

MERGING UNITS

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PURPOSE AND SCOPE

Conventional NG Protection and Control practice is for direct point to point hard wired connections between the primary plant interfaces (Conventional Instrument Transformers (CT/VTs) and digital Inputs/Outputs(I/O) used for monitoring and control) and Intelligent Electronic Devices (IEDs). This approach does not easily facilitate secondary system upgrade or replacement without securing a long primary circuit outage of the bay or substation.

IEC 61850 (bay) Process Bus technology has the potential to significantly reduce the required wiring work. Such installations would then use Merging Units (MU) as common plant interfaces and distribute digitised analogue and digital data to the respective control, protection and measurement IEDs via fibre networks. The perceived benefits of this approach being the reduction in replacement time and costs for both systems and IEDs, and in the longer term interchangeability between different manufacturer's offerings as a result of a well-defined interface.

PART 1 – PROCEDURAL

1 GENERAL REQUIREMENTS

1.1 The Process Bus interface of any Merging Unit (MU) shall comply with IEC 61850-9-2 Ed.2 (or later) and as far as available with the IEC 61869 series of standards.

1.2 The IEC 61869 standard for Instrument transformers and their interface to other digital equipment (as shown below) is being developed by IEC TC38, inclusive of the specification of Merging Units which are intended to supersede those ones currently specified in the IEC 61850-9-2. The sections that are specific to the needs for merging units are:

- IEC 61869-1: Instrument Transformers - General requirements,
- IEC 61869-6: Additional General Requirements for Low Power Instrument Transformers
- IEC 61869-9: Digital Interface for Instrument Transformers,
- IEC 61869-13: Stand Alone Merging Unit (SAMU).

- 1.3** The MU shall comply with the IEC 61869 requirements.
- 1.4** Aspects not covered by the above group of standards shall be addressed in line with, the following guideline.
- Informative: IEC TC38 activities cover current and/or voltage measurement devices such as instrument transformers, including, sensing devices, signal treatment, data conversion and analogue/digital interfacing, used for AC and/or DC metering, protection, fault location or power quality measurement purposes. This may lead to new standards being available in the near future.*
- 1.5** This specification deals with NG functional, hardware and performance requirements for MUs required for AS³ (bay) Process Bus architecture based on the IEC 61850 standard. Please refer to TS3.24.25 for IEC 61850 configuration requirements and the Architecture for Substation Secondary Systems (AS³).
- 1.6** MUs are required to deliver Analogue to Digital conversion performance commensurate with the needs of:
- Protection
 - Control
 - Operational Metering
 - Settlement Metering
 - System Monitor – Fault Recorder (TS 3.24.71)
 - Quality Of Supply
 - Dynamic System Monitoring (Slow & fast scan) (TS 3.24.70)
 - Phasor Measurement Unit (IEEE C37.118 2005 and TS 3.24.92)

2 OVERVIEW

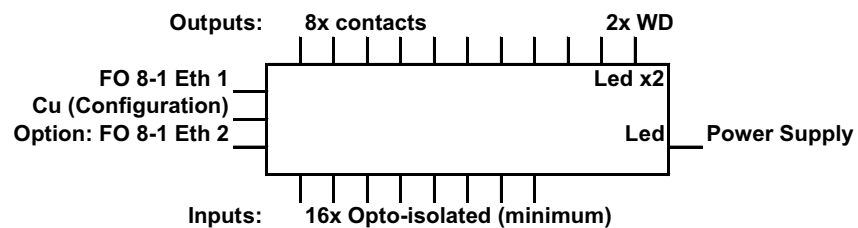
- 2.1** The IEC 61850 standard is used for communication between the Substation Control System (SCS) and Intelligent Electronic devices (IEDs) over the Station Bus, and for communication between IEDs and Merging Units (MUs) over the Bay Process Bus and Inter Bay Process Bus / Measurement Bus. The AS3 architecture, engineering process and configuration requirements for IEC61850 applications on the NG network are explained in TS3.24.25 and it is recommended to read this MU specification in conjunction with the IEC61850 configuration requirements.
- 2.2** National Grid substations may be controlled and protected with IEDs connected to the Bay Process Buses and interfacing with primary equipment through MUs that may be shared by a number of IEDs.
- 2.3** The functional scope of MUs is intended to cover requirements of all protection, control, operational metering, power quality monitoring and power system dynamic recording applications.
- 2.4** Each of these applications will require its own set of physical and performance criteria, which may be met by a single wide ranging device (preferred), or by multiple discrete MUs suited to specific applications.
- 2.5 Merging Unit Types**
- 2.5.1** Various generic forms of Merging Unit are available:
- Non-Conventional Merging Unit (NMU) connected to NCITs
 - Analogue Merging Unit (AMU) connected to Conventional CT/VTs
 - Digital Merging Unit (DMU) connected to Isolators and/or CBs
 - Combined Merging Unit (CMU), a AMU and a DMU in a single box
 - Enhanced Merging Units (EMU)
 - Enhanced Combined Merging Units (ECMU)

2.5.2 Merging Units would be connected to High Voltage Current and Voltage sensors and/or Digital I/Os. The AMU or CMU acts as a remote analogue to digital converter. The DMU or CMU acts as an I/O box and it inherits the characteristics (typically trip and control) from its source IED(s) Logical Node (LN).

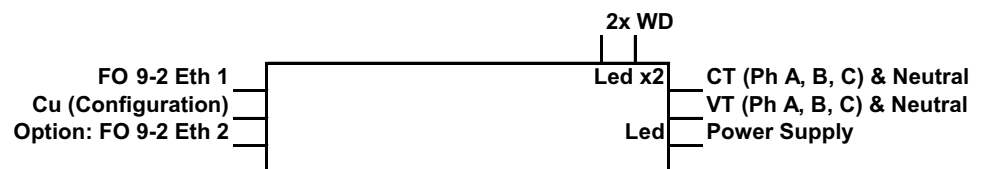
2.5.3 Enhanced Merging Units would also be connected to additional analogue sensors such as temperature, pressure, low voltage, tap changer and have additional functionalities such as Disturbance Recording. Where such analogue data is slowly changing it should be reported as a GOOSE rather than SV with the appropriate dead-band. This avoids the requirement to connect EMUs to the station bus.

Informative: Examples of MUs are given in the following diagrams. Whilst WD's are shown separately it should be noted that digital supervision is preferred.

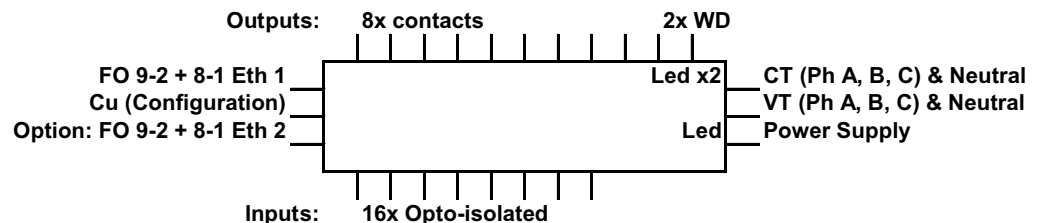
Basic DMU



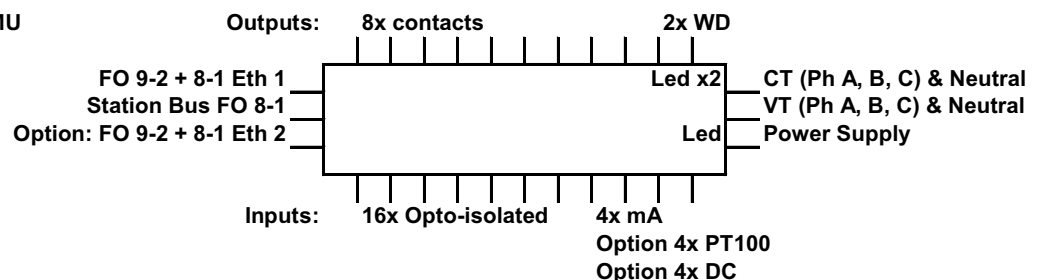
Basic AMU



Basic CMU



Enhanced CMU



2.6 Process Bus Architecture Options

2.6.1 The Substation Protection and Control network shall follow the requirements described in TS3.24.25 for IEC61850 configuration which includes the following:

- Station Bus
- Interbay Process Bus / Measurement Bus
- Bay Process Buses

2.6.2 The information flowing through the Bay Process Buses are:

- IEC 61850-9-2LE Logical Nodes (Currents and Voltages)
- IEC 61850-8-1 GOOSE messages (For positions, trips & open/close orders and other events)
- IEEE 1588 time synchronisation frames

2.6.3 The information flowing through the Interbay Process bus / Measurement Bus are:

- Up to 8 (or 10) IEC 61850-9-2LE Busbar voltages Logical Nodes (for 100Mbit/s network; more for Gbit/s networks) for synchrocheck and Busbar voltage selection functions.
- Up to 8 (or 10) IEC 61850-9-2LE feeder Logical Nodes (for 100Mbit/s network; more for Gbit/s networks) for mutual current functions (or Busbar protection).
- IEC 61850-8-1 GOOSE messages for positions, trips & "INTER" trips and open/close orders
- IEC 61850-9-2LE Measurement Logical Nodes (mainly 256 sample/cycle)

2.6.4 Sampling rates and frame publishing rates shall be configured in line with IEC61850-9-2 LE as shown in the table below

Digital output sample rates [Hz]	Number of ASDUs per frame	Digital output publishing rate [frames/s]	Notes
4000	1	4 000	For use on 50 Hz systems backward compatible with 9-2LE guideline.
12 800	8	1 600	For use on 50 Hz systems, with 256 samples per cycle with 9-2LE guideline.

Table 1: Sampling rates and publishing rates

2.7 Hardware

2.7.1 Command Outputs on CMU and DMU type Merging Units shall provide:

- A minimum of 8 high break and high make-and-carry contacts (6 for trip, 2 for close, to replace the master trip relay where possible)(also refer to Hardware Platform – TS3.24.4 and TS3.24.87 – Trip Relays)
- Optionally, these should be high speed with operating/make time: <200µs & Reset time: 7.5ms. The actual performance shall be declared to NG.

2.7.2 The minimum dwell or pulse duration should be settable (the minimum period that the contact should remain operated for) shall meet the requirements in TS 3.24.4.

2.7.3 Optionally each discrete output should be configurable for either:

- Instantaneous Pick-Up (PU) or Drop-Off (DO) (no deliberate additional time delay)
- Or time delayed on PU and/or DO with a Settable time.

Informative: This allows two different DMUs to be configured to behave identically.

2.7.4 In the event of a total loss of communication, each output shall be open.

2.7.5 Optionally each output can have a default value:

- False (open)
- True (closed)
- Last known value (latched)

2.7.6 All output conditioning shall be via GOOSE messages (i.e. minimum operating time or latching properties) and shall be configured in the source IEDs and not within the MU.

- 2.7.7 Trip Circuit Supervision and Anti-pumping (simultaneous Trip and Close commands) features required in protection schemes need not be part of the MU functionality.
- 2.7.8 Status Inputs shall meet the requirements of TS 3.24.4
- 2.7.9 CMU and DMU type Merging Units shall be:
- Equipped with a minimum of 16 opto-isolated inputs divided into at least 2 isolated groups
 - Fully configurable for single point, double point and transformer tap position indication applications as specified in TS 3.24.4
- 2.7.10 All MU types shall be equipped with 2 sets of single point watchdog alarm output contacts, as described in TS 3.24.4, unless digital supervision can be provided which would be preferred.
- 2.7.11 MUs are required for operation on 110V DC supplies, (48V DC in some cases) as specified in TS 3.12.4
- 2.7.12 MU configuration and stored data such as alarm logs shall be stored in non-volatile memory. Preference will be given to devices with the fewest specific configuration requirements.
- 2.7.13 All analogue inputs on the MU shall meet with the requirements of TS 3.24.4.
- 2.7.14 The MU shall ensure the required accuracy class of the Sampled Values (according to IEC 60044-8) is achieved taking the whole measurement chain into account, i.e. Accuracy needs to be based on or reflect the complete acquisition chain and not only any discrete element or component; it needs to reflect the Actual CT/VT/source and associated MU accuracy as a single end to end process).
- 2.7.15 The bandwidth for 80 samples per cycle for 50 Hz shall be 2 kHz or higher.
- 2.7.16 The bandwidth for 256 samples per cycle for 50 Hz shall be 6.4 kHz or higher.
- 2.7.17 The MU shall have a nominal range of 1A/5A, 50Hz. Preference will be given for the same physical terminals for 1A and 5A current inputs provided the required accuracy can be achieved. The MU shall comply with the IEC 61869-9 standard, particularly the dynamic range shown in Annex 9A.
- 2.7.18 The MU voltage inputs shall have a nominal range of $110/\sqrt{3}$ Vph-n (110Vph-ph), 50Hz.
- 2.7.19 It is required that the MU performs 32-bit encoding of sampled data to ensure sufficient accuracy and fine granularity of the measurements.
- 2.7.20 Where fitted as an option, the EMU shall allow digitization of (PT100) Temperature Transducer inputs for Ethernet IEC 61850-8-1 onward communication via the Station Bus interface or report via GOOSE over the PB.
- 2.7.21 The EMU shall provide configurable set-points, one high and one low, for each of the temperature probes where required.
- 2.7.22 The EMU shall scale and reconstruct the measured quantity for Ethernet IEC 61850-8-1 onward communication via the Station Bus interface or report via GOOSE over the PB.
- 2.7.23 The EMU shall provide configurable set-points, one high and one low, for each of the current loop inputs where required.
- 2.7.24 The EMU shall allow digitization of the DC voltage for DC Voltage Monitoring. It shall be sent as Ethernet IEC 61850-8-1 for onward communication via the Station Bus interface or report via GOOSE over the PB.

2.7.25 The EMU shall provide configurable thresholds, one high and one low, for each DC voltage input where required.

2.7.26 Comprehensive self-monitoring shall be provided.

2.8 IEC 61850 Data-Model

2.8.1 Logical Nodes

When the MUs are connected to the Station Bus, the data model shall include the mandatory parts of the following Logical Nodes:

- XCBR (DMU or CMU) (Control)
- XSWI (DMU or CMU) (Control / Status)
- GGIO (DMU or CMU) (General, Generic process I/O)
- YLTC (DMU or CMU) (Transformer Tap Changer)
- SIMG (Enhanced MU) (Supervision of Insulation Medium (Gas))
- SIML (Enhanced MU) (Supervision of Insulation Medium (Liquid))
- Optional - RDRE (Disturbance Recorder) for protection

This list is not comprehensive.

2.8.2 The MU shall at a minimum be capable of subscribing to 64 GOOSE datasets in total originating from up to 32 IEDs. MUs shall be capable to read both, BER (Basic Encoding Rule) and fixed length GOOSE messages as defined in IEC61850-8-1 appendix A. Each GOOSE dataset shall have a minimum of 16 configurable data points.

2.9 User interface

2.9.1 As a minimum the following LED indications shall be provided for each MU (this is not necessarily the number of LEDs)

- Power on (i.e. steady state),
- Healthy (i.e. steady state),
- Failed,
- Test Mode,
- Port status (linked, traffic, provided per communication port)
- Synchronised (i.e. flashing at the "0 pulse" at a rate of once per sec)

2.9.2 Optionally : LEDs providing information on the status of the opto-inputs or outputs:

- Real Status & Command outputs or
- When the MU is in test mode additional indication can be provided of simulated Status & Command input status either received by the MU IEC 61850-8-1 GOOSE messages or simulated via HMI.

Informative: The use of LCD displays for this purpose is not acceptable due to concerns regarding design life.

2.10 Local / Remote Access

2.10.1 The MU shall provide a Web Server mode or other tool for Configuration / Maintenance purposes.

- RS232 and RS485 type ports shall not be used for this purpose
- The use of USB style connectors or Ethernet port is permitted
- Cross site communications shall be in general accordance with TS 3.24.40
- Fibre optic transmission system type 100Base-FX full duplex with ST connectors is preferred although type 100Base-FX with LC, MT-RJ connectors are also acceptable.
- For equipment room mounted MUs, Bay Process Bus using 100Base-TX full duplex with RJ-45 connectors for up to 10m within the equipment room will be acceptable (see TS 3.24.40 section 4.4)