this section.

Each time a Maintenance Report is generated, an event is also created. The event simply states that a report was generated, with a corresponding time stamp.

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1.2.1.6 Setting changes

Changes to any setting within the relay are logged as an event. Two examples are shown in the following table:

Type of Setting Change	Displayed Text in Event Record	Displayed Value
Control/Support Setting	C & S Changed	22
Group # Change	Group # Changed	#

Where # = 1 to 4

Note: Control/Support settings are communications, measurement and CT/VT ratio settings, which are not duplicated within the four setting groups. When any of these settings are changed, the event record is created simultaneously. However, changes to protection or disturbance recorder settings only generate an event once the settings have been confirmed at the 'setting trap'.

1.2.2 Resetting of event/fault records

Go to the "RECORD CONTROL" column to delete the event, fault or maintenance reports.

1.2.3 Viewing event records using S1 Agile support software

When the event records are extracted and viewed on a PC they look slightly different than when viewed on the LCD. The following shows an example of how various events appear when displayed using S1 Agile:

- Monday 03 January 2005 15:33:11 GMT Logic Inputs

    MiCOM : MiCOM P842

    Model Number: P842315A1B0050B

    Address: 001 Column: 00 Row: 20

Event Type: Logic input changed state

- Monday 03 January 2005 15:34:54 GMT Output Contacts

  MiCOM : MiCOM P842

  Model Number: P842315A1B0050B

  Address: 001 Column: 00 Row: 21

  Event Type: Relay output changed state

- Monday 03 January 2005 15:35:55 GMT Line 1 DBI Alarm

  MiCOM : MiCOM P842

  Model Number: P842315A1B0050B

  Address: 001 Column: 00 Row: 22

  Event Type: Alarm event

- Tuesday 04 January 2005 20:18:22.988 GMT Protection DAR Required

  MiCOM : MiCOM P842

  Model Number: P842315A1B0050B

  Address: 001 Column: 0F Row: 30

  Event Type: Setting event

The first line gives the description and time stamp for the event. Additional information is displayed below and can be collapsed using the +/– symbol.

For more information regarding events and their specific meaning, refer to relay menu database document (P842/EN MD). This is a standalone document not included in this manual.

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1.2.4 Event filtering

It is possible to disable the reporting of events from all interfaces that supports setting changes. The settings that control the various types of events are in the record control column. The effect of setting each to disabled is as follows:

Menu Text	Default Setting	Available Settings
Clear Event	No	No or Yes
Selecting “Yes” will cause the existing event log to be cleared and an event will be generated indicating that the events have been erased.		
Clear Maint.	No	No or Yes
Selecting “Yes” will cause the existing maintenance records to be erased from the relay.		
Alarm Event	Enabled	Enabled or Disabled
Disabling this setting means that all the occurrences that produce an alarm will result in no event being generated.		
Relay O/P Event	Enabled	Enabled or Disabled
Disabling this setting means that no event will be generated for any change in logic input state.		
Opto Input Event	Enabled	Enabled or Disabled
Disabling this setting means that no event will be generated for any change in logic input state.		
General Event	Enabled	Enabled or Disabled
Disabling this setting means that no General Events will be generated		

Menu Text	Default Setting	Available Settings
Maint. Rec. Event	Enabled	Enabled or Disabled
Disabling this setting means that no event will be generated for any occurrence that produces a maintenance record.		
Protection Event	Enabled	Enabled or Disabled
Disabling this setting means that any operation of protection elements will not be logged as an event.		
DDB 31 - 0	11111111111111111111111111111111	
Displays the status of DDB signals 0 – 31.		
DDB 1022 - 992	11111111111111111111111111111111	
Displays the status of DDB signals 1022 – 992.		

Note: Some occurrences will result in more than one type of event, e.g. a battery failure will produce an alarm event and a maintenance record event.

If the Protection Event setting is Enabled a further set of settings are revealed, which allow the event generation by individual DDB signals to be enabled or disabled.

For further information regarding events and their specific meaning, refer to relay menu database document.

1.3 Disturbance recorder

The integral disturbance recorder has an area of memory specifically set aside for record storage. The number of records that are stored by the relay is dependent on the selected recording duration. The relay can typically store a minimum of 20 records, each of 1.5 seconds duration. VDEW relays, however, have the same total record length but the VDEW protocol dictates that only 8 records (of 3 seconds duration) can be extracted via the rear port. Disturbance records continue to be recorded until the available memory is exhausted, at which time the oldest record(s) are overwritten to make space for the newest one.

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The recorder stores actual samples that are taken at a rate of 24 samples per cycle.

Each disturbance record consists of eight analog data channels and thirty-two digital data channels. The relevant CT and VT ratios for the analog channels are also extracted to enable scaling to primary quantities.

Note: If a CT ratio is set less than unity, the relay will choose a scaling factor of zero for the appropriate channel.

The "DISTURBANCE RECORDER" menu column is shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
DISTURB. RECORDER				
Duration	1.5s	0.1s	10.5s	0.01s
This sets the overall recording time.				
Trigger Position	33.3%	0	100%	0.1%
This sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 1.5s with the trigger point being at 33.3% of this, giving 0.5s pre-fault and 1s post fault recording times.				
Trigger Mode	Single	Single or Extended		
If set to single mode, if a further trigger occurs whilst a recording is taking place, the recorder will ignore the trigger. However, if this has been set to "Extended", the post trigger timer will be reset to zero, thereby extending the recording time.				

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Analog. Channel 1	V1	V1/V2/V3/V4		
Selects any available analog input to be assigned to this channel.				
Analog. Channel 2	V2	V1/V2/V3/V4		
Analog. Channel 3	V3	V1/V2/V3/V4		
Analog. Channel 4	V4	V1/V2/V3/V4		
Digital Inputs 1 to 32	Relays 1 to 12 and Opto's 1 to 12	Any of 12 O/P Contacts or Any of 12 Opto Inputs or Internal Digital Signals		
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to a number of internal relay digital signals, such as starts, LEDs etc.				
Inputs 1 to 32 Trigger	No Trigger except Dedicated Trip Relay O/P's which are set to Trigger L/H	No Trigger, Trigger L/H, Trigger H/L		
Any of the digital channels can be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				

The pre and post fault recording times are set by a combination of the "Duration" and "Trigger Position" cells. "Duration" sets the overall recording time and the "Trigger Position" sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 1.5s with the trigger point being at 33.3% of this, giving 0.5s pre-fault and 1s post fault recording times.

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If a further trigger occurs while a recording is taking place, the recorder will ignore the trigger if the "Trigger Mode" has been set to "Single". However, if this has been set to "Extended", the post trigger timer will be reset to zero, thereby extending the recording time.

As can be seen from the menu, each of the analog channels is selectable from the available analog inputs to the relay. The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to a number of internal relay digital signals, such as protection starts, LEDs etc. The complete list of these signals can be found by viewing the available settings in the relay menu or using a setting file in S1 Agile. Any of the digital channels can be selected to trigger the disturbance recorder on either a low to high or a high to low transition, via the "Input Trigger" cell. The default trigger settings are that any dedicated trip output contacts (e.g. relay 3) will trigger the recorder.

It is not possible to view the disturbance records locally using the LCD, they must be extracted using suitable software such as S1 Agile. This process is fully explained in the SCADA Communications chapter (P842/EN SC).

1.4 Measurements

The relay produces a variety of both directly measured and calculated power system quantities. These measurement values are updated on a per second basis and can be viewed in the “MEASUREMENTS 1” column or through the S1 Agile Measurement viewer. The P842 relay can measure and display the following quantities as summarized.

- Phase Voltages
- Slip Frequency
- Rms. Voltages and Currents

1.4.1 Measured voltages

The relay produces 4 phase to ground voltages. They are produced directly from the DFT (Discrete Fourier Transform) used by the relay protection functions and present both magnitude and phase angle measurement.

1.4.2 Slip frequency

The relay produces a slip frequency measurement by measuring the rate of change of phase angle, between the bus and line voltages, over a one-cycle period. The slip frequency measurement assumes the bus voltage to be the reference phasor.

1.4.3 Settings

The following settings under the heading measurement set-up can be used to configure the relay measurement function.

Menu Text	Default Settings	Available settings
MEASUREMENT SETUP		
Default Display	Description	Description/Plant Reference/ Frequency/Access Level/Date and Time
This setting can be used to select the default display from a range of options, note that it is also possible to view the other default displays whilst at the default level using the ⟨ and ⟩ keys. However, once the 15-minute timeout elapses the default display will revert to that selected by this setting.		
Local Values	Primary	Primary/Secondary
This setting controls whether measured values via the front panel user interface and the front courier port are displayed as primary or secondary quantities.		
Remote Values	Primary	Primary/Secondary
This setting controls whether measured values via the rear communication port are displayed as primary or secondary quantities.		

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1.4.4 Measurement display quantities

There are three "Measurement" columns available in the relay for viewing of measurement quantities. They can also be viewed with S1 Agile (see MiCOM Px40 – Monitoring section of the S1 Agile User Manual) and are shown below:

MEASUREMENTS 1	
V1 Magnitude	0 A
V1 Phase Angle	0 deg.
V2 Magnitude	0 A
V2 Phase Angle	0 deg.
V3 Magnitude	0 A
V3 Phase Angle	0 deg.
V4 Magnitude	0 deg.
V4 Phase Angle	0 A
Frequency	
CB1 C/S angle	0 deg
Slip Freq CB1.	0 deg.
CB2 C/S angle	0 deg
Slip Freq CB2.	0 deg.
C/S Rem-Local Ang1	0 deg.
C/S Rem-Local Ang2	0 deg.

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FIRMWARE DESIGN

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Date: **2019**
Hardware Suffix: **B**
Software Version: **04**

CONTENTS

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FIGURES

1. RELAY SYSTEM OVERVIEW

1.1 Hardware overview

The relay hardware is based on a modular design whereby the relay is made up of an assemblage of several modules that are drawn from a standard range. Some modules are essential while others are optional depending on the user's requirements.

The different modules that can be present in the relay are as follows:

1.1.1 Processor board

The processor board performs all calculations for the relay and controls the operation of all other modules within the relay. The processor board also contains and controls the user interfaces (LCD, LEDs, keypad, function keys and communication interfaces).

1.1.2 Input module

The input module converts the information contained in the analog and digital input signals into a format suitable for processing by the processor board. The standard input module consists of two boards; a transformer board to provide electrical isolation and a main input board which provides analog to digital conversion and the isolated digital inputs.

1.1.3 Power supply module

The power supply module provides a power supply to all of the other modules in the relay, at three different voltage levels. The power supply board also provides the EIA(RS)485 electrical connection for the rear communication port. On a second board the power supply module contains the relays that provide the output contacts.

The power supply module also provides a 48V external field supply output to drive the opto isolated digital inputs (or the substation battery may be used to drive the optos).

1.1.4 IRIG-B board (currently not available in P842)

This board, which is optional, can be used where an IRIG-B signal is available to provide an accurate time reference for the relay. There is also an option on this board to specify a fiber optic rear communication port, for use with Courier and IEC60870-5-103 communication.

1.1.5 Ethernet board

This is a mandatory board for UCA2.0 GOOSE communications. It provides network connectivity through either copper or fiber media at rates of 10Mb/s or 100Mb/s.

All modules are connected by a parallel data and address bus that allows the processor board to send and receive information to and from the other modules as required. There is also a separate serial data bus for conveying sample data from the input module to the processor. Figure 1 shows the modules of the relay and the flow of information between them.

1.2 Software overview

The software for the relay can be conceptually split into four elements; the real-time operating system, the system services software, the platform software and the protection and control software. These four elements are not distinguishable to the user and are all processed by the same processor board. The distinction between the four parts of the software is made purely for the purpose of explanation here:

1.2.1 Real-time operating system

The real time operating system is used to provide a framework for the different parts of the relay's software to operate within. To this end the software is split into tasks.

The real-time operating system is responsible for scheduling the processing of these tasks such that they are carried out in the time available and in the desired order of priority. The operating system is also responsible for the exchange of information between tasks, in the form of messages.

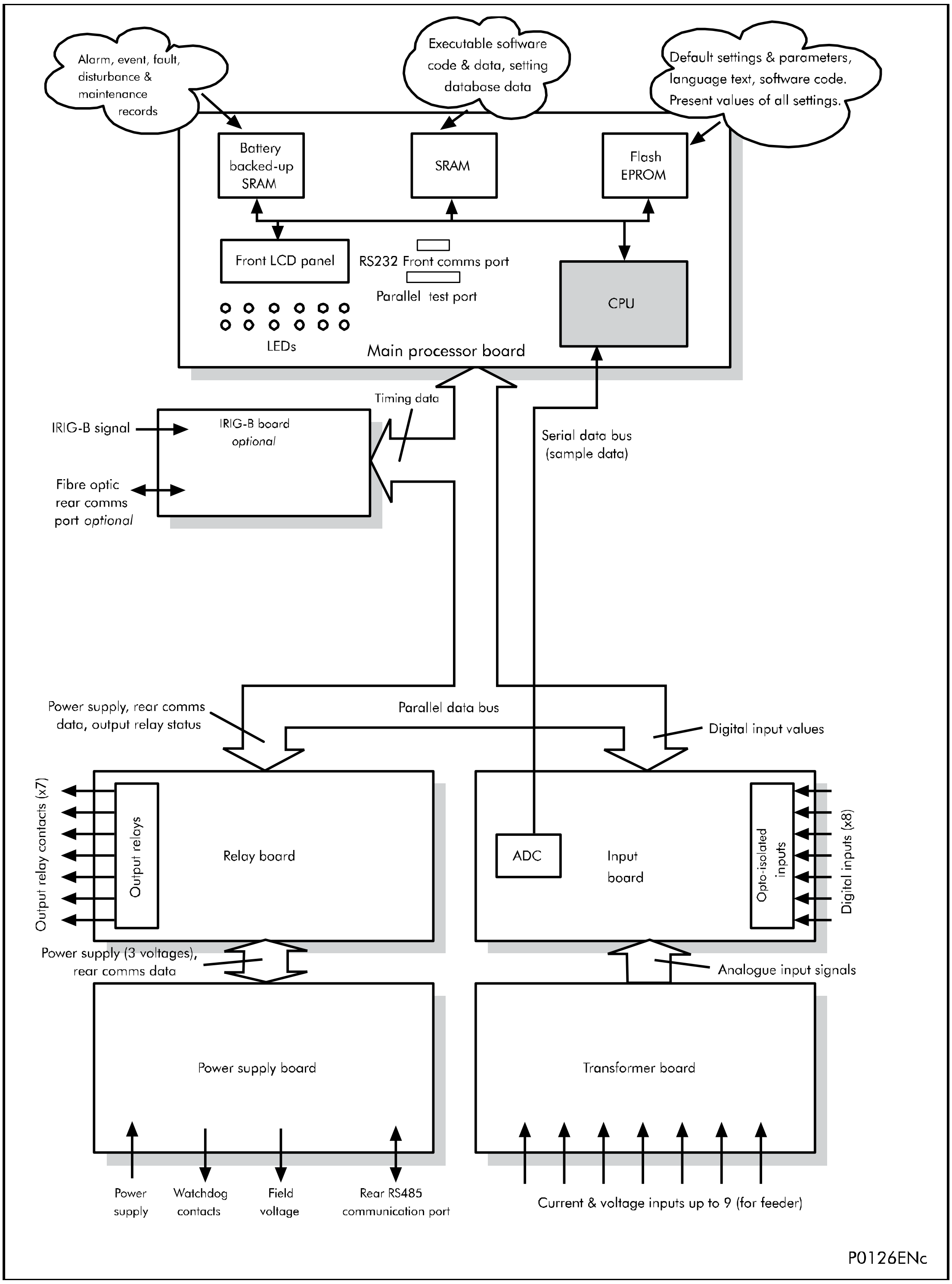

Figure 1: Relay modules and information flow

1.2.2 System services software

The system services software provides the low-level control of the relay hardware. For example, the system services software controls the boot of the relay's software from the non-volatile flash EPROM memory at power-on and provides driver software for the user interface via the LCD and keypad, and via the serial communication ports. The system services software provides an interface layer between the control of the relay's hardware and the rest of the relay software.

1.2.3 Platform software

The platform software deals with the management of the relay settings, the user interfaces and logging of event, alarm and maintenance records. All of the relay settings are stored in a database within the relay that provides direct compatibility with Courier communications. For all other interfaces (i.e. the front panel keypad and LCD interface, IEC60870-5-103) the platform software converts the information from the database into the format required. The platform software notifies the protection & control software of all settings changes and logs data as specified by the protection & control software.

1.2.4 Protection & control software

The protection and control software performs the Mesh corner autoreclose algorithm of the relay. This includes digital signal processing such as Fourier filtering and ancillary tasks such as the measurements. The protection & control software interfaces with the platform software for settings changes and logging of records, and with the system services software for acquisition of sample data and access to output relays and digital opto-isolated inputs.

1.2.5 Disturbance recorder

The analog values and logic signals are routed from the protection and control software to the disturbance recorder software. The platform software interfaces to the disturbance recorder to allow extraction of the stored records.

2. HARDWARE MODULES

The relay is based on a modular hardware design where each module performs a separate function within the relay operation. This section describes the functional operation of the various hardware modules.

2.1 Processor board

The relay is based around a TMS320VC33 floating point, 32-bit digital signal processor (DSP) operating at a clock frequency of 75MHz. This processor performs all of the calculations for the relay, including the protection functions, control of the data communication and user interfaces including the operation of the LCD, keypad and LEDs.

The processor board is located directly behind the relay's front panel which allows the LCD, function keys and LEDs to be mounted on the processor board along with the front panel communication ports. These comprise the 9-pin D-connector for EIA(RS)232 serial communications (e.g. using S1 Agile and Courier communications) and the 25-pin D-connector relay test port for parallel communication. All serial communication is handled using a field programmable gate array (FPGA).

The memory provided on the main processor board is split into two categories, volatile and non-volatile; the volatile memory is fast access SRAM which is used for the storage and execution of the processor software, and data storage as required during the processor's calculations. The non-volatile memory is sub-divided into 2 groups; 4MB of flash memory for non-volatile storage of software code, present setting values, text, configuration data, latched data signals (from control inputs, function keys, LEDs, relay outputs) and 4MB of battery backed-up SRAM for the storage of disturbance, event and maintenance record data.

2.2 Internal communication buses

The relay has two internal buses for the communication of data between different modules. The main bus is a parallel link that is part of a 64-way ribbon cable. The ribbon cable carries the data and address bus signals in addition to control signals and all power supply lines. Operation of the bus is driven by the main processor board that operates as a master while all other modules in the relay are slaves.

The second bus is a serial link that is used exclusively for communicating the digital sample values from the input module to the main processor board. The DSP processor has a built-in serial port that is used to read the sample data from the serial bus. The serial bus is also carried on the 64-way ribbon cable.

2.3 Input module

The input module provides the interface between the relay processor board and the analog and digital signals coming into the relay. The input module consists of two PCBs; the main input board and a transformer board. The relay provides voltage inputs for the check sync. function.

2.3.1 Transformer board

The transformer board holds up to four phase segregated voltage transformers (VTs). The current inputs are not used. The voltage transformers are used to step-down the voltages to levels appropriate to the relay's electronic circuitry and to provide effective isolation between the relay and the power system. The connection arrangements of volltage transformer secondaries provide differential input signals to the main input board to reduce noise.

2.3.2 Input board

The main input board is shown as a block diagram in figure 2. It provides the circuitry for the digital input signals and the analog-to-digital conversion for the analog signals. Therefore, it takes the differential analog signals from the VTs on the transformer board(s), converts these to digital samples and transmits the samples to the processor board via the serial data bus. On the input board the analog signals are passed through an anti-alias filter before being multiplexed into a single analog to digital converter chip. The A - D converter provides 16-bit resolution and a serial data stream output. The digital input signals are opto isolated on this board to prevent excessive voltages on these inputs causing damage to the relay's internal circuitry.

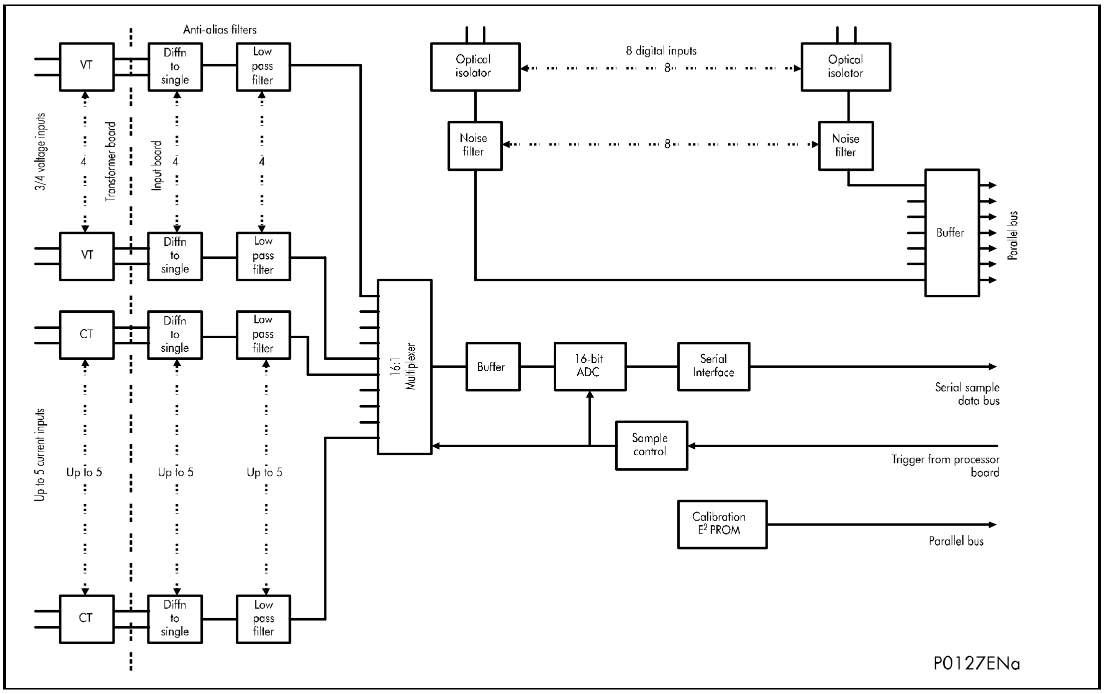

Figure 2: Main input board

The signal multiplexing arrangement provides for 16 analog channels to be sampled. The P842 relay provides 4 voltage inputs. The sample rate is maintained at 24 samples per cycle of the power waveform by a logic control circuit that is driven by the frequency tracking function on the main processor board. The calibration E^{2}PROM holds the calibration coefficients that are used by the processor board to correct for any amplitude or phase errors introduced by the transformers and analog circuitry.

The other function of the input board is to read the state of the signals present on the digital inputs and present this to the parallel data bus for processing. The input board holds 8 optical isolators for the connection of up to eight digital input signals. The opto-isolators are used with the digital signals for the same reason as the transformers with the analog signals; to isolate the relay’s electronics from the power system environment. The input board provides some hardware filtering of the digital signals to remove unwanted noise before buffering the signals for reading on the parallel data bus.

2.3.3 Universal opto isolated logic inputs

The P842 relay is fitted with universal opto isolated logic inputs that can be programmed for the nominal battery voltage of the circuit of which they are a part. The inputs can be programmed with a pick-up/drop-off characteristic selectable as the standard 60% - 80% value. This implies, that they nominally provide a Logic 1 or On value for Voltages ≥80% of the set lower nominal voltage and a Logic 0 or Off value for the voltages ≤60% of the set higher nominal voltage. This lower value eliminates fleeting pickups that may occur during a battery earth fault, when stray capacitance may present up to 50% of battery voltage across an input. Each input also has a filter of ½ cycle which renders the input immune to induced noise on the wiring.

In the Opto Config. menu the nominal battery voltage can be selected for all opto inputs by selecting one of the five standard ratings in the Global Nominal V settings. If Custom is selected, then each opto input can individually be set to a nominal voltage value.

The P842 has six opto-input cards, 48 opto inputs in total.

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Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
OPTO CONFIG				
Global Nominal V	24-27	24 - 27, 30 - 34, 48 - 54, 110 - 125, 220 - 250, Custom		
Opto Input 1-48	24-27	24 - 27, 30 - 34, 48 - 54, 110 - 125, 220 - 250		
Characteristic	Standard 60% - 80%	Standard 60% - 80		

In the P842 the protection task is executed twice per cycle, i.e. after every 12 samples for the sample rate of 24 samples per power cycle used by the relay. Therefore, the time taken to register a change in the state of an opto input can vary between a half to one cycle. The time to register the change of state will depend on if the opto input changes state at the start or end of a protection task cycle with the additional half cycle filtering time.

2.4 Power supply module (including output relays)

The power supply module contains two PCBs, one for the power supply unit itself and the other for the output relays. The power supply board also contains the input and output hardware for the rear communication port which provides an EIA(RS)485 communication interface.

2.4.1 Power supply board (including EIA(RS)485 communication interface)

One of three different configurations of the power supply board can be fitted to the relay. This will be specified at the time of order and depends on the nature of the supply voltage that will be connected to the relay. The three options are shown in table 1 below:

Nominal dc Range	Nominal ac Range
24/54 V	DC only
48/125 V	30/100 Vrms
110/250 V	100/240 Vrms

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Table 1: Power supply options

The output from all versions of the power supply module are used to provide isolated power supply rails to all of the other modules within the relay. Three voltage levels are used within the relay, 5.1V for all of the digital circuits, ±16V for the analog electronics, e.g. on the input board, and 22V for driving the output relay coils. All power supply voltages including the 0V earth line are distributed around the relay via the 64-way ribbon cable. The power supply board provides one further voltage level that is the field voltage of 48V. This is brought out to terminals on the back of the relay so that it can be used to drive the optically isolated digital inputs.

The two other functions provided by the power supply board are the EIA(RS)485 communications interface and the watchdog contacts for the relay. The EIA(RS)485 interface is used with the relay's rear communication port to provide communication using either Courier or IEC60870-5-103 protocols. The EIA(RS)485 hardware supports half-duplex communication and provides optical isolation of the serial data being transmitted and received. All internal communication of data from the power supply board is conducted via the output relay board that is connected to the parallel bus.

The watchdog facility provides two output relay contacts, one normally open and one normally closed that are driven by the processor board. These are provided to give an indication that the relay is in a healthy state.

The power supply board incorporates inrush current limiting. This limits the peak inrush current, during energization, to approximately 10A.

2.4.2 Output relay board

The output relay board holds eight relays, six with normally open contacts and two with changeover contacts. The relays are driven from the 22V power supply line. The relays' state is written to or read from using the parallel data bus.

Four output relay boards are fitted in the P842 relay to provide a total number of 32 relay outputs.

2.4.3 IRIG-B board (currently not available)

The IRIG-B board is an order option that can be fitted to provide an accurate timing reference for the relay. This can be used wherever an IRIG-B signal is available. The IRIG-B signal is connected to the board via a BNC connector on the back of the relay. The timing information is used to synchronize the relay's internal real-time clock to an accuracy of 1ms. The internal clock is then used for the time tagging of the event maintenance and disturbance records.

The IRIG-B board can also be specified with a fiber optic transmitter/receiver that can be used for the rear communication port instead of the EIA(RS)485 electrical connection (Courier and IEC60870-5-103).

2.4.4 Ethernet board

The Ethernet board, presently only available for UCA2.0 GOOSE communication, supports network connections of the following type:

- 10BASE-T
- 10BASE-FL
- 100BASE-TX
- 100BASE-FX

For all copper based network connections an RJ45 style connector is supported. 10Mb fiber network connections use an ST style connector while 100Mb connections use the SC style fiber connection.

An extra processor, a Motorola PPC, and memory block is fitted to the Ethernet card that is responsible for running all the network related functions such as TCP/IP/OSI as supplied by VxWorks and the UCA2.0/MMS server as supplied by Sisco inc. The extra memory block also holds the UCA2.0 data model supported by the relay.

2.5 Mechanical layout

The case materials of the relay are constructed from pre-finished steel that has a conductive covering of aluminum and zinc. This provides good earthing at all joints giving a low impedance path to earth that is essential for performance in the presence of external noise. The boards and modules use a multi-point earthing strategy to improve the immunity to external noise and minimize the effect of circuit noise. Ground planes are used on boards to reduce impedance paths and spring clips are used to ground the module metalwork.

Heavy duty terminal blocks are used at the rear of the relay for the current and voltage signal connections. Medium duty terminal blocks are used for the digital logic input signals, the output relay contacts, the power supply and the rear communication port. A BNC connector is used for the optional IRIG-B signal (not in P842). 9-pin and 25-pin female D-connectors are used at the front of the relay for data communication.

Inside the relay the PCBs plug into the connector blocks at the rear and can be removed from the front of the relay only. The connector blocks to the relay's CT inputs are provided with internal shorting links inside the relay which will automatically short the current transformer circuits before they are broken when the board is removed.

The front panel consists of a membrane keypad with tactile dome keys, an LCD and 12 LEDs mounted on an aluminum backing plate.

3. RELAY SOFTWARE

The relay software was introduced in the overview of the relay at the start of this chapter. The software is made up of four sections:

- The real-time operating system
- The system services software
- The platform software
- The protection & control software

This section describes in detail the platform software and the protection & control software, which between them control the functional behavior of the relay. Figure 3 shows the structure of the relay software.

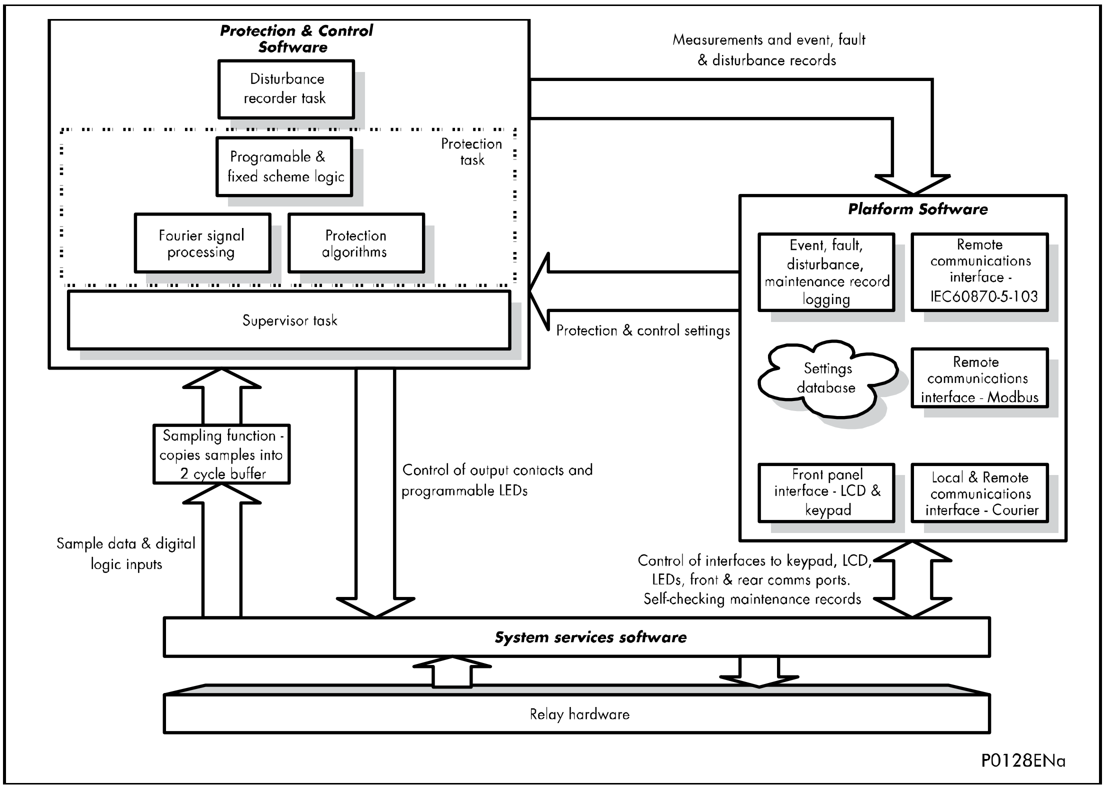

Figure 3: Relay software structure

3.1 Real-time operating system

The software is split into tasks. The real-time operating system is used to schedule the processing of the tasks to ensure that they are processed in the time available and in the desired order of priority. The operating system is also responsible in part for controlling the communication between the software tasks through the use of operating system messages.

3.2 System services software

As shown in Figure 3, the system services software provides the interface between the relay's hardware and the higher-level functionality of the platform software and the protection & control software. For example, the system services software provides drivers for items such as the LCD display, the keypad and the remote communication ports, and controls the boot of the processor and downloading of the processor code into SRAM from flash EPROM at power up.

3.3 Platform software

The platform software has three main functions:

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- To control the logging of records that are generated by the protection software, including alarms and event and maintenance records.
- To store and maintain a database of all of the relay's settings in non-volatile memory.
- To provide the internal interface between the settings database and each of the relay's user interfaces, i.e. the front panel interface and the front and rear communication ports, using whichever communication protocol has been specified (Courier or IEC 60870-5-103).

3.3.1 Record logging

The logging function is provided to store all alarms, events and maintenance records. The records for all of these incidents are logged in battery backed-up SRAM in order to provide a non-volatile log of what has happened. The relay maintains four logs: one each for up to 32 alarms, 512 event records and 5 maintenance records. The logs are maintained such that the oldest record is overwritten with the newest record. The logging function can be initiated from the protection software or the platform software is responsible for logging of a maintenance record in the event of a relay failure. This includes errors that have been detected by the platform software itself or error that are detected by either the system services or the protection software function. See the supervision and diagnostics section later in this chapter.

3.3.2 Settings database

The settings database contains all of the settings and data for the relay, including the protection, disturbance recorder and control & support settings. The settings are maintained in non-volatile memory. The platform software's management of the settings database includes the responsibility of ensuring that only one user interface modifies the settings of the database at any one time. This feature is employed to avoid conflict between different parts of the software during a setting change. For changes to protection settings and disturbance recorder settings, the platform software operates a 'scratchpad' in SRAM memory. This allows a number of setting changes to be applied to the protection elements, disturbance recorder and saved in the database in non-volatile memory. For more information on the user interface go to the Introduction chapter. If a setting change affects the protection & control task, the database advises it of the new values.

3.3.3 Database interface

The other function of the platform software is to implement the relay's internal interface between the database and each of the relay's user interfaces. The database of settings and measurements must be accessible from all of the relay's user interfaces to allow read and modify operations. The platform software presents the data in the appropriate format for each user interface.

3.4 Protection and control software

The protection and control software task is responsible for processing all of the Mesh corner auto-reclose functional blocks and measurement functions of the relay. To achieve this, it has to communicate with both the system services software and the platform software as well as organize its own operations. The protection software has the highest priority of any of the software tasks in the relay to provide the fastest possible protection response. The protection & control software has a supervisor task that controls the start-up of the task and deals with the exchange of messages between the task and the platform software.

3.4.1 Overview - protection and control scheduling

After initialization at start-up, the protection and control task is suspended until there are sufficient samples available for it to process. The acquisition of samples is controlled by a 'sampling function' which is called by the system services software and takes each set of new samples from the input module and stores them in a two-cycle buffer. The protection and control software resumes execution when the number of unprocessed samples in the buffer reaches a certain number. For the P842 relay, the protection task is executed twice per cycle, i.e. after every 12 samples for the sample rate of 24 samples per power cycle used by the relay. The protection and control software is suspended again when all of its processing on a set of samples is complete. This allows operations by other software tasks to take place.

3.4.2 Signal processing

The sampling function provides filtering of the digital input signals from the opto-isolators and frequency tracking of the analog signals. The digital inputs are checked against their previous value over a period of half a cycle. Therefore, a change in the state of one of the inputs must be maintained over at least half a cycle before it is registered with the protection and control software.

The frequency tracking of the analog input signals is achieved by a recursive Fourier algorithm which is applied to one of the input signals, and works by detecting a change in the measured signal's phase angle. The calculated value of the frequency is used to modify the sample rate being used by the input module to achieve a constant sample rate of 24 samples per cycle of the power waveform. The value of the frequency is also stored for use by the protection and control task.

3.4.3 Fourier filtering

When the protection and control task is re-started by the sampling function, it c P1124ENa e Fourier components for the analog signals. With the exception of the RMS measurements all other measurements and protection functions are based on the Fourier derived fundamental component. The Fourier components are calculated using a one-cycle, 24-sample Discrete Fourier Transform (DFT). The DFT is always calculated using the last cycle of samples from the 2-cycle buffer, i.e. the most recent data is used. The DFT used in this way extracts the power frequency fundamental component from the signal and produces the magnitude and phase angle of the fundamental in rectangular component format. This gives good harmonic rejection for frequencies up to the 23rd harmonic. The 23rd is the first predominant harmonic that is not attenuated by the Fourier filter and this is known as 'Alias'. However, the Alias is attenuated by approximately 85% by an additional, analog, 'anti-aliasing' filter (low pass filter). The combined affect of the anti-aliasing and Fourier filters is shown below:

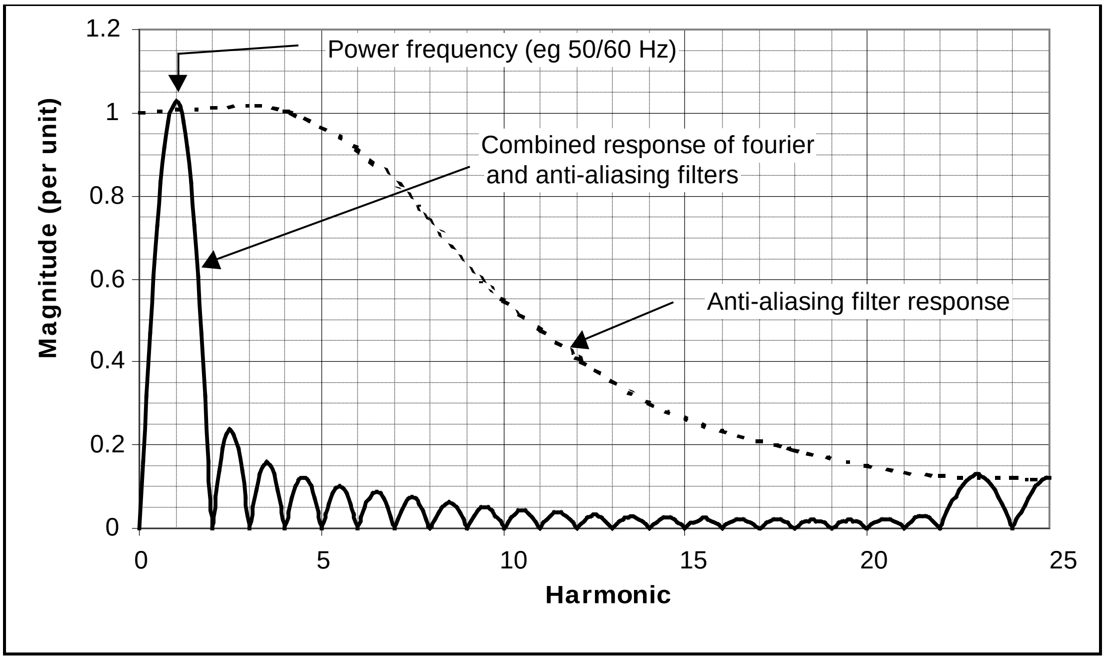

Figure 4: Frequency response

The Fourier components of the input current and voltage signals are stored in memory so they can be accessed by all of the protection elements' algorithms. The samples from the input module are also used in an unprocessed form by the disturbance recorder for waveform recording and to calculate true rms. values of current, voltage and power for metering purposes.

3.4.4 Programmable scheme logic

The purpose of the programmable scheme logic (PSL) is to allow the relay user to configure an individual Mesh corner auto-reclose scheme to suit their own particular application. This is achieved through the use of programmable logic gates and delay timers.

The input to the PSL is any combination of the status of the digital input signals from the opto-isolators on the input board, the outputs of the Mesh corner Function blocks, e.g. DAR requested, control inputs, GOOSE signals and the outputs of the fixed Mesh corner scheme logic. The fixed scheme logic provides the relay's standard Mesh corner auto-reclose schemes. The PSL itself consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay, and/or to condition the logic outputs, e.g. to create a pulse of fixed duration on the output regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

The execution of the PSL logic is event driven; the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals or output from the fixed Mesh corner scheme logic. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL. The protection and control software updates the logic delay timers and checks for a change in the PSL input signals every time it runs.

This system provides flexibility for the user to create their own scheme logic design. However, it also means that the PSL can be configured into a very complex system, and because of this setting of the PSL is implemented through the PC support package S1 Agile.

3.4.5 Event recording

A change in any digital input signal or Mesh corner output signal causes an event record to be created. When this happens, the protection and control task sends a message to the supervisor task to indicate that an event is available to be processed and writes the event data to a fast buffer in SRAM which is controlled by the supervisor task. When the supervisor task receives an event, it instructs the platform software to create the appropriate log in battery backed-up SRAM. The operation of the record logging to battery backed-up SRAM is slower than the supervisor's buffer. This means that the protection software is not delayed waiting for the records to be logged by the platform software. However, in the rare case when a large number of records to be logged are created in a short period of time, it is possible that some will be lost if the supervisor's buffer is full before the platform software is able to create a new log in battery backed-up SRAM. If this occurs, then an event is logged to indicate this loss of information.

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3.4.6 Disturbance recorder

The disturbance recorder operates as a separate task from the protection and control task. It records the waveforms for up to 4 analog channels and the values of up to 32 digital signals. The recording time is user selectable up to a maximum of 10.5 seconds. The disturbance recorder is supplied with data by the protection and control task once per cycle. The disturbance recorder collates the data that it receives into the required length disturbance record.

The disturbance records can be extracted using S1 Agile and it can store in the data in COMTRADE format. This allows the use of other packages to view the recorded data.

4. SELF TESTING & DIAGNOSTICS

The relay includes a number of self-monitoring functions to check the operation of its hardware and software when it is in service. These are included so that if an error or fault occurs within the relay's hardware or software, the relay can detect and report the problem and attempt to resolve it by performing a re-boot. This involves the relay being out of service for a short period of time which is indicated by the 'Healthy' LED on the front of the relay being extinguished and the watchdog contact at the rear operating. If the restart fails to resolve the problem, then the relay will take itself permanently out of service. Again, this will be indicated by the LED and watchdog contact.

If a problem is detected by the self-monitoring functions, the relay attempts to store a maintenance record in battery backed-up SRAM to allow the nature of the problem to be notified to the user.

The self-monitoring is implemented in two stages. The first stage is a thorough diagnostic check, which happens when the relay is booted-up. The second stage is a continuous self-checking operation, which checks the operation of the relay's critical functions while it is in service.

4.1 Start-up self-testing

The self-testing which is carried out when the relay is started takes a few seconds to complete, during which time the relay's protection is unavailable. This is signaled by the 'Healthy' LED on the front of the relay which will illuminate when the relay has passed all of the tests and entered operation. If the testing detects a problem, the relay will remain out of service until it is manually restored to working order.

The operations that are performed at start-up are as follows:

4.1.1 System boot

The integrity of the flash memory is verified using a checksum before the program code and data stored in it is copied into SRAM to be used for execution by the processor. When the copy has been completed the data then held in SRAM is compared to that in the flash to ensure that the two are the same and that no errors have occurred in the transfer of data from flash to SRAM. The entry point of the software code in SRAM is then called which is the relay initialization code.

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4.1.2 Initialization software

The initialization process includes the operations of initializing the processor registers and interrupts, starting the watchdog timers (used by the hardware to determine whether the software is still running), starting the real-time operating system and creating and starting the supervisor task. In the course of the initialization process the relay checks:

- The status of the battery
- The integrity of the battery backed-up SRAM that is used to store event and disturbance records
- The voltage level of the field voltage supply which is used to drive the opto-isolated inputs
- The operation of the LCD controller
- The watchdog operation

At the end of the initialization software the supervisor task begins the process of starting the platform software.

4.1.3 Platform software initialization & monitoring

When starting the platform software the relay checks the integrity of the data held in non-volatile memory with a checksum, the operation of the real-time clock, and the IRIG-B board if fitted (not available in P842). The final test concerns the input and output of data. The presence and healthy condition of the input board is checked and the analog data acquisition system is checked through sampling the reference voltage.

If all the tests have been successful the relay goes into service and the protection starts up.

4.2 Continuous self-testing

When the relay is in service, it continually checks the operation of the critical parts of its hardware and software. The checking is carried out by the system services software (see section on relay software earlier in this chapter) and the results reported to the platform software. The functions checked are as follows:

- The flash containing all program code setting values and language text is verified by a checksum
- The code and constant data held in SRAM is checked against the corresponding data in flash to check for data corruption
- The SRAM containing all data other than the code and constant data is verified with a checksum
- The battery status
- The level of the field voltage
- The integrity of the digital signal I/O data from the opto-isolated inputs and the relay contacts is checked by the data acquisition function every time it is executed. The operation of the analog data acquisition system is continuously checked by the acquisition function every time it is executed, by means of sampling the reference voltages
- The operation of the IRIG-B board (currently not available) is checked, where it is fitted, by the software that reads the time and date from the board
- The operation of the Ethernet board is checked, where it is fitted, by the software on the main processor card. If the Ethernet board fails to respond an alarm is raised and the card is reset in an attempt to resolve the problem

If one of the checks detects an error within the relay's subsystems, the platform software is notified and will attempt to log a maintenance record in battery backed-up SRAM. If the problem is with the battery status or the IRIG-B board, the relay will continue in operation. However, for problems detected in any other area the relay will initiate a shutdown and re-boot. This will result in a period of up to 5 seconds when the protection is unavailable, but the complete restart of the relay including all initializations should clear most problems that can occur. As described above, an integral part of the start-up procedure is a thorough diagnostic self-check. If this detects the same problem that caused the relay to restart, i.e. the restart has not cleared the problem, then the relay will take itself permanently out of service. This is indicated by the 'Healthy' LED on the front of the relay, which will extinguish, and the watchdog contact that will operate.

COMMISSIONING

CM

Date: **2019**
Hardware Suffix: **B**
Software Version: **04**

CM

CONTENTS

FIGURES

CM

1. INTRODUCTION

The P842 Auto-reclose relay is fully numerical in design, implementing all Autoswitching logic in the software. The relay employs a high degree of self-checking and, in the unlikely event of a failure, will give an alarm. As a result of this, the commissioning tests do not need to be as extensive as with non-numeric electronic or electro-mechanical relays.

To commission numeric relays, it is only necessary to verify that the hardware is functioning correctly and the application-specific software settings have been applied to the relay. It is considered unnecessary to test every function of the relay if the settings have been verified by one of the following methods:

- Extracting the settings applied to the relay using appropriate setting software (Preferred method)
- Via the operator interface.

To confirm that the product is operating correctly once the application-specific settings have been applied, a test should be performed on a selective features/ sequencies, depending on the plant status, circuit breaker opening and closing permission and other restricting factors.

Unless previously agreed to the contrary, the customer is responsible for determining the application-specific settings to be applied to the relay and for testing of any scheme logic applied by external wiring and/or configuration of the relay's internal programmable scheme logic, if different from default.

Blank commissioning test records are provided at the end of this chapter for completion as required.

To simplify the specifying of menu cell locations in these Commissioning Instructions, they will be given in the form [courier reference: COLUMN HEADING, Cell Text]. For example, the cell for selecting then relay operating frequency is located in the System Data column (column 00) so it would be given as [0001: SYSTEM DATA, Frequency].

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety and Technical Data sections and the ratings on the equipment's rating label.

2. COMMISSIONING TESTS – RELAY FACILITIES

To help minimise the time required to test MiCOM relays the relay provides several test facilities under the 'COMMISSION TESTS' menu heading. There are menu cells which allow the status of the opto-isolated inputs, output relay contacts, internal digital data bus (DDB) signals and user-programmable LEDs to be monitored. Additionally there are cells to test the operation of the output contacts, user-programmable LEDs and, where available, the auto-reclose cycles.

The following table shows the relay menu of commissioning tests, including the available setting ranges and factory defaults:

Menu text	Default setting	DDB	Settings
COMMISSION TESTS			
Opto I/P Status	-		-
Relay O/P Status	-		-
Test Port Status	-		-
LED Status	-		-
Monitor Bit 1	Opto input 1	64	0 to 1022 See P842/EN PL for details of digital data bus signals
Monitor Bit 2	Opto input 2	65	
Monitor Bit 3	Opto input 3	66	
Monitor Bit 4	Opto input 4	67	
Monitor Bit 5	Opto input 5	68	
Monitor Bit 6	Opto input 6	69	
Monitor Bit 7	Opto input 7	70	
Monitor Bit 8	Opto input 8	71	
Test Mode	Disabled		Disabled Test Mode Contacts Blocked
Test Pattern	All bits set to 0		0 = Not Operated 1 = Operated
Contact Test	No Operation		No Operation Apply Test Remove Test
Test LEDs	No Operation		No Operation Apply Test
Test Auto-reclose (Not applicable in P842)	No Operation		No Operation 3 Pole Test Pole A Test Pole B Test Pole C Test

2.1 Opto I/P status

This menu cell displays the status of the relay's opto-isolated inputs as a binary string, a '1' indicating an energised opto-isolated input and a '0' a de-energised one. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each logic input.

The menu cell can be used during commissioning or routine testing to monitor the status of the opto-isolated inputs while they are sequentially energised with a suitable dc voltage.

2.2 Relay O/P status

This menu cell displays the status of the digital data bus (DDB) signals that result in energization of the output relays as a binary string, a ‘1’ indicating an operated state and ‘0’ a non-operated state. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each relay output.

The information displayed can be used during commissioning or routine testing to indicate the status of the output relays when the relay is ‘in service’. Additionally fault finding for output relay damage can be performed by comparing the status of the output contact under investigation with it’s associated bit.

Note: When the ‘Test Mode’ cell is set to ‘Contacts Blocked’ the cell will continue to indicate which contacts would operate if the relay was in-service, it does not show the actual status of the output relays.

2.3 Test port status

This menu cell displays the status of the eight digital data bus (DDB) signals that have been allocated in the ‘Monitor Bit’ cells. If the cursor is moved along the binary numbers the corresponding DDB signal text string is displayed for each monitor bit.

By using this cell with suitable monitor bit settings, the state of the DDB signals can be displayed as various operating conditions or sequences are applied to the relay. Therefore, the programmable scheme logic can be tested.

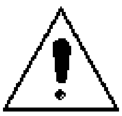
2.4 LED status

The ‘LED Status’ cell is an eight bit binary string that indicates which of the user-programmable LEDs on the relay are illuminated when accessing the relay from a remote location, a ‘1’ indicating a particular LED is lit and a ‘0’ not lit.

2.5 Monitor bits 1 to 8

The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port. Each ‘Monitor Bit’ is set by entering the required digital data bus (DDB) signal number (0 – 1022) from the list of available DDB signals in the P842/EN PL. The pins of the monitor/download port used for monitor bits are given in the table overleaf. The signal ground is available on pins 18, 19, 22 and 25.

Monitor Bit	1	2	3	4	5	6	7	8
Monitor/ Download Port Pin	11	12	15	13	20	21	23	24



THE MONITOR/DOWNLOAD PORT DOES NOT HAVE ELECTRICAL ISOLATED AGAINST INDUCED VOLTAGES ON THE COMMUNICATIONS CHANNEL. IT SHOULD THEREFORE ONLY BE USED FOR LOCAL COMMUNICATIONS.

2.6 Test mode

This menu cell allows secondary injection testing to be performed on the relay. It also enables a facility to directly test the output contacts by applying menu controlled test signals. To select test mode the option ‘Test Mode’ should be selected. This takes the relay out of service causing an alarm condition to be recorded and the yellow ‘Out of Service’ LED to illuminate. This also in IEC60870-5-103 builds changes the Cause of Transmission, COT, to Test Mode. However the output contacts are still active in this mode. To disable the output contacts in addition to the above select ‘Blocked’. Once testing is complete the cell must be set back to ‘Disabled’ to restore the relay back to service. Test mode can also be selected by energising an opto mapped to the Test Mode signal.

WHEN THE 'TEST MODE' CELL IS SET TO 'BLOCKED' THE RELAY SCHEME LOGIC DOES NOT DRIVE THE OUTPUT RELAYS AND SO THE P842 WILL NOT INTERACT WITH THE ASSOCIATED CIRCUIT BREAKER IF A FAULT OCCURS.

2.7 Test pattern

The 'Test Pattern' cell is used to select the output relay contacts that are tested when the 'Contact Test' cell is set to 'Apply Test'. The cell has a binary string with one bit for each user-configurable output contact which can be set to '1' to operate the output under test conditions and '0' to not operate it.

2.8 Contact test

When the 'Apply Test' command in this cell is issued the contacts set for operation (set to '1') in the 'Test Pattern' cell change state. After the test has been applied the command text on the LCD will change to 'No Operation' and the contacts will remain in the Test State until reset issuing the 'Remove Test' command. The command text on the LCD will again revert to 'No Operation' after the 'Remove Test' command has been issued.

Note: When the 'Test Mode' cell is set to 'Contacts Blocked' the 'Relay O/P Status' cell does not show the current status of the output relays and so can not be used to confirm operation of the output relays. Therefore, it is necessary to monitor the state of each contact in turn.

2.9 Test LEDs

When the 'Apply Test' command in this cell is issued the eight user-programmable LEDs will illuminate for approximately 2 seconds before they extinguish and the command text on the LCD reverts to 'No Operation'.

2.10 Test auto-reclose

Not applicable in P842.

2.11 Using a monitor/download port test box

A monitor/download port test box containing 8 LED's and a switchable audible indicator is available. It is housed in a small plastic box with a 25-pin male D-connector that plugs directly into the relay's monitor/download port. There is also a 25-pin female D-connector which allows other connections to be made to the monitor/download port whilst the monitor/download port test box is in place.

Each LED corresponds to one of the monitor bit pins on the monitor/download port with 'Monitor Bit 1' being on the left hand side when viewing from the front of the relay. The audible indicator can either be selected to sound if a voltage appears any of the eight monitor pins or remain silent so that indication of state is by LED alone.

3. SETTING FAMILIARIZATION

When commissioning a MiCOM P842, allow sufficient time to become familiar with how to apply the settings.

The Settings chapter contains a detailed description of the menu structure of P842 relays.

With the secondary front cover in place all keys except the key are accessible. All menu cells can be read, LEDs and alarms can be reset. However, no protection or configuration settings can be changed, or fault and event records cleared

Removing the secondary front cover allows access to all keys so that settings can be changed, LEDs and alarms reset, and records cleared. However, to make changes to menu cells that have access levels higher than the default level, the appropriate password is needed.

Alternatively, if a portable PC with suitable setting software is available (such as S1 Agile), the menu can be viewed one page at a time to display a full column of data and text. This PC software also allows settings to be entered more easily, saved to a file on disk for future reference or printed to produce a setting record. Refer to the PC software user manual for details. If the software is being used for the first time, allow sufficient time to become familiar with its operation.

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4. EQUIPMENT REQUIRED FOR COMMISSIONING

4.1 Minimum equipment required

- Two variable 110V ac voltage sources, with the capability of varying frequency and phase angle on one of them, such as Doble, Omicron or similar.

  Note: It is possible to output two voltages at different frequencies from a single Omicron unit, using state sequencer.

- Multimeter with suitable ac voltage range of 0-250V
- Continuity tester (if not included in multimeter)
- Phase angle meter (desirable, not essential, if Omicron is used)

  Note: Modern test equipment may contain many of the above features in one unit.

Bistable relay to mimic the CB if the operation of the CB from P842 is not permissible. The closing coil should be connected to the P842 "CB Close" output. The relay contacts should be connected to P842 opto inputs to mimic the real 52A and 52B position. The recommended relay for this purpose would be any electrically reset relay, i.e. PRIMA electrically reset relay.

4.2 Optional equipment

- Frequency meter (50/60 Hz diapason)
- Multi-finger test plug type MMLB01 (if test block type MMLG installed)
- An electronic or brushless insulation tester with a dc output not exceeding 500V (for insulation resistance testing when required)
- A portable PC, with appropriate software (this enables the rear communications port to be tested if this is to be used and will also save considerable time during commissioning).
- A printer (for printing a setting record from the portable PC).

5. PRODUCT CHECKS

These product checks cover all aspects of the relay that need to be checked to ensure that it has not been physically damaged prior to commissioning, is functioning correctly and all input quantity measurements are within the stated tolerances.

If the application-specific settings have been applied to the relay prior to commissioning, it is advisable to make a copy of the settings so as to allow their restoration later. This could be done by:

- Obtaining a setting file on a diskette from the customer (This requires a portable PC with appropriate setting software for transferring the settings from the PC to the relay)
- Extracting the settings from the relay itself (This again requires a portable PC with appropriate setting software)
- Manually creating a setting record. This could be done using a copy of the setting record located at the end of this chapter to record the settings as the relay's menu is sequentially stepped through via the front panel user interface.

Issue of the PSL may be important as this is likely to be modified.

If password protection is enabled and the customer has changed password 2 that prevents unauthorized changes to some of the settings, either the revised password 2 should be provided, or the customer should restore the original password prior to commencement of testing.

Note: If the password has been lost, a recovery password can be obtained from General Electric by quoting the serial number of the relay. The recovery password is unique to that relay and will not work on any other relay.

5.1 With the relay de-energized

The following group of tests should be carried out without the auxiliary supply being applied to the relay and with the trip circuit isolated.

The voltage transformer connections must be isolated from the relay for these checks. If an MMLG test block or P991 are provided, the required isolation can easily be achieved by inserting test plug type MMLB01 or P992 which effectively open circuits all wiring routed through the test block.

Before inserting the test plug, reference should be made to the scheme (wiring) diagram to ensure that this will not potentially cause damage or a safety hazard. For example, the test block may also be associated with protection current transformer circuits. It is essential that the sockets in the test plug which correspond to the current transformer secondary windings are linked before the test plug is inserted into the test block.

If a test block is not provided, the voltage transformer supply to the relay should be isolated by means of the panel links or connecting blocks. The line current transformers should be short-circuited and disconnected from the relay terminals. Where means of isolating the auxiliary supply and trip circuit (e.g. isolation links, fuses, MCB, etc.) are provided, these should be used. If this is not possible, the wiring to these circuits will have to be disconnected and the exposed ends suitably terminated to prevent them from being a safety hazard.

If a test block is not provided, the voltage transformer supply to the relay should be isolated by means of the panel links or connecting blocks. The line current transformers should be short-circuited and disconnected from the relay terminals. Where means of isolating the auxiliary supply and trip circuit (e.g. isolation links, fuses, MCB, etc.) are provided, these should be used. If this is not possible, the wiring to these circuits will have to be disconnected and the exposed ends suitably terminated to prevent them from being a safety hazard.

5.1.1 Visual inspection

Carefully examine the relay to see that no physical damage has occurred since, installation.

The rating information given under the top access cover on the front of the relay should be checked to ensure it is correct for the particular installation.

Ensure that the case earthing connections, bottom left-hand corner at the rear of the relay case, are used to connect the relay to a local earth bar using an adequate conductor.

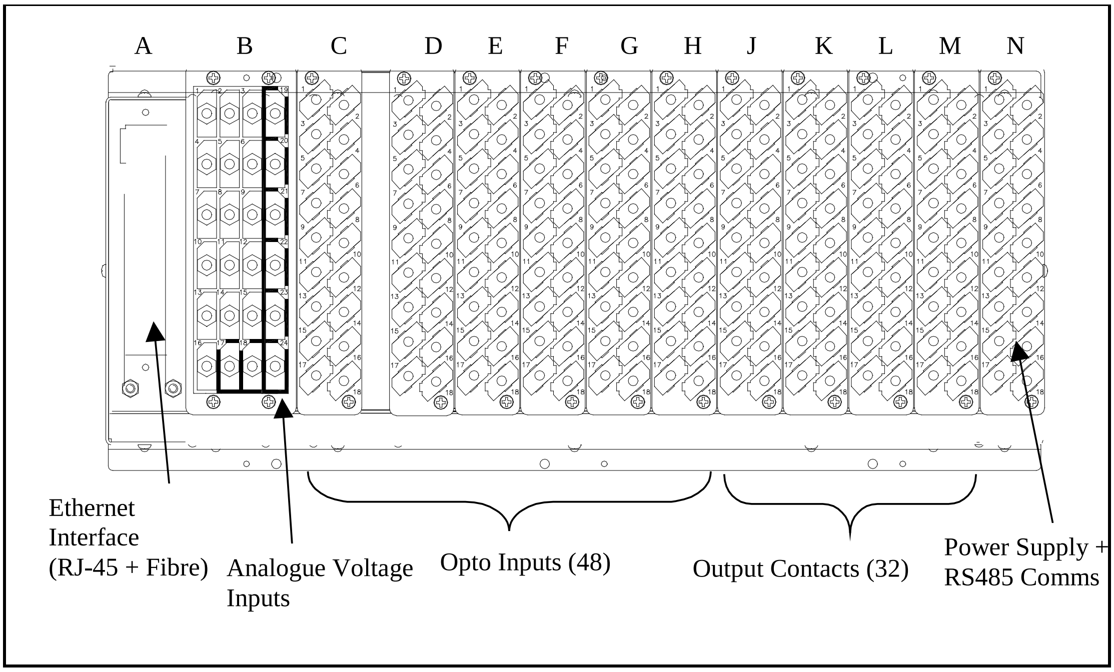

Figure 1: Rear terminal blocks of P842

5.1.2 Insulation

Insulation resistance tests are only necessary during commissioning if it is required for them to be done and they haven’t been performed during installation.

Isolate all wiring from the earth and test the insulation with an electronic or brushless insulation tester at a dc voltage not exceeding 500 V. Terminals of the same circuits should be temporarily connected together.

The main groups of relay terminals are:

- Voltage transformer circuits.
- Auxiliary voltage supply.
- Field voltage output and opto-isolated control inputs.
- Relay contacts.
- RS485 communication port.
- Case earth.

The insulation resistance should be greater than 100MΩ at 500 V.

On completion of the insulation resistance tests, ensure all external wiring is correctly reconnected to the unit.

5.1.3 External wiring

Check that the external wiring is correct to the relevant relay diagram and scheme diagram. Ensure as far as practical that phasing/phase rotation appears to be as expected. The relay diagram number appears on the rating label under the top access cover on the front of the relay.

If an MMLG or P991 test block is provided, the connections should be checked against the scheme (wiring) diagram. It is recommended that the supply connections are to the live side of the test block (colored orange with the odd numbered terminals (1, 3, 5, 7 etc.). The auxiliary supply is normally routed via terminals 13 (supply positive) and 15 (supply negative), with terminals 14 and 16 connected to the relay's positive and negative auxiliary supply terminals respectively. However, check the wiring against the schematic diagram for the installation to ensure compliance with the customer's normal practice.

5.1.4 Watchdog contacts

Using a continuity tester, check that the normally closed watchdog contacts N13–N14 are OPEN when relay is de-energized and CLOSED when relay is energized.

5.1.5 Auxiliary supply

The relay can be operated from either a dc only or an ac/dc auxiliary supply depending on the relay's nominal supply rating. The incoming voltage must be within the operating range specified in Table 1.

Without energising the relay, measure the auxiliary supply to ensure it is within the operating range.

Nominal Supply Rating DC [AC rms]		DC Operating Range	AC Operating Range
24 - 48V	[-]	19 to 65V	-
48 - 110V	[30 - 100V]	37 to 150V	24 - 110V
125 - 250V	[100 - 240V]	87 to 300V	80 to 265V

Table 1: Operational range of auxiliary supply Vx

Note: The relay can withstand an ac ripple of up to 12% of the upper rated voltage on the dc auxiliary supply.

Do not energize the relay or interface unit using the battery charger with the battery disconnected as this can irreparably damage the relay's power supply circuitry.

Energize the relay only if the auxiliary supply is within the specified operating ranges. If a test block is provided, it may be necessary to link across the front of the test plug to connect the auxiliary supply to the relay.

5.2 With the relay energized

The following group of tests verify that the relay hardware and software is functioning correctly and should be carried out with the auxiliary supply applied to the relay.

The voltage transformer connections must remain isolated from the relay for these checks.

5.2.1 Watchdog contacts

Using a continuity tester, check the watchdog contacts N13–N14 are closed when relay is energized.

5.2.2 Date and time

Before setting date and time, remove factory-fitted battery isolation strip, that prevents battery drain during transportation and storage.

The date and time should now be set to the correct values.

Note: IRIG –B input is currently not available within the relay and therefore can not be used for time setting. To get IRIG-B, IEC60870 optical connection has to be replaced.

5.2.3 Light emitting diodes (LEDs)

On power up the green LED should have illuminated and stayed on indicating that the relay is healthy. The relay has non-volatile memory which remembers the state (on or off) of the alarm, top programmable red LED and, if configured to latch, user-programmable LED indicators when the relay was last energized from an auxiliary supply. Therefore, these indicators may also illuminate when the auxiliary supply is applied. If any of these LEDs are on then they should be reset before proceeding with further testing. If the LEDs successfully reset (the LED goes out), there is no testing required for that LED because it is known to be operational.

Testing the alarm and out of service LED

The alarm and out of service LEDs can be tested using the COMMISSIONING TESTS menu column. Set cell [0F0D: COMMISSIONING TESTS, Test Mode] to ‘Enabled’. Check that the alarm and out of service LED illuminates.

Go back to cell [0F0D: COMMISSIONING TESTS, Test Mode] and set ‘Disabled’. The LED will turn off.

Testing the top red LED

This LED (usually Trip Indication in MiCOM) is not used for P842.

5.2.3.1 Testing the other user-programmable LEDs located on the right hand side of the front panel

To test the user-programmable LEDs set cell [0F10: COMMISSIONING TESTS, Test LEDs] to ‘Apply Test’. Check that all 8 LEDs, located on the right-hand side of the relay, illuminate.

5.2.4 Field voltage supply

The relay generates a field voltage of nominally 48V that can be used to energize the opto-isolated inputs.

Measure the field voltage across the terminals N7 (+) and N9 (-) and ensure that the field voltage is within the range of 40V to 60V dc when no load is connected and that polarity is correct.

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5.2.5 Input opto-isolators

This test checks that all the opto-isolated inputs are functioning correctly. The P842 relay has 48 UNIVERSAL opto-isolated inputs.

The opto-isolated inputs should be energized one at a time. To simplify the test, it is recommended to set all opto-inputs to a common setting equal to the field voltage. Ensuring correct polarity, connect the field supply voltage to the appropriate terminals for the input being tested. The opto-isolated input terminal allocations are given in Table 2 below.

Note: Battery voltage could be directly applied, if a particular opto-input is set to operate at battery voltage level, without using a resistive box. Regardless of opto-input operating voltage setting, each opto-input can withstand 300V dc without being damaged. For more information see the opto inputs section.

The status of each opto-isolated input can be viewed using cell [0020: SYSTEM DATA, Opto I/P Status], a ‘1’ indicating an energized input and a ‘0’ indicating a de-energized input. When each opto-isolated input is energized, the display will change from “0” to “1”.

Note: Terminal numbers are positive polarity and odds terminal numbers are negative polarity.

Input	Terminal
L1	C1-2
L2	C3-4
L3	C5-6
L4	C7-8
L5	C9-10
L6	C11-12
L7	C13-14
L8	C15-16
L9	D1-2
L10	D3-4
L11	D5-6
L12	D7-8
L13	D9-10
L14	D11-12
L15	D13-14
L16	D15-16
L17	E1-2
L18	E3-4
L19	E5-6
L20	E7-8
L21	E9-10
L22	E11-12
L23	E13-14
L24	E15-16
L25	F1-2
L26	F3-4
L27	F5-6
L28	F7-8
L29	F9-10
L30	F11-12
L31	F13-14
L32	F15-16
L33	G1-2
L34	G3-4
L35	G5-6
L36	G7-8
L37	G9-10
L38	G11-12
L39	G13-14
L40	G15-16
L41	H1-2
L42	H3-4
L43	H5-6
L44	H7-8
L45	H9-10
L46	H11-12
L47	H13-14
L48	H15-16

Table 2: Opto-isolated input terminals

5.2.6 Output relays

This test checks that all the output relays are functioning correctly. The P842 has 32 output relays.

Ensure that the relay is still in test mode by viewing cell [0F0D: COMMISSIONING TESTS, Test Mode].

The output relays should be energized one at a time. To select output relay 1 for testing, set cell [0F0E: COMMISSIONING TESTS, Test Pattern] as shown in Table 3. Connect a continuity tester across the terminals corresponding to output relay 1 given in Table 3.

To operate the output relay set cell [0F0F: COMMISSIONING TESTS, Contact Test] to 'Apply Test'. Operation will be confirmed by the continuity tester operating for a normally open contact and ceasing to operate for a normally closed contact. Reset the output relay by setting cell [0F0F: COMMISSIONING TESTS, Contact Test] to 'Remove Test'.

Note: Ensure that thermal ratings of anything connected to the output relays during the contact test procedure is not exceeded by the associated output relay being operated for too long. It is advised that the time between application and removal of contact test is kept to the minimum.

Repeat the test for relays 2 to 32 in a same way.

Note: It is possible to make a Test Pattern to operate several relays simultaneously to accelarate the testing.

Output monitor terminals

Input	Terminal
R1	M1-2
R2	M3-4
R3	M5-6
R4	M7-8
R5	M9-10
R6	M11-12
R7	M13-14-15
R8	M16-17-18
R9	L1-2
R10	L3-4
R11	L5-6
R12	L7-8
R13	L9-10
R14	L11-12
R15	L13-14-15
R16	L16-17-18
R17	K1-2
R18	K3-4
R19	K5-6
R20	K7-8
R21	K9-10
R22	K11-12
R23	K13-14-15
R24	K16-17-18
R25	J1-2
R26	J3-4
R27	J5-6
R28	J7-8
R29	J9-10
R30	J11-12
R31	J13-14-15
R32	J16-17-18

Table 3: Relay output terminals

Return the relay to service by setting cell [0F0D: COMMISSIONING TESTS, Test Mode] to 'Disabled'.

5.2.7 Rear communications port

This test should only be performed when the relay is be accessed from a remote location and will vary depending on the communications standard being adopted. It is not the intention of the test to verify the operation of the complete system from the relay to the remote location, just the relay's rear communications port and any protocol converter necessary.

5.2.7.1 Courier communications

If a K-Bus to RS232 KITZ protocol converter is installed, connect a portable PC running the appropriate software to the incoming (remote from relay) side of the protocol converter.

If a KITZ protocol converter is not installed, it may not be possible to connect the PC to the type installed. In this case a KITZ protocol converter and portable PC running appropriate software should be temporarily connected to the relay's K-Bus port. The terminal numbers for the relay's K-Bus port are given in Table 4.

However, as the installed protocol converter is not being used in the test, only the correct operation of the relay's K-Bus port will be confirmed.

K-Bus connection	P842 terminals
Screen	N16
1 (+ve)	N17
2 (-ve)	N18

Table 4: RS485 terminals

Ensure that the communications baud rate and parity settings in the application software are set the same as those on the protocol converter (usually a KITZ but could be a SCADA RTU). The relay's Courier address in cell [0E02: COMMUNICATIONS, Remote Address] must be set to a value between 0 and 255.

Check that communications can be established with this relay using the portable PC.

5.2.7.2 IEC60870-5-103 (VDEW) communications

If the relay has the optional fiber optic communications port fitted, the port to be used should be selected by setting cell [0E09: COMMUNICATIONS, Physical Link] to 'Fiber Optic' or 'RS485'.

IEC60870-5-103/VDEW communication systems are designed to have a local Master Station and this should be used to verify that the relay's fiber optic or RS485 port, as appropriate, is working.

Ensure that the relay address and baud rate settings in the application software are set the same as those in cells [0E03: COMMUNICATIONS, Remote Address] and [0E06: COMMUNICATIONS, Baud Rate] of the relay.

Check that, using the Master Station, communications with the relay can be established.

5.2.8 Voltage inputs

This test verifies the accuracy of voltage measurement is within the acceptable tolerances.

Apply rated voltage to each voltage transformer input in turn, checking its magnitude using a multimeter. Refer to Table 5 for the corresponding reading in the relay's MEASUREMENTS 1 column and record the value displayed.

Cell in MEASUREMENTS 1 column (02	Voltage applied to
[0201: V1 Magnitude]	B19-B20
[0203: V2 Magnitude]	B21-B22
[0205: V3 Magnitude]	B23-B24
[0207: V4 Magnitude]	B17-B18

Table 5: Voltage input terminals

The measured voltage values on the relay will either be in primary or secondary volts. If cell [0D02: MEASURE'T SETUP, Local Values] is set to 'Primary', the values displayed on the relay should be equal to the applied voltage multiplied by the voltage transformer ratio set in the 'VT and CT RATIOS' menu. If cell [0D02: MEASURE'T SETUP, Local Values] is set to 'Secondary', the value displayed should be equal to the applied voltage.

The measurement accuracy of the relay is ±1%. However, an additional allowance must be made for the accuracy of the test equipment being used.

6. PEER TO PEER COMMUNICATION TEST

If the peer-peer communication facility via Ethernet is being used to implement a scheme with more than one P842 relay then this facility must be tested to verify correct operation. The aim of the tests within this section are to prove that the communication is established between relays; not the correct design of the scheme using this facility. The peer-peer communications is implemented using either fiber or copper ethernet links between the relays using the GOOSE (Generic Object Orientated Substation Event) facility of the UCA2 protocol.

6.1 Download of GOOSE scheme logic

To configure the peer-peer communication facilities it is necessary for the GOOSE Scheme Logic (GSL) to be downloaded to the relay via an editor provided as part of the S1 Agile support software. It is assumed that these configuration files for the relays have been prepared prior to the commissioning.

Note: For correct operation of the peer-peer scheme the configuration provides a unique identifier for each of the relays connected. Therefore, an individual GSL configuration file must be provided for each relay.

The GSL logic for each relay is provided as a file on disk and is downloaded to the relay via the front Courier port using the MiCOM S1 Agile GSL Editor tool.

6.2 Verify link

To test the correct operation of the peer-peer scheme each of the relays should be powered and connected via either copper or fiber Ethernet. If the scheme involves more than two relays then at least one Ethernet switch/hub must be used to provide connection between the relays. These devices must also be energized for the scheme to operate.

To verify that a link is presented for each of the relays and the hub, check that the green LED on the rear of the relay Ethernet board is illuminated. If this is not the case then check the wiring between the relay and the hub.

6.3 Verify configuration

Once a link has been verified the relay menu should be used to prove that other relays connected on the peer-peer network can be detected by each other. This is achieved using the cell [0E40: COMMUNICATIONS, Enrolled IED to determine that each device that the relay has been programmed to receive information from has been detected. This is presented as a bit field; with a “1” indicating that the device is present. If the device is not indicated as being present then re-check the link is established between all the devices within the scheme. If this does not reveal a problem then check the configuration of the device, verifing that the correct file has been downloaded to each of the devices within the scheme.

6.4 Virtual inputs

The signals received via the Ethernet communications to the relay are processed on the Ethernet card and are then incorporated into the relay Programmable Scheme Logic via 32 ‘Virtual Inputs’. To assist in the testing of the scheme the status of these virtual inputs can be monitored using the menu cell [0E34: COMMUNICATIONS, VIP Status].

7. SCHEME TESTS

Check the relay has not been damaged during transportation and storage, before being put in to service, as detailed in the previous sections. It is not necessary to perform tests on all internal features of the relay since a manufacture guaranties that the relay will perform in accordance to the performance claims. Therefore, the aim of these tests would be only to add a confidence in the relay performance and check whether the connections to the relay are correct.

P842 is a successor of LFAA103. No standard commissioning procedure for scheme tests were established in the past, the commissioning was done on a site to site basis. Therefore, it is difficult to specify the test procedure and identify test items, since every site may have different approach and restrictions in terms of operation of plant items such as circuit breakers, isolators etc.

If the P842 is modified for the application using the PSL and GOOSE Scheme Logic it will be necessary to verify correct operation of the mesh corner scheme. This test will of necessity be application specific.

8. FINAL CHECKS

The tests are now complete.

Remove all test or temporary shorting leads. If it was necessary to disconnect any of the external wiring from the relay to perform the wiring verification tests, ensure that all connections are replaced in accordance with the relevant external connection or scheme diagram.

Ensure that the relay has been restored to service by checking that cell [0F0D: COMMISSION TESTS, Test Mode] is set to ‘Disabled’.

If the relay is in a new installation or the circuit breaker has just been maintained, the circuit breaker maintenance and current counters should be zero. These counters can be reset using cell [0609: CB CONDITION, Reset All Values]. If the required access level is not active, the relay will prompt for a password to be entered so that the setting change can be made.

If the menu language has been changed to allow accurate testing it should be restored to the customer’s preferred language.

If a P991/MMLG test block is installed, remove the P992/MMLB test plug and replace the cover so that the protection is put into service.

Ensure that all event records, fault records, disturbance records, alarms and LED’s have been reset before leaving the relay.

If applicable, replace the secondary front cover on the relay.

9. COMMISSIONING TEST RECORD

Date:		Engineer:	
Station:		Circuit:	
		System Frequency:	Hz
VT Ratio:	/ V		

Front Plate Information

Distance protection relay	**MiCOM P842**
Model number	
Serial number	
Rated voltage Vn	
Auxiliary voltage Vx	

Test Equipment Used

This section should be completed to allow future identification of protective devices that have been commissioned using equipment that is later found to be defective or incompatible but may not be detected during the commissioning procedure.

Variable ac voltage source 1	Model: Serial No:	
Variable ac voltage source 2	Model: Serial No:	
Phase angle meter	Model: Serial No:	
Frequency meter	Model: Serial No:	
Insulation tester	Model: Serial No:	
Setting software:	Type: Version:	

			*Delete as appropriate
	Have all relevant safety instructions been followed?		Yes/No*
4	Product Checks		
4.1	**With the relay de-energized**		
4.1.1	Visual inspection		
	Relay damaged?		Yes* ☐ No* ☐
	Rating information correct for installation?		Yes* ☐ No* ☐
	Case earth installed?		Yes* ☐ No* ☐
4.1.2	Insulation resistance >100MΩ at 500V dc		Yes* ☐ No* ☐ Not tested* ☐
4.1.3	External wiring		
	Wiring checked against diagram?		Yes* ☐ No* ☐
	Test block connections checked?		Yes* ☐ No* ☐ N/A* ☐
4.1.4	Watchdog contacts (auxiliary supply off)		
	Terminals 11 and 12	Contact closed?	Yes* ☐ No* ☐
	Terminals 13 and 14	Contact open?	Yes* ☐ No* ☐
4.1.5	Measured auxiliary supply		_____ V ac/dc*
4.2	**With the relay energized**		
4.2.1	Watchdog contacts (auxiliary supply on)		
	Terminals 11 and 12	Contact open?	Yes* ☐ No* ☐
	Terminals 13 and 14	Contact closed?	Yes* ☐ No* ☐
4.2.2	LCD front panel display		
	LCD contrast setting used		_____
4.2.3	Date and time		
	Clock set to local time?		Yes* ☐ No* ☐
	Time maintained when auxiliary supply removed?		Yes* ☐ No* ☐

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4.2.4 Light emitting diodes

Alarm (yellow) LED working?	Yes* ☐ No* ☐
Out of service (yellow) LED working?	Yes* ☐ No* ☐
All 8 programmable LEDs working?	Yes* ☐ No* ☐

4.2.5 Field supply voltage

Value measured between terminals 8 and 9	_____ V dc

4.2.6 Input opto-isolators

Opto input 1 working?	Yes* ☐ No* ☐
Opto input 2 working?	Yes* ☐ No* ☐
Opto input 3 working?	Yes* ☐ No* ☐
Opto input 4 working?	Yes* ☐ No* ☐
Opto input 5 working?	Yes* ☐ No* ☐
Opto input 6 working?	Yes* ☐ No* ☐
Opto input 7 working?	Yes* ☐ No* ☐
Opto input 8 working?	Yes* ☐ No* ☐
Opto input 9 working?	Yes* ☐ No* ☐
Opto input 10 working?	Yes* ☐ No* ☐
Opto input 11 working?	Yes* ☐ No* ☐
Opto input 12 working?	Yes* ☐ No* ☐
Opto input 13 working?	Yes* ☐ No* ☐
Opto input 14 working?	Yes* ☐ No* ☐
Opto input 15 working?	Yes* ☐ No* ☐
Opto input 16 working?	Yes* ☐ No* ☐
Opto input 17 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 18 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 19 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 20 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 21 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 22 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 23 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 24 working?	Yes* ☐ No* ☐ N/A* ☐

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Opto input 25 working?	Yes* ☐ No* ☐
Opto input 26 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 27 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 28 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 29 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 30 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 31 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 32 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 33 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 34 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 35 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 36 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 37 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 38 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 39 working?	Yes* ☐ No* ☐
Opto input 40 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 41 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 42 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 43 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 44 working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 45 working?	Yes* ☐ No* ☐ N/A* ☐

Opto input 46	working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 47	working?	Yes* ☐ No* ☐ N/A* ☐
Opto input 48	working?	Yes* ☐ No* ☐ N/A* ☐

4.2.7 Output relays

Relay 1	working?	Yes* ☐ No* ☐
Relay 2	working?	Yes* ☐ No* ☐
Relay 3	working?	Yes* ☐ No* ☐
Relay 4	working?	Yes* ☐ No* ☐
Relay 5	working?	Yes* ☐ No* ☐
Relay 6	working?	Yes* ☐ No* ☐
Relay 7	working?	Yes* ☐ No* ☐
Relay 8	working?	Yes* ☐ No* ☐
Relay 9	working?	Yes* ☐ No* ☐
Relay 10	working?	Yes* ☐ No* ☐
Relay 11	working?	Yes* ☐ No* ☐
Relay 12	working?	Yes* ☐ No* ☐
Relay 13	working?	Yes* ☐ No* ☐
Relay 14	working?	Yes* ☐ No* ☐
Relay 15	working?	Yes* ☐ No* ☐
Relay 16	working?	Yes* ☐ No* ☐
Relay 17	working?	Yes* ☐ No* ☐
Relay 18	working?	Yes* ☐ No* ☐
Relay 19	working?	Yes* ☐ No* ☐
Relay 20	working?	Yes* ☐ No* ☐
Relay 21	working?	Yes* ☐ No* ☐
Relay 22	working?	Yes* ☐ No* ☐
Relay 23	working?	Yes* ☐ No* ☐
Relay 24	working?	Yes* ☐ No* ☐
Relay 25	working?	Yes* ☐ No* ☐ N/A* ☐
Relay 26	working?	Yes* ☐ No* ☐ N/A* ☐
Relay 27	working?	Yes* ☐ No* ☐ N/A* ☐
Relay 28	working?	Yes* ☐ No* ☐ N/A* ☐

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Relay 29	working?	Yes* ☐ No* ☐ N/A* ☐
Relay 30	working?	Yes* ☐ No* ☐ N/A* ☐
Relay 31	working?	Yes* ☐ No* ☐ N/A* ☐
Relay 32	working?	Yes* ☐ No* ☐ N/A* ☐

Communication standard	K-Bus/ IEC60870-5-103*/
Communications established?	Yes/No*
Protocol convertor tested?	Yes/No/na*

4.2.8 Peer to peer communication (UCA2 GOOSE)

Peer to peer communication (UCA2 GOOSE)	K-Bus/ IEC60870-5-103*/
Communications established?	Yes/No*
Correct opreration	Yes/No/na*

4.2.9 Voltage Inputs

Displayed Voltage		Primary/Secondary*
Main VT Ratio		_______V/na*
C/S VT Ratio		_______V/na*
Input VT	Applied value	Displayed value
VA	_______V	_______V
VB	_______V	_______V
VC	_______V	
VD	_______V	_______V

4.2.10 Confirm voltage transformers wiring

4.2.11 Voltage Connections

Correct connection for 1CB controlled setting?	Yes/na
Correct connection for 2CB controlled setting?	Yes/na

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COMMENTS #
(# Optional, for site observations or utility-specific notes).

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Commissioning Engineer

Customer Witness

Date:

Date:

10. SETTING RECORD

Date:		Engineer:	
Station:		Circuit:	
		System Frequency:	Hz
VT Ratio:	/ V		

Front Plate Information

Mesh corner relay	**MiCOM P842**
Model number	
Serial number	
Rated voltage Vn	
Auxiliary voltage Vx	

Setting Groups Used

*Delete as appropriate

Group 1	Yes* ☐ No* ☐
Group 2	Yes* ☐ No* ☐
Group 3	Yes* ☐ No* ☐
Group 4	Yes* ☐ No* ☐

0000 SYSTEM DATA

0001	Language	English* ☐ Francais* ☐ Deutsche* ☐ Espanol* ☐
0002	Password	
0003	Sync. Fn. Links	
0004	Description	
0005	Plant Reference	
0006	Model Number	
0008	Serial Number	
0009	Frequency	
000B	Relay Address	
0011	Software Ref. 1	
00D1	Password Control	Level 0* ☐ Level 1* ☐ Level 2* ☐
00D2	Password Level 1	
00D3	Password Level 2	

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0800 DATE AND TIME *Delete as appropriate

0804	IRIG-B Sync.	Disabled*	☐	Enabled*	☐
0807	Battery Alarm	Disabled*	☐	Enabled*	☐

0900 CONFIGURATION

0902	Setting Group	Select via Menu*	☐	Select via Optos*	☐
0903	Active Settings	Group 1* ☐ Group 2* ☐ Group 3* ☐ Group 4* ☐			
0907	Setting Group 1	Disabled*	☐	Enabled*	☐
0908	Setting Group 2	Disabled*	☐	Enabled*	☐
0909	Setting Group 3	Disabled*	☐	Enabled*	☐
090A	Setting Group 4	Disabled*	☐	Enabled*	☐
0910	CBs Controlled				
0911	Number Of Lines				
0912	No. Transformers				
0914	Ferrores Suppr	Disabled*	☐	Enabled*	☐
0925	Input Labels	Invisible*	☐	Visible*	☐
0926	Output Labels	Invisible*	☐	Visible*	☐
0928	CT & VT Ratios	Invisible*	☐	Visible*	☐
0929	Record Control	Invisible*	☐	Visible*	☐
092A	Disturb Recorder	Invisible*	☐	Visible*	☐
092B	Measure’t. Setup	Invisible*	☐	Visible*	☐
092C	Comms. Settings	Invisible*	☐	Visible*	☐
092D	Commission Tests	Invisible*	☐	Visible*	☐
092E	Setting Values	Primary*	☐	Secondary*	☐
092F	Control Inputs	Invisible*	☐	Visible*	☐
0936	Control I/P Config	Invisible*	☐	Visible*	☐

CM

0A00 CT AND VT RATIOS

0A01	Main VT Primary	
0A02	Main VT Sec'y.	

0B00 RECORD CONTROL

0B04	Alarm Event	Disabled*	☐	Enabled*	☐
0B05	Relay O/P Event	Disabled*	☐	Enabled*	☐
0B06	Opto Input Event	Disabled*	☐	Enabled*	☐
0B07	General Event	Disabled*	☐	Enabled*	☐
0B08	Fault Rec. Event	Disabled*	☐	Enabled*	☐
0B09	Maint. Rec. Event	Disabled*	☐	Enabled*	☐
0B0A	Protection Event	Disabled*	☐	Enabled*	☐

0C00 DISTURB. RECORDER

0C01	Duration				
0C02	Trigger Position	Single*	☐	Extended*	☐
0C04	Analog Channel 1				
0C05	Analog Channel 2				
0C06	Analog Channel 3				
0C07	Analog Channel 4				
0C0C	Digital Input 1				
0C0D	Input 1 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C0E	Digital Input 2				
0C0F	Input 2 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C10	Digital Input 3				
0C11	Input 3 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C12	Digital Input 4				
0C13	Input 4 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C14	Digital Input 5				
0C15	Input 5 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C16	Digital Input 6				
0C17	Input 6 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C18	Digital Input 7				
0C19	Input 7 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C1A	Digital Input 8				
0C1B	Input 8 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C1C	Digital Input 9				
0C1D	Input 9 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C1E	Digital Input 10				
0C1F	Input 10 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C20	Digital Input 11				
0C21	Input 11 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C22	Digital Input 12				

0C00 DISTURB. RECORDER

0C23	Input 12 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C24	Digital Input 13				
0C25	Input 13 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C26	Digital Input 14				
0C27	Input 14 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C28	Digital Input 15				
0C29	Input 15 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C2A	Digital Input 16				
0C2B	Input 16 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C2C	Digital Input 17				
0C2D	Input 17 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C2E	Digital Input 18				
0C2F	Input 18 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C30	Digital Input 19				
0C31	Input 19 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C32	Digital Input 20				
0C33	Input 20 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C34	Digital Input 21				
0C35	Input 21 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C36	Digital Input 22				
0C37	Input 22 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C38	Digital Input 23				
0C39	Input 23 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C3A	Digital Input 24				
0C3B	Input 24 Trigger	No Trigger* Trigger H – L*	☐ ☐	Trigger L – H*	☐
0C3C	Digital Input 25				

0C00 DISTURB. RECORDER

0C3D	Input 25 Trigger	No Trigger* ☐ Trigger H – L* ☐		Trigger L – H* ☐	
0C3E	Digital Input 26				
0C3F	Input 26 Trigger	No Trigger* ☐ Trigger H – L* ☐		Trigger L – H* ☐	
0C40	Digital Input 27				
0C41	Input 27 Trigger	No Trigger* ☐ Trigger H – L* ☐		Trigger L – H* ☐	
0C42	Digital Input 28				
0C43	Input 28 Trigger	No Trigger* ☐ Trigger H – L* ☐		Trigger L – H* ☐	
0C44	Digital Input 29				
0C45	Input 29 Trigger	No Trigger* ☐ Trigger H – L* ☐		Trigger L – H* ☐	
0C46	Digital Input 30				
0C47	Input 30 Trigger	No Trigger* ☐ Trigger H – L* ☐		Trigger L – H* ☐	
0C48	Digital Input 31				
0C49	Input 31 Trigger	No Trigger* ☐ Trigger H – L* ☐		Trigger L – H* ☐	
0C4A	Digital Input 32				
0C4B	Input 32 Trigger	No Trigger* ☐ Trigger H – L* ☐		Trigger L – H* ☐	

CM

0D00 MEASURE'T. SETUP

0D01	Default Display	Date & Time* ☐ Description* ☐ Frequency* ☐	 Plant Reference* ☐ Access Level* ☐
0D02	Local Values	Primary* ☐	Secondary* ☐
0D03	Remote Values	Primary* ☐	Secondary* ☐

0E00 COMMUNICATIONS

0E01	RP1 Protocol	Courier* ☐		IEC870-5-103* ☐
0E02	RP1 Address			
0E03	RP1 InactivTimer			
0E04	RP1 Baud Rate	1200* ☐ 9600* ☐	2400* ☐ 19200* ☐	4800* ☐ 38400* ☐
0E05	RP1 Parity	Odd* ☐	Even* ☐	None* ☐
0E06	RP1 Meas. Period			
0E07	RP1 Physical Link	EIA(RS)485* ☐		Fiber Optic* ☐

0E08	RP1 Time Sync.	Disabled* ☐	Enabled* ☐
0E0A	RP1 CS103Blocking	Disabled* ☐ Command Blocking* ☐	Monitor Blocking* ☐

0F00 COMMISSION TESTS

0F05	Monitor Bit 1	
0F06	Monitor Bit 2	
0F07	Monitor Bit 3	
0F08	Monitor Bit 4	
0F09	Monitor Bit 5	
0F0A	Monitor Bit 6	
0F0B	Monitor Bit 7	
0F0C	Monitor Bit 8	

1100 OPTO CONFIG.

1101	Global Nominal V	
1102	Opto Input 1	
1103	Opto Input 2	
1104	Opto Input 3	
1105	Opto Input 4	
1106	Opto Input 5	
1107	Opto Input 6	
1108	Opto Input 7	
1109	Opto Input 8	
110A	Opto Input 9	
110B	Opto Input 10	
110C	Opto Input 11	
110D	Opto Input 12	
110E	Opto Input 13	
110F	Opto Input 14	
1110	Opto Input 15	
1111	Opto Input 16	
1112	Opto Input 17	
1113	Opto Input 18	
1114	Opto Input 19	
1115	Opto Input 20	
1116	Opto Input 21	
1117	Opto Input 22	
1118	Opto Input 23	
1119	Opto Input 24	
111A	Opto Input 25	

1100	OPTO CONFIG.	
111B	Opto Input 26	
111C	Opto Input 27	
111D	Opto Input 28	
111E	Opto Input 29	
111F	Opto Input 30	
1120	Opto Input 31	
1121	Opto Input 32	
1122	Opto Input 33	
1121	Opto Input 34	
1122	Opto Input 35	
1121	Opto Input 36	
1122	Opto Input 37	
1121	Opto Input 38	
1122	Opto Input 39	
1123	Opto Input 40	
1124	Opto Input 41	
1125	Opto Input 42	
1126	Opto Input 43	
1127	Opto Input 44	
1128	Opto Input 45	
1129	Opto Input 46	
1130	Opto Input 47	
1131	Opto Input 48	

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1300	CTRL. I/P CONFIG.				
1310	Control Input 1	Latched*	☐	Pulsed*	☐
1311	Ctrl Command 1				
1314	Control Input 2	Latched*	☐	Pulsed*	☐
1315	Ctrl Command 2				
1318	Control Input 3	Latched*	☐	Pulsed*	☐
1319	Ctrl Command 3				
131C	Control Input 4	Latched*	☐	Pulsed*	☐
131D	Ctrl Command 4				
1320	Control Input 5	Latched*	☐	Pulsed*	☐
1321	Ctrl Command 5				
1324	Control Input 6	Latched*	☐	Pulsed*	☐
1325	Ctrl Command 6				
1328	Control Input 7	Latched*	☐	Pulsed*	☐
1329	Ctrl Command 7				
132C	Control Input 8	Latched*	☐	Pulsed*	☐

1300	**CTRL. I/P CONFIG.**				
132D	Ctrl Command 8				
1330	Control Input 9	Latched*	☐	Pulsed*	☐
1331	Ctrl Command 9				
1334	Control Input 10	Latched*	☐	Pulsed*	☐
1335	Ctrl Command 10				
1338	Control Input 11	Latched*	☐	Pulsed*	☐
1339	Ctrl Command 11				
133C	Control Input 12	Latched*	☐	Pulsed*	☐
133C	Ctrl Command 12				
1340	Control Input 13	Latched*	☐	Pulsed*	☐
1341	Ctrl Command 13				
1344	Control Input 14	Latched*	☐	Pulsed*	☐
1345	Ctrl Command 14				
1348	Control Input 15	Latched*	☐	Pulsed*	☐
1349	Ctrl Command 15				
134C	Control Input 16	Latched*	☐	Pulsed*	☐
134D	Ctrl Command 16				
1350	Control Input 17	Latched*	☐	Pulsed*	☐
1351	Ctrl Command 17				
1354	Control Input 18	Latched*	☐	Pulsed*	☐
1355	Ctrl Command 18				
1358	Control Input 19	Latched*	☐	Pulsed*	☐
1359	Ctrl Command 19				
135C	Control Input 20	Latched*	☐	Pulsed*	☐
135D	Ctrl Command 20				
1360	Control Input 21	Latched*	☐	Pulsed*	☐
1361	Ctrl Command 21				
1364	Control Input 22	Latched*	☐	Pulsed*	☐
1365	Ctrl Command 22				
1368	Control Input 23	Latched*	☐	Pulsed*	☐
1369	Ctrl Command 23				
136C	Control Input 24	Latched*	☐	Pulsed*	☐
136D	Ctrl Command 24				
1370	Control Input 25	Latched*	☐	Pulsed*	☐
1371	Ctrl Command 25				
1374	Control Input 26	Latched*	☐	Pulsed*	☐
1375	Ctrl Command 26				
1378	Control Input 27	Latched*	☐	Pulsed*	☐
1379	Ctrl Command 27				
137C	Control Input 28	Latched*	☐	Pulsed*	☐

1300 CTRL. I/P CONFIG.

137D	Ctrl Command 28				
1380	Control Input 29	Latched*	☐	Pulsed*	☐
1381	Ctrl Command 29				
1384	Control Input 30	Latched*	☐	Pulsed*	☐
1385	Ctrl Command 30				
1388	Control Input 31	Latched*	☐	Pulsed*	☐
1389	Ctrl Command 31				
138C	Control Input 32	Latched*	☐	Pulsed*	☐
138D	Ctrl Command 32				

3000 MESH CORNER

Group 1 Settings		Group 1 Settings	Group 2 Settings	Group 3 Settings	Group 4 Settings
3001	Plant Reference				

3100 FEEDER 1

Group 1 Settings		Group 1 Settings	Group 2 Settings	Group 3 Settings	Group 4 Settings
3101	Plant Reference				
3102	Plant Sw. delay				
3103	Pers. ITrip Time				
3104	Plant Op. Time				
3105	Analog Live Chk				
3106	Live Line Chk VT				
3107	Live Line Level				
3108	Plant Serv. Stat				
3109	Live Dead Level				

3300 TRANSFORMER 1

Group 1 Settings		Group 1 Settings	Group 2 Settings	Group 3 Settings	Group 4 Settings
3301	Plant Reference				
3302	Plant Sw. delay				
3303	Plant Op. Time				
3304	Plant Serv. Stat				

3600 CIRCUIT BREAKER 1

Group 1 Settings		Group 1 Settings	Group 2 Settings	Group 3 Settings	Group 4 Settings
3601	Plant Reference				
3602	Min ISw. Delay				

CM

3603	Dead Time				
3604	Reclaim Time				
3605	Dead RemoteClose				
3606	Dead Local Close				
3607	Check-Sync Close				
3608	Check-Sync Timeout				
3609	Plant Op. Time				
360A	Lck Dropoff Time				
360B	Plant Serv. Stat				

3800 FERRORES SUPPR

Group 1 Settings		Group 1 Settings	Group 2 Settings	Group 3 Settings	Group 4 Settings
3801	Ferro Scheme Lev				

4800 SYSTEM CHECKS

Group 1 Settings		Group 1 Settings	Group 2 Settings	Group 3 Settings	Group 4 Settings
4815	Live Voltage				
4816	Dead Voltage				
4818	CS1 Status				
4819	CS1 Phase Angle				
481A	CS1 Slip Control				
481B	CS1 Slip Freq.				
481C	CS1 Slip Timer				
481D	CS2 Status				
481E	CS2 Phase Angle				
481F	CS2 Slip Control				
4820	CS2 Slip Freq.				
4821	CS2 Slip Timer				
4822	CS Undervoltage				
4823	CS Overvoltage				
4824	CS Diff. Voltage				
4825	CS Voltage Block				
4827	SS Status				
4828	SS Phase Angle				
4829	SS Under V Block				
482A	SS Undervoltage				
482B	SS Timer				

4A00 INPUT LABELS

Group 1 Settings		Group 1 Settings	Group 2 Settings	Group 3 Settings	Group 4 Settings
4A01	Opto Input 1				
4A02	Opto Input 2				
4A03	Opto Input 3				
4A04	Opto Input 4				
4A05	Opto Input 5				
4A06	Opto Input 6				
4A07	Opto Input 7				
4A08	Opto Input 8				
4A09	Opto Input 9				
4A0A	Opto Input 10				
4A0B	Opto Input 11				
4A0C	Opto Input 12				
4A0D	Opto Input 13				
4A0E	Opto Input 14				
4AOF	Opto Input 15				
4A10	Opto Input 16				
4A11	Opto Input 17				
4A12	Opto Input 18				
4A13	Opto Input 19				
4A14	Opto Input 20				
4A15	Opto Input 21				
4A16	Opto Input 22				
4A17	Opto Input 23				
4A18	Opto Input 24				
4A19	Opto Input 25				
4A1A	Opto Input 26				
4A1B	Opto Input 27				
4A1C	Opto Input 28				
4A1D	Opto Input 29				
4A1E	Opto Input 30				
4A1F	Opto Input 31				
4A20	Opto Input 32				
4A21	Opto Input 33				
4A22	Opto Input 34				
4A23	Opto Input 35				
4A24	Opto Input 36				
4A25	Opto Input 37				

4A00	**INPUT LABELS**				
4A26	Opto Input 38				
4A27	Opto Input 39				
4A28	Opto Input 40				
4A29	Opto Input 41				
4A2A	Opto Input 42				
4A2B	Opto Input 43				
4A2C	Opto Input 44				
4A2D	Opto Input 45				
4A2E	Opto Input 46				
4A2F	Opto Input 47				
4A30	Opto Input 48				

4B00	**OUTPUT LABELS**				
Group 1 Settings		Group 1 Settings	Group 2 Settings	Group 3 Settings	Group 4 Settings
4B01	Relay 1				
4B02	Relay 2				
4B03	Relay 3				
4B04	Relay 4				
4B05	Relay 5				
4B06	Relay 6				
4B07	Relay 7				
4B08	Relay 8				
4B09	Relay 9				
4B0A	Relay 10				
4B0B	Relay 11				
4B0C	Relay 12				
4B0D	Relay 13				
4B0E	Relay 14				
4B0F	Relay 15				
4B10	Relay 16				
4B11	Relay 17				
4B12	Relay 18				
4B13	Relay 19				
4B14	Relay 20				
4B15	Relay 21				
4B16	Relay 22				
4B17	Relay 23				
4B18	Relay 24				
4B19	Relay 25				

4B00	**OUTPUT LABELS**				
4B1A	Relay 26				
4B1B	Relay 27				
4B1C	Relay 28				
4B1D	Relay 29				
4B1E	Relay 30				
4B1F	Relay 31				
4B20	Relay 32				

Commissioning Engineer

Customer Witness

Date:

Date:

MAINTENANCE

MT

Date:	**2019**
Hardware Suffix:	**B**
Software Version:	**04**

MT

CONTENTS

MT

1. MAINTENANCE

1.1 Maintenance period

It is recommended that products supplied by General Electric receive periodic monitoring after installation. In view of the critical nature of protective relays and their infrequent operation, it is necessary to confirm they are operating correctly at regular intervals.

General Electric protective relays are designed for a life in excess of 20 years.

MiCOM relays are self-supervizing and so require less maintenance than earlier designs. Most problems will result in an alarm so that remedial action can be taken. However, some periodic tests should be done to ensure that the relay is functioning correctly, and the external wiring is intact.

1.2 Maintenance checks

Although some functionality checks can be performed from a remote location by utilizing the communications ability of the relays, these are predominantly restricted to checking that the relay is measuring the applied currents and voltages accurately and checking the circuit breaker maintenance counters. Therefore, it is recommended that maintenance checks are performed locally (i.e. at the substation itself).

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety and Technical Data sections and the ratings on the equipment's rating label.

1.2.1 Alarms

The alarm status LED should first be checked to identify if any alarm conditions exist. If so, press the read key [] repeatedly to step through the alarms.

Clear the alarms to extinguish the LED.

1.2.2 Opto-isolators

The opto-isolated inputs can be checked to ensure that the relay responds to their energization by repeating the commissioning test detailed in section 5.2.5 of the Commissioning section (P842/EN CM).

1.2.3 Output relays

The output relays can be checked to ensure that they operate by repeating the commissioning test detailed in section 5.2.6 of the Commissioning section (P842/EN CM).

1.2.4 Measurement accuracy

If the power system is energized, the values measured by the relay can be compared with known system values to check that they are in the approximate range that is expected. If they are then the analog/digital conversion and calculations are being performed correctly by the relay. Suitable test methods can be found in the Commissioning section (P842/EN CM).

Alternatively, the values measured by the relay can be checked against known values injected into the relay via the test block, if fitted, or injected directly into the relay terminals. Suitable test methods can be found in sections 5.2.8 of the Commissioning section (P842/EN CM). These tests will prove the calibration accuracy is being maintained.

1.3 Method of repair

If the relay develops a fault while in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. Due to the extensive use of surface-mount components faulty PCBs should be replaced, as it is not possible to perform repairs on damaged circuits. Therefore, either the complete relay or just the faulty PCB, identified by the in-built diagnostic software, can be replaced. Advice about identifying the faulty PCB can be found in the Troubleshooting section (P842/EN TS).

The preferred method is to replace the complete relay. This ensures the internal circuitry is protected against electrostatic discharge and physical damage at all times and overcomes the possibility of incompatibility between replacement PCBs. However, it may be difficult to remove an installed relay due to limited access in the back of the cubicle and rigidity of the scheme wiring.

Replacing PCBs can reduce transport costs but requires clean, dry conditions on site and higher skills from the person performing the repair. However, if the repair is not performed by an approved service center, the warranty will be invalidated.

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety and Technical Data sections and the ratings on the equipment's rating label. This should ensure that no damage is caused by incorrect handling of the electronic components.

1.3.1 Replacing the complete relay

The case and rear terminal blocks have been designed to facilitate removal of the complete relay should replacement or repair become necessary without having to disconnect the scheme wiring.

Before working at the rear of the relay, isolate all voltage and current supplies to the relay.

Note: The MiCOM range of relays have integral current transformer shorting switches which will close when the heavy duty terminal block is removed.

1. Disconnect the relay earth, IRIG-B and fiber optic connections, as appropriate, from the rear of the relay.

There are two types of terminal block used on the relay, medium and heavy duty, which are fastened to the rear panel using crosshead screws, as in Figure 1 of the Commissioning section (P842/EN CM).

Note: The use of a magnetic bladed screwdriver is recommended to minimize the risk of the screws being left in the terminal block or lost.

2. Without exerting excessive force or damaging the scheme wiring, pull the terminal blocks away from their internal connectors.
3. Remove the screws used to fasten the relay to the panel, rack, etc. These are the screws with the larger diameter heads that are accessible when the access covers are fitted and open.

If the top and bottom access covers have been removed, do not remove the screws with the smaller diameter heads which are accessible. These screws secure the front panel to the relay.

4. Withdraw the relay carefully from the panel or rack as it will be heavy because of the internal transformers.
5. To reinstall the repaired or replacement relay, follow steps 1 to 5 in in reverse. Relocate each terminal block in the correct position. Replace the case earth, IRIG-B and fiber optic connections. To help identify each terminal block, they are labeled alphabetically with 'A' on the left hand side when viewed from the rear.

Once reinstallation is complete the relay should be re-commissioned using the instructions in sections 1 to 9 of the Commissioning section (P842/EN CM), inclusive of this section.

1.3.1.1 Replacing a PCB

Replacing printed circuit boards and other internal components of protective relays must be undertaken only by Service Centers approved by General Electric. Failure to obtain the authorization of General Electric After Sales Engineers prior to commencing work could invalidate the product warranty.

Before removing the front panel to replace a PCB the auxiliary supply must be removed, and you must wait 5s for capacitors to discharge. It is also strongly recommended that the voltage and current transformer connections and trip circuit are isolated.

General Electric Automation Support teams are available world-wide, and it is strongly recommended that any repairs be entrusted to those trained personnel. For this reason, details on product disassembly and re-assembly are not included here.

1.4 Re-calibration

Re-calibration is not required when a PCB is replaced **unless it happens to be one of the boards in the input module;** the replacement of either directly affects the calibration.

Although it is possible to carry out re-calibration on site, this requires test equipment with suitable accuracy and a special calibration program to run on a PC. It is therefore recommended that the work be carried out by the manufacturer or entrusted to an approved service center.

1.5 Changing the relay battery

Each relay has a battery to maintain status data and the correct time when the auxiliary supply voltage fails. The data maintained includes event, fault and disturbance records and the thermal state at the time of failure.

This battery will periodically need changing, although an alarm will be given as part of the relay's continuous self-monitoring in the event of a low battery condition.

If the battery-backed facilities are not required to be maintained during an interruption of the auxiliary supply, the steps below can be followed to remove the battery, but do not replace with a new battery.

Before carrying out any work on the equipment, the user should be familiar with the contents of the safety and technical data sections and the ratings on the equipment's rating label.

1.5.1 Instructions for replacing the battery

1. Open the bottom access cover on the front of the relay.
2. Gently extract the battery from its socket. If necessary, use a small, insulated screwdriver to prize the battery free.
3. Ensure that the metal terminals in the battery socket are free from corrosion, grease and dust.

The replacement battery should be removed from its packaging and placed into the battery holder, taking care to ensure that the polarity markings on the battery agree with those adjacent to the socket.

Note: Only use a type ½AA Lithium battery with a nominal voltage of 3.6V and safety approvals such as UL (Underwriters Laboratory), CSA (Canadian Standards Association) or VDE (Vereinigung Deutscher Elektrizitätswerke).

4. Ensure that the battery is securely held in its socket and that the battery terminals are making good contact with the metal terminals of the socket.
5. Close the bottom access cover.

1.5.2 Post modification tests

To ensure the replacement battery maintains the time and status data if the auxiliary supply fails, check cell [0806: DATE and TIME, Battery Status] reads 'Healthy'.

If further confirmation that the replacement battery is installed correctly is required, the commissioning test described in section 5.2.2 of the Commissioning section (P842/EN CM), 'Date and Time', can be performed.

1.5.3 Battery disposal

Dispose the removed battery according to the disposal procedure for Lithium batteries in the country in which the relay is installed.

1.6 Cleaning

Before cleaning the relay ensure that all ac and dc supplies, current transformer and voltage transformer connections are isolated to prevent any chance of an electric shock whilst cleaning.

Only clean the equipment with a lint-free cloth dampened with clean water. Do not use detergents, solvents or abrasive cleaners as they may damage the relay's surface and leave a conductive residue.

TROUBLESHOOTING

Date: **2019**
Hardware Suffix: **B**
Software Version: **04**

CONTENTS

TS

1. INTRODUCTION

Before carrying out any work on the equipment, the user should be familiar with the contents of the safety and technical data sections and the ratings on the equipment's rating label

The purpose of this chapter is to allow an error condition on the relay to be identified so that appropriate corrective action can be taken.

If the relay develops a fault, usually it is possible to identify which relay module needs attention. The Maintenance chapter (P842/EN MT) advises on the recommended method of repair where faulty modules need replacing. It is not possible to perform an on-site repair to a faulted module.

If a faulty relay or module is being returned to the manufacturer or one of their approved service centers, a completed copy of the Repair or Modification Return Authorization Form should be included.

2. INITIAL PROBLEM IDENTIFICATION

Use the table below to find the description that best matches the problem experienced, then consult the section referenced to perform a more detailed analysis of the problem.

Symptom	Refer To
Relay fails to power up	Section 4
Relay powers up - but indicates error and halts during power-up sequence	Section 5
Relay Powers up but Out of Service LED is illuminated	Section 6
Error during normal operation	Section 7
Mal-operation of the relay during testing	Section 8

Table 1: Problem identification

3. POWER UP ERRORS

If the relay does not appear to power up, use the procedure in the following table to determine whether the fault is in the external wiring, auxiliary fuse, power supply module of the relay or the relay front panel.

Test	Check	Action
1	Measure auxiliary voltage on terminals 1 and 2; verify voltage level and polarity against rating the label on front. Terminal 1 is –dc, 2 is +dc	If auxiliary voltage is present and correct, then proceed to test 2. Otherwise the wiring/fuses in auxiliary supply should be checked.
2	Do LEDs/and LCD backlight illuminate on power-up, also check the N/O watchdog contact for closing.	If they illuminate or the contact closes and no error code is displayed then error is probably in the main processor board (front panel). If they do not illuminate and the contact does not close then proceed to test 3.
3	Check Field voltage output (nominally 48V DC)	If field voltage is not present then the fault is probably in the relay power supply module.

Table 2: Failure of relay to power up

4. ERROR MESSAGE/CODE ON POWER-UP

During the power-up sequence of the relay self-testing is performed as indicated by the messages displayed on the LCD. If an error is detected by the relay during these self-tests then an error message will be displayed and the power-up sequence will be halted. If the error occurs when the relay application software is executing then a maintenance record will be created and the relay will reboot.

Test	Check	Action
1	Is an error message or code permanently displayed during power up?	If relay locks up and displays an error code permanently then proceed to test 2. If the relay prompts for input by the user proceed to test 4. If the relay re-boots automatically then proceed to test 5
2	Record displayed error, then remove and re-apply relay auxiliary supply.	Record whether the same error code is displayed when the relay is rebooted. If no error code is displayed then contact the local service center stating the error code and relay information. If the same code is displayed proceed to test 3.
3	Error code Identification Following text messages (in English) will be displayed if a fundamental problem is detected preventing the system from booting: Bus Fail – address lines SRAM Fail – data lines FLASH Fail format error FLASH Fail checksum Code Verify Fail The following hex error codes relate to errors detected in specific relay modules:	These messages indicate that a problem has been detected on the main processor board of the relay (located in the front panel).
	0c140005/0c0d0000	Input Module (inc. Opto-isolated inputs)
	0c140006/0c0e0000	Output Relay Cards
	Last 4 digits provide details on the actual error.	Other error codes relate to problems within the main processor board hardware or software. It will be necessary to contact General Electric with details of the problem for a full analysis.
4	Relay displays message for corrupt settings and prompts for restoration of defaults to the affected settings.	The power up tests have detected corrupted relay settings, it is possible to restore defaults to allow the power-up to be completed. It will then be necessary to re-apply the application-specific settings.
5	Relay resets on completion of power up - record error code displayed	Error 0x0E080000, programmable scheme logic error due to excessive execution time. If relay powers up successfully, check programmable logic for feedback paths. Other error codes will relate to software errors on the main processor board, contact General Electric.

Table 3: Power-up self test error

5. OUT OF SERVICE LED ILLUMINATED ON POWER UP

Test	Check	Action	
1	Using the relay menu confirm whether the Commission Test/Test Mode setting is Enabled. Otherwise proceed to test 2.	If the setting is Enabled then disable the test mode and, verify that the Out of Service LED is extinguished.	
2	Select and view the last maintenance record from the menu (in the View Records).	Check for H/W Verify Fail this indicates a discrepancy between the relay model number and the hardware; examine the “Maint. Data”, this indicates the causes of the failure using bit fields: Bit Meaning	
		0	The application type field in the model number does not match the software ID
		1	The application field in the model number does not match the software ID
		2	The variant 1 field in the model number does not match the software ID
		3	The variant 2 field in the model number does not match the software ID
		4	The protocol field in the model number does not match the software ID
		5	The language field in the model number does not match the software ID
		6	The VT type field in the model number is incorrect (110V VTs fitted)
		7	The VT type field in the model number is incorrect (440V VTs fitted)
		8	The VT type field in the model number is incorrect (no VTs fitted)

Table 4: Out of service LED illuminated

6. ERROR CODE DURING OPERATION

The relay performs continuous self-checking. If the relay detects an error it displays an error message, logs a maintenance record and after a 1.6 second delay the relay resets. A permanent problem (for example due to a hardware fault) is usually detected in the power up sequence, then the relay displays an error code and halts. If the problem was transient, the relay reboots correctly and continues operation. By examining the maintenance record logged, the nature of the detected fault can be determined.

There is a cases where a maintenance record will be logged due to a detected error where the relay will not reset. Detection of a failure of either the field voltage or the lithium battery are indicated by an alarm message, however the relay will continue to operate.

If the field voltage is detected to have failed (the voltage level has dropped below threshold), then a scheme logic signal is also set. This allows the scheme logic to be adapted in the case of this failure. For example, if a blocking scheme is being used.

To prevent the relay from issuing an alarm when there is battery failure, select the Date and Time setting. The setting ‘Battery Alarm’ can be set to 'Disabled' to allow the relay to be used without a battery and no battery alarm message will appear.

7. MAL-OPERATION OF THE RELAY DURING TESTING

7.1 Failure of output contacts

An apparent failure of the relay output contacts can be caused by the relay configuration. Perform the following tests to identify the real cause of the failure. The relay self-tests verify that the coil of the contact has been energized. An error is displayed if there is a fault in the output relay board.

Test	Check	Action
1	Is the Out of Service LED illuminated?	Illumination of this LED may indicate that the relay is in test mode or that the protection has been disabled due to a hardware verify error (see Table 4).
2	Examine the Contact status in the Commissioning section of the menu.	If the relevant bits of the contact status are operated then proceed to test 4, if not proceed to test 3.
3	Verify by examination of the fault record or by using the test port whether the protection element is operating correctly.	If the protection element does not operate verify whether the test is being correctly applied. If the protection element does operate then it will be necessary to check the programmable logic, to ensure that the mapping of the protection element to the contacts is correct.
4	Using the Commissioning/Test mode function apply a test pattern to the relevant relay output contacts and verify whether they operate (note the correct external connection diagram should be consulted). A continuity tester can be used at the rear of the relay for this purpose.	If the output relay does operate then the problem must be in the external wiring to the relay. If the output relay does not operate this could indicate a failure of the output relay contacts (note that the self-tests verify that the relay coil is being energized). Ensure that the closed resistance is not too high for the continuity tester to detect.

Table 5: Failure of output contacts

7.2 Failure of opto-isolated inputs

The opto-isolated inputs are mapped onto the relay internal signals using the programmable scheme logic. If an input does not appear to be recognized by the relay scheme logic the Commission Tests/Opto Status menu option can be used to verify whether the problem is in the opto-isolated input itself or the mapping of its signal to the scheme logic functions. If the opto-isolated input does appear to be read correctly, examine its mapping in the programmable logic.

Ensure the voltage rating for the opto inputs has been configured correctly with applied voltage. If the opto-isolated input state is not being correctly read by the relay the applied signal should be tested. Verify the connections to the opto-isolated input using the correct wiring diagram. Using a voltmeter, verify that 80% opto setting voltage is present on the terminals of the opto-isolated input in the energized state. If the signal is being correctly applied to the relay then the failure may be on the input card. Depending on which opto-isolated input has failed, the complete analog input module or a separate opto board may need to be replaced. The board in the analog input module cannot be individually replaced without recalibrating the relay.

7.3 Incorrect analog signals

The measurements can be configured in primary or secondary to assist. If the analog quantities being measured by the relay are not correct, use the measurement function of the relay to determine the nature of the problem. Compare the measured values displayed by the relay with the actual magnitudes at the relay terminals. Check the correct terminals are used (in particular the dual rated CT inputs) and check the CT and VT ratios set on the relay are correct. Use the correct 120 degree displacement of the phase measurements to confirm the inputs have been correctly connected.

7.4 PSL editor troubleshooting

A failure to open a connection could be because of one or more of the following:

- The relay address is not valid (note: this address is always 1 for the front port).
- Password in not valid
- Communication Set-up - COM port, Baud rate, or Framing - is not correct
- Transaction values are not suitable for the relay and/or the type of connection
- Modem configuration is not valid. Changes may be necessary when using a modem
- The connection cable is not wired correctly or broken. See S1 Agile V2 connection configurations
- The option switches on any KITZ101/102 may be incorrectly set

7.4.1 Diagram reconstruction after recover from relay

Although a scheme can be extracted from a relay, the facility is provided to recover a scheme if the original file is unobtainable.

A recovered scheme is logically correct but much of the original graphical information is lost. Many signals will be drawn in a vertical line down the left side of the canvas. Links are drawn orthogonally using the shortest path from A to B.

Any annotation added to the original diagram, like titles or notes are lost.

Sometimes a gate type may not be what was expected. For example, a 1-input AND gate in the original scheme will appear as an OR gate when uploaded. Programmable gates with an inputs-to-trigger value of 1 will also appear as OR gates.

7.4.2 PSL version check

The PSL is saved with a version reference, time stamp and CRC check. This gives a visual check whether the default PSL is in place or whether a new application has been downloaded.

8. REPAIR AND MODIFICATION PROCEDURE

Please follow these 5 steps to return an Automation product to us:

1. Get the Repair and Modification Authorization Form (RMA)

- To obtain an electronic version of the RMA form, please visit the following URL:

  www.gegridsolutions.com

2. Fill in RMA form

Fill in only the white part of the form.

Please ensure that all fields marked **(M)** are completed such as:

- Equipment model
- Model No. and Serial No.
- Description of failure or modification required (please be specific)
- Value for customs (in case the product requires export)
- Delivery and invoice addresses
- Contact details

3. Send RMA form to your local contact

4. Receive from local service contact, the information required to ship the product

Your local service contact will provide you with all the information:

- Pricing details
- RMA n°
- Repair center address

If required, an acceptance of the quote must be delivered before going to next stage.

5. Send the product to the repair center

- Address the shipment to the repair center specified by your local contact
- Ensure all items are protected by appropriate packaging: anti-static bag and foam protection
- Ensure a copy of the import invoice is attached with the unit being returned
- Ensure a copy of the RMA form is attached with the unit being returned
- E-mail or fax a copy of the import invoice and airway bill document to your local contact.

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SCADA COMMUNICATIONS

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Date: 2019
Hardware Suffix: B
P842 Software Version: 04

CONTENTS

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FIGURES

1. SCADA COMMUNICATIONS

1.1 Introduction

This chapter outlines the remote communications interfaces of the MiCOM relay. The relay supports two protocols through the rear communication interface, selected using the model number when ordering. This is in addition to the front serial interface, which supports the Courier protocol only.

The rear EIA(RS)485 interface is isolated and is suitable for permanent connection whichever protocol is selected. The advantage of this type of connection is that up to 32 relays can be 'daisy chained' together using a simple twisted pair electrical connection.

The descriptions in this chapter do not aim to fully detail the protocol itself. Refer to the relevant documentation protocol for this information. This chapter serves to describe the specific implementation of the protocol in the relay.

2. REAR PORT INFORMATION AND CONNECTION ADVICE – EIA(RS)485 PROTOCOLS

2.1 Rear communication port EIA(RS)485 interface

The rear EIA(RS)485 communication port is provided by a 3-terminal screw connector located on the back of the relay. See chapter P842/EN IN for details of the connection terminals. The rear port provides K-Bus/EIA(RS)485 serial data communication and is intended for use with a permanently wired connection to a remote control center. Of the three connections, two are for the signal connection, and the other is for the earth shield of the cable. When the K-Bus option is selected for the rear port, the two signal connections are not polarity conscious, however for IEC60870-5-103 care must be taken to observe the correct polarity.

The protocol provided by the relay is indicated in the relay menu in the ‘Communications’ column. Using the keypad and LCD, first check that the ‘Comms. settings’ cell in the ‘Configuration’ column is set to ‘Visible’, then move to the ‘Communications’ column. The first cell down the column shows the communication protocol being used by the rear port.

2.2 EIA(RS)485 bus

The EIA(RS)485 two-wire connection provides a half-duplex fully isolated serial connection to the product. The connection is polarized and while the product’s connection diagrams indicate the polarization of the connection terminals, there is no agreed definition of which terminal is which. If the master is unable to communicate with the product, and the communication parameters match, then it is possible that the two-wire connection is reversed.

2.2.1 Bus termination

The EIA(RS)485 bus must have 120Ω (Ohm) ½ Watt terminating resistors fitted at either end across the signal wires – see Figure 1. Some devices may be able to provide the bus terminating resistors by different connection or configuration arrangements, in which case separate external components are not required. However, this product does not provide such a facility, so if it is located at the bus terminus then an external termination resistor is required.

2.2.2 Bus connections & topologies

The EIA(RS)485 standard requires that each device be directly connected to the physical cable that is the communications bus. Stubs and tees are expressly forbidden, as are star topologies. Loop bus topologies are not part of the EIA(RS)485 standard and are forbidden by it.

Two-core screened cable is recommended. The specification of the cable is dependent on the application, although a multi-strand 0.5mm^2 per core is normally adequate. Total cable length must not exceed 1000m. The screen must be continuous and connected to ground at one end, normally at the master connection point. It is important to avoid circulating currents, especially when the cable runs between buildings, for both safety and noise reasons.

This product does not provide a signal ground connection. If a signal ground connection is present in the bus cable then it must be ignored, although it must have continuity for the benefit of other devices connected to the bus. At no stage must the signal ground be connected to the cables screen or to the product’s chassis. This is for both safety and noise reasons.

2.2.3 Biasing

It may also be necessary to bias the signal wires to prevent jabber. Jabber occurs when the signal level has an indeterminate state because the bus is not being actively driven. This can occur when all the slaves are in receive mode and the master is slow to turn from receive mode to transmit mode. This may be because the master purposefully waits in receive mode, or even in a high impedance state, until it has something to transmit. Jabber causes the receiving device(s) to miss the first bits of the first character in the packet, which results in the slave rejecting the message and consequentially not responding. Symptoms of this are poor response times (due to retries), increasing message error counters, erratic communications, and even a complete failure to communicate.

Biasing requires that the signal lines be weakly pulled to a defined voltage level of about 1V. There should only be one bias point on the bus, which is best situated at the master connection point. The DC source used for the bias must be clean; otherwise noise will be injected.

Note: Some devices may (optionally) be able to provide the bus bias, in which case external components will not be required.

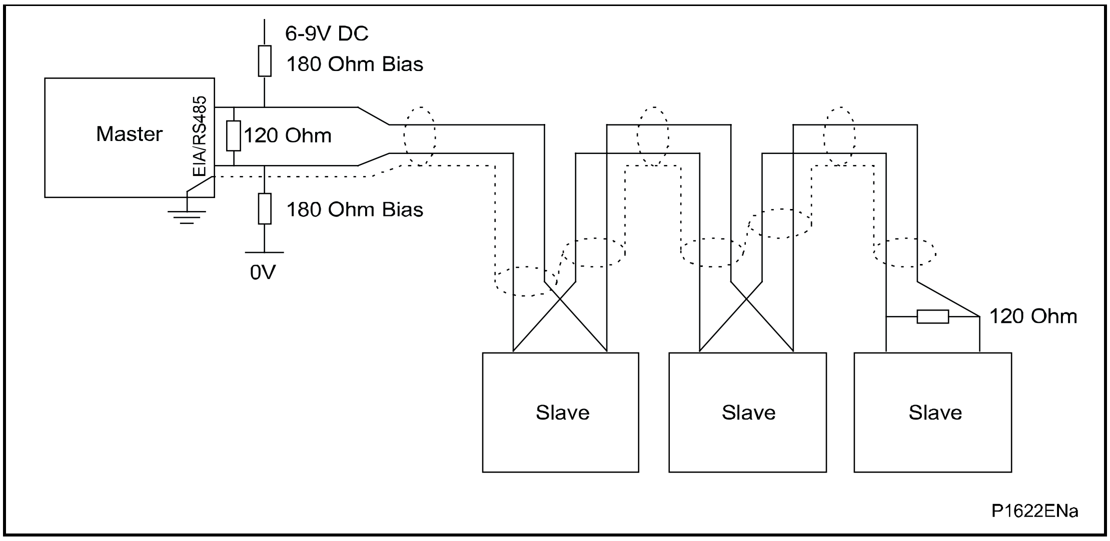

Figure 1: EIA(RS)485 bus connection arrangements

It is possible to use the products field voltage output (48V DC) to bias the bus using values of 2.2kΩ (½W) as bias resistors instead of the 180Ω resistors shown in the above diagram.

The following warnings apply:

- It is extremely important that the 120Ω termination resistors are fitted. Failure to do so will result in an excessive bias voltage that may damage the devices connected to the bus.
- As the field voltage is much higher than that required, General Electric cannot assume responsibility for any damage that may occur to a device connected to the network as a result of incorrect application of this voltage.
- Ensure that the field voltage is not being used for other purposes, such as powering logic inputs, because noise may be passed to the communication network.

2.2.4 Courier communication

Courier works on a master/slave basis where the slave units contain information in the form of a database, and respond with information from the database when it is requested by a master unit.

The relay is a slave unit that is designed to be used with a Courier master unit such as S1 Agile, MiCOM S10, PAS&T or a SCADA system.

To use the rear port to communicate with a PC-based master station using Courier, a KITZ K-Bus to EIA(RS)232 protocol converter is required. This unit is available from General Electric. A typical connection arrangement is shown in Figure 2. For more detailed information on other possible connection arrangements refer to the manual for the Courier master station software and the manual for the KITZ protocol converter. Each spur of the K-Bus twisted pair wiring can be up to 1000m in length and have up to 32 relays connected to it.

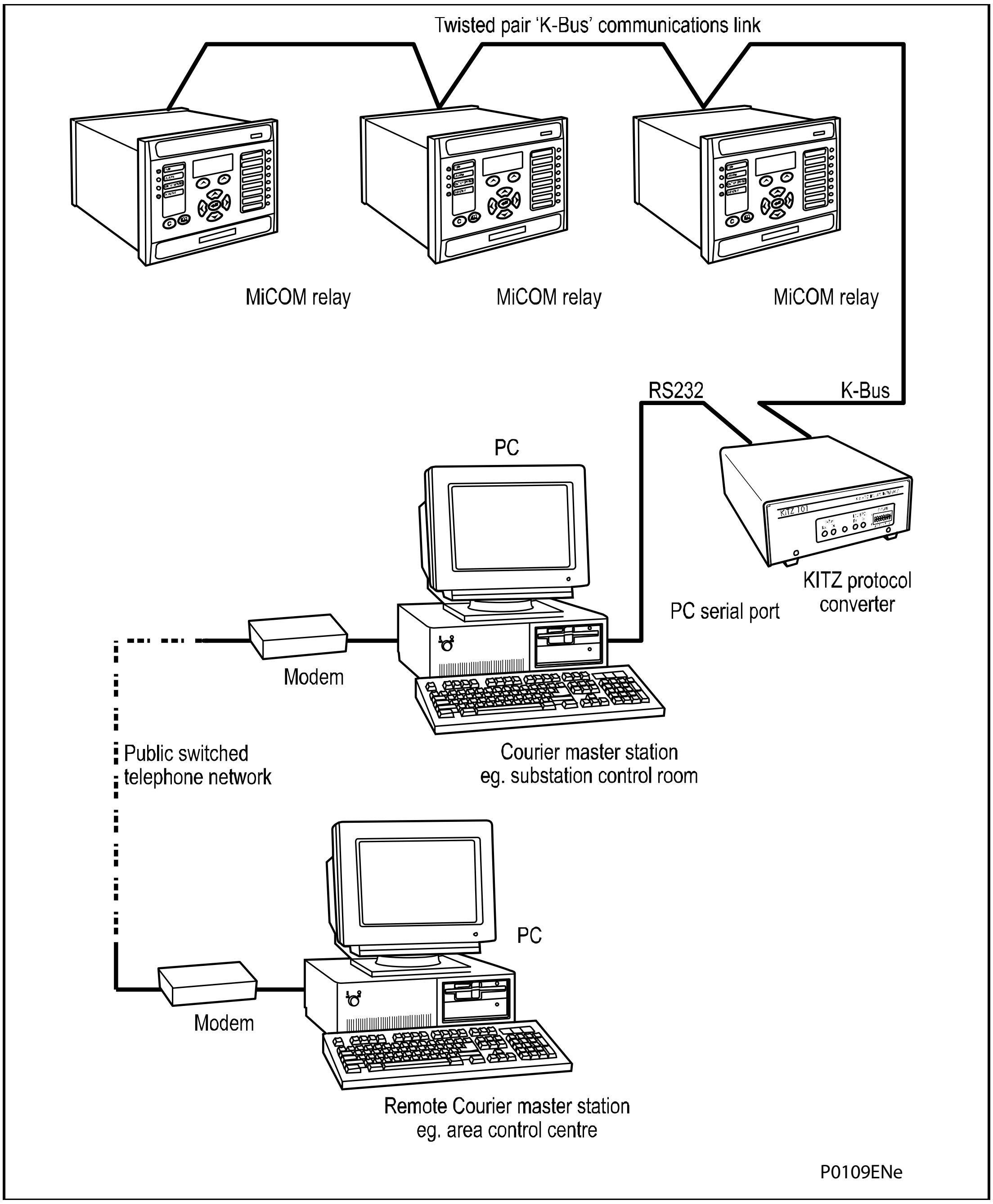

Figure 2: Remote communication connection arrangements

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Once the physical connection is made to the relay, configure the relay's communication settings to the keypad and LCD user interface.

In the relay menu, select the 'Configuration' column, then check the 'Comms. settings' cell is set to 'Visible'.

Select the 'Communications' column. Only two settings apply to the rear port using Courier, the relay's address and the inactivity timer. Synchronous communication is used at a fixed baud rate of 64kbits/s.

Move down the 'Communications' column from the column heading to the first cell down which indicates the communication protocol:

Protocol Courier

The next cell down the column controls the address of the relay:

Remote address 1

Since up to 32 relays can be connected to one K-bus spur, as indicated in Figure 2, each relay must have a unique address so that messages from the master control station are accepted by one relay only. Courier uses an integer number between 0 and 254 for the relay address, which is set with this cell. It is important that no two relays have the same Courier address. The Courier address is then used by the master station to communicate with the relay. Default value of remote address is 255 and must be changed to a value in the range of 1 to 254 before use.

The next cell down controls the inactivity timer:

Inactivity timer 10.00 mins.

The inactivity timer controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes.

Protection and disturbance recorder settings that are modified using an on-line editor such as PAS&T must be confirmed with a write to the 'Save changes' cell of the 'Configuration' column. Off-line editors such as S1 Agile do not require this action for the setting changes to take effect.

2.2.5 IEC60870-5 CS 103 communication

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The IEC specification IEC60870-5-103: Telecontrol Equipment and Systems, Part 5: Transmission Protocols Section 103 defines the use of standards IEC60870-5-1 to IEC60870-5-5 to perform communication with protection equipment. The standard configuration for the IEC60870-5-103 protocol is to use a twisted pair EIA(RS)485 connection over distances up to 1000m. The relay operates as a slave in the system, responding to commands from a master station.

To use the rear port with IEC60870-5-103 communication, configure the relay's communication settings using the keypad and LCD user interface.

1. In the relay menu, select the 'Configuration' column, then check the 'Comms. settings' cell is set to 'Visible',
2. Select the 'Communications' column. Four settings apply to the rear port using IEC60870-5-103 that are described below.
3. Move down the 'Communications' column from the column heading to the first cell that indicates the communication protocol:

Protocol IEC60870-5-103

4. The next cell down controls the IEC60870-5-103 address of the relay:

Remote address 162

Up to 32 relays can be connected to one IEC60870-5-103 spur, and therefore it is necessary for each relay to have a unique address so that messages from the master control station are accepted by one relay only. IEC60870-5-103 uses an integer number between 0 and 254 for the relay address. It is important that no two relays have the same IEC60870-5-103 address. The IEC60870-5-103 address is then used by the master station to communicate with the relay.

5. The next cell down the column controls the baud rate to be used:

Baud rate 9600 bits/s

IEC60870-5-103 communication is asynchronous. Two baud rates are supported by the relay, '9600 bits/s' and '19200 bits/s'. It is important that whatever baud rate is selected on the relay is the same as that set on the IEC60870-5-103 master station.

6. The next cell down controls the period between IEC60870-5-103 measurements:

Measure't. period 30.00 s

The IEC60870-5-103 protocol allows the relay to supply measurements at regular intervals. The interval between measurements is controlled by this cell and can be set between 1 and 60 seconds.

7. The following cell is not currently used but is available for future expansion

Inactive timer

8. The next cell down can be used for monitor or command blocking:

CS103 blocking

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There are three settings associated with this cell, these are:

- Disabled - No blocking selected.
- Monitor Blocking - When the monitor blocking DDB Signal is active high, either by energizing an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the relay returns a "Termination of general interrogation" message to the master station.
- Command Blocking - When the command blocking DDB signal is active high, either by energizing an opto input or control input, all remote commands will be ignored (i.e. CB Trip/Close, change setting group etc.). When in this mode the relay returns a "negative acknowledgement of command" message to the master station.

2.2.6 Fiber optic converter

An optional fiber optic card is available in this product. This converts the EIA(RS)485 protocols into a fiber optic output. This communication card is available for use on Courier and IEC60870-5-103 and it adds the following setting to the communication column.

This controls the physical media used for the communication:

Physical link Copper

The default setting is to select the electrical EIA(RS)485 connection. If the optional fiber optic connectors are fitted to the relay, then this setting can be changed to ‘Fiber optic’. This cell is also invisible if a second rear comms. port, or Ethernet card is fitted, as it is mutually exclusive with the fiber optic connectors, and occupies the same physical location.

3. COURIER INTERFACE

3.1 Courier protocol

K-Bus is based on EIA(RS)485 voltage levels with HDLC FM0 encoded synchronous signaling and its own frame format. The K-Bus twisted pair connection is unpolarized, whereas the EIA(RS)485 and EIA(RS)232 interfaces are polarized.

The EIA(RS)232 interface uses the IEC60870-5 FT1.2 frame format.

The relay supports an IEC60870-5 FT1.2 connection on the front-port. This is intended for temporary local connection and is not suitable for permanent connection. This interface uses a fixed baud rate, 11-bit frame, and a fixed device address.

The rear interface is used to provide a permanent connection for K-Bus and allows multi-drop connection. It should be noted that although K-Bus is based on EIA(RS)485 voltage levels it is a synchronous HDLC protocol using FM0 encoding. It is not possible to use a standard EIA(RS)232 to EIA(RS)485 converter to convert IEC60870-5 FT1.2 frames to K-Bus. Nor is it possible to connect K-Bus to an EIA(RS)485 computer port. A protocol converter, such as the KITZ101, should be employed for this purpose.

Alternatively, for direct connections, the fiber optic converter card may be used to convert the rear EIA(RS)485 port into a fiber optic (ST) port. See section 1.3 for more information.

3.2 Supported command set

The following Courier commands are supported by the relay:

Protocol Layer

- Reset Remote Link
- Poll Status
- Poll Buffer*

Low Level Commands

- Send Event*
- Accept Event*
- Send Block
- Store Block Identifier
- Store Block Footer

Menu Browsing

- Get Column Headings
- Get Column Text
- Get Column Values
- Get Strings
- Get Text
- Get Value
- Get Column Setting Limits

Setting Changes

- Enter Setting Mode
- Preload Setting
- Abort Setting

Execute Setting

Reset Menu Cell

Set Value

Control Commands

Select Setting Group

Change Device Address*

Set Real Time

Note: Commands indicated with a * are not supported via the front Courier port.

3.3 Relay courier database

The Courier database is a two dimensional structure with each cell in the database being referenced by a row and column address. Both the column and the row can take a range from 0 to 255. Addresses in the database are specified as hexadecimal values; e.g. 0A02 is column 0A (10 decimal) row 02. Associated settings/data will be part of the same column, row zero of the column contains a text string to identify the contents of the column, i.e. a column heading.

P842/EN MD contains the complete database definition for the relay. For each cell location the following information is stated:

- Cell text
- Cell datatype
- Cell value
- Whether the cell is settable, if so
- Minimum value
- Maximum value
- Step size
- Password level required to allow setting changes
- String information (for Indexed String or Binary flag cells)

3.4 Setting changes

(See R6512, Courier User Guide - Chapter 9)

There are three categories of settings within the relay database:

- Control and support
- Disturbance recorder
- Protection settings group

Setting changes made to the control and support settings are implemented immediately and stored in non-volatile memory. Changes made to either the disturbance recorder settings or the protection settings groups are stored in a 'scratchpad' memory and are not immediately implemented by the relay.

To action setting changes stored in the scratchpad the save changes cell in the configuration column must be written to. This allows the changes to either be confirmed and stored in non-volatile memory, or the setting changes to be aborted.

3.4.1 Setting transfer mode

If you need to transfer all of the relay settings to or from the relay, use a cell within the communication system data column. When set to 1 this cell (location BF03) makes all of the relay settings visible. Any setting changes made, with the relay set in this mode, are stored in scratchpad memory (including control and support settings). When the value of BF03 is set back to 0 any setting changes are verified and stored in non-volatile memory.

3.5 Event extraction

Events can be extracted either automatically (rear port only) or manually (either Courier port). For automatic extraction all events are extracted in sequential order using the standard Courier event mechanism, this includes fault/maintenance data if appropriate. The manual approach allows the user to select events, faults, or maintenance data at random from the stored records.

3.5.1 Automatic event extraction

(See chapter 7 Courier User Guide, publication R6512)

This method is intended for continuous extraction of event and fault information as it is produced. It is only supported through the rear Courier port.

When new event information is created the event bit is set within the status byte, this indicates to the master device that event information is available. The oldest, unextracted event can be extracted from the relay using the send event command. The relay will respond with the event data, which will be either a Courier Type 0 or Type 3 event. The Type 3 event is used for fault records and maintenance records.

Once an event has been extracted from the relay, the accept event can be used to confirm that the event has been successfully extracted. If all events have been extracted then the event bit will reset, if there are more events still to be extracted the next event can be accessed using the send event command as before.

3.5.2 Event types

Events will be created by the relay under the following circumstances:

- Change of state of output contact
- Change of state of opto input
- Protection element operation
- Alarm condition
- Setting change
- Password entered/timed-out
- Maintenance record (Type 3 Courier Event)

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3.5.3 Event format

The send event command results in the following fields being returned by the relay:

- Cell reference
- Timestamp
- Cell text
- Cell value

The menu database, P842/EN MD, contains a table of the events created by the relay and indicates how the contents of the above fields are interpreted. Fault records and maintenance records will return a Courier Type 3 event, which contains the above fields together with two additional fields:

- Event extraction column

- Event number

These events contain additional information that is extracted from the relay using the referenced extraction column. Row 01 of the extraction column contains a setting that allows the fault/maintenance record to be selected. This setting should be set to the event number value returned within the record; the extended data can be extracted from the relay by uploading the text and data from the column.

3.5.4 Manual event record extraction

Column 01 of the database can be used for manual viewing of event, fault, and maintenance records. The contents of this column will depend on the nature of the record selected. It is possible to select events by event number and to directly select a fault record or maintenance record by number.

Event Record Selection (Row 01) - This cell can be set to a value between 0 to 249 to select which of the 512 stored events is selected, 0 will select the most recent record; 249 the oldest stored record. For simple event records, (Type 0) cells 0102 to 0105 contain the event details. A single cell is used to represent each of the event fields. If the event selected is a fault or maintenance record (Type 3) then the remainder of the column will contain the additional information.

Maintenance Record Selection (Row F0) – This cell can be used to select a maintenance record using a value between 0 and 4 and operates in a similar way to the fault record selection.

Note: If this column is used to extract event information from the relay the number associated with a particular record will change when a new event or fault occurs.

3.6 Disturbance record extraction

Select Record Number (Row 01) - This cell can be used to select the record to be extracted. Record 0 will be the oldest unextracted record, already extracted older records will be assigned positive values, and negative values will be used for more recent records. To facilitate automatic extraction via the rear port the disturbance bit of the status byte is set by the relay whenever there are unextracted disturbance records.

Once a record has been selected, using the above cell, the time and date of the record can be read from cell 02. The disturbance record itself can be extracted using the block transfer mechanism from cell B00B.

As has been stated, the rear Courier port can be used to automatically extract disturbance records as they occur. This operates using the standard Courier mechanism defined in chapter 8 of the Courier User Guide. The front Courier port does not support automatic extraction although disturbance record data can be extracted manually from this port.

3.7 Programmable scheme logic settings

The programmable scheme logic (PSL) settings can be uploaded from and downloaded to the relay using the block transfer mechanism defined in chapter 12 of the Courier User Guide.

The following cells are used to perform the extraction:

- B204 Domain/: Used to select either PSL settings (Upload or download) or PSL configuration data (Upload only)
- B208 Sub-Domain: Used to select the Protection Setting Group to be uploaded/downloaded.
- B20C Version: Used on a download to check the compatibility of the file to be downloaded with the relay.
- B21C Transfer Mode: Used to set-up the transfer process.
- B120 Data Transfer Cell: Used to perform upload/download.

The programmable scheme logic settings can be uploaded and downloaded to and from the relay using this mechanism. If it is necessary to edit the settings S1 Agile must be used as the data format is compressed. S1 Agile also performs checks on the validity of the settings before they are downloaded to the relay.

4. IEC60870-5-103 INTERFACE

The IEC60870-5-103 interface is a master/slave interface with the relay as the slave device. The relay conforms to compatibility level 2; compatibility level 3 is not supported.

The following IEC60870-5-103 facilities are supported by this interface:

- Initialization (reset)
- Time synchronization
- Event record extraction
- General interrogation
- Cyclic measurements
- General commands
- Disturbance record extraction
- Private codes

4.1 Physical connection and link layer

Two connection options are available for IEC60870-5-103, either the rear EIA(RS)485 port or an optional rear fiber optic port. Should the fiber optic port be fitted the selection of the active port can be made via the front panel menu or the front Courier port, however the selection will only be effective following the next relay power up.

For either of the two modes of connection it is possible to select both the relay address and baud rate using the front panel menu/front Courier. Following a change to either of these two settings a reset command is required to re-establish communications, see reset command description below.

4.2 Initialization

When the relay has been powered up, or if the communication parameters have been changed a reset command is required to initialize the communications. The relay will respond to either of the two reset commands (Reset CU or Reset FCB), the difference being that the Reset CU will clear any unsent messages in the relay's transmit buffer.

The relay will respond to the reset command with an identification message ASDU 5, the Cause Of Transmission COT of this response will be either Reset CU or Reset FCB depending on the nature of the reset command. The content of ASDU 5 is described in the IEC60870-5-103 section of the menu database, P842/EN MD.

In addition to the above identification message, if the relay has been powered up it will also produce a power up event.

4.3 Time synchronization

The relay time and date can be set using the time synchronization feature of the IEC60870-5-103 protocol. The relay will correct for the transmission delay as specified in IEC60870-5-103. If the time synchronization message is sent as a send/confirm message then the relay will respond with a confirm. Whether the time-synchronization message is sent as a send confirm or a broadcast (send/no reply) message, a time synchronization Class 1 event will be generated/produced.

If the relay clock is being synchronized using the IRIG-B input then it will not be possible to set the relay time using the IEC60870-5-103 interface. An attempt to set the time via the interface will cause the relay to create an event with the current date and time taken from the IRIG-B synchronized internal clock.

4.4 Spontaneous events

Events are categorized using the following information:

- Function type
- Information number

The IEC60870-5-103 profile in the menu database, P842/EN MD, contains a complete listing of all events produced by the relay.

4.5 General interrogation

The GI request can be used to read the status of the relay, the function numbers, and information numbers that will be returned during the GI cycle are indicated in the IEC60870-5-103 profile in the menu database, P842/EN MD.

4.6 Cyclic measurements

The relay will produce measured values using ASDU 9 on a cyclical basis, this can be read from the relay using a Class 2 poll (note ADSU 3 is not used). The rate at which the relay produces new measured values can be controlled using the measurement period setting. This setting can be edited from the front panel menu/front Courier port and is active immediately following a change.

Note: Measurands transmitted by the relay are sent as a proportion of 2.4 times the rated value of the analog value.

4.7 Commands

A list of the supported commands is contained in the menu database, P842/EN MD. The relay will respond to other commands with an ASDU 1, with a cause of transmission (COT) indicating ‘negative acknowledgement’.

4.8 Test mode

It is possible using either the front panel menu or the front Courier port to disable the relay output contacts to allow secondary injection testing to be performed. This is interpreted as ‘test mode’ by the IEC60870-5-103 standard. An event will be produced to indicate both entry to and exit from test mode. Spontaneous events and cyclic measured data transmitted whilst the relay is in test mode will have a COT of ‘test mode’.

4.9 Disturbance records

The disturbance records are stored in uncompressed format and can be extracted using the standard mechanisms described in IEC60870-5-103.

Note: IEC60870-5-103 only supports up to 8 records.

4.10 Blocking of monitor direction

The relay supports a facility to block messages in the monitor direction and also in the command direction. Messages can be blocked in the monitor and command directions using the menu commands, Communications – CS103 Blocking – Disabled/Monitor Blocking/Command Blocking or DDB signals Monitor Blocked and Command Blocked.

SYMBOLS AND GLOSSARY

Date: **2019**
Hardware Suffix: **B**
Software Version: **04**

SG

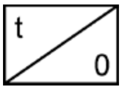
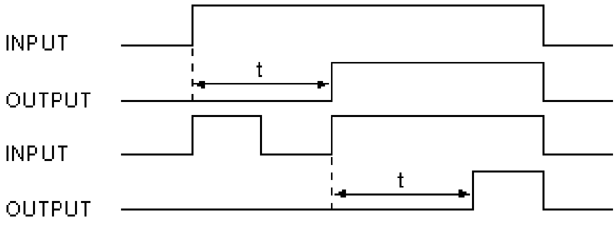
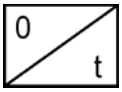
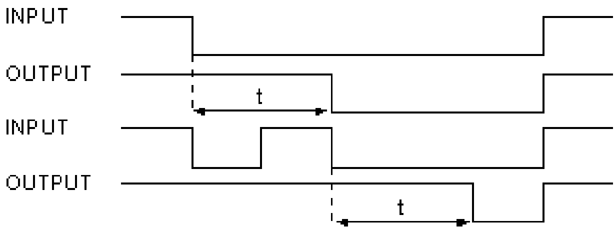
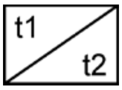
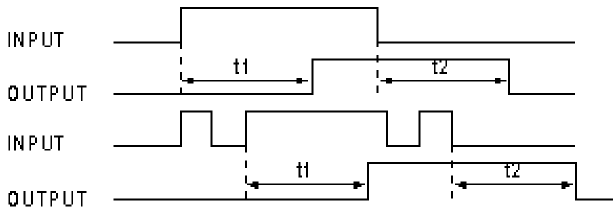
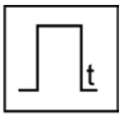
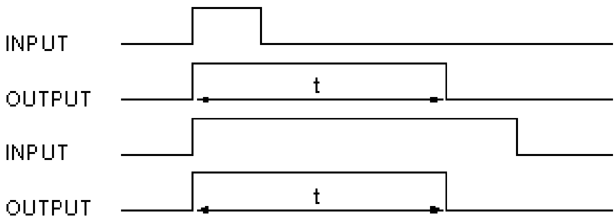
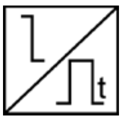
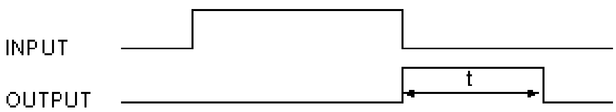
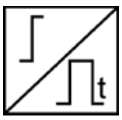
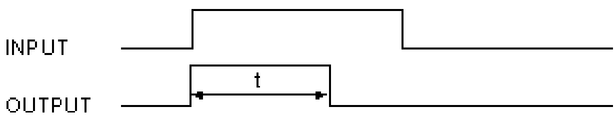
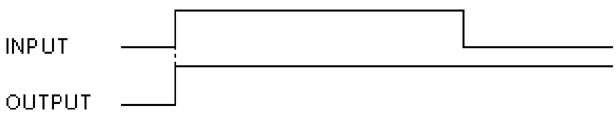
Logic Symbols

Symbols	Explanation
<	**Less than:** Used to indicate an “under” threshold, such as undercurrent (current dropout).
>	**Greater than:** Used to indicate an “over” threshold, such as overcurrent (current overload).
&	**Logical “AND”:** Used in logic diagrams to show an AND-gate function.
1	**Logical “OR”:** Used in logic diagrams to show an OR-gate function.
o	**A small circle on the input or output of a logic gate:** Indicates a NOT (invert) function.
52a	**A circuit breaker closed auxiliary contact:** The contact is in the same state as the breaker primary contacts.
52b	**A circuit breaker open auxiliary contact:** The contact is in the opposite state to the breaker primary contacts.
A/S	**Autoswitching**
C/O	**A changeover contact having normally closed and normally open connections:** Often called a “form C” contact.
CB	Circuit breaker
CB Aux.	**Circuit breaker auxiliary contacts:** Indication of the breaker open/closed status.
CBF	Circuit breaker failure protection.
CS	Check synchronism.
CT	Current transformer.
CTRL.	**Abbreviation of “Control”:** As used for the Control Inputs function.
DAR	**Delayed Autoreclose**
DDB	**Digital data bus within the programmable scheme logic:** A logic point that has a zero or 1 status. DDB signals are mapped in logic to customize the relay’s operation.
Dly	Time delay.
F1	**Ferroresonance alarm scheme**
F3	**Ferroresonance suppression scheme**
FR	**Ferroresonance**
Flt.	**Abbreviation of “Fault”:** Typically used to indicate faulted phase selection.
FN	Function.
Gnd.	**Abbreviation of “Ground”**
GOOSE	**Generic Object Orientated Sub-Station Event**
GRP.	**Abbreviation of “Group”:** Typically an alternative setting group.

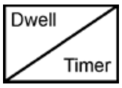
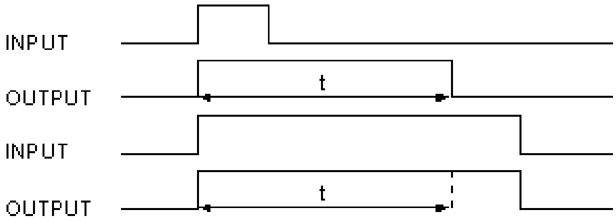
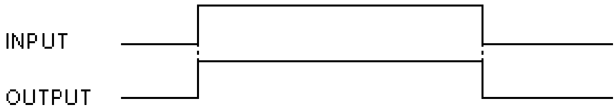
Symbols	Explanation
HV	**High Voltage**
I	**Current.**
ID	**Abbreviation of “Identifier”:** Often a label used to track a software version installed.
In	**The rated nominal current of the relay:** Software selectable as 1 amp or 5 amp to match the line CT input.
Inh	**An inhibit signal**
I/O	**Abbreviation of “Inputs and Outputs”:** Used in connection with the number of optocoupled inputs and output contacts within the relay.
I/P	**Abbreviation of “Input”.**
I/T	**Intertrip**
LCD	**Liquid crystal display:** The front-panel text display on the relay.
Lck	**Lockout**
LD	**Abbreviation of “Level Detector”:** An element responding to a current or voltage below its set threshold.
LED	**Light emitting diode:** Red or green indicator on the relay front-panel.
LV	**Low Voltage**
MCU	**Mesh Corner Unit**
N/A	Not applicable.
N/C	**A normally closed or “break” contact:** Often called a “form B” contact.
N/O	**A normally open or “make” contact:** Often called a “form A” contact.
O/P	**Abbreviation of “output”.**
Opto	**An optocoupled logic input:** Alternative terminology: binary input.
P1	**Used in IEC terminology to identify the primary CT terminal polarity:** Replace by a dot when using ANSI standards.
P2	**Used in IEC terminology to identify the primary CT terminal polarity:** The non-dot terminal.
PCB	**Printed circuit board.**
Ph	**Abbreviation of “Phase”:** Used in distance settings to identify settings that relate to phase-phase faults.
PSL	**Programmable scheme logic:** The part of the relay’s logic configuration that can be modified by the user, using the graphical editor within MiCOM S1 Agile software.
RMS	**The equivalent a.c. voltage:** Taking into account the fundamental, plus the equivalent heating effect of any harmonics. Abbreviation of “root mean square”.
RP	**Abbreviation of “Rear Port”:**

Symbols	Explanation
	The communication ports on the rear of the relay.
Rx	**Abbreviation of "Receive":** Typically used to indicate a communication receive line/pin.
S1	**Used in IEC terminology to identify the secondary CT terminal polarity:** Replace by a dot when using ANSI standards.
S2	**Used in IEC terminology to identify the secondary CT terminal polarity:** The non-dot terminal.
SS	**System Split**
t	**A time delay.**
TE	**A standard for measuring the width of a relay case:** One inch = 5TE units.
TR	**Transformer**
Tfr	**Transformer**
Tx	**Abbreviation of "Transmit":** Typically used to indicate a communication transmit line/pin.
V	**Voltage.**
Vn	**The rated nominal voltage of the relay:** To match the line VT input.
VT	Voltage transformer.
Vx	**An auxiliary supply voltage:** Typically the substation battery voltage used to power the relay.

Logic Timers

Logic Symbols	Explanation	Time Chart
	Delay on pick-up timer, t	
	Delay on drop-off timer, t	
	Delay on pick-up/drop-off timer	
	Pulse timer	
	Pulse pick-up falling edge	
	Pulse pick-up raising edge	
Latching	Latch	

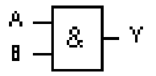
SG

Logic Symbols	Explanation	Time Chart
	Dwell timer	
	**Straight (non latching):** Hold value until input reset signal	

Logic Gates

AND GATE

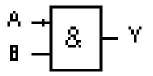
Symbol



Truth Table

IN		OUT
0	1	0
0	1	0
0	1	0
1	0	0
1	1	1

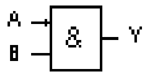
Symbol



Truth Table

IN		OUT
A	B	Y
0	0	0
0	1	1
1	0	0
1	1	0

Symbol

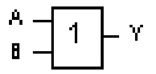


Truth Table

IN		OUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

OR GATE

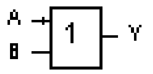
Symbol



Truth Table

IN		OUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

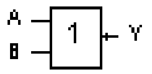
Symbol



Truth Table

IN		OUT
A	B	Y
0	0	1
0	1	1
1	0	0
1	1	1

Symbol

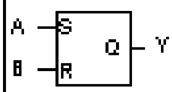


Truth Table

IN		OUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

R - S FLIP-FLOP

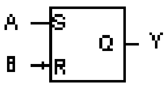
Symbol



Truth Table

A	B	QN	QN+	Active Mode
0	0			Hold Mode
0	1	0		Hold Mode
		1	0	Reset
1	0	0	1	Set
		1		Hold Mode
0	0	-	-	Inhibit Mode

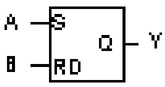
Symbol



Truth Table

A	B	QN	QN+	Active Mode
0	0	0		Hold Mode
		1	0	Reset
0	1			Hold Mode
1	0	-	-	Inhibit Mode
0	1	0	1	Set
		1		Hold Mode

Symbol



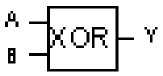
* RD = Reset Dominant

Truth Table

A	B	QN	QN+	Active Mode
0	0			Hold Mode
0	1			0
1	0	0	1	Set
		1		Hold Mode
1	1			0

EXCLUSIVE OR GATE

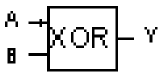
Symbol



Truth Table

IN		OUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

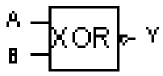
Symbol



Truth Table

IN		OUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Symbol

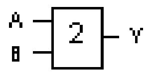


Truth Table

IN		OUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

MULTI INPUT GATE

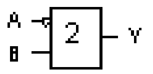
Symbol



Truth Table

IN		OUT
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

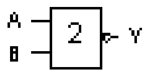
Symbol



Truth Table

IN		OUT
A	B	Y
0	0	0
0	1	1
1	0	0
1	1	0

Symbol

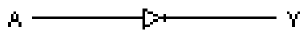


Truth Table

IN		OUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

NOT GATE

Symbol



Inverter (NOT)

Truth Table

IN	OUT
A	Y
0	1
1	0

SG

State Charts Glossary

SG

INSTALLATION

Date:	**2019**
Hardware Suffix:	**B**
Software Version:	**04**

IN

CONTENTS

FIGURES

IN

1. RECEIPT OF RELAYS

On receipt, relays should be examined immediately to ensure no external damage has been sustained in transit. If damage has been sustained, a claim should be made to the transport contractor and General Electric should be promptly notified.

Relays that are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags and delivery carton. Section 3 below gives more information about the storage of relays.

2. HANDLING OF ELECTRONIC EQUIPMENT

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semiconductor devices when handling electronic circuits can cause serious damage that, although not always immediately apparent, will reduce the reliability of the circuit. The relay's electronic circuits are protected from electrostatic discharge when housed in the case. Do not expose them to risk by removing the front panel or printed circuit boards unnecessarily.

Each printed circuit board incorporates the highest practicable protection for its semiconductor devices. However, if you need to remove a printed circuit board, the following precautions should be taken to preserve the high reliability and long life for which the relay has been designed and manufactured.

Before removing a printed circuit board, ensure that you are at the same electrostatic potential as the equipment by touching the case.

Handle analog input modules by the front panel, frame or edges of the circuit boards. Printed circuit boards should only be handled by their edges. Avoid touching the electronic components, printed circuit tracks or connectors.

Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.

Place the module on an anti-static surface, or on a conducting surface that is at the same potential as yourself.

If you need to store or transport printed circuit boards removed from the case, place them individually in electrically conducting anti-static bags.

In the unlikely event that you are making measurements on the internal electronic circuitry of a relay in service, it is preferable that you are earthed to the case with a conductive wrist strap. Wrist straps should have a resistance to ground between 500kΩ to 10MΩ. If a wrist strap is not available you should maintain regular contact with the case to prevent a build-up of electrostatic potential. Instrumentation which may be used for making measurements should also be earthed to the case whenever possible.

More information on safe working procedures for all electronic equipment can be found in BS EN 100015: Part 1:1992. It is strongly recommended that detailed investigations on electronic circuitry or modification work should be carried out in a special handling area such as described in the British Standard document.

3. STORAGE

If relays are not installed immediately on receipt, they should be stored in a place free from dust and moisture in their original cartons. Where de-humidifier bags have been included in the packing they should be retained.

To prevent battery drain during transportation and storage a battery isolation strip is fitted during manufacture. With the lower access cover open, presence of the battery isolation strip can be checked by a red tab protruding from the positive polarity side.

Care should be taken on subsequent unpacking that any dust, which has collected on the carton, does not fall inside. In locations of high humidity the carton and packing may become impregnated with moisture and the de-humidifier crystals will lose their efficiency.

Prior to installation, relays should be stored at a temperature of between –25˚C to +70˚C (-13˚F to +158˚F).

4. UNPACKING

Care must be taken when unpacking and installing the relays so that none of the parts are damaged and additional components are not accidentally left in the packing or lost. Ensure that any User’s CDROM or technical documentation is NOT discarded – this should accompany the relay to its destination substation.

Note: With the lower access cover open, the red tab of the battery isolation strip will be seen protruding from the positive (+) side of the battery compartment. Do not remove this strip because it prevents battery drain during transportation and storage and will be removed as part of the commissioning tests.

Relays must only be handled by skilled persons.

The site should be well lit to facilitate inspection, clean, dry and reasonably free from dust and excessive vibration.

5. RELAY MOUNTING

MiCOM relays are dispatched either individually or as part of a panel/rack assembly.

Individual relays are normally supplied with an outline diagram showing the dimensions for panel cutouts and hole centers. This information can also be found in the product publication.

Secondary front covers can also be supplied as an option item to prevent unauthorized changing of settings and alarm status. They are available in size 60TE (GN0038 001) for the P842, suitable to fit the 80TE case model.

The design of the relay is such that the fixing holes in the mounting flanges are only accessible when the access covers are open and hidden from sight when the covers are closed.

If a P991 or MMLG test block is included, it is recommended that when viewed from the front it is positioned on the right-hand side of the relay (or relays) with which it is associated. This minimizes the wiring between the relay and test block and allows the correct test block to be easily identified during commissioning and maintenance tests.

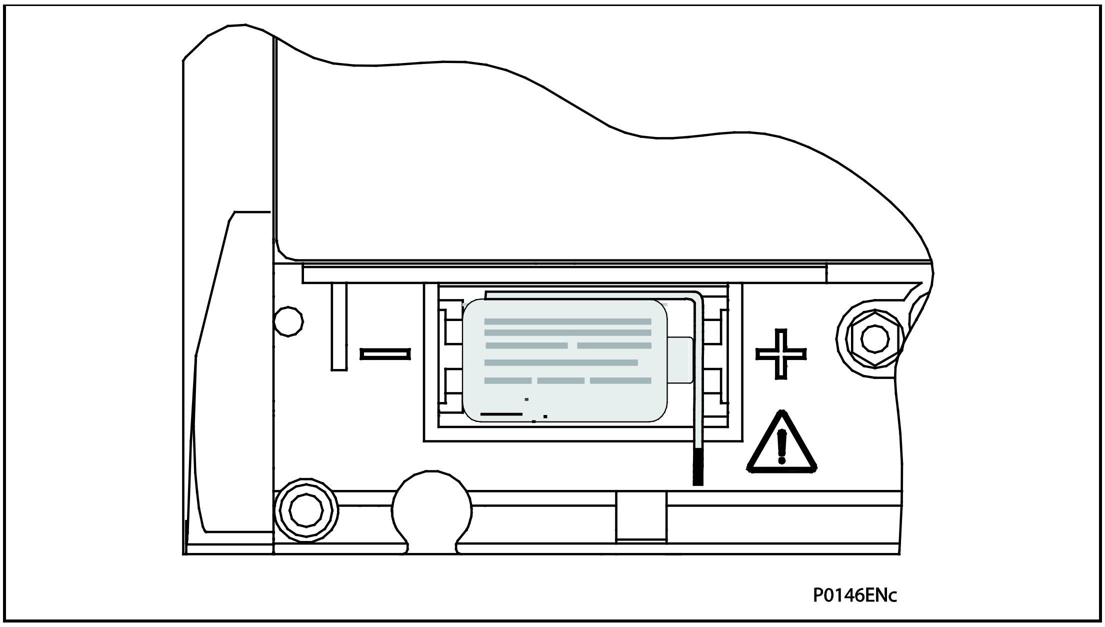


Figure 1: Location of battery isolation strip

If it is necessary to test correct relay operation during the installation, the battery isolation strip can be removed but it should be replaced if commissioning of the scheme is not imminent. The red tab of the isolation strip can be seen protruding from the positive side of the battery compartment when the lower access cover is open. To remove the isolation strip, pull the red tab while lightly pressing the battery to prevent it falling out of the compartment. When replacing the battery isolation strip, ensure that the strip is refitted as shown in Figure 1. For example, with the strip behind the battery with the red tab protruding.

5.1 Rack mounting

The P842 may be specifically-ordered for rack mounting. The model number must have a "B" selection as the 10th digit, example:

P842xxxxx**B**xxxxx

The relay case has mounting flanges factory-fitted, with dimensions in accordance with IEC60297, to fit directly into a standard 483mm (19") rack system. The relay occupies the full width of the rack, with a tier height of 177mm (4U, equivalent to 7").

5.2 Panel mounting

The P842 may be specifically-ordered for panel mounting. The model number must have an "A" selection as the 10th digit, example:

P842xxxxx**A**xxxxx

The relays can be flush mounted into panels using M4 SEMS Taptite self-tapping screws with captive 3mm thick washers (also known as a SEMS unit). These fastenings are available in packs of 5 (our part number ZA0005 104).

Note: Conventional self-tapping screws, including those supplied for mounting MIDOS relays, have marginally larger heads which can damage the front cover moulding if used.

Alternatively, tapped holes can be used if the panel has a minimum thickness of 2.5mm.

For applications where relays need to be semi-projection or projection mounted, a range of collars are available.

Where several relays are to be mounted in a single cut-out in the panel, it is advised that they are mechanically grouped together horizontally and/or vertically to form rigid assemblies prior to mounting in the panel.

Note: Do not fasten the relays using pop rivets as this will not allow the relay to be easily removed from the panel in the future if repair is necessary.

If it is required to mount a relay assembly on a panel complying to IEC 60529 IP52 enclosure protection, it will be necessary to fit a metallic sealing strip between adjoining relays (Part no GN2044 001) and a sealing ring around the complete assembly.

Width	Single tier	Double tier
80TE	GJ9018 016	GJ9018 032

6. RELAY WIRING

This section serves as a guide to selecting the appropriate cable and connector type for each terminal on the MiCOM relay.

6.1 Medium and heavy duty terminal block connections

Key:

Heavy duty terminal block: CT and VT circuits, terminals with “D” prefix

Medium duty: All other terminal blocks (grey color)

Loose relays are supplied with sufficient M4 screws for making connections to the rear mounted terminal blocks using ring terminals, with a recommended maximum of two ring terminals per relay terminal.

If required, General Electric can supply M4 90° crimp ring terminals in three different sizes depending on wire size (see table below). Each type is available in bags of 100.

Part Number	Wire Size	Insulation Colour
ZB9124 901	0.25 - 1.65mm^2 (22 - 16AWG)	Red
ZB9124 900	1.04 - 2.63mm^2 (16 - 14AWG)	Blue

*To maintain the terminal block insulation requirements for safety, an insulating sleeve should be fitted over the ring terminal after crimping.

The following minimum wire sizes are recommended:

Current Transformers 2.5mm^2

Auxiliary Supply, Vx 1.5mm^2

EIA(RS)485 Port See separate section

Other Circuits 1.0mm^2

Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium or heavy duty terminals is 6.0mm^2 using ring terminals that are not pre-insulated. Where it is required to only use pre-insulated ring terminals, the maximum wire size that can be used is reduced to 2.63mm^2 per ring terminal. If a larger wire size is required, two wires should be used in parallel, each terminated in a separate ring terminal at the relay.

The wire used for all connections to the medium and heavy duty terminal blocks, except the EIA(RS)485 port, should have a minimum voltage rating of 300Vrms.

It is recommended that the auxiliary supply wiring should be protected by a 16A high rupture capacity (HRC) fuse of type NIT or TIA. For safety reasons, current transformer circuits must never be fused. Other circuits should be appropriately fused to protect the wire used.

6.2 EIA(RS)485 port

Connections to the EIA(RS)485 port are made using ring terminals. It is recommended that a 2-core screened cable be used with a maximum total length of 1000m or 200nF total cable capacitance. A typical cable specification would be:

Each core:	16/0.2mm copper conductors
	PVC insulated
Nominal conductor area:	0.5mm^2 per core
Screen:	Overall braid, PVC sheathed

6.3 IRIG-B connections (currently not available in P842)

The IRIG-B input and BNC connector have a characteristic impedance of 50Ω. It is recommended that connections between the IRIG-B equipment and the relay are made using coaxial cable of type RG59LSF with a halogen free, fire retardant sheath.

6.4 EIA(RS)232 front port

Short term connections to the EIA(RS)485 port, located behind the bottom access cover, can be made using a screened multi-core communication cable up to 15m long, or a total capacitance of 2500pF. The cable should be terminated at the relay end with a 9-way, metal shelled, D-type male plug. See section 3.7 in the Introduction chapter, for details on pin allocations.

6.5 Download/monitor port

Short term connections to the download/monitor port, located behind the bottom access cover, can be made using a screened 25-core communication cable up to 4m long. The cable should be terminated at the relay end with a 25-way, metal shelled, D-type male plug. See section 3.7 in the Introduction chapter, for details on pin allocations.

6.6 Earth connection

Every relay must be connected to the cubicle earth bar using the M4 earth studs in the bottom left hand corner of the relay case. The minimum recommended wire size is 2.5mm^2 and should have a ring terminal at the relay end.

To prevent any possibility of electrolytic action between brass or copper earth conductors and the rear of the relay, precautions should be taken. Examples include placing a nickel-plated washer between the conductor and the relay case or using tinned ring terminals.

7. P842 CASE DIMENSIONS

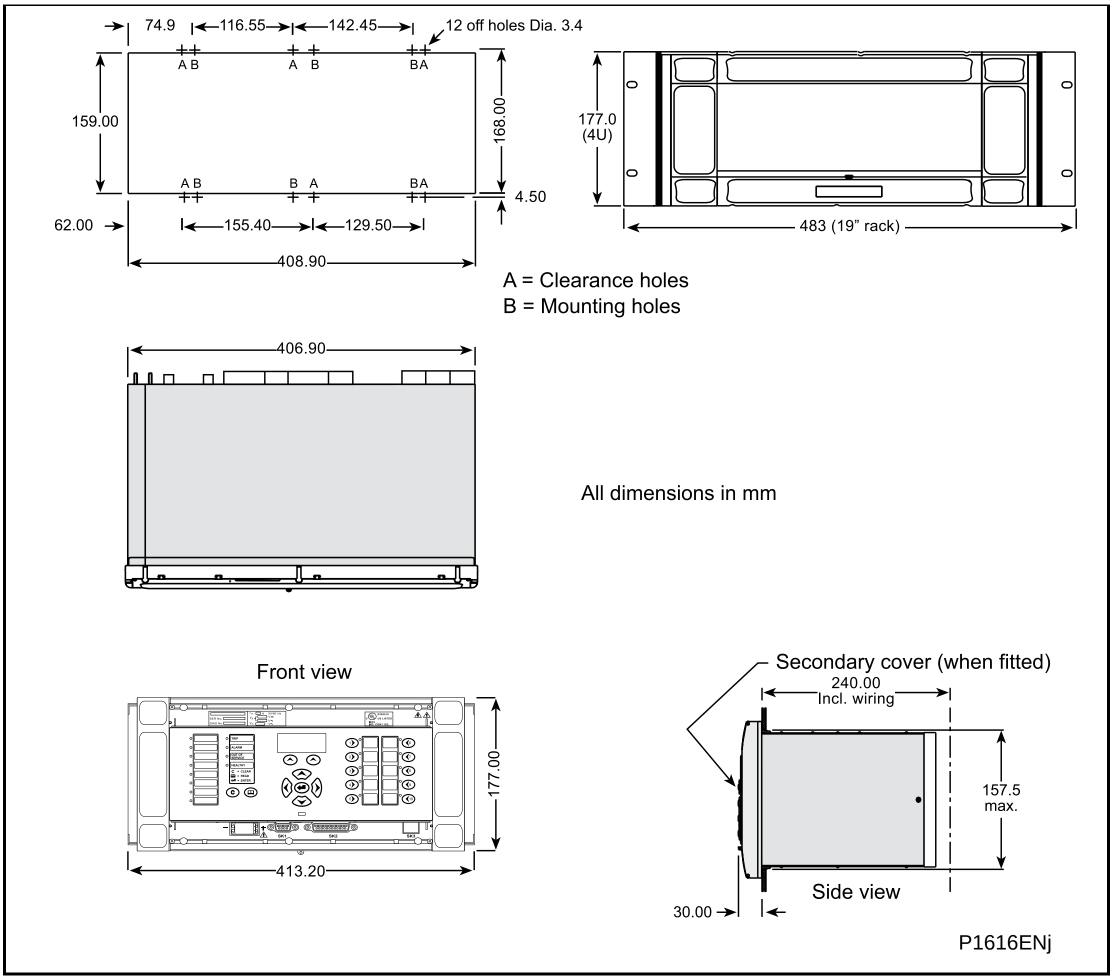


Figure 2: Case dimensions – 80TE case

8. P842 ETHERNET BOARD CONNECTION DIAGRAM

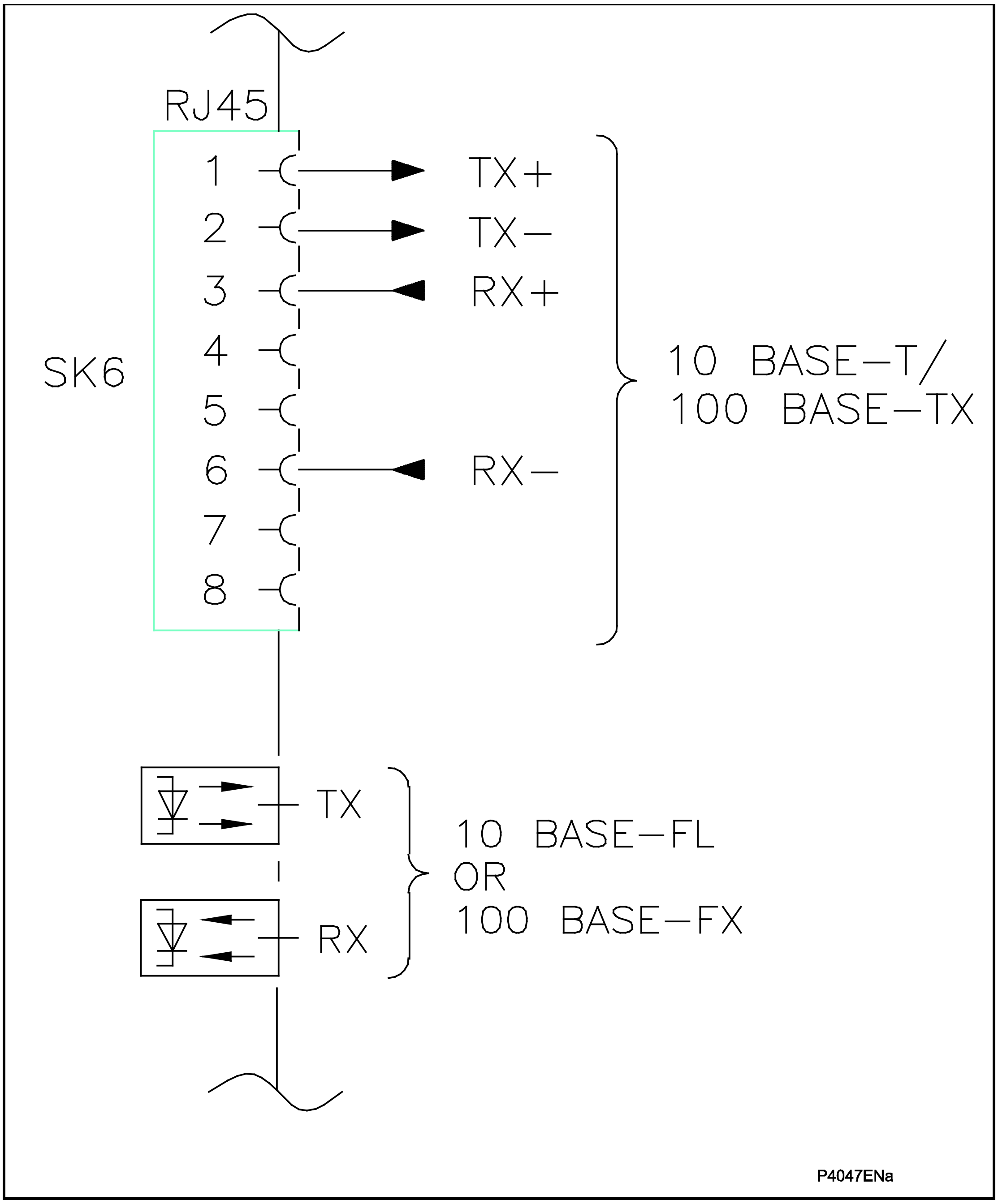


Figure 3: P842 Ethernet board connections

P842 EXTERNAL CONNECTION DIAGRAM

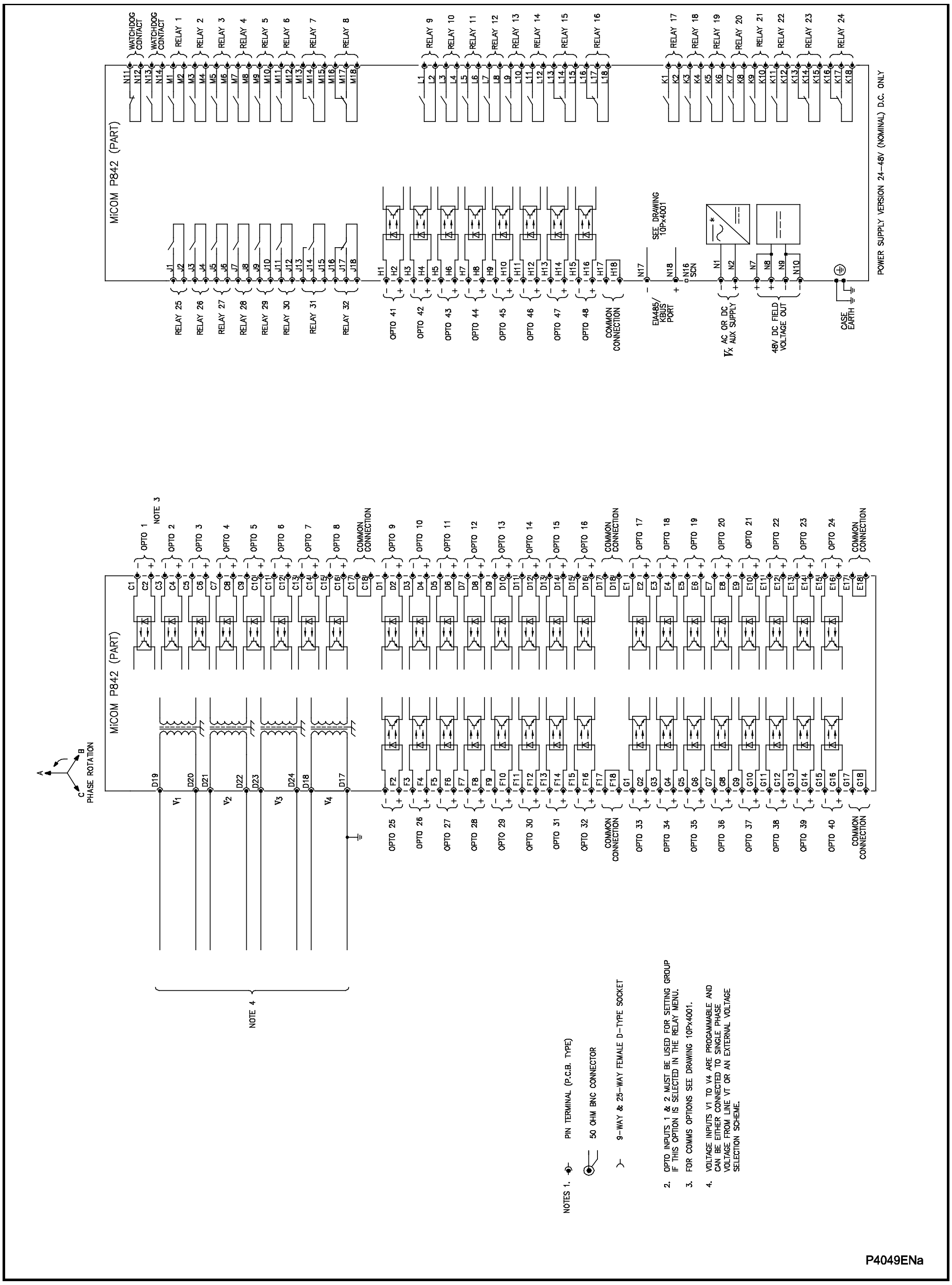


Figure 4: P842 with 32 output contacts and 48 digital inputs

FIRMWARE AND SERVICE MANUAL VERSION HISTORY

Hardware Suffix: **B**

Software Version: **04**

VH

Relay type: P842						
Software Version		**Hardware Suffix**	**Original Date of Issue**	**Description of Changes**	**S1 Compatibility**	**Technical Documentation**
Major	Minor					
02	A	B		Original Issue used for Scheme Testing	V2.12	P842/EN M/A11
03	C	B		Scheme modifications and platform enhancements following site testing	V2.12	P842/EN M/A11
04	E	B		Improvements to stability of GOOSE communications and scheme logic enhancements. Control Inputs non-volatile, improved monitoring of logic signals via user interface.	V2.12	P842/EN M/A11
			January 2011	Rebranded from Areva to Alstom Grid		P842/EN M/ C11

Setting File Software Version	Relay Software Version: 02	03	04
02	✓	×	×
03	×	✓	×
04	×	×	✓

PSL File Software Version	Relay Software Version	02	03	04
	02	✓	×	×
	03	×	✓	×
	04	×	×	✓

Menu Text File Software Version	Relay Software Version 02	03	04
02	✓	×	×
03	×	✓	×
04	×	×	✓

Imagination at work

Grid Solutions
St Leonards Building
Redhill Business Park
Stafford, ST16 1WT, UK
+44 (0) 1785 250 070
www.gegridsolutions.com/contact

P842/EN M/D11