

ControlWave® EFM Standard Integrated Package

Emerson's ControlWave® EFM is intended for applications that require combined electronic flow computer (EFM), process control, and remote terminal unit (RTU) functionality in one integrated remote installation.

ControlWave EFM combines the capabilities of an advanced RTU with the convenient "one-box" packaging of a highly-integrated flow computer. Transducer assembly, solar/battery power system, and communication devices can all be specified as integrated components in the package.

Instead of expanding on a very limited chart replacement or flow computer, Emerson designed the ControlWave Micro platform as the heart of the package. Users will appreciate the processing capabilities that allow ControlWave EFM to handle all functions at sites, such as 4-run M&R stations. At the same time, power management minimizes power consumption, and keeps battery and solar panel costs under control.

Open card slots for communication or I/O distinguish this product and provide you with a great deal of flexibility in matching up with installation requirements.

ControlWave EFM is extremely effective in any of the following capacities:

- Monitoring and control of entire well site, including the well head, meter, separator, compressor, etc.
- Artificial lift and production optimization (such as Injection Control and Plunger Lift)
- Multiple-run M&R Station Automation—not only flow measurement but also run switching, flow/pressure control, control of odorizers and samplers, communication with a chromatograph, and communication on multiple networks.

ControlWave EFM Overview

Hardware/Packaging Features

- 32-bit, ARM 9 processor provides exceptional performance.
- Two processor selections are available: 33 MHz ARM 9 minimizes power consumption or the 150 MHz ARM 9 includes Ethernet.
- Multivariable transducer assembly is integrated in the instrument package and allows quick replacement as an independent component.



Using low-power electronics, the ControlWave Micro 4-slot chassis (shown above) or 8-slot chassis is the heart of the ControlWave EFM Standard Integrated Package (top).

- Three serial communication ports are standard.
- Two or six open card slots for communication and I/O expansion allow up to 10 serial ports or 96 I/O points.
- Mixed I/O cards provide cost effective I/O for RTU applications using only one or two card slots.
- Broad selection of modem and wireless communications are instrument package options.
- Integral 4-line LCD with 25-key keypad (optional) allows operators to change configurable parameters, on site, without packing a PC.
- Operating temperature range is -40 to 158°F (-40 to 70°C).

Firmware/Software Features

- ControlWave EFM is pre-programmed to meet API 21.1 requirements for a 4-run metering station with networking via BSAP or Modbus.
- Additional, standard application programs will be introduced on a continual basis.
- Using our ControlWave Designer, IEC 61131-3 programming environment, any user or third-party can modify the standard application or create a completely customized program and full support from Emerson is available, every step of the way.
- PC web style menu pages are pre-configured for all user operations.

Application Areas

ControlWave EFM is appropriate to all applications for combined flow computers, process controllers, and RTU products, including:

- Production wells
- Injection wells
- Production optimization applications
- Off-shore platforms
- Separation plants
- Compressor stations
- Storage facilities
- Transmission metering stations
- Distribution/LDC metering/gate stations

ControlWave EFM Standard Integrated Package Overview

ControlWave EFM is delivered in a fiberglass enclosure that has provisions for not only the electronics but also a display/keypad, DP/P/T transducer assembly, battery/solar power system, and a broad selection of modem and radio communications options.

Specifications – Package

- Housing Dimensions: 14 ½ in. H by 12 in. W by 8 ½ in. D (368 mm H by 305 mm W by 216 mm D)
- Clearance: Please allow at least 2.5 in (64 mm) space underneath for cabling
- Dimensions: MVT Wet End (optional): 3 in. H by 3 ¾ in. W by 2 ½ in. D (76 mm H by 95 mm W by 64 mm D)
- Weight: Minimum 26 lbs (11.8 kg)
- With Battery: 57 lbs (25.8 kg)

- Maximum w/Battery & Radio: 61 lbs (27.7 kg)
- Mounting: Pipe or wall-mounting is recommended; a kit for affixing to a 2 in. (51 mm) pipe or mast is included
- Solar Panel Mounting: All solar panels are delivered with all hardware necessary for 2 in. (51 mm) pipe or mast-mounting



Specifications – Operating Environment

- Wide operating power input voltage range of 4.9 to 16.0 Vdc
- System can be set for operation as either 6 Vdc nominal or 12 Vdc nominal jumper settings determine appropriate shutdown/start-up voltage levels
Note: Certain options, most notably standard model radios, require 12 Vdc.
- Operating Temperature Range: -40 to 158°F (-40 to 70°C); de-rated 2°C per 1000 feet when above 6600 feet-above-sea-level elevation
- Operating Humidity Range: 5 to 95% non- condensing
- Vibration Rating: Maintains proper operation while subjected to a 2.0g acceleration over 10-150 Hz and 1.0g acceleration over 150-2000 Hz
- RFI Susceptibility: In conformity with IEC 61000-4-3 (Level 2): 3V/meter - 80MHz to 1000MHz
- ESD: Field connected circuits meet IEC 61000-4-2 for ESD withstand capability up to 4KV
- NEMA Rating: NEMA 3R (NEMA 4x except with a battery vent)

Hazardous Area Approvals

- UL approved Non-incendive for operation in Class I, Division 2 Hazardous Areas

Performance

- Computation accuracy: 0.01% Corrected Flow, including all input values
- DP Reference accuracy: 0.075% URL
- SP Reference accuracy: 0.035% URL
- Pressure Effect on DP: 0.1% URL zero and 0.1% URL span
- Temperature Effects: 0.21% URL

Item Descriptions and Specifications

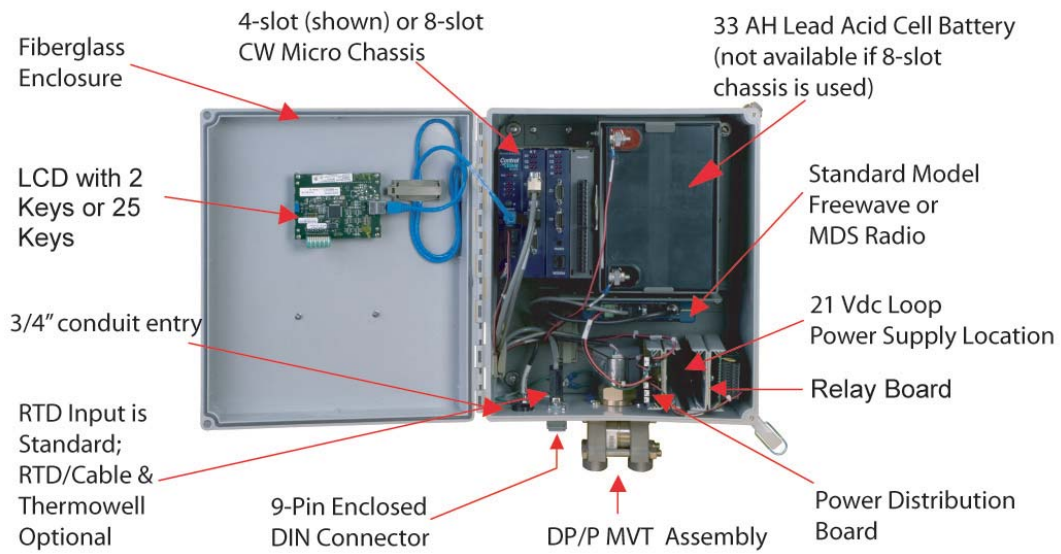
The integrated package is ordered using a model number specification.

Standard equipment includes fiberglass housing, 4-slot or 8-slot base chassis with CPU and System Controller, and the standard API 21.1 EFM application program. The model number additionally allows you to specify the following:

- Emerson's MVT "wet end" transducer assembly, which provides measurement of differential pressure and static pressure
- Bendable RTD assembly, pre-wired
- Thermowell
- 33 MHz low-power CPU or 150 MHz CPU with Ethernet
- Either a two-line LCD with two pushbuttons or a four-line LCD with 25-key keypad
- Hazardous area approval – either Class I Division 2 by component or for the Integral Package as a whole
- Internal, 12V, 33 AH battery with 30W or 40W solar panel and charger module.

Note: The internal battery and solar power systems are available **only** with the 4-slot chassis.

A Guided Tour of the Standard Integrated Package with Specifications



- Comm expansion or I/O cards in slot 3 and slot 4 of the chassis
- Choice of OEM modem and radio on comm expansion module; these are tightly integrated, embedded models.
- Choice of standard radio that is installed on a bracket in the Integral Package, not on the comm expansion module; standard radios are those that are commonly available from Freewave and MDS. Due to space limitations for wiring and connectors, the package is limited to one radio, whether it is an OEM or standard model.
- PolyPhaser surge suppressor
- 21 V dc/dc power supply—used to provide power for analog loops, but is not necessary if external loop power is provided or 4 – 20 mA loops are not used.
- Discrete output relay board
- Power distribution board—required if any of the following are also ordered: 21 Vdc loop supply module, Discrete output relay module, standard model radio.

Emerson's Sensor Assembly

Using the MVT in the standard integrated package is the easiest implementation for a single meter run; however, the standard application program also allows use of external transmitters, with or without the MVT.

Most multiple run systems use the MVT for the first run and external, multivariable transmitters for the additional meter runs.

A key feature of ControlWave EFM is that the MVT assembly can be removed and replaced, independently of all other components in the package.

If the MVT assembly requires a repair, you can change it out and continue operating with the electronics, including flow information, alarms and historical archives, all intact.



Emerson recommends that users practice of “depot level” service, in which the MVT assembly is removed and replaced at the shop rather than out at the site.

Each MVT assembly has a 9-digit part number, which can be used to specify a replacement part (a listing follows).

Cross Reference Between “ABC” Code in the Model Number and Emerson 9-Digit Part Number for Replacement MVT Assembly

CODE DP/PURL	PARTNUMBER
121150”/1000 psi	396531-01-6
122150”/2000 psi	396531-02-4
132100”/2000 psi	396531-04-0
141300”/1000 psi	396531-05-9
142300”/2000 psi	396531-06-7
2025psid/2000 psi	396531-07-5
20425psid/4000 psi	396531-09-1

Physical Specifications – MVT Assembly

- Flange Material: 316 SS
- Flange Bolt Material: 316 SS
- Diaphragm Material: 316 SS
- Fill Medium: DC 200 Silicone
- Flange Process Connections: ¼” NPT
- Connects to the System Controller card via a dedicated SPI bus cable.

Accuracy and Performance Specifications – MVT Differential Pressure and Static Pressure

- Combined effects of nonlinearity, non-repeatability and hysteresis at reference pressure and over the operating temperature range: DP: $\pm 0.075\%$ of Calibrated Span or 0.015% of URL, whichever is greater. SP: 0.035% of calibrated span or 0.1% of URL, whichever is greater.
- Temperature effect on Static and Differential pressure: $\pm 0.21\%$ URL maximum combined shift of zero and span with an ambient temperature change of 60°C (108°F).
- Static Pressure Effects on Differential Pressure: Zero error: $\pm 0.1\%$ URL, for a change in static pressure of 1000 psi; Span error: $\pm 0.1\%$ reading, for a change in static pressure of 1000 psi.
- Long Term Stability at Constant Conditions: $\pm 0.1\%$ URL/Year typical.

- Mounting position effect: ± 2 in H2O maximum, which can be calibrated out.
- Power Supply effect: $\pm 0.005\%$ of URL maximum for any change within specified input power supply voltage range.
- Ripple and noise: Per ISA 50.1 Section 4.6.

MVT Static Pressure Orientation

You can specify whether the static pressure sensor is oriented to the right or to the left from the point of view of a user looking at the front of the ControlWave EFM. Following the AGA3-1992 convention, we refer to the static pressure sensor location as the “upstream” (or “high side”) location.

Integral Enclosure and LCD/Keypad

You can choose between two aspects of the enclosure: whether a 4-slot or 8-slot ControlWave Micro chassis is installed and which display/keypad assembly is to be used.

Both display/keypad assemblies have identical, 4-line by 20 character liquid crystal displays and connect to the System Controller via a dedicated, CAT5 cable, which is delivered pre-wired.

Features – Display/Keypads

- 4-line by 20-character backlit liquid crystal display (LCD)
- Adjustable display contrast
- Membrane keys with tactile feedback
- Self-adhesive overlay mounts to the enclosure door or panel (Standard Integrated Package is delivered with this assembly installed on the door)
- Easy configuration via ACCOL III function block
- Scrolling display mode
- Adjustable timer turns off display when not in use
- The standard application program works with either display/keypad

Specifications – Display/Keypads

- Window size: 1.1 in. H by 3.1 in W (28 mm by 79 mm). Character size: 4mm H x 3mm W
- Dimensions: 2-button and 25-button versions have the same footprint: 7.4 in. H by 5.5 in. W (188 mm x 140 mm)
- Power consumption: Local Display: 2.5 mA @ 3.3V (0.008 watts); Remote Display/Keypad: 2.5 mA @ 3.3V (0.008 watts)
- Operating Temperature: -4 to 158°F (-20 to 70°C)

The 2-button display allows you to view site, configuration and process data. The screens are organized in a series of lists. You can select a list and then manually scroll through the data or define a “scroll list” and set the ControlWave EFM to automatically scroll through this list.

The 25-button Display/Keypad performs the same functions and additionally allows you to view and modify ControlWave EFM inputs, process variables, calculated variables, setpoints, tuning parameters, and outputs used in a measurement or control application.



Status bits include the alarm state, alarm acknowledge, control, and manual (Auto/Man). Providing access to such variable information allows you complete control over the process operation.

ControlWave Micro Chassis, CPU and 5 - 16 V System Controller

You can choose all combinations of the following:

- 4-slot or 8-slot CW Micro Chassis
- 33 MHz low-power CPU or 150 MHz CPU that includes Ethernet and larger memory module

Note: Internal battery and solar power options are not available with the 8-slot chassis.



2-button display example



25-button display example

Please remember that dedicated interfaces for the MVT Wet End, RTD, and LCD/ Keypad are all located on the System Controller. You need not allocate serial communication ports for any of these devices!

Specifications for CPU and System Controller

CPU

- 32-bit ARM 9 processor with 33 MHz or 150MHz clock rate
- Sleep mode for low-power applications
- The 150 MHz CPU also includes a keylock security switch
- Memory Models
 - 33 MHz CPU
 - Program Execution and Data Memory: 2 MB SRAM battery backed memory
 - File and Historical Archive Memory: 8 MB on-board flash
 - 150 MHz CPU
 - Program Execution: 64 MB SD RAM
 - Data Memory: 2 MB SRAM battery backed memory
 - File and Historical Archive Memory: 16 MB on-board flash
- LED status indicators – 6 failure status LEDs, Watchdog and Idle and communication LEDs
- Power consumption:
 - Chassis, 33 MHz CPU + System Controller + MVT Assembly + LCD/keypad: 7.2 mA at 12 Vdc minimum but varies based on the application program requirements. Assembly + LDC/Keypad: 7.2 mA at 12 Vdc minimum but varies based on the application program requirements.

- Chassis, 150 MHz Ethernet CPU + System Controller + MVT Assembly + LCD/Keypad: 102 mA.

System Controller

- LCD/Keypad interface
- RTD Interface
- LEDs for idle and watchdog
- 6 runtime diagnostic LEDs
- Power fail detection and recovery sequencer
- 4.9 to 16 Vdc power input can be configured via jumper (for shutdown sequencing purposes) as nominal 6 Vdc or 12 Vdc input.
- Operating Range: +4.5/4.9 V to +16.0 V (+6 V Input Supply) (Shutdown occurs at +4.72/4.33 V nominal); +9.6/10.3 V to +16.0 V (+12 V Input Supply) (Shutdown occurs at +10.29/9.56 V nominal)
- Output Voltage: +3.3 Vdc \pm 1%
- Output Current: 1 A Max. @ 3.3 Vdc
- Output Ripple P/P: +3.3 V Output: 10 mV
- Fusing: 1 A Slow Blow 5x20 mm fuse
- Surge Suppression: 16 V Transorb to DGND and Chassis Meets ANSI/IEEE C37.90-1978
- Terminations: Pluggable, maximum wire size is 16 gauge

Communication Ports – Base (Located on the CPU Card)

- Two RS-232 and one RS-485 serial communication ports with standard 9-pin male D-sub connectors on CPU module, supporting baud rates up to 115.2 KB
- 10/100 Ethernet Interface on the 150 MHz CPU using an RJ45 connector

Note: Additional communication ports are available on the Comm Expansion Module, which is installed in an I/O slot. Please refer to the discussion on I/O Slots 3 and 4 for further information.

ControlWave EFM Standard Application Program

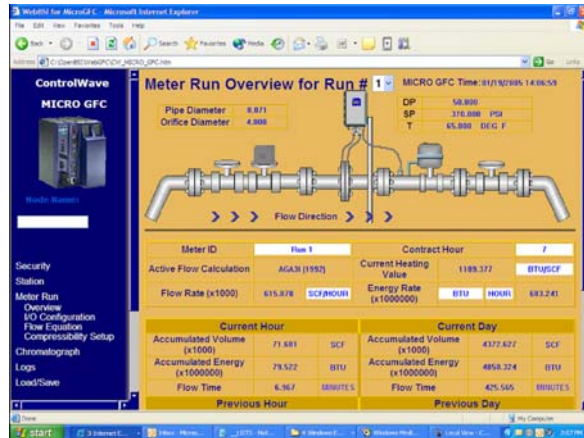
The ControlWave EFM ships with the 1 – 4 run M&R load program (.pro file) loaded in flash; the Flash Configuration Program (FCP) is also pre-loaded.

Overview of the Standard Application Program

- Uses pre-configured web style menu pages for user readings, configuration and maintenance—PC menu pages can be modified and new pages configured to work with a modified application load
- Uses the TechView Utility for calibration of all transducers, including the integral MVT and external transmitters.
- The PC menu pages, calibration utility, and program load are all included on the BSI Config CD.
- Standard configuration is a 4-run station
- Each run can be orifice, turbine, or ultrasonic meter type
- Flow calculations include:
 - AGA3-1992 with selectable AGA8 Gross or AGA8 Detail
 - AGA3-1985/NX-19
 - AGA7/NX-19
 - AGA7 with selectable AGA8 Gross or AGA8 Detail
 - Auto Adjust AGA7/NX-19
 - Auto Adjust AGA7 with selectable AGA8 Gross or AGA8 Detail
 - AGA9
- Allows you to select the integral MVT or an external transmitter for a single run configuration or as run 1 in a multiple run configuration. External transmitters can be interfaced via RS 485 or analog inputs.
- Includes run switching
- Includes an auto-selector, PID flow/pressure control algorithm per run or per station
- Resides on a BSAP SCADA network
- Supports samplers and odorizers
- Hourly Historical Data Log

The Hourly Data Log holds one record for every contract hour. Hourly logs hold 840 entries or 35 days; this ensures that the previous period of hourly data is always resident in ControlWave EFM flash memory. The system stores the following items in the Hourly Data Log:

- Corrected Volume
- Uncorrected Volume
- Accumulated Energy



The user interface to the Standard Application Program is via a series of straightforward web style menu pages.

- Average Static Pressure
- Average Temperature
- Average Differential Pressure
- Average Specific Gravity
- Average Heating Value
- Flow Time
- Uncorrected Count

Each log entry also contains the date and time. The ControlWave EFM has an Hourly Historical Log for each of four runs.

- Daily Historical Data Log

The Daily Data Log holds one record for every contract day. The contract hour may be changed by the user. The daily log holds 62 entries; this ensures that the previous calendar month of daily data is always resident in ControlWave EFM flash memory. The system stores the following items in the Daily Data Log:

- Corrected Volume
- Uncorrected Volume
- Accumulated Energy
- Average Static Pressure
- Average Temperature
- Average Differential Pressure
- Average Specific Gravity
- Average Heating Value
- Flow Time
- Uncorrected Count

Each log entry also contains the date and time. The ControlWave EFM has a Daily Historical Log for each of four runs.

- Periodic Historical Data Log

The periodic data log holds one record for every log interval. Log interval is 15 minutes. The Periodic Historical Data Log holds 1440 records, or four days of 15-minute data. The system stores the following items in the Periodic Historical Data Log:

- Flowing Differential Pressure
- Flowing Static Pressure
- Flowing Temperature
- Frequency

Each log entry also contains the date and time. The ControlWave EFM has a Periodic Historical Data Log for each of four runs.

- Audit Trail Alarm and Event Storage

The ControlWave EFM keeps an Audit Trail Buffer capable of storing the most recent 500 alarms and the most recent 500 events. Internally, these buffers are maintained separately to prevent recurring alarms from overwriting configuration audit data. Externally, they are reported to the user as a single entity. Both operate in a circular fashion with new entries overwriting the oldest entry when the buffer is full. The following circumstances generate an entry in the Audit Trail Buffer:

- Any operator change to a ControlWave EFM configuration variable
- Any change in the state of a ControlWave EFM alarm signal
- A system restart
- Certain other system events

- Includes a nominations function
- Allows you to select engineering units from a broad variety of measurements, including English and metric
- Interfaces to a chromatograph and provides energy throughput as well as composition information.
Note: This function requires a Comm Expansion Module so that port COM4 could connect to the chromatograph.
- Self Diagnostics

The ControlWave EFM periodically runs a series of diagnostics to verify the operational status of various system components. The tests include transducer parameters, main and backup battery voltages, software sanity checks, and other

indications of system health. An appropriate alarm is generated if any test fails.

Communication Port Configuration for the Standard Application Program

COM1

Local RS-232 port for configuration via a PC. Flash configuration is BSAP Slave, 115.2K baud rate. The PC port connector, that is accessible, externally, on the bottom of the Standard Integrated Package, is connected to this port on the ControlWave Micro CPU.

COM2

RS-232 Network port with flash configuration of BSAP Slave, 9600 baud. The standard application program is compatible with an external communication device or standard radio. If a standard radio is included, the Standard Integrated Package also includes a cable that connects this port, on the ControlWave Micro CPU, to the RS-232 port on the radio.

Notes on other Network Options: If an OEM radio or modem is to be used for networking, ports on the Comm Expansion Module would be allocated. If the Comm Expansion Module is in slot 3, COM6 is used for the radio and COM7 is used for the modem. A Comm Expansion Module installed in slot 4 uses COM10 for the radio and COM11 for the modem. Use of the OEM modem or radio requires a change to the standard application program as well as to the flash configuration for compatibility.

COM3

RS-485 port with flash configuration of BSAP Master at 9600 baud. The standard application program assumes that 3808 MVT multivariable transmitters for meter run measurement are to be interfaced to this port.

COM4

Located on the optional Comm Expansion Module, an RS-232 port with flash configuration of Modbus (ASCII) Master at 9600 baud. The standard application program assumes that this port is used to interface to a chromatograph. Allocation of COM4 assumes that the Comm Expansion Module is in Slot 3. If the module is installed in Slot 4, the corresponding port is COM8 and the flash configuration must be changed to reflect that.

COM5

Located on the optional Comm Expansion Module, an RS-485 port with flash configuration of Modbus (RTU) Master at 9600 baud. The standard application program assumes that this port is used to interface with multivariable transmitters, such as the 3808 MVT, using the Modbus protocol. Allocation of COM5 assumes that the Comm Expansion Module is in Slot 3. If the module installed in Slot 4, the corresponding port is COM9 and the flash configuration must be changed to reflect that.

Ports COM6 and up

Please note that these ports are not configured in flash or

in the standard application program. As explained in the descriptions for the other ports, flash configuration and, in some cases, a change to the standard application program, are required to use these ports.

Power System

You can specify the solar/battery power system. For most applications, the 33 Ampere-hour (AH) battery that is internal to the Standard Integrated Package can be matched with either a 30-watt or 40-watt, 2" mast-mounting solar panel.

Note that the internal battery and solar panel options are **not** available if the 8-slot chassis is used. An external power source must be used.

For power loading details, please refer to the Emerson product data sheet *ControlWave EFM Power System Sizing* (part D301327X012).

Other "red flags," which may tell you to specify a larger, external battery include the 150 MHz Ethernet CPU, multiple analog loops that operate from the 21 V dc/dc power supply rather than 12 V, and operation of a standard model radio with power constantly on rather than duty cycling.

The 40-watt panel may need to be selected for locations, which receive less than 2 sun-hours per day. Again, the *Power System Sizing* data sheet provides further information.

A charge regulator is always included with the solar panel. This component is shipped with the panel and must be installed inside a compartment on the back of the panel.

A peculiarity in selection of the power system is that the BP solar panels are FM approved for operation in Class I, Division 2 areas while the ControlWave EFM Standard Integrated Package, including the internal battery, is approved for the same by UL. Therefore, a UL-approved Standard Integrated Package is ordered by specifying the battery but *without* the solar panel. The solar panel is then specified by part number.

If the solar panel is included in the model number, hazardous area approval is only available at the component level. Refer to the *Hazardous Area Certification* section below.

Refer to the Emerson Process Management website (www.EmersonProcess.com/Remote) for data sheets on the following components in the power system:

- 33 AH Battery
- 30-Watt Solar Panel
- 40-Watt Solar Panel

Hazardous Area Certification

If Class I, Division 2 certification is chosen, the Standard Integrated Package is approved by UL as an instrument. Note that this certification strictly prohibits installation of any other hardware, not indicated by the model number, in the instrument enclosure. Wiring to and from the I/O, communication and power connections inside the enclosure, according to the *ControlWave EFM Instruction Manual* (part D301383X012), are, of course, allowed.

Even without certification of the instrument by model number, all the components have been UL-approved for installation in Class I, Division 2 hazardous areas (except the solar panels, which are FM-approved). Selecting certification by component level only allows you to install other hardware, such as a ControlWave Micro I/O card that is not in the model number specification, without the worry of violating the certification.

A Class I Division 2 Non-incendive hazardous area approval for the package as well as Industry Canada approval is also available. Note that the latter is a metrological approval for custody transfer installations. The Industry Canada version of ControlWave EFM differs from all other versions in a few areas:

- An external connector for a PC cable is not included. A blank filler plate is installed instead.
- To access a PC connector, you must open the front door. Using the clasp that is available in all models, installations are expected to use a security wire to lock the front door. The seal would need to be broken in order to open the door.
- The data plate is different in a number of line items in order to satisfy Industry Canada requirements.

Furthermore, Industry Canada approval applies to a specific model configuration. The entire model number **must be:** CWM-EFM-2-142-121-02-32100-07-02-00-00-00-00-1000-000.

Bendable RTD

You can choose a bendable RTD that is attached to the ControlWave EFM via an armored cable of 6-foot, 15-foot, or 25-foot length. The individual wires attach to a terminal block on the System Controller card.

Normally, this RTD would be used to provide the process temperature input but the standard application program also allows you to select an external temperature transmitter instead.

The bendable RTD is a "one size fits all" solution that is perfect for most applications and excellent for depot-level inventory situations in which the ultimate installation (and, therefore, the thermowell depth) is not necessarily known.

The 12" probe can quickly be inserted in a thermowell, whereupon you can tighten the included fitting to lock it in place and bend the excess length out of the way. Note that a thermowell is *always* required for this bendable RTD.

Note: If the RTD cable assembly is ordered with the model, it is shipped "pre-installed" to the Standard Integrated Package.

RTD Interface Information

The ControlWave EFM supports a three-wire platinum RTD per DIN 43760. The temperature, T, in degrees Celsius is calculated using the Resistance vs. Temperature Tables according to the DIN EN 60751 standard for Class A & B RTDs. The DIN EN 60751 equation is:

$$R(t) = R_0 * (1 + At + Bt^2)$$

where:

$$A = 3.9083 * 10^{-3} \text{ } ^\circ\text{C}^{-1}$$

$$B = -5.775 * 10^{-7} \text{ } ^\circ\text{C}^{-2}$$

$$R_0 = 100\text{ohms}$$

In addition, you may enter the R_{00} , A, and B coefficients of a custom calibrated RTD, another platinum standard or a different material (nickel, Balco, or copper).

During the RTD calibration, you can set the coefficients, restore the factory default for these coefficients, and calibrate the internal Reference resistor.

Specifications: RTD Input

These specifications are for the interface only, not including the RTD probe or wiring.

Note: The RTD probe interchangeability can add $\pm 0.7 \text{ } ^\circ\text{C}$ of uncertainty to the measurement).

- RTD Conversion Accuracy: $\pm 0.1 \text{ } ^\circ\text{C}$, or $\pm 0.1\%$ of reading, whichever is greater
- Ambient temperature effect on RTD measurement: $\pm 0.01 \text{ } ^\circ\text{C} / \text{ } ^\circ\text{C}$ max
- Long Term Stability at Constant Conditions: $\pm 0.25 \text{ } ^\circ\text{C} / \text{ month}$ max



Thermowell Options For RTD

For new installations or those lacking a thermowell, you can choose one of three lengths of thermowell for the RTD.

21 V DC/DC Power Supply

Since the Mixed I/O cards (refer to the next section) available in ControlWave EFM do not include loop power, this option provides power if 4 – 20 mA loops are to be used or if transmitters that require a voltage that is higher than the nominal, 12 Vdc supply voltage are to be powered.

This option converts the nominal, 12 Vdc input to 21.4 Vdc for field devices such as transmitters.

Note: Since the minimum input voltage for this option is 10.8 Vdc, it **does not** work with nominal 6 Vdc or 9 Vdc power sources.

While the 21 V dc/dc Power Supply is required for use with a 3508 transmitter, it is not necessary to provide power to the Emerson 2808 or 3808 MVT models. For those, we recommend that system power be routed to the transmitter. The Power Distribution Board is a good way to provide power routing to either of those transmitters. Furthermore, the 2808 and **3808** MVT operates using nominal 6 Vdc and 9 Vdc power sources.

The 21 V dc/dc Power Supply is not necessary if loop power is otherwise available or if there are no analog I/O points.

This option is a circuit board located on a Snap Track, which is installed onto the back panel in the lower, right-hand section of the Standard Integrated Package. The Power Distribution Board is **required** if you select the 21 V dc/dc Power Supply. This is another Snap Track option that is located nearby the 21 V dc/dc Power Supply.

Specifications: 21 V dc/dc Power Supply

- Input voltage: 10.8 to 16.0 Vdc
- Input current: Double the current draw of the output device (that is, 100 mA typical at 12 Vdc with a 50 mA load on the output; 140 mA max over temperature range with a 50 mA output load).
- Output voltage: 21.4 Vdc \pm 0.8 Vdc
- Output Current: 50 mA max
- Ripple/Noise: 20 mV max P-to-P
- Efficiency: 88% typical
- Fuses: F1=500 mA (slow blow) protects host power source; F2=350mA (fast blow) protects 21 V dc/dc Power Supply from short circuits on the output.

I/O Card Slots

These slots are open for you to select any combination of I/O modules can be used in slots 3 and 4.

For the Standard Integrated Package, we have provided in the model number specification, an assortment of modules we consider most appropriate to gas measurement applications and remote sites. However, any ControlWave Micro I/O modules can be installed.

Important Hazardous Area Certification Note:

If modules that are not listed in the model number are installed, certification is only allowed at the component level.

If the Standard Integrated Package is approved by instrument model number, installing such modules violates that approval.

Standard Application Program – Use of I/O Card Slots

Although the standard application program does not necessarily require any I/O slots to be occupied, it has been written to support a Comm Expansion Module in slot 3 and a Mixed I/O Module (6 DIO, 4 AI, 2 HSC and with or without 1 AO) in slot 4. You can configure the use of ports 4 and 5 on the Comm Expansion Module and any of the I/O points using PC menu pages.

ControlWave EFM I/O – Features

- Convenient pluggable local wiring terminations simplify installation.
- Mixed AI/AO, DI/DO and AI/DI/HSC/AO/ DO modules are very cost effective and reduce board count for low I/O applications.
- Sleep mode operation conserves power (Electronics are not operating while I/O Clock is off while I/O is in sleep mode; however, loop power remains active).

- Low-power loop current operations are also available to conserve power.
- Any module can plug into either slot.
- Terminal and wire covers neatly dress wiring and protect connections.
- Note that remote termination I/O modules are also available for use with the CW Micro chassis, although they are not included in the ControlWave EFM model number.
- Optional isolated ControlWave Micro I/O is available (but not in the model number).

Specifications

All I/O

- Surge protection meets C37.90-1978 and IEC 801-5
- Terminations are pluggable and accept a maximum wire size of 14 gauge
- Power consumption is stated for each I/O module measured at the 3.3 Vdc input supply (for an equivalent at 12 Vdc that considers efficiency, divide the stated figure by 3) and does not include loop power.

Mixed Digital Input / Output Module

- Number of points: 12 non-interrupting inputs and 4 outputs
- Input Voltage Range: Internally sourced dry contact input: 3.3 Vdc
- On state: >1.5 V, Off state: <1.5 V
- Input current: selectable 66 μ A for low-power applications or 2 mA for in-plant noise immunity
- Digital outputs: Open drain. 100 mA max @ 31 Vdc.
- Surge suppression: 31 Vdc transorb between signal and ground meets ANSI/IEEE C37.90-1978
- Input filtering: 15 ms time constant (contact bounce)
- Status indication: Optional plug-on LED board with per point status indicators
- Power consumption: Includes Dos

Status LEDs Disabled

1.3 mA @ 3.3 Vdc: 12 DIs OFF, CLK stopped

2.1 mA @ 3.3 Vdc: 12 DIs ON @ 66 μ A, CLK stopped

25.3 mA @ 3.3 Vdc: 12 DIs ON @ 2 mA, CLK stopped

3.6 mA @ 3.3 Vdc: 12 DIs OFF, CLK active

4.4 mA @ 3.3 Vdc: 12 DIs ON @ 66 μ A, CLK active

27.6 mA @ 3.3 Vdc: 12 DIs ON @ 2 mA, CLK active

Status LEDs Enabled

All DIs and DOs OFF: 33 μ A @ 3.3 Vdc

All DIs and DOs ON: add 32 mA @ 3.3 Vdc

Note: Specifications are at 3.3 Vdc; for a 12 Vdc equivalent, divide by 3.

Mixed Analog Input/Output Module

- Number of Channels: 6 AI or 6 AI/2 AO
- AI Resolution: 14-bit SAR ADC
- AO Resolution: 12-bit
- Input Configuration: Externally sourced. Single-ended inputs - jumper selectable 4–20 mA or 1–5 Vdc
- Input Impedance: 1 megOhm - 1 to 5 Vdc; 250 Ohms - 4–20 mA
- Input & output accuracy:
 - 0.1% of span at 25 °C
 - 0.2% of span -40 to 70 °C
 - 0.3% of span -40 to 70 °C (AO only)
- Surge suppression: 31 Vdc transorb between signal and ground meets ANSI/IEEE C37.90-1978
- Output configuration: Externally sourced 4-20 mA: 650 W for 24 Vdc source
1-5 Vdc: 5 mA max., 11 to 30 Vdc external source
- Power consumption:
 - 5.0 mA at 3.3Vdc for the module
 - External Power V to I (AI/AO at 20mA each): 24.3mA
 - External Power V to I (AI/AO at 5V @ 0mA): 4.2mA
 - External Power V to I (AI/AO at 5 V @ 5 mA): 9.2mA

High Speed Counter Module

- Number of points: 4
- Frequency Range: 0-10 kHz
Input Voltage Range: Internally sourced: 3.3 Vdc dry contact
- On state: >1.5 V, Off state: <1.5V
- Debounce: Yes (selectable)
- Input current: selectable 200 μ A for low-power applications or 2 mA for in-plant noise immunity

- Surge Suppression: 31 Vdc transorb between signal and ground meets ANSI/IEEE C37.90-1978
- Power consumption at 3.3 Vdc (divide by 3 to obtain equivalent at 12 Vdc):
 - 3.9 mA CLK stopped (All Inputs OFF)
 - 6.8 mA CLK running (All Inputs OFF)
- Additional Current per Input
 - 200uA or 2mA per HSCSET or HSCRST Input (ON State)
 - 2mA per ON LED
 - 33uA for LED circuitry

Mixed I/O Module

- Number of points: 4 AI, 1 AO (optional), 6 DI/DO, 2 High Speed Counter Inputs
- Base power consumption: 5 mA at 3.3 Vdc

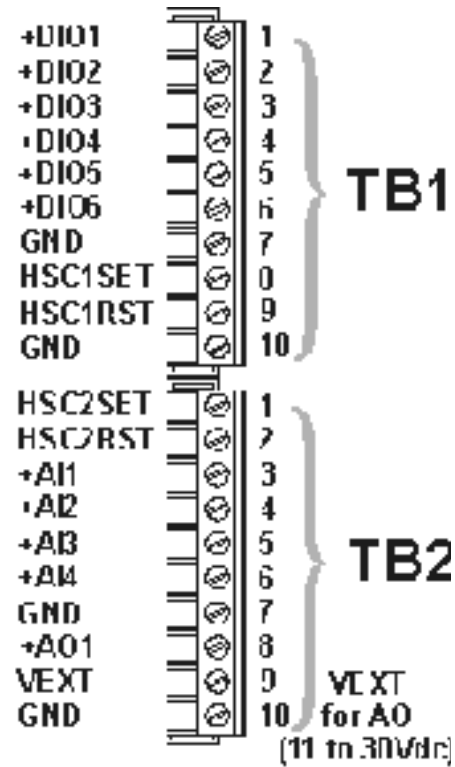
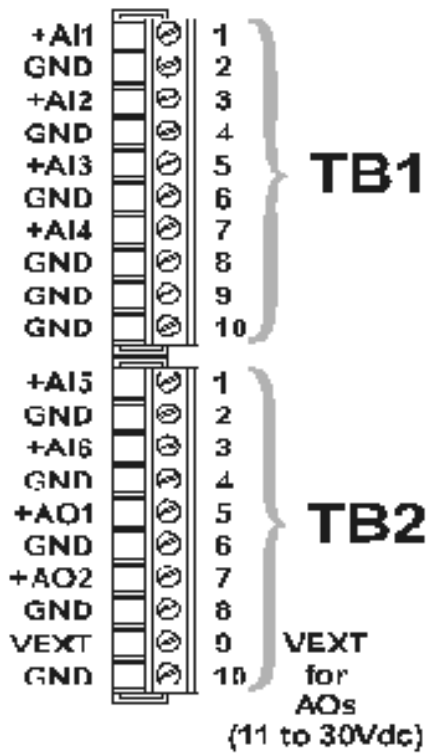
Digital Inputs and Outputs

- Number of points: 6 non-interrupting inputs or dry contact outputs
- Input Voltage Range: Internally sourced dry contact input: 3.3 Vdc
- On state: >1.5 V, Off state: <1.5V
- Input current: selectable 66 μ A for low-power applications or 2 mA for in-plant noise immunity
- Digital outputs: Open drain. 100 mA max @ 31 Vdc
- Surge suppression: 31 Vdc transorb between signal and ground
- Input filtering: 15 ms time constant (contact bounce)
- Status indication: Optional plug-on LED board with per point status indicators
- Power consumption for Digital Inputs/Outputs: add 66 mA or 2 mA for each point that is on.

Analog Inputs and Analog Output

- Number of Channels: 4 Analog Inputs and 1 optional Analog Output
- AI Resolution: 14-bit SAR ADC
- AO Resolution: 12-bit
- Input Configuration: Externally sourced. Single-ended inputs - jumper selectable 4–20 mA or 1–5 Vdc
Input Impedance: 1 megOhm - 1 to 5 Vdc; 250 Ohms - 4-20 mA
- Input & output accuracy:
 - 0.1% of span at 25 °C

- 0.2% of span -40 to 7°C
- 0.3% of span -40 to 7°C (AO only)
- On state: >1.5 V, Off state: <1.5V
- Debounce: Yes



Wiring Terminations for the Mixed Analog I/O Module

Wiring Terminations for the Mixed I/O Module

- Output configuration: Externally sourced
 - 4-20 mA: 650 Ohms for 24 Vdc source
 - 1-5 Vdc: 5 mA max., 11 to 30 Vdc external source
- Surge Suppression: 30 Vdc transorb between signal and ground
- Power consumption:
 - External Power V to I (AI/AO at 20 mA each): 24.3 mA
 - External Power V to I (AI/AO at 5 V @ 0 mA): 4.2 mA
 - External Power V to I (AI/AO at 5 V @ 5 mA): 9.2 mA

- Input current: selectable 175 mA for low-power applications or 2 mA for in-plant noise immunity
- Accumulator: 16-bit
- Surge Suppression: 31 Vdc transorb between signal and ground
- Power consumption: 200 µA or 2 mA per Input on state

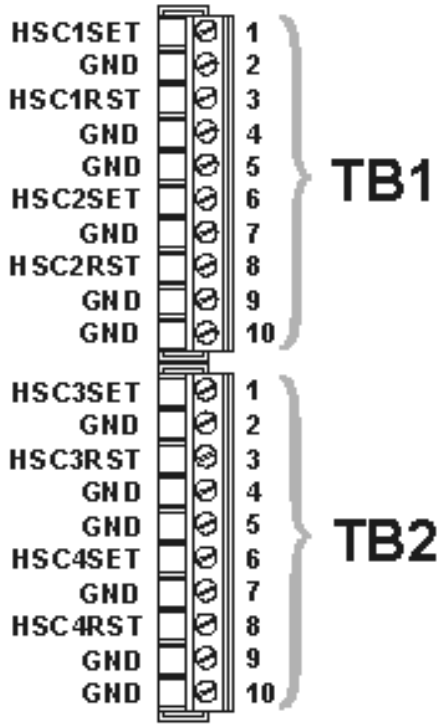
High Speed Counter Inputs

- Number of points: 2
- Frequency Range: 0-10 kHz
- Input Voltage Range: Internally sourced: 3.3 Vdc; Externally sourced: 3 Vdc to 24 Vdc

Isolated Analog Output Module

- Number of Channels: 4
- Output Configurations: 4-20 mA (650 max. drive) and 1-5 Vdc @ 5 mA max.
- D/A resolution: 12-bit
- Accuracy:
 - 0.1% of span @ 25°C for current output;
 - 0.1% +6% of span @ 25°C for voltage
 - 0.3% of span @ -40 to 70 °C for current
 - 0.3% +6% of span @ -40 to 70 °C for voltage

- Electrical Isolation: 500 Vdc channel to bus
- Settling time: 50 microseconds
- Surge Suppression: 16 Vdc transorb across output signals and (-) output to common.



Wiring Terminations for the High Speed Counter Module

- Power consumption - 4 inputs:
 - Analog current output: 3.0 watt
 - Analog voltage output: 1.3 watt

Communication Expansion Module

- One RS 232 and one RS 485 serial communication port up to 115.2 Kbaud. The RS-485 port is isolated to 500 Vdc.
- One optional internal dial-line modem
- One optional internal 900 MHz spread Spectrum radio
- The Communication Expansion Module installs in either I/O slot 3 or I/O slot 4.

Power Consumption Information for the Communication Expansion Module

Note: To size a 12 Vdc power system and account for efficiency in dc/dc conversion, please divide current

draw at 3.3 Vdc by 3 to convert to current draw at 12 Vdc.

- Base current draw: 6 mA at 3.3 Vdc
- RS-485 port driver: 3 mA at 3.3 Vdc
- RS-232 port driver: 6 mA at 3.3 Vdc
- OEM modem, typical: 180 mA at 3.3 Vdc
- OEM modem, sleep: 88 mA at 3.3 Vdc
- Freewave radio, transmit: 500 mA at 12 Vdc
- Freewave radio, receive: 86 mA at 12 Vdc
- Freewave radio, idle: 21 mA at 12 Vdc
- Freewave radio, sleep: 5 mA at 12 Vdc

Power Distribution Board

- This option organizes the power wiring inside the enclosure.
- The Power Distribution Board is required if any of the following is selected:
 - 21 V dc/dc Loop Power Supply
 - Relay Board
 - Standard Model Radio

The Power Distribution Board is pre-wired to all the above listed items, as well as to the solar panel, the battery, and the System Controller in the ControlWave Micro 4-slot chassis.

The Power Distribution Board is located on the leftmost snap track in the lower right-hand area, inside the enclosure.

Relay Board

The Relay Board is another snap track option located nearby the Power Distribution Board.

You can select this option if on/off control devices operate under conditions that are higher than the 100 mA/35 Vdc ratings of the MOSFETS on the ControlWave Micro discrete outputs.

Four solid state relays (SSRs) are included, organized in a Form C configuration corresponding to two discrete outputs. You must specify in either slot 3 or slot 4 an I/O card with two or more discrete outputs. Note that the first two discrete output points are wired to the relay board.

The Form C relay output signals can be configured via on-board jumpers, for opposite or identical conditions:

- Both Normally Open (NO) or Normally Closed (NC)
- One Normally Open with the other Normally Closed

Specifications: Relay Board Terminations

- Pluggable terminal block; maximum wire size is 14-gauge
- Input Requirements
 - Power Source Range: 3-15 Vdc
 - SSR Input Impedance: 400 Ohms
 - Maximum Sink Current from DO point MOSFET: 20 mA (both SSRs in Normally Closed mode)
 - Minimum Current Load: 100 mA
- Output Requirements
 - Contact Ratings: 3-60 Vdc
 - Maximum Current: 3 Amps @ 25°C or 1.5 Amps @ 70°C

If the Relay Board is selected, the Power Distribution Board is required and connections between the two are pre-wired.

Switched Network Modem

You can specify whether any modems are included. Physically, an OEM modem chip is installed on a Comm Expansion Module, which is located in I/O slot 3 or 4. Naturally, the Comm Expansion Module must also be specified and, if two modems are specified, two Comm Expansion Modules must also be included.

If two Comm Expansion Modules are specified but only one modem is specified, the modem is installed on the Comm Expansion Module in I/O slot 3. Please remember that a Comm Expansion Module can include both an OEM modem and OEM radio.

Please keep in mind that the modem **cannot** be added *after* shipment if UL approval is by instrument model number (but can be if approval is at the component level, only). We strongly urge you to order the modem in the model number so it is installed at the factory before shipment.

For replacement purposes or for later add-on, the modem kit part number is 396582-03-6.

Power consumption specifications for the modem are listed under the description of the Communication Expansion Module (prior page).

PolyPhaser Option for Radio

If a radio is specified, you can select whether a PolyPhaser surge protector is also included. Emerson always recommends the PolyPhaser.

Radio Option

Due mainly to space constraints for connections on the bottom panel, the Standard Integrated Package is limited to one radio.

The embedded OEM radio and standard model radios are available.

Embedded OEM radios are tightly coupled spread-spectrum models, which, like the modem, are installed on the Comm Expansion Module. If two Comm Expansion Modules are selected, the OEM radio is installed on the module in I/O slot 3. A modem and radio can coexist on the same Comm Expansion Module.

Like the modem, the OEM radio can be added later to the Comm Expansion Module, but **only** if you select hazardous area approval at the component level, **not** by instrument model number. Again, we strongly urge you to order the radio in the model number so it is installed at the factory before shipment.

Freewave radio kits are available (part number 396582-02-8).

Standard radios are popular models offered by Freewave and MDS. A broad selection is available.

Since some users prefer to procure the radios separately, Emerson offers “radio-ready” configurations for each of the standard models. Radio-ready models include everything except for the radio; a mounting bracket as well as all cables and connections are in place. The user or integrator/installer just mounts the radio to the bracket and makes connections.

Note: It is important to match the radio-ready configuration with the specific radio you expect to install: cables and connections for the antenna, RS-232 port, and power can all vary by radio mode.

For specifications on the radios, please refer to the Emerson Process Management website (www.EmersonProcess.com/Remote), where individual data sheets are available in pdf format.

Power Consumption Information for Standard Radios

For OEM radio power consumption, please refer to the description of the Communication Expansion Module.

- Freewave FGR Spread Spectrum Radio Figures at 12 Vdc:
 - Receive: 75 mA
 - Transmit: 500 mA
 - Idle: 20 mA
 - Sleep: 5 mA

- MDS TransNet 900™ Spread Spectrum Radio Figures at 13.8 Vdc:
 - Receive: 115 mA
 - Transmit: 510 mA
 - Sleep: 8 mA
- MDS models 4710 and 9710 Licensed, UHF Radios with figures at 13.8 Vdc:
 - Receive: 125 mA
 - Transmit: 2000 mA
 - Sleep: 15 mA
- MDS entraNet 900™ IP Radio Figures at 13.8 Vdc:
 - Receive: 100 mA
 - Transmit: 510 mA
 - Sleep: 7 mA
- MDS iNet 900™ Ethernet/IP Radio Figures at 13.8 Vdc:
 - Receive: 203 mA
 - Transmit: 580 mA

Accessories

DB-9 Cable

The DB-9 cables are null modem, 9-pin female to 9-pin female, which match up to the weatherproof hood assembly on the bottom of the ControlWave EFM enclosure.

10-foot Cable – p/n 396647-01-4

25-foot Cable – p/n 396647-02-2

TeleFlow Cable

The TeleFlow cables match up to the circular, Alden connector, which ships with the ControlWave EFM products.

10-foot Cable – p/n 395402-01-8

25-foot Cable – p/n 395402-02-6

TeleFlow Cable Adapter

An adapter is available to match up the TeleFlow PC cable so it can be used with the DB-9 connector, which was originally used on ControlWave EFM. Users can plug the circular connector, on the existing cable, to the adapter, which, in turn, plugs into the DB-9 connector inside the weatherproof hood on the bottom of the ControlWave EFM enclosure.

Adapter – p/n 395694-01-9

Standard Application Program and PC Menu Pages

ControlWave EFM comes pre-loaded with the Standard Application Program (.pro file) in flash. However, the PC menu pages are not loaded in flash but are available either via the Emerson Process Management website or on the BSI Config DVD (part number 395575-02-8), which also contains the LocalView calibration tool as well as a copy of the Standard Application Program.

If you want to modify the Standard Application Program, it is available as source code. Please contact Emerson's Remote Automation Solutions Application Services department for further information.

Product Family Compatibility

ControlWave EFM is compatible with Emerson's ControlWave family. It is fully software compatible with ControlWave GFC, ControlWave Micro, and the ControlWave Process Automation Controller (PAC). The ControlWave PAC provides the highest I/O capacity and supports up to three Ethernet ports as well as redundancy.

This family compatibility is a major benefit to users whose operations include a number of larger installations in addition to those that require flow computers. ControlWave family products are capable of all measurement and control (M&C) functions at sites such as major, custody transfer metering stations, compressor stations, off-shore platforms, processing plants, and storage facilities.

You can not only appreciate the similarity in much of the hardware but will also find the documentation, networking, and software compatibilities to be very favorable to their asset management.



The ControlWave family of products

Open Standards

Only ControlWave brings the perfect combination of industry standards to minimize learning, engineering, and implementation costs.

By adhering to such industry standards as Ethernet, TCP/IP, Microsoft Windows®, COM/DCOM, FTP, OLE, and ActiveX®, ControlWave can achieve the highest degree of openness in control system architecture and bring the optimal process efficiency and productivity needed to ensure a successful system implementation.

ControlWave Designer with ACCOL III

To minimize your engineering and development time, Emerson has adopted the international standard for controller programming, IEC 61131-3. ControlWave Designer is a fully IEC 61131-3-compliant programming environment for the ControlWave family of products. ControlWave Designer includes all five IEC 61131-3 process languages for batch, continuous and discrete control: Function Block Diagram, Structured Text Sequential Function Chart, Ladder Logic Diagram and Instruction List.

ControlWave Designer includes an extensive library of more than 200 basic IEC 61131-3 functions and function blocks common to many IEC 61131-3 based products. These include:

- Flip-flop, counters and Timers
- Ladder diagram functions (coils and contacts, etc.)
- Numerical, Arithmetic & Boolean functions (Sine, Cosine, Add, Sub, Square Root, And, Or, etc.)
- Selection & Comparison (Min, Max, Greater than, Equal, Less than, etc.)
- Type conversions (integer to real, Boolean to Word, etc.)

ACCOL III

In addition to the basic functions and function blocks, ControlWave Designer brings the benefit of many years of experience in measurement and SCADA to the ACCOL III function block library. ACCOL III includes over 60 function blocks that are valuable for use in oil & gas, water & waste water, and process measurement & control applications. Further, ACCOL III is designed to take full advantage of the significant features ControlWave offers.

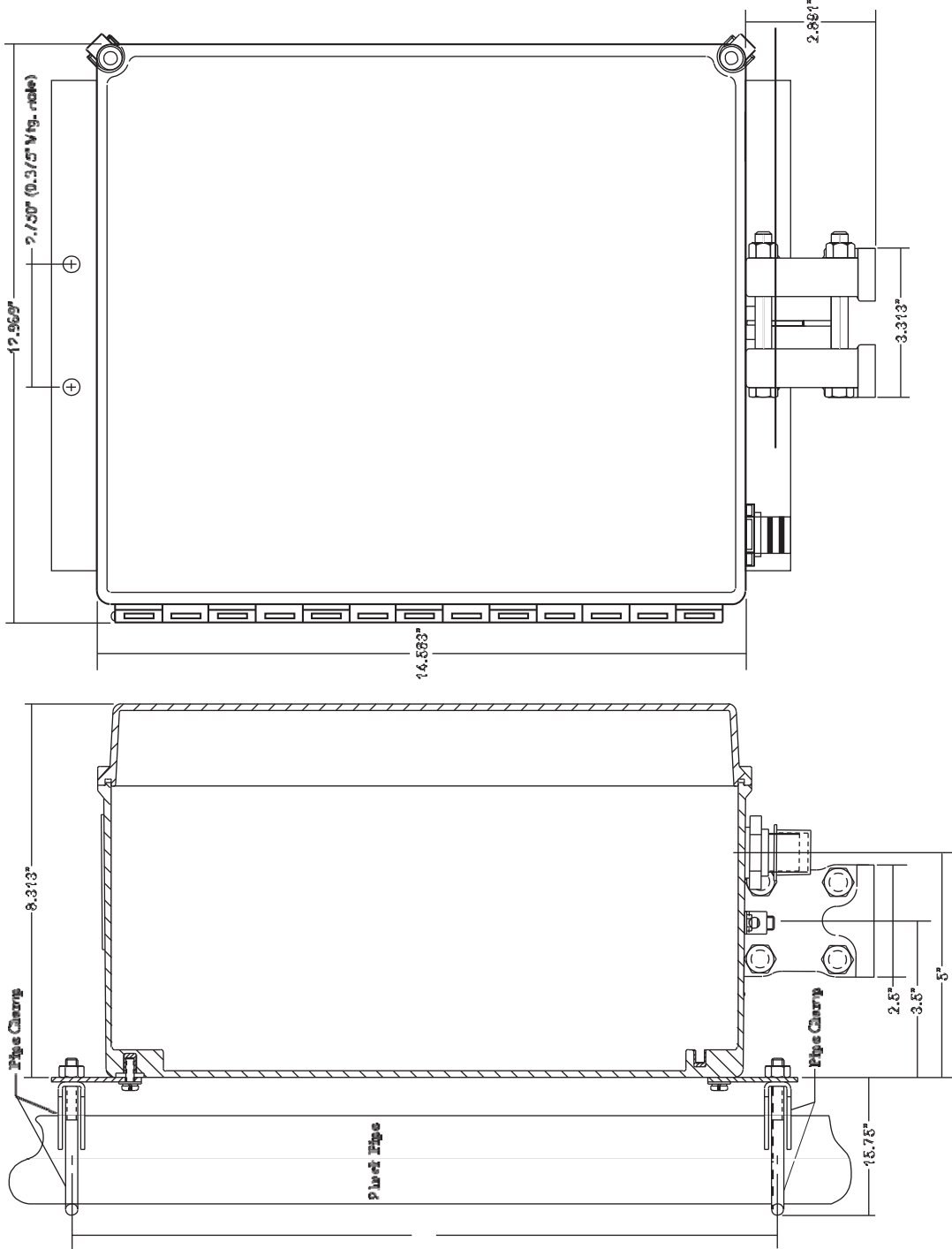
Briefly, this library includes function blocks for:

- AGA gas flow and API liquids calculations
- Audit, Archive, and File Handling
- Average, Compare, and Totalize

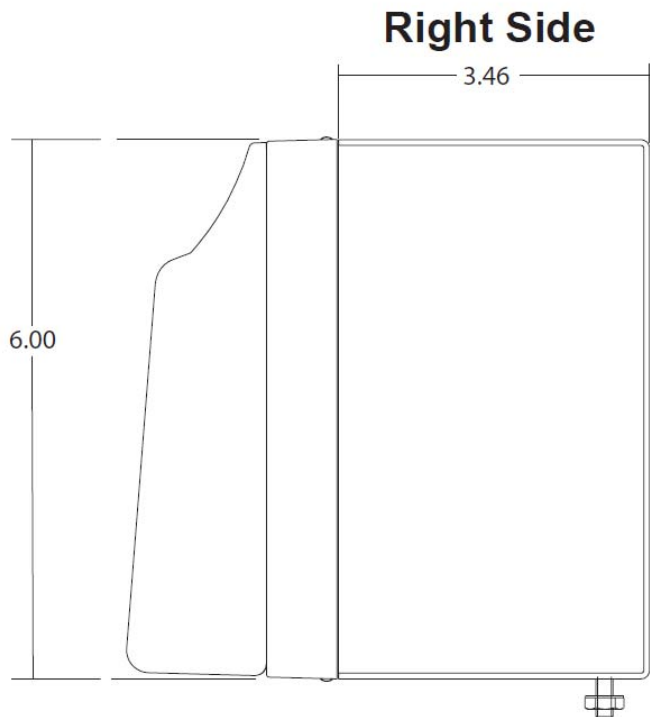
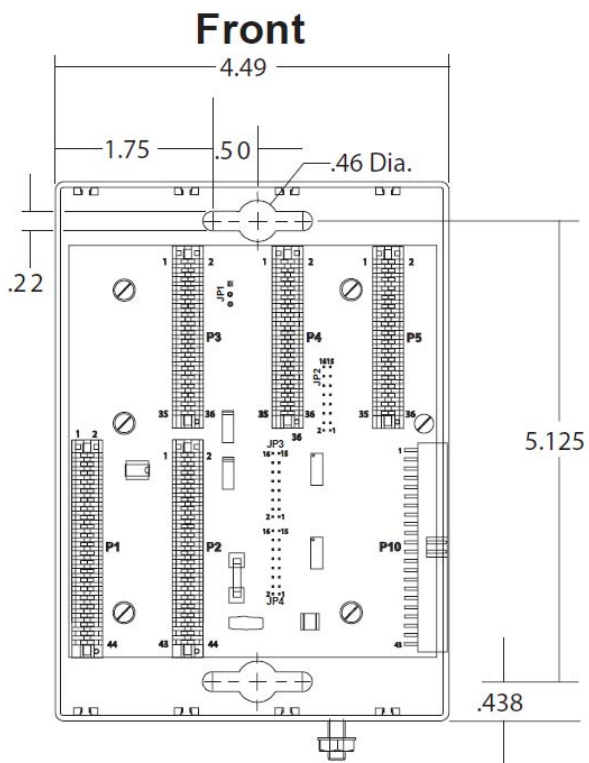
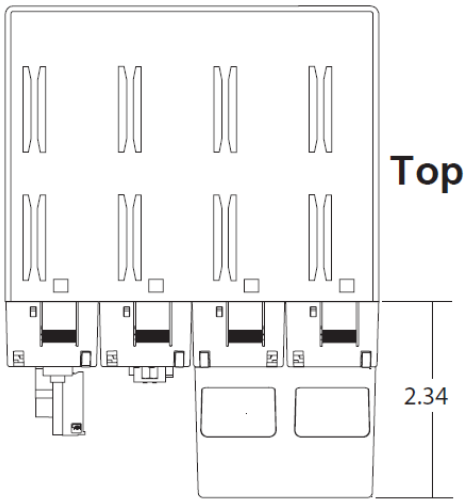
- Scheduling and Sequencing
- PID and Lead/Lag

Additionally, in the event of a communication interruption, ControlWave ensures data integrity by storing critical time-stamped alarm and historical data in the controller memory. This data is then securely retrieved when communication is restored.

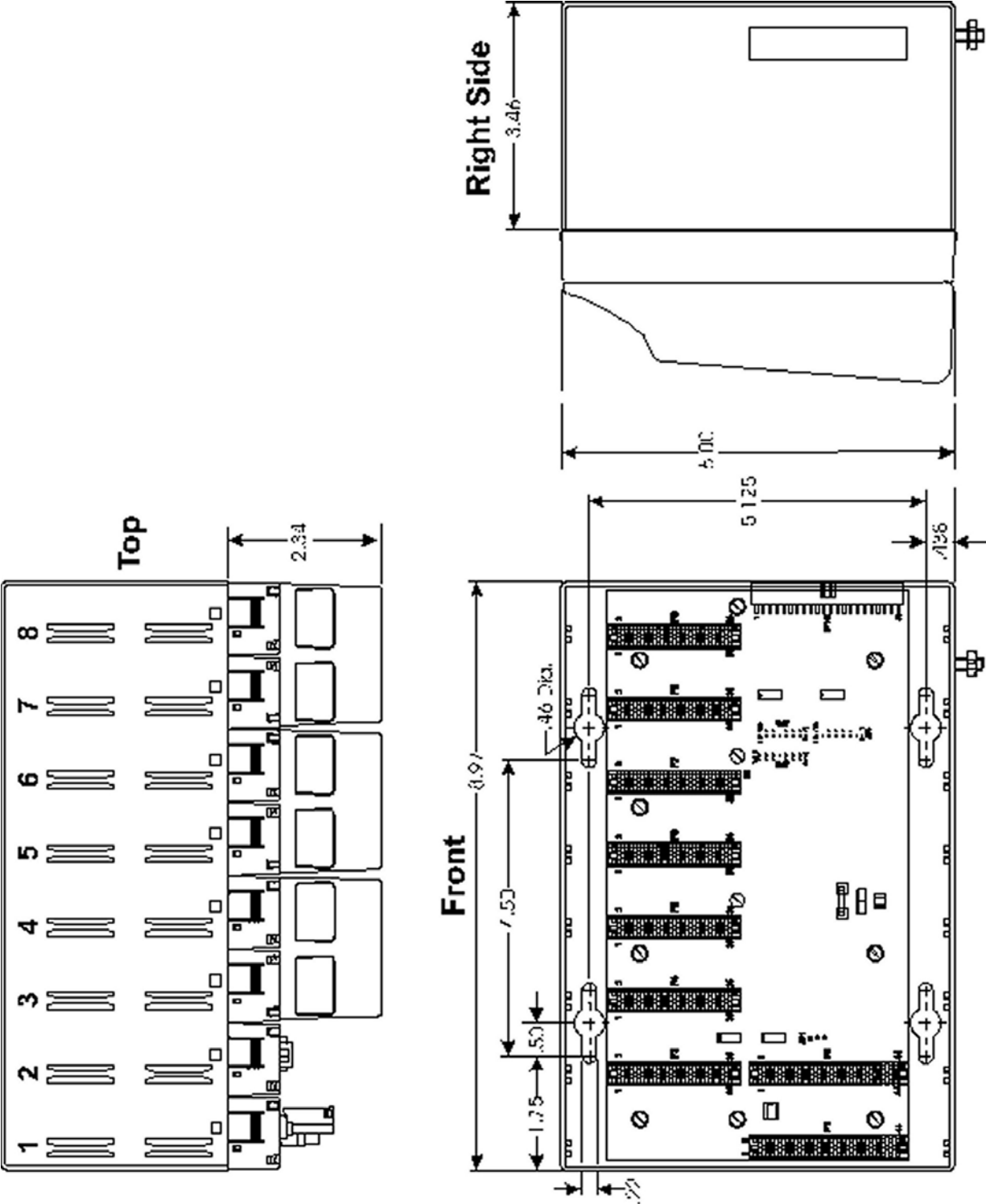
Dimensions – Standard Integrated Package




ControlWave Micro 4 slot Chassis



ControlWave Micro 8 slot Base Chassis



Approvals		
Miscellaneous Approvals	RoHS2	RoHS (2) EU Directive 2011/65/EU: This product may be considered out-of-scope when used for the intended design purpose in a Large Scale Fixed Installation (LSFI). Consult https://www.emerson.com/compliance for up-to-date product information.
	RoHS (China)	

For customer service and technical support, visit www.EmersonProcess.com/Remote/Support.

**Global Headquarters,
North America, and Latin America:**

Emerson Process Management
Remote Automation Solutions
6005 Rogerdale Road
Houston, TX 77072 U.S.A.
T +1 281 879 2699 | F +1 281 988 4445
www.EmersonProcess.com/Remote

Europe:

Emerson Process Management
Remote Automation Solutions
Unit 8, Waterfront Business Park
Dudley Road, Brierley Hill
Dudley UK DY5 1LX
T +44 1384 487200 | F +44 1384 487258

Middle East/Africa:

Emerson Process Management
Remote Automation Solutions
Emerson FZE
P.O. Box 17033
Jebel Ali Free Zone – South 2
Dubai U.A.E.
T +971 4 8118100 | F +971 4 8865465

Asia-Pacific:

Emerson Process Management
Remote Automation Solutions
1 Pandan Crescent
Singapore 128461
T +65 6777 8211 | F +65 6777 0947

© 2007–2017 Remote Automation Solutions, a business unit of Emerson Process Management. All rights reserved.

This publication is for informational purposes only. While every effort has been made to ensure accuracy, this publication shall not be read to include any warranty or guarantee, express or implied, including as regards the products or services described or their use or applicability. Remote Automation Solutions (RAS) reserves the right to modify or improve the designs or specifications of its products at any time without notice. All sales are governed by RAS terms and conditions which are available upon request. RAS accepts no responsibility for proper selection, use or maintenance of any product, which remains solely with the purchaser and/or end-user.