Bitronics M87x

Monitoring and Recording Device Catalog

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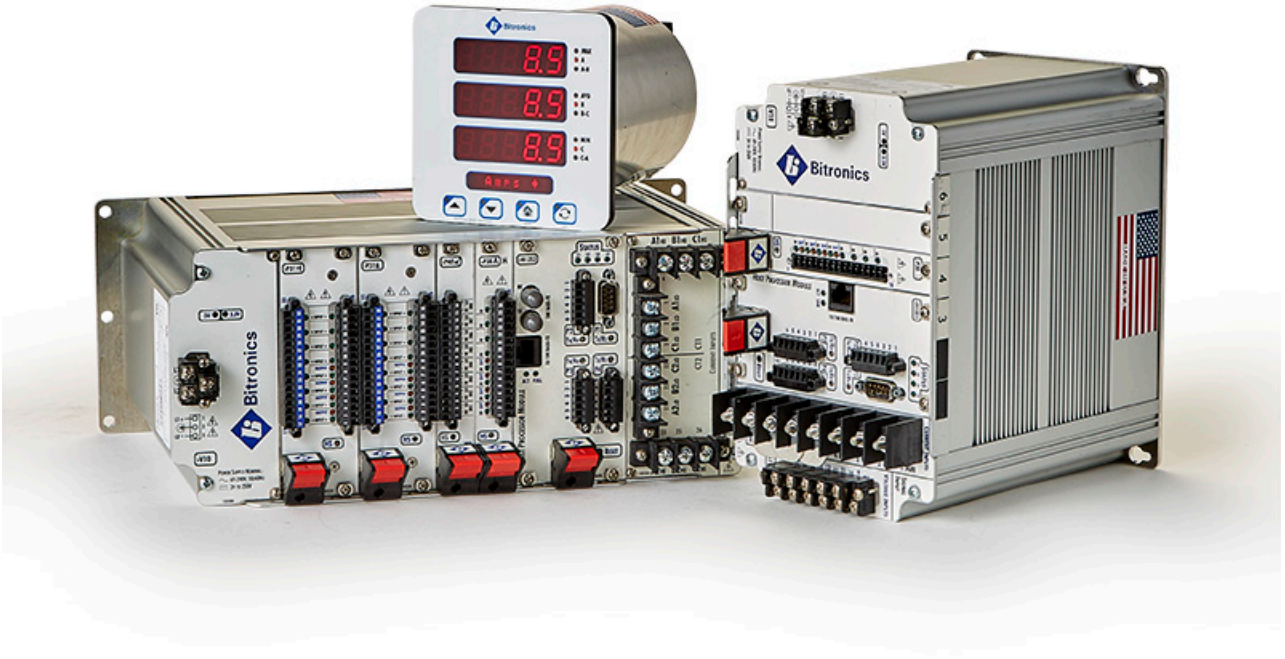
Table of Contents **Page**

M87x Overview

The Bitronics M87x Monitoring and Recording devices provide a complete solution for applications in AC distribution and transmission systems where a combination of utility-grade construction, measurement, communication, and recording are needed. With tens of thousands of installations worldwide, the M87x continues to provide quality and value in monitoring line and equipment conditions in utility substations. The M87x comes in different chassis sizes offering options to cover single and dual feeders with different combinations of digital I/O, transducer inputs, memory, and Ethernet communication options.

The M87x are especially useful in providing automation updates to older substations with mechanical or early digital relays, and in compliance with PRC-002-2 standards.



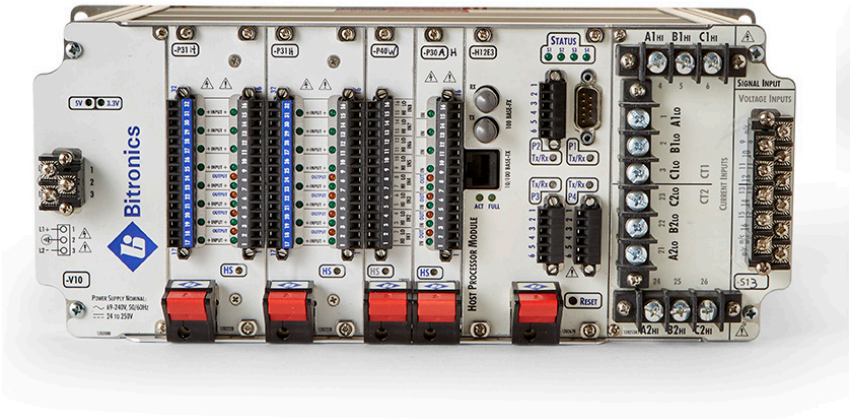
M87x Features and Functions

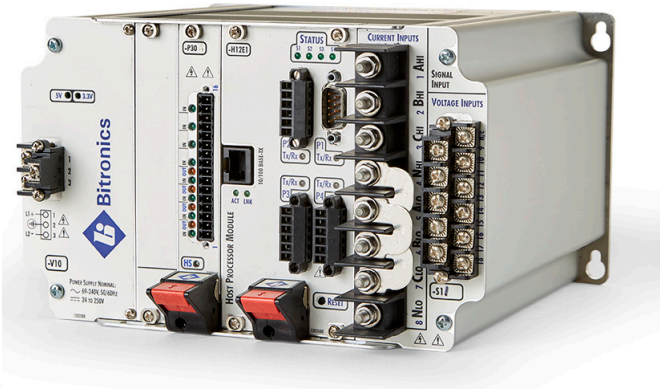
Feature Summary

- One model for 2, 2½ or 3-Element systems with selectable CT and PT ratios
- ¼ to 1-cycle measurement update rate
- Wide input frequency range of 15-70Hz
- Voltage and current accuracy better than 0.1% of reading
- 0.2% revenue-class energy measurement with S11, S12, S14, S15, S16, and S17 signal input modules
- Assignable Modbus registers and DNP3 analog points
- Simultaneous recording for all recorders
- Event triggering with logic includes hysteresis from any analog threshold value, rate-of-change of analog value, digital input, or “virtual” input (GOOSE message)
- IEC 61850 Compliant
- Automatic event notification

Functional Summary

- Over 2000 high accuracy measurements
- Distance to fault measurements
- Supports multiple protocols simultaneously
- One set of 3-phase current inputs with separate neutral (M871) or two sets of 3-phase current inputs (M872)
- Two sets of 3-phase voltage inputs
- Battery voltage inputs (M871)
- Wide-range universal auxiliary power supply
- Two waveform recorders
- Two disturbance recorders
- Sequence of Events Recorder
- Up to 2GB of nonvolatile memory for recording
- Optional digital inputs and digital outputs
- Optional transducer inputs
- One RS-232 and three configurable RS-232/RS-485 ports
- Optional Ethernet, copper or copper and fiber optic
- Other optional accessories are: D650 detached displays, Analog Output Converters and Modulated IRIG-B adapter
- Three modular chassis sizes





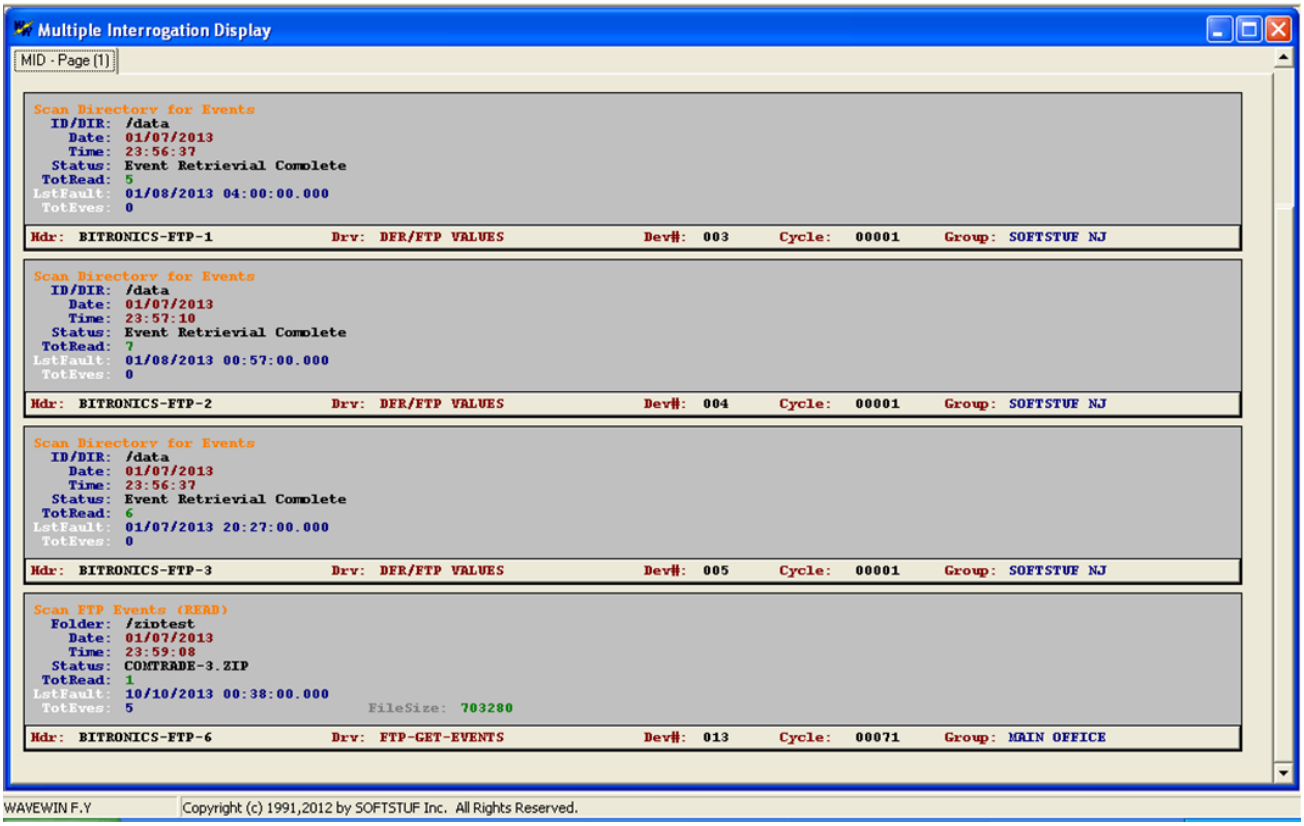
Specifications

Measurement and Signal Inputs

- Measurements including volts, currents, power, energy, frequency, demand, individual and total harmonics, K-factor, current & voltage unbalance, flicker, impedance, and symmetrical components.
- Current input for the S10 Signal Input module has a nominal range of 0 - 5A ac, linear to 100A ac symmetrical rms at all rated temperatures.
- Current input for the S11 Signal Input has a range 0-1A ac or 0-5A ac, linear to 20A ac symmetrical rms at all rated temperatures and the 0–5A ac range is compliant to IEC 60687 and ANSI C12-30-1998 revenue class accuracy of 0.2%.
- Current input for the S12 Signal Input has a nominal range of 0-1A ac, linear to 4A ac at all rated temperatures and is compliant to IEC60687 and ANSI C12-30-1998 revenue class accuracy of 0.2%.
- Current input for the S1C split-core external CT option has a nominal range of 0-5A ac, linear to 100A ac symmetrical rms at all rated temperatures.
- Current input for the S13 Signal Input module has a nominal range of 0-5A ac, linear to 100A ac symmetrical rms at all rated temperatures.
- Current input for the S14 Signal Input has a range 0-1A ac or 0-5A ac, linear to 20A ac symmetrical rms at all rated temperatures and the 0 – 5A ac range is compliant to IEC 60687 and ANSI C12-30-1998 revenue class accuracy of 0.2%.
- Current input for the S15 Signal Input has a nominal range of 0-1A ac, linear to 4A ac at all rated temperatures and is compliant to IEC 60687 and ANSI C12-30-1998 revenue class accuracy of 0.2%.
- Current input for the S16 Signal Input has a range of 0-5A ac, linear to 20A ac symmetrical rms at all rated temperatures and is compliant to IEC 60687 and ANSI C12-30-1998 revenue class accuracy of 0.2% on the low-range side, and 0-5A linear to 100A ac on the high range side.
- Current input for the S17 Signal Input has a range of 0-1A ac, linear to 4A ac symmetrical rms at all rated temperatures and is compliant to IEC 60687 and ANSI C12-30-1998 revenue class accuracy of 0.2% on the low-range side, and 0-1A linear to 20A ac on the high range side.
- Current input for the S2C split-core external CT option has a nominal range of 0-5A ac, linear to 100A ac symmetrical rms at all rated temperatures and is compliant to IEC60687 and ANSI C12-30-1998 revenue class accuracy of 0.2%.
- The AC voltage inputs are intended for use on nominal system voltages up to 480V ac rms phase-phase (277V ac RMS phase-neutral).
- Two auxiliary AC/DC voltage inputs (M871) are intended for use on nominal system voltages up to 480V ac rms phase-phase (277V ac RMS phase-neutral), and on DC system voltages up to 250V dc.
- Transducer input option that provides eight inputs in 0 - 1mA, 4-20mA or 0-10V ranges.

Recording

- Waveform recorders have up to 14 assignable analog channels with adjustable sampling rates of 32 or 64 and 128 samples per cycle. With the M871, a reduced number of channels can be selected to allow 256 samples per cycle. Pre-trigger and post trigger size is assignable. Digital inputs can be included in the recording. Stored in COMTRADE format.
- The Disturbance recorders have up to 64 assignable measurement channels with a selectable time resolution from one cycle to sixty seconds. Pre-trigger and post trigger size is assignable. Stored in COMTRADE format.
- Disturbance recorders, along with periodic triggers, are used for satisfying the continuous Dynamic Disturbance Recording (DDR) in PRC-002-2 applications.
- The trend recorders have up to 230 selectable parameters with time resolution of one minute to twelve hours. Choice of instantaneous or min, max and average.
- Sequence of Event recording has 5,000 event record storage with events time stamped to 1 microsecond. Stored in Text format.
- All triggers have three trigger modes.
- Available Wavewin® software for automated retrieval of record files (Device Manager) and analysis of COMTRADE files.



Device Manager Device Text Window Display

Communications

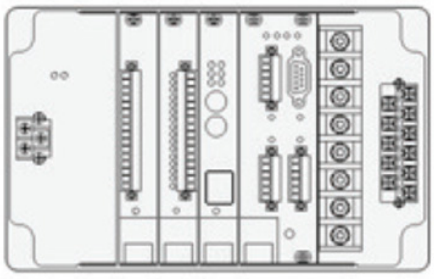
- One RS-232 and three configurable RS-232/RS-485 ports supporting baud rates from 9600 to 38400.
- Optional 10BaseT/100BaseTX or added 100Mb fiber-optic port (100BaseFX).
- Supports protocols: DNP3 Level 2, DNP3 TCP/IP, DNP3/UDP, Modbus RTU, Modbus TCP/IP, ZMODEM, FTP, telnet, IRIG-B, SNTP and IEC 61850.
- An IRIG-B port adapter with BNC connector is available that accepts modulated signals and interfaces directly to one of the serial ports.
- Automatic event notification via Ethernet or serial media.

Modular Design

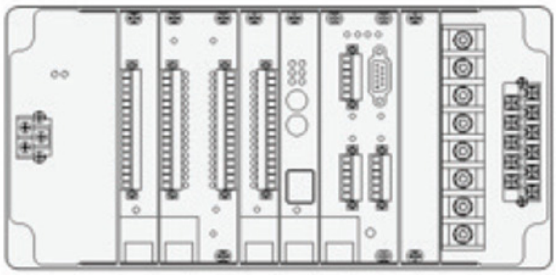
The M87x uses a modular design based on the Compact PCI® bus. There are three chassis sizes:

- Standard Chassis (M871 only) with 3 optional module slots at 8.5” wide
- Intermediate Chassis with 5 optional module slots at 10.9” wide
- Long Chassis with 6 optional module slots at 13.45” wide

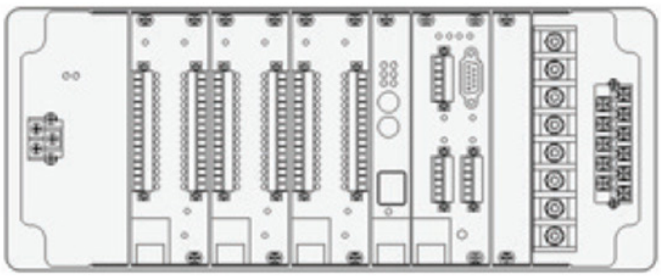
Small: **8.50” wide 3 cPCI slots**
Max I/O: **16 w/Ethernet, 24 w/o**



Medium: **10.90” wide 5 cPCI slots**
Max I/O: **32 w/Ethernet, 40 w/o**



Wide: **13.45” wide 6 cPCI slots**
Max I/O: **48 w/Ethernet, 56 w/o**
(18 I/O per RU)



All chassis: 5.20” (3U) high by 8.80” deep

Modular Design

An M87x must have the following modules:

- V10 universal power supply module, rated 20-300V dc/ 55-275V ac.
- H12 host processor and A10 analog processor module consisting of a 486 Processor, 32-bit DSP, 16-bit A/D converter and RAM and nonvolatile memory.
- One signal input module. There are choices of an S10, S11, S12, or S1C (split-core) for M871 and S13, S14, S15, S16, S17 or S2C (split-core) for M872.

The choices of optional modules and their max quantity depend on the chassis size and what module space is available:

- E1 or E3 Ethernet Option (1 Max)
- P30A Digital I/O Module 8 DI/ 4 DO (6 Max)
- P31 Digital I/O Module 16 DI/ 4 DO (3 Max)
- P33 Digital Output Module 8 DO (6 Max)
- P40 Transducer Input Module 8 AI (6 Max)

Applications

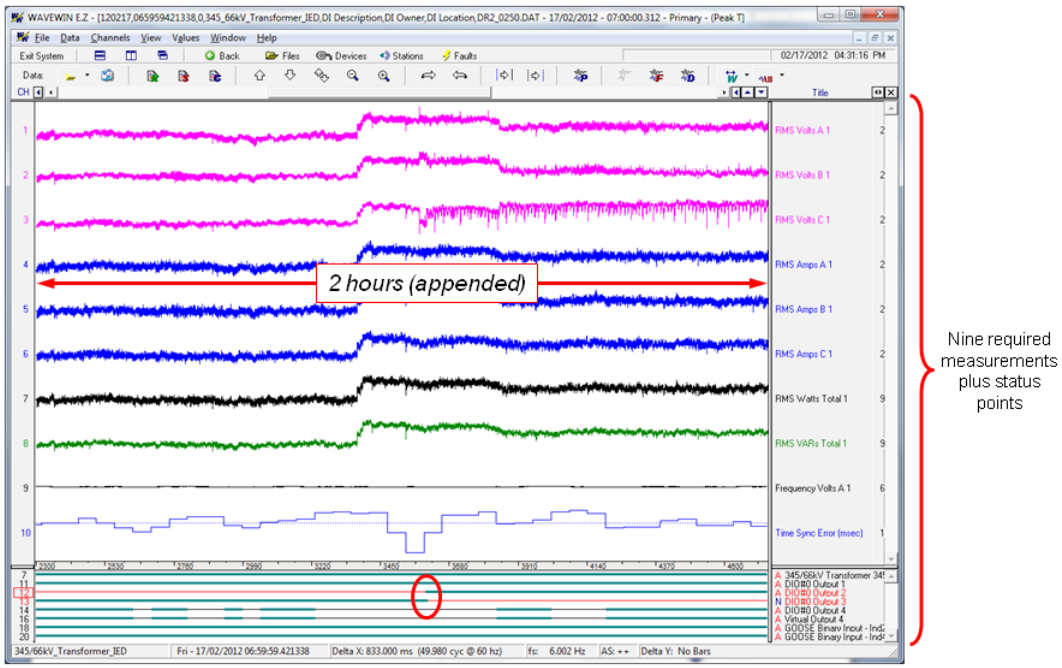
The M87x, through its multi-mode recording and its ability to make high speed, high accuracy measurements, provides the information necessary to analyze:

- Network faults
- Reactions of the protective devices
- Dynamic response of the network
- Long-term trends
- Substation equipment performance

The M87x provides a low-cost entry into disturbance recording through a distributed approach. One M871 covers one line or feeder, and one M872 covers two. It can also be interconnected via peer-to-peer GOOSE messaging that allows cross-triggering to occur without the need for hard-wiring of the contacts. It thus provides a scalable approach to station-level recording.

The ability to support multiple physical links and protocols simultaneously allows easy integration in retrofit applications or newer substation automation projects. The M87x serves as a front-end to SCADA while also providing system-wide access to important substation data.

The M87x can replace conventional measuring instruments (measurement centers) by covering one or two feeders, as well as trend, sequence-of-event, disturbance, and station fault recorders.



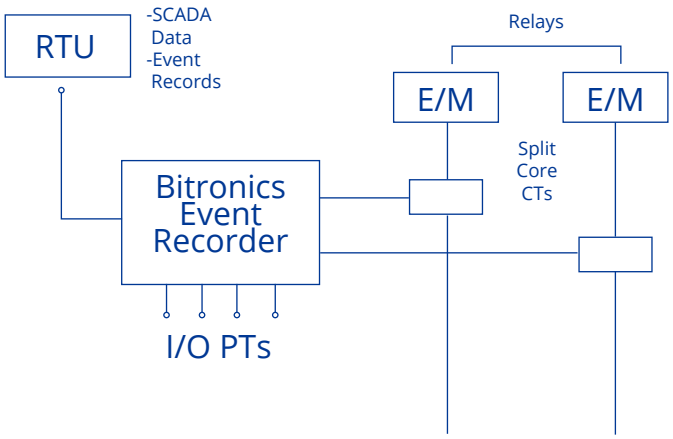
Two-hour DDR record from M87x

Two key applications for the M87x are 1) providing automation upgrades for substations with mechanical or older style digital relays, and 2) PRC-002-2 compliance for Disturbance Monitoring Equipment (DME).

The M87x complements relays by providing independent, higher-fidelity waveform capture. It has two waveform recorders and provides two disturbance recording modes and trend recording not typically found even in the most advanced digital relays. It also provides functions such as fault location and SCADA communication to automate a substation where electro-mechanical relays are in place. The split-core CT option simplifies installation without the need for an outage.

Automated Electromechanical Relay Substations

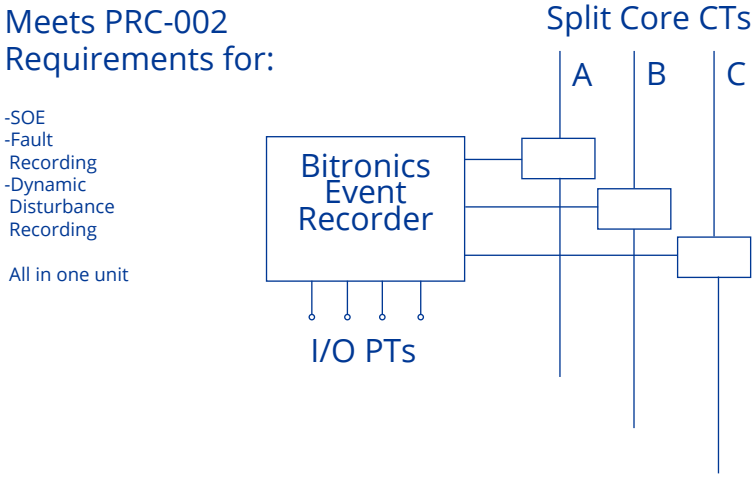
A Bitronics 70 Series Event Recorder can provide substation automation, event recording and SCADA functionality in a substation that still uses electromechanical relays. By connecting to local discrete I/O, PTs, and the relaying circuits of the electromechanical relays using split-core CTs, the Bitronics Event Recorder provides SCADA data and event records to the local RTU, providing complete substation and fault data to the utility while preserving the investment in reliable electromechanical protection equipment.



The M87x fully complies with the requirements under NERC PRC-002-2 for Disturbance Monitoring Equipment (DME). It satisfies all three recording requirements of the DME, Sequence of Event Recording (SER), Dynamic Disturbance Recording (DDR) and Fault Recording (FR).

Disturbance Monitoring (PRC-002)

Bitronics 70 Series Event Recorders meet all three PRC-002 Disturbance Monitoring requirements – SOE Equipment, Fault Recording, and Dynamic Disturbance Recording – in a single unit. Once connected to local I/O, PTs and optional split-core CTs, the Bitronics Event Recorder collects time-stamped events, waveform, and trend data. Files are made accessible to the Wavewin Bitronics Device Manager software via serial or Ethernet FTP transfer. The Bitronics 70 Series can be retrofitted quickly into existing circuit without taking an outage.



Appendix

M87x Modules

HOST / ANALOG-DIGITAL SIGNAL PROCESSOR MODULE H12 AND A10

The Host/Analog-Digital Signal Processor Module is an assembly consisting of two sections: the Host board and the Analog-Digital Signal Processor board.

H12 Host Board

The Host CPU module consists of a 486-class microprocessor, four communications ports and a CompactP-CITM master bridge. The H12 host module utilizes a Compact Flash card, available in optional sizes, and offers optional Ethernet interfaces (E1 and E3).

The H12 Serial Port/Front Panel Board consists of the four serial driver connectors, four status LED's, four bi-color serial port LEDs, and a reset button. Port P1 is a PC AT style 9-pin D connector for the dedicated RS 232 port, and ports P2, P3, and P4 are universal 150-mil, 6-pin removable connectors for the RS 232/RS 485 serial ports. P2, P3, and P4 are software (user) configurable for RS 232 or RS 485 mode. The RS 232 drivers support full and half duplex modes.

The M87x has an internal System Clock with a capacitor backed RAM (typical data retention of 7 days at room temperature) when no power is applied to the unit. The clock is located on the Host board. The time settings may be changed via the Serial Port (P1) or various communication protocols.

A10 Analog-Digital Signal Processor Board

The Analog/DSP board is part of the modular M87x system. This board contains amplifiers, track and hold circuits, multiplexers, an analog to digital converter, a digital signal processor (DSP), and a PCI bridge. Analog signals from the CT/VT board are routed through the backplane to the Analog/DSP board. Once on the board each signal is connected to the track and hold circuitry. The track and hold circuitry is designed to hold the channel's present value during the time required for the analog to digital converter to sample all of the channels. This effectively allows the M87x to simultaneously sample all of its input channels, eliminating any channel-to-channel skew. A single 16-bit analog to digital converter is used for all measurements. The DSP uses the samples to calculate all of the measured parameters. Each sample is corrected for offset and gain using factory calibration values stored in non-volatile memory on the board. Additionally, a continuous DC removal is performed on all inputs, except the AUX Voltages. An adaptive sampling system is used to maintain 128 samples per cycle over the input frequency range of 15 to 70 Hz. See Section 3.2.2.

The M87x measures all signals at 128 samples/cycle, accommodating fundamental signal frequencies from 15 to 70 Hz. Samples of all bus signals are taken at the same instant in time, using a 16-Bit A/D converter, effectively creating 128 "snapshots" of the system voltage and current per cycle.

The sampling rate is synchronized to the frequency of any of the bus voltage or current inputs, prioritized as follows: V1A-N, V1B-N, V1C-N, V2A-N, V2B-N, V2C-N, IA, IB, IC. This is the frequency reported as the "System Frequency". The AUX voltage inputs and Neutrals are not used to synchronize the sampling. The sampling rate is the same for all channels.

Basic measurement quantities are calculated and updated every 1/4 cycle. These quantities include RMS Amperes and RMS Volts. Watts, VARs, VAs, Power Factor, all harmonic-based measurements (such as fundamental-only quantities), Energy, Frequency, and Phase Angle are updated every cycle.

POWER SUPPLY MODULE - V10

The V10 power supply can operate from any voltage between 20 300Vdc or 55 275Vac (45 65Hz). It is therefore possible to power the M87x with AC or DC station power or an auxiliary VT, provided the voltage remains above 55Vac or 20Vdc. The power supply creates 3.3V, 5V, and +/-12Vdc outputs and consists of an isolated flyback converter that provides at least 12.5W of output power at 3.3Vdc and/or 5Vdc.

Features

- 25W minimum output power from the combined 5V and 3.3V supplies
- +/-12Vdc capable of delivering up to 500mA
- Standard cPCI power connector
- Removable terminal block accepts bare wire or terminal lugs
- 5Vdc and 3.3Vdc power indicator LEDs

Specifications

Input (Auxiliary) Voltage Nominal:	24-250Vdc, 69-240Vac (50/60Hz)
Operating Range:	20 300Vdc, 55 275Vac (45 65Hz)
Output Voltage:	3.3Vdc, 5Vdc, and +/-12Vdc

SIGNAL INPUT MODULE S10 - S12, S1C (M871), S13 - S17, S2C (M872)

The Signal Input Module provides the terminal blocks, current transformers, and voltage input dividers for the signals to be measured. Compensation for normal variations in input circuits is achieved by storing calibration constants in non-volatile memory (EEPROM), which resides on the Signal Input Board. These constants are factory programmed to provide identical signal gain (attenuation) in each of the 14 signal input paths. Checksums are incorporated into the EEPROM, which are read periodically by the microcontroller to check the integrity of the calibration constants.

Features

- Utility-grade current input terminal block with 10-32 studs (M871) or 8-32 screws (M872)
- Current shunts are #12 AWG SIS, 600V wire, crimped ring-lugs with brazed seams
- Options for split-core CTs (external)
- Voltage measurements to 424V rms line-to-neutral (730V rms line-to-line)
- 7kV, 7.5MΩ input resistors on voltage inputs
- Removable voltage input terminal block accepts bare wire or terminal lugs
- Non-volatile memory backup of CT/VT calibration data

Specifications

Input Signals (S10, S11, S12, S1C)		
CT Current Inputs (S10)	Configuration	4 Inputs. 3 Phase Currents and 1 Neutral.
	Nominal	5Aac
	Peak Current	Linear to 100A symmetrical (141A peak) at all rated temperatures
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum
	Burden	0.04VA @ 5A rms, 60Hz (0.0016Ω @ 60Hz)
	Frequency	15-70Hz
CT Current Inputs (S11)	Configuration	4 Inputs. 3 Phase Currents and 1 Neutral.
	Nominal	1Aac/5Aac
	Peak Current	Linear to 20A symmetrical (28A peak) at all rated temperatures.
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum
	Burden	0.0016VA @ 1A rms, 60Hz (0.0016Ω @ 60Hz)/0.04VA @ 5A rms, 60Hz
	Frequency	15-70Hz
CT Current Inputs (S12)	Configuration	4 Inputs. 3 Phase Currents and 1 Neutral.
	Nominal	1Aac
	Peak Current	Linear to 4A symmetrical (5.7A peak) at all rated temperatures
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum
	Burden	0.0016VA @ 1A rms, 60Hz (0.0016Ω @ 60Hz).
	Frequency	15-70Hz
CT Current Inputs (S1C)	Configuration	3 Inputs, 3 Phase Currents, or 4 Inputs, 3 Phase Currents and 1 Neutral Current
	Nominal	5Aac
	Peak Current	Linear to 100A symmetrical (141A peak) at all rated temperatures.
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum.
	Burden	Not applicable
	Frequency	15-70Hz

Input Signals (S10, S11, S12, S1C) continued		
VT (PT) AC Voltage Inputs (S10, S11, S12) Terminals 9 to 16	Configuration	8 Inputs, Measures 2 Buses, 3 or 4 Wire.
	Nominal	120Vac
	Peak Current	Intended for use on nominal system voltages up to 480V rms phase-to-phase (277V rms phase-to-neutral).
	Overload	Reads to 600V peak (425V rms), input-to-case (ground)
	Isolation	>7.5MΩ, input-to-case (ground)
	Burden	2.5kV rms 1min, input-to-case (ground)
	Frequency	2kV rms 1min, input-to-input
AUX Measurement Voltage Inputs (S10, S11, S12) Terminals 17 & 18	Configuration	2 Inputs: VAX1 & VAX2
	Nominal	125Vdc / 120Vac
	Peak Current	Intended for use on nominal AC system voltages up to 480V rms phase-to-phase (277V rms phase-to-neutral), and DC system voltages up to 250Vdc.
	Overload	Reads to 600V peak (425V rms), input-to-case (ground)
	Isolation	>7.5MΩ, input-to-case (ground)
	Burden	2.5kV rms 1min, input-to-case (ground)
	Frequency	2kV rms 1min, input-to-input

Input Signals (S13, S14, S15, S16, S17, S2C)		
CT Current Inputs (S13)	Configuration	6 Inputs. 2 sets of 3 Phase Currents
	Nominal	5Aac
	Peak Current	Linear to 100A symmetrical (141A peak) at all rated temperatures.
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum.
	Burden	0.04VA @ 5A rms, 60Hz (0.0016Ω @ 60Hz).
	Frequency	15-70Hz
CT Current Inputs (S14)	Configuration	6 Inputs. 2 sets of 3 Phase Currents
	Nominal	1Aac/5Aac
	Peak Current	Linear to 20A symmetrical (28A peak) at all rated temperatures.
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum.
	Burden	0.0016VA @ 1A rms, 60Hz (0.0016Ω @ 60Hz)/0.04VA @ 5A rms, 60Hz.
	Frequency	15-70Hz
CT Current Inputs (S15)	Configuration	6 Inputs. 2 sets of 3 Phase Currents
	Nominal	1Aac
	Peak Current	Linear to 4A symmetrical (5.7A peak) at all rated temperatures.
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum.
	Burden	0.0016VA @ 1Arms, 60Hz (0.0016Ω @ 60Hz).
	Frequency	15-70Hz
CT Current Inputs (S16) M872 with dual peak ranges 20A/100A	Configuration	6 Inputs. 3 Phase Currents from 2 Lines with different peak current ranges.
	Nominal	5Aac
	Peak Current	Linear to 20A symmetrical (28A peak)/linear to 100A symmetrical (141A peak) at all rated temperatures.
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum.
	Burden	0.04VA @ 5A rms, 60Hz (0.0016ohms @ 60Hz).
	Frequency	15-70Hz

Input Signals (S13, S14, S15, S16, S17, S2C) Continued		
CT Current Inputs (S17) M872 with dual peak ranges 4A/20A	Configuration	6 Inputs. 3 Phase Currents from 2 Lines with different peak current ranges.
	Nominal	1Aac
	Peak Current	Linear to 4A symmetrical (5.7A peak)/linear to 20A symmetrical (28A peak) at all rated temperatures.
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum.
	Burden	0.0016VA @ 1Arms, 60Hz (0.0016ohms @ 60Hz).
	Frequency	6 Inputs. 3 Phase Currents from 2 Lines with different peak current ranges.
CT Current Inputs (S2C); External, Split Core	Configuration	6 Inputs. 2 sets of 3 Phase Currents
	Nominal	5Aac
	Peak Current	Linear to 100A symmetrical (141A peak) at all rated temperatures.
	Overload	30Aac continuous. Withstands 400Aac for 2 seconds.
	Isolation	2500Vac, minimum.
	Burden	Not applicable
	Frequency	15-70Hz
VT (PT) AC Voltage Inputs (S13, S14, S15, S16, S17) Terminals 9 to 16	Configuration	8 Inputs, Measures 2 Buses, 3 or 4 Wire.
	Nominal	120Vac
	Peak Current	Intended for use on nominal system voltages up to 480V rms phase-to-phase (277V rms phase-to-neutral).
	Overload	Reads to 600V peak (425V rms), input-to-case (ground)
	Isolation	>7.5MΩ, input-to-case (ground)
	Burden	2.5kV rms 1min, input-to-case (ground) 2kV rms 1min, input-to-input
	Frequency	15-70Hz

Sampling System		
Sample Rate	128 samples per cycle	
Data Update Rate	Amps, Volts	Available every ¼ cycle
	Watts, VAs, VARs, PF	Available every cycle
Number of Bits	16	

Accuracy	
Accuracies are specified at nominal Frequency and 25C, unless otherwise specified. Temperature Coefficient <25ppm. All values are true RMS and include Harmonics to the 63rd (minimum)	
Voltage	AC: Better than 0.1% of reading (20 to 425V rms, input-to-case). DC (AUX Inputs): +/- 0.2V (24 to 250Vdc, input-to-case)
Current (S10, S13, S16 bus 2)	Better than 0.1% of reading +/- 500µA (0.5A to 100.0A)
	Better than 0.1% of reading +/- 1mA (0.05A to 0.5A)
Current (S11, S14, S16 bus 1, S17 bus 2)	Better than 0.1% of reading +/- 100µA (0.5A to 20.0A)
	Better than 0.1% of reading +/- 250µA (0.05A to 0.5A)
Current (S12, S15, S17 bus 1)	Better than 0.1% of reading +/- 20µA (0.1A to 4.0A)
	Better than 0.1% of reading +/- 50µA (0.01A to 0.1A)
Current (S1C, S2C) External Split-Core CTs	Better than 0.1% of reading +/- 2mA (0.05A to 100.0A, -10C to 70C)
Frequency	+/- 0.001 Hertz (accuracy is specified at nominal Frequencies and over operating temperature range)
Phase Angle	+/- 0.2 Deg
Power	Better than 0.2% of reading (>20% of nominal inputs, 1PF to 0.7PF)
Power S1C, S2C	For S1C and S2C split core versions, better than 0.2% of reading +/- 250mVA (>20% of nominal inputs, 1PF to 0.7PF)

Environment	
Operating Temperature	-40C to 70C
Relative Humidity	0-95% non-condensing
Installation Category	IC III (Distribution Level)
Pollution Degree	Pollution Degree 2
Enclosure Protection	IP20 to IEC60529:1989
Altitude	Up to and including 2000m above sea level
Intended Use	Indoor use; Indoor/Outdoor use when mounted in an appropriately rated protective enclosure to NEMA or IP protection classifications, as required for the installation.

Physical		
Connections (Signal Input Modules)	Current (S10, S11, S12)	Terminal block with 10-32 Studs for current inputs. Use ring lugs sized for #10 stud. Accepts #10-16 AWG (5.3-1.3mm2) wire. Recommended Torque: 16 In-Lbs, 1.81 N-m. Current inputs are connected to the output from the secondary of permanently installed Current Transformers (CTs). Grounding of CT signals per ANSI/IEEE C57.13.3-1983 is required.
	Current (S13, S14, S15, S16, S17)	Terminal block with 8-32 Screws for current inputs. Use ring lugs sized for #10 screw thread. Accepts #10-22 AWG (5.3-0.33mm2) wire. Recommended Torque: 16 In-Lbs, 1.81 N-m. Current inputs are connected to the output from the secondary of permanently installed Current Transformers (CTs). Grounding of CT signals per ANSI/IEEE C57.13.3-1983 is required.
	External Split-Core CTs (S1C, S2C)	2 position removable terminal block, accepts 26-14AWG stranded wire. Recommended Torque 7 in-lbs, 0.79N-m.
	Overcurrent protection for Voltage (measurement) input (VT) connections	To maintain the safety features of this product, a 3 Ampere time delay (T) fuse must be connected in series with the ungrounded/ non-earthed (hot) side of the supply input connected to the voltage measurement (VT) input of the instrument prior to installation. The fuse must carry a voltage rating appropriate for the power system on which it is to be used. A 3 Ampere slow blow UL Listed fuse in an appropriate fuse holder should be used in order to maintain any UL product approval.
	Voltage (CE units)	Removable Terminal Block, accepts #22-12 AWG (0.35 to 3.3mm2) wire, or terminal lugs up to 0.250” (6.35mm) wide. Standard 0.200” (5.08mm) header socket accepts other standard terminal types. Precautions must be taken to prevent shorting of lugs at the terminal block. A minimum distance of 1/8” (3mm) is recommended between uninsulated lugs to maintain insulation requirements. Recommended Torque: 10 In-Lbs, 1.13 N-m
	Voltage (non-CE)	Removable Terminal Block, accepts #22-12 AWG (0.35 to 3.3mm2) wire, or terminal lugs up to 0.325” (8.25mm) wide. Standard 0.200” (5.08mm) header socket accepts other standard terminal types. Precautions must be taken to prevent shorting of lugs at the terminal block. A minimum distance of 1/8” (3mm) is recommended between uninsulated lugs to maintain insulation requirements. Recommended Torque: 10 In-Lbs, 1.13 N-m
		Class I equipment to IEC61140: 1997

ETHERNET MODULE E1, E3 OPTION WITH H12 HOST

The CompactPCI™ high-speed Ethernet interface is available as an option for the M87x consolidated with the H12 host module (H12E1 or H12E3). The consolidated options meet or exceed all requirements of ANSI/IEEE Std 802.3 (IEC 8802-3:2000) and additionally meet the requirements of the EPRI Substation LAN Utility Initiative "Statement of Work" version 0.7. The Ethernet interface is also compliant with IEC 61850 Part 3 and Part 8-1 TCP/IP T-profile for physical layer 1 (Ethernet copper interface) and physical layer 2 (for with 100 Megabit fiber). These documents define an interface designed to inter-operate with other devices with little user interaction ("Plug-and-Play").

M87x instruments are offered with two versions E1 or E3:

- The E1 features a 10/100 Megabit (Mb) RJ45 (copper) interface (10BASE-T and 100BASE-TX) which automatically selects the most appropriate operating conditions via auto-negotiation.
- The E3 has the features of E1, plus a 100Mb fiber-optic port (100BASE-FX) operating at 1300nm (far infrared) using ST connectors.

All interfaces are capable of operating either as half-duplex (compatible with all Ethernet infrastructure) or full-duplex interfaces (which allow a potential doubling of network traffic). Note that only one port may be connected to a network at one time.

The 70 Series IEDs come preconfigured for TCP/IP interface with an IP address, a SUBNET mask, and a ROUTER (GATEWAY) address. They also have a preconfigured NSAP address for an OSI network. Configuration of these addresses may be accomplished by using the 70 Series Configurator, or via a front panel serial port using a terminal emulator such as HyperTerminalTM or ProCommTM.

If using the IEC61850 protocol the IP address may be configured from either the 70 Series Configurator software or from the IEC61850 IED Configurator software. A user radio button selection is provided on the 70 Series Configurator Identity page, giving a user the flexibility to decide which software tool will control the IP address configuration setting, which is loaded upon reboot. IP address configuration settings will be stored in either the INI file or MCL file. The INI files are loaded by the 70 Series Configurator and the MCL file is loaded by the IEC61850 IED Configurator.

The units are pre-configured for TCP/IP with an IP address/subnet mask/gateway address of:
192.168.0.254 / 255.255.255.0 / 192.168.0.1

and for OSI with an NSAP of:
49 00 01 42 49 09 01 01

The 70 Series IEDs use the following port numbers for each type of protocol:

Protocol	Port Number
DNP	20000 (TCP, UDP)
FTP (recommend passive mode)	20, 21 (TCP)
Modbus	502 (TCP)
MMS (UCA & 61850)	102 (TCP)
SMTP (electronic mail)	25 (TCP)
SNTP (network time sync)	123 (UDP)
Telnet	23 (TCP)

Features

- 10/100 Megabit auto-negotiable copper interface with RJ-45 connector (E1, E3)
- Optional 100 Megabit fiber optic interface with ST connector for 62/125um glass fiber (E3)
- Compliant to IEEE 802.3-1996 and IEEE 802.3u-1995
- Compliant to UCA Utility Initiative Statement Of Work Rev 7
- Compliant with IEC61850 Part 3 and Part 8-1 TCP/IP T-profile physical layer option 1 (copper)
- Compliant with IEC61850 Part 3 and Part 8-1 TCP/IP T-profile physical layer option 2 (100Mb fiber – E3 only)

Features Cont.

- Fully automatic port switching with manual override capability
- Two indicator LEDs
- Protected, utility-grade copper interface

Specifications

Ethernet Connection:

E1	10/100 Megabit (Mb) RJ45 (copper) interface (10BASE-T and 100BASE-TX)
E3	10/100 Megabit (Mb) RJ45 (copper) interface (10BASE-T and 100BASE-TX) 1300nm 100Mb fiber-optic port (100BASE-FX)

Indicator LEDs: E1: Activity, Link; E3: Activity, Duplex
Bus Interface: Standard 5V CompactPCITM Backplane
Power Requirements: 50mA @ 3.3Vdc and 500mA @ 5Vdc (supplied from backplane)

This product contains fiber optic transmitters that meet Class I Laser Safety requirements in accordance with the US FDA/CDRH and international IEC-825 standards.

Physical

Connections: RJ45 (copper), ST connectors (62/125um glass fiber)
Package: Option integrated into H12 host module (E1, E3 options)

DIGITAL INPUT/OUTPUT MODULE P30A, P31, P33

The high-speed Digital I/O module features 8 (P30A) or 16 (P31) inputs that are fully isolated from each other and the case. The terminals of 4 of these are shared with 4 output relays. Other than the terminals themselves, the output relay circuits are completely independent of the inputs. The P33 has no inputs and 8 output relays.

Because the output relay terminals are shared with inputs, they may be monitored to provide feedback verifying proper operation of output commands. Protection and control industry standard-type output relays ensure system reliability.

The inputs are jumper-selectable for input level and threshold (thresholds of 15Vdc or 70Vdc). The outputs are jumper-selectable for “normal” output state (Normally Open or Normally Closed) and for relay condition (energized or de-energized). The input LED indicator is green when an input is driven high, and the output LED is amber when an output is activated (relay activated).

The Digital I/O Module inputs can be read by the Host Processor Board and/or the Analog-Digital Signal Processor Board. Input transition times are time-stamped. Outputs can be turned on or off by the Host Processor based on commands received over communication links, or by internal states generated by energy pulses, recorders, etc.

The Analog-Digital Signal Processor Board reads the state of the digital inputs every time it samples the analog inputs, and the sample rate of the digital inputs is tied to the frequency of the analog inputs. The Waveform and Disturbance Recorders may be configured to record the status of the digital inputs.

Features

- Two input ranges, for nominal system voltages of up to 100V or from 100 to 300V
- Inputs protected against continuous overload to 300Vdc on low input range
- All Input / Output terminals protected with internal transient limiting devices
- Protection and control industry standard-type output relays and circuitry ensure system reliability
- Outputs on the P30A/P31 have “wrap-around” inputs to allow confirmation of circuit operation
- 2000Vac, 1min isolation, I/O to Case; 1500Vdc, 1min isolation, I/O to I/O
- Removable terminal block for ease of installation
- Two input ranges, for nominal system voltages of up to 100V or from 100 to 300V

Specifications

Inputs: 8 (P30A) or 16 (P31) uni-directional, isolated inputs (4 are shared with output relays) jumper selectable for voltage range. Input terminals have internal 510V clamp.

Low Input Voltage Range
- Input Range: 0 to 100Vdc
- Threshold Voltage: 15V dc +/-1V (at 25C)
- Input Resistance: 33kΩ

High Input Voltage Range
- Input Range: 0 to 300Vdc
- Threshold Voltage: 70Vdc +/-3.5V (at 25C)
- Input Resistance: 153kΩ

Input Channel-to-Channel Time Resolution: 200µs (maximum)

Outputs: 8 isolated outputs on P33; 4 isolated outputs, terminals shared with 4 inputs (P30A, P31); jumper selectable for Normally Closed (NC) or Normally Open (NO) operation and for energized or de-energized condition. Output terminals have internal 510V clamp.

Output Maximum Switched Current (Resistive)

Voltage	Tripping (C37.90 Resistive)	Continuous Carry	Break (Inductive)
24Vdc	30A	5A	8A
48Vdc	30A	5A	700mA
125Vdc	30A	5A	200mA
250Vdc	30A	5A	100mA

Input De-bounce Time: Selectable, from 60ns to 260s in 60 ns steps.

Output Operate Time (time from command by Host, does not include protocol delays)
- Assert (Close time with “N.O.” jumper): 8ms
- Release (Open time with “N.O.” jumper): 3ms

Input Delay Time (from terminals): <100µs

Indicator LEDs
- Inputs: Green, on when input voltage exceeds threshold.
- Outputs: Amber, on when relay coil is energized.

Isolation
- I/O Terminals to Case: 2000Vac, 1min
- I/O Channel to Channel: 1500Vdc, 1min

Input / Output Capacitance, any Terminal to Case: 1400pF

Power Supply Requirements: 3.3Vdc, 5Vdc, +/-12Vdc (supplied from backplane)

Hot Swap: P30A, P31 complies with Hot Swap specification PICMG 2.1 R1.0 for Basic Hot Swap (requires Host Processor reboot)

TRANSDUCER INPUT MODULE P40

The Transducer Input Module features 8 separate inputs each with two terminals, one which provides a unique return path for each input. This permits the inputs configured as current inputs to be series connected to multiple transducer input devices and inputs configured as voltage inputs to be parallel connected to multiple transducer input devices.

The inputs are jumper-selectable for three different transducer input formats. The inputs can be jumpered for either 0–1 mA or 4-20 mA current inputs or for 0–10V voltage inputs. Both the 0-1 mA and 0 -10 V formats are bipolar (bi-directional) such that they span (-)1mA to (+)1mA and (-)10V to (+)10V respectively. Each format allows for input over-range such that inputs exceeding the normal range can still be reported accurately. The reportable range for each input type is approximately: (+/-) 2.5 mA for 0-1mA inputs; (+/-) 12.5V for the 0-10V inputs; and 0 to 25mA for 4-20mA inputs.

Each transducer input can be independently configured for any of the three input formats. This permits one Transducer Input Module to be used to read eight analog inputs with any mix of the three standard current and voltage formats. Transducer Input Modules can only be ordered pre-configured for one standard input type (all inputs are pre-configured at the factory for one input type), however, each input on every Transducer Input Module is calibrated to support all format types. Changing an input's type is easy and only requires changing that input's jumper setting.

Each transducer input is sampled by a 24-Bit delta sigma analog to digital converter, adjusted by a factory set pre-stored gain and offset calibration constant, and then converted to a 16-Bit integer value. The Host Processor Board updates the transducer input values in the floating point database every 500msec by reading each input's 16-Bit integer value and converting it to a floating point value. By default the floating point value represents the actual current (in mA) or voltage (in volts) present at the input. The Host Processor can be configured (via the Mx70 Series Configurator software) to independently scale each transducer input's floating point value. The scaling is accomplished by assigning a floating point value to the extreme values of the transducer input's format.

Features

- Each input has jumper selectable ranges for support of 0 to (+/-)10 volt, 0 to (+/-)1mA, and 4-20mA transducer input formats
- All input terminals protected with internal transient limiting devices and spark gap protection
- Module meets CompactPCI Hardware Hot Swap specification
- Design includes local microcontroller with 24-bit sigma delta analog-to-digital converter
- Robust local microcontroller design incorporates local watchdog and continuously monitors offset and gain calibration constants integrity via checksum calculation
- Removable terminal block for ease of installation

Specifications

Inputs: 8 bi-directional, jumper selectable for voltage or current range. Input terminals have internal transorb clamp and 90V spark gap protection.

0 – 10V Voltage Range

Overload Range:	-12.5 V to +12.5 Vdc
Resolution:	0.381 mV
Input Resistance:	10KΩ

0 – 1mA Current Range

Overload Range:	-2.5 mA to +2.5 mA
Resolution:	0.0763 µA
Input Resistance:	500Ω

4 – 20mA Current Range

Overload Range:	0 mA to +25 mA
Resolution:	0.381 µA
Input Resistance:	50Ω

Common Mode Input Range +/- 9V, Input to Chassis

Common Mode Error
Vcm DC: 0.3% of FS @ 9Vp Common Mode
Vcm 50/60Hz AC: 0.1% of FS @ 9Vp Common Mode
Accuracy 0.25% of Full Scale Input

Data Update Rate (poll rate): 100 ms minimum (single P40 Transducer input module)
500 ms minimum (multiple P40 Transducer input modules)

Input Capacitance, any Terminal to Case: 470pF

Power Supply Requirements: 3.3Vdc, 5Vdc, +/-12Vdc (supplied from backplane)

Hot Swap: Complies with Hot Swap specification PICMG 2.1 R1.0 for Basic Hot Swap (requires Host Processor re-boot)

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