



GE Industrial Systems

EPM 2000

Power Metering System

INSTRUCTION MANUAL

Manual P/N: 1601-0156-A2
Manual Order Code: GEK-106556A
Copyright © 2005 GE Multilin



GE Multilin

215 Anderson Avenue, Markham, Ontario
Canada L6E 1B3

Tel: (905) 294-6222 Fax: (905) 201-2098

Internet: <http://www.GEmultilin.com>

Customer Service and Support

Customer service and support is available 24 hours a day, 7 days a week. Please have the model, serial number and a detailed problem description available. If the problem concerns a particular reading, please have all meter readings and settings available.

For customer or technical assistance, call: 1-888-GE4SERVICE (1-888-434-7378)

Product Warranty

GE warrants all products to be free from defects in material, workmanship and title and will be of the kind and quality specified in GE's written description in the manual. The foregoing shall apply only to failures to meet said warranties, which appear within one year from the date of shipping. During the warranty period, GE will, at its option, either repair or replace any product that proves to be defective.

Limitation of Warranty

This warranty does not apply to defects resulting from unauthorized modification, misuse or use for any reason other than electrical power monitoring.

OUR PRODUCTS ARE NOT TO BE USED FOR PRIMARY OVER-CURRENT PROTECTION. ANY PROTECTION FEATURE IN OUR PRODUCTS IS TO BE USED FOR ALARM OR SECONDARY PROTECTION ONLY.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ENERCON SHALL NOT BE LIABLE FOR ANY PENAL, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING FROM ANY AUTHORIZED OR UNAUTHORIZED USE OF ANY ENERCON PRODUCT. LIABILITY SHALL BE LIMITED TO THE ORIGINAL COST OF THE PRODUCT SOLD.

Statement of Calibration

Our instruments are inspected and tested in accordance with specifications published by an independent testing facility. The accuracy and calibration of our instruments are traceable to the National Institute of Standards and Technology through equipment that is calibrated at planned intervals by comparison to certified standards.

Disclaimer

The information presented in this publication has been carefully checked for reliability; however, no responsibility is assumed for inaccuracies. The information contained in this document is subject to change without notice.

CONTENTS

| | |
|--|----|
| 1. OVERVIEW | 6 |
| 1.1. Physical Description | 7 |
| 1.2. Front Panel | 7 |
| 1.2.1. The Indicators | 8 |
| 1.2.2. The Keys | 9 |
| 1.2.2.1. Keys Example | 11 |
| 1.3. EPM 2000 Technical Specs | 11 |
| 1.3.1. Main Features | 11 |
| 1.3.2. Standard Measurements | 12 |
| 1.1.1.1. Accuracy | 12 |
| 1.3.3. Auxiliary (Control) Power Supply | 13 |
| 1.3.4. Front Panel Display | 13 |
| 1.3.5. Dimensions & Shipping | 13 |
| 1.3.6. Environmental Conditions | 13 |
| 1.3.7. Installation & Input Ratings | 13 |
| 1.3.8. Safety Construction | 14 |
| 2. QUICK START GUIDE | 15 |
| 2.1. Keypad Operation | 15 |
| 2.1.1. Auto-Scroll | 18 |
| 2.1.2. TURBO key | 19 |
| 2.2. Setup (Program) | 20 |
| 2.2.1. Editing the Setup | 21 |
| 2.2.2. Notes on the Energy Integrator | 26 |
| 2.2.2.1. Integrator Overflow | 26 |
| 2.3. Summary | 27 |
| 3. AC POWER MEASUREMENT | 28 |
| 3.1. Three-Phase Systems | 28 |
| 3.2. Consumption & Poor PF | 29 |
| 3.3. “3D” kVA Measurement | 29 |
| 4. MECHANICAL INSTALLATION | 30 |
| 4.1. Installation Process | 33 |
| 4.1.1. Panel Mounting for New Installations | 33 |
| 4.1.2. Location | 33 |
| 4.1.2.1. Usage | 33 |
| 4.1.2.2. Panel Considerations and Environment | 33 |
| 4.1.2.3. Viewing | 34 |
| 4.1.3. Mounting | 34 |
| 5. ELECTRICAL INSTALLATION | 35 |
| 5.1. Auxiliary (Control) Power Supply | 36 |
| 5.2. Potential Transformers and Current Transformers | 36 |
| 5.2.1. PT, CT Wiring Considerations | 36 |
| 5.3. Voltage Signal Connections | 37 |
| 5.3.1. PT Connections | 37 |
| 5.3.2. Selecting the Voltage Fuses | 37 |
| 5.4. Current Signal Connections | 37 |
| 5.4.1. CT Connections | 38 |
| 5.4.2. CT Polarity | 38 |
| 5.4.2.1. CT Connection Reversal | 39 |
| 5.5. Setup – System Type | 39 |
| 5.6. Phase Labels | 39 |

| | | |
|---------|-------------------------------|----|
| 5.7. | Connection Diagrams | 39 |
| 5.7.1. | EPM 2000 Rear Panel | 40 |
| 5.7.2. | Three Phase 3 Wire Delta | 41 |
| 5.7.3. | Three Phase 4 Wire Star (Wye) | 42 |
| 6. | COMMUNICATION INSTALLATION | 43 |
| 6.1. | RS-485 | 43 |
| 6.2. | Repeaters | 45 |
| 6.3. | Factory Settings | 46 |
| 6.4. | Modbus Registers | 46 |
| 6.5. | Register Map | 47 |
| 6.5.1. | RMS Total/Average Block | 47 |
| 6.5.2. | RMS Phase A Block | 47 |
| 6.5.3. | RMS Phase B Block | 48 |
| 6.5.4. | | 48 |
| 6.5.5. | RMS Phase C Block | 48 |
| 6.5.6. | Forward Integrator Block | 49 |
| 6.5.7. | | 50 |
| 6.5.8. | Favorite Block | 50 |
| 6.5.9. | | 51 |
| 6.5.10. | Display-Only Parameters | 52 |

1. OVERVIEW

The EPM 2000 Digital Power Meters offer comprehensive Three-Phase Electrical Instrumentation and load management facilities in a compact and rugged package.

To get the best out of your investment, we suggest that you take a few moments to review this Manual. This Chapter contains the main operating instructions. The remaining Chapters explain the Installation and Setup steps before the Meter is ready for use.

The EPM 2000 is a universal meter. Before use, please program the SYS (measurement system configuration), PT and CT ratios through the front panel keys. Otherwise, it will read your system incorrectly.

GE stands behind your EPM 2000 products with complete User Support and Service. If the need arises, please do not hesitate to contact us at 1-888-GE4SERVICE (1-888-434-7378).



Figure 1-1. The EPM 2000 Digital Power Meter.

1.1. Physical Description

FRONT: The front panel has 3 rows of 4 digits / characters each, with auto scaling “K” kilo, “M” Mega and “-” negative indications. The “kilo” and “Mega” indications lit together show Giga readings. Load bar graph on right side of the display gives the indication of consumption in terms of the %Average load. Five smart-keys make navigating the parameter set very quick and intuitive for viewing data and configuring (Setup) the EPM 2000.

REAR: The voltage and current terminals and the communication port are located on the back of the meter.

1.2. Front Panel

The front panel contains the following indicators and controls:

- Three rows of Numeric displays, 4 digits each that display three RMS parameters simultaneously, or one Energy Parameter. The displayed readings update every second.
- For each row: Kilo, Mega (Kilo + Mega = Giga) indicator and a Negative(-) indicator.
- Load bar graph gives the indication of consumption in terms of the %Aavg of load.
- Five keys to scroll through the display pages.

The EPM 2000 products solves the problem of cluttered indicators by prominently displaying the parameter name right on the large, numeric readouts. For the first time in a Panel Meter, the Parameter Name is as clearly readable as the value. The name is displayed every 9th second for 2seconds(8+2), as well as each time you press a key. This also allows programmable Phase Labels in the EPM 2000 products. You can choose from 123 (Factory setting), Abc, ryb, pqr, or rst.

At this point you can scroll to the next page you want to see. If you’re not sure which page you’re watching, one press of any key will immediately identify the Name of the Parameter being displayed. The second key press takes you to the next page.



Figure 1-2: The EPM 2000 front panel with display and keypad

1.2.1. The Indicators

Table 1-1:- Kilo, Mega and Negative Indicators

| | |
|----------|--|
| M | Mega: When lit, indicates that the reading is in Mega, (10^6). 10,000K is shown as 10.00M. 1.0 M is displayed as 1000K. When Kilo and Mega are both glowing, the reading is in Giga (10^9). 10,000M is shown as 10.00G. 1.0G is shown as 1000M. |
| — | Neg: - When lit, indicates that the reading is negative Per IEEE 100 and industry standard practice by meter men, the following are Negative: <ul style="list-style-type: none"> • With Forward Flow of Watts: Capacitive (Leading) VARs & PF. • With Reverse Flow of Watts: Inductive (Lagging) VARs & PF and Watts. |
| K | Kilo: When lit, indicates that the reading is in Kilo (10^3). 10,000 is shown as 10.00K. 1.0K is shown as 1000. |

Table 1-3: Giga, Mega (M), Kilo (K) & Decimal Point Scaling

| RMS Reading | Indicator |
|--------------------|---|
| Less than 0.001 | K, M Off, displays “0.000” |
| Less then 9999 | K, M indicators Off |
| Above 9999 | K ON |
| Above 9999 k | M ON |
| Above 9999 M | Giga (K + M indicators ON) |
| Upto 9999G | Giga |
| Above 9999G | Display shows “Hi” for +ve numbers and “Lo” for –ve numbers |






RMS readings are 4 digits. Energy readings have eight digits, including four additional fractional digits. The maximum number the Meter handles is 9,999 G for RMS and Energy values.

This means that the Energy readings of the meter will overflow between approximately 2 months to 3 years depending upon the PT and CT ratios programmed. See Table 2.6 “[Integrator Overflow Period](#)”

1.2.2. The Keys

Operating the meter is easy using the five keys to take navigate through the [Keypad Operations Table](#). The Display Pages “expand” as you go right, much like the directory or Explorer “tree” displayed on any computer. **The display shows where you’re headed.**

Table 1-5: The Keys

| | |
|---|---|
|  | Right Key: <ul style="list-style-type: none"> Go forward into sub-parameter pages. During Edit Setup values, select next (right side) digit. |
|  | Left Key: <ul style="list-style-type: none"> The Opposite of the Right key. Go Back towards the Main Parameter Pages. Going Left past “Prog” requires Code entry to enter Main Menu (Setup and Clear) During Edit Setup, selects previous (left side) digit Exits from Edit mode, back to the Main Menu. |
|  | Up Key: <ul style="list-style-type: none"> Scroll Up thru other Display Pages at the same level. Continuous pressing for 3 seconds initiates limited Auto-scroll (within the same group of pages). Press any key to return to Manual scrolling. Increases the value of the blinking digit during Edit. Typically while changing the Meter Setup settings. |
|  | Down Key: <ul style="list-style-type: none"> The Opposite of the Up key. Scroll Down thru other Display Pages at the same level, thru all functions. Continuous pressing for 3 seconds initiates the Full Auto-scroll mode, thru all functions. Press any key to return to Manual scrolling. Decreases the value of the blinking digit during Edit. |
|  | TURBO Key: <ul style="list-style-type: none"> The TURBO key scrolls thru the following pages: RMS (Home page), VLL, A,PF VLN,A,F VA, W, VAR W,VAR, PF PF1, PF2,PF3 , VAh and Wh. This gives simple one-touch access to the most commonly used parameters, even for unskilled operators. “One Touch” does not operate in the Setup (Program) Mode. If you’re lost, the TURBO key is a quick way to get back to the RMS home page. Continuous pressing for 3 seconds initiates Auto-scrolling through the above Favorite pages. |





The parameter name is displayed every 9th second for 2seconds, as well as the first time you press a key.

At this point you can scroll to the next page you want to see. If you’re not sure which page you’re watching, one press of any key will immediately identify the Name. The second key press takes you to the next page.

The Meter Menus and Displays are organized as below. Navigating with the EPM 2000 is very easy and intuitive. For full details, see the [Keypad Operations Table](#). The left-most column (RUN, CLR, SET) constitutes the “Main Menu”. Press the key in the direction you want to go. **Display shows where you’re headed.**

Table 1-6: Menu and Display Map.

Press the key that takes you in the desired direction. You can't cross the thick boundary.

| | | | |
|---|-----------|---|---|
| | |  |  |
| | Run | Prog | |
|  | Main Menu | RMS | V, A, PF |
| | | | V1, V2, V3 |
| | | | A1, A2, A3 |
| | | Integ | VAh |
| | | | Wh |
| | Clr | | |
|  | Set | V pri | |
| | | A pri | |

1.2.2.1. Keys Example

Here's an example to try:

When you switch on a factory fresh meter, it starts at the “RMS” page, circled “1” in the diagram below. This will be our “Home Page”.

From here, to now go to the VAh Energy Page, circled “3” in the diagram below:

1. Start at “RMS”
2. Go Down ▼ to “Intg” and
3. Go Right ► to “VAh”

There are no complicated key sequences, since the grouping of parameters is intuitive. And the keys always do what they say, under all modes.

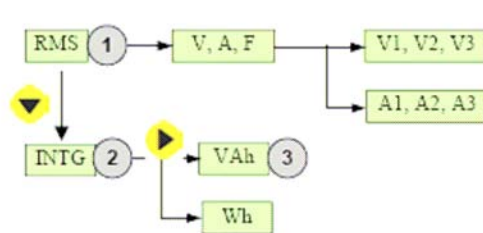


Figure 1-3: Getting Around- an Example

A complete [Keypad Operations Map](#) appears in the next chapter. “RUN” constitutes the Main Menu, along with “Clear” and “Set”, not shown above, but evident in the left-most “Main Menu” (“RUN”, “CLR”, “SET”) column. Getting into the Main Menu requires you to first enter a code.

1.3. EPM 2000 Technical Specs

- The EPM 2000 is a high-accuracy, low cost, ultra-compact, power and energy meter that offers ISO 9000 quality, accuracy, functional flexibility and MODBUS RTU communications capability. The standard unit flush-mounts in a DIN 96 cutout. Conforms to UL and CE safety requirements.
- The EPM 2000 is designed for retrofit application such as replacement of existing analog meters and is also usable as a stand-alone meter in custom panels, PDUs, switchboards, switchgear, UPS's, generator sets, MCCs systems etc.
- The EPM 2000 provides easy communication to PLCs, DCS, BMS and other systems through the use of Modbus RTU communications on RS 485, isolated to 2kV for 1 minute, from other circuits.
- The EPM 2000 Series of products are configurable & programmable through the front panel.

1.3.1. Main Features

The EPM 2000 Series supports the following features:

- Measures true RMS electrical parameters. 1 Second updation.
- IEC 61036 class 1.0 accuracy.
- Provides surge Impulse withstand to IEEE C37.90.1 Surge: 6kV IEC 60060 1.2μS/50μS.
- Fast Transient: >4kV IEC 61000-4-4 Level 4, ESD IEC 61000-4-2, Emission meets CISPR 22
- Power 4 Quadrant, Energy 2 Quadrant. Provides 3D power computation for kVA
- load bar graph for the quick estimation of consumption from a distance without touching any keys.
- Customized new display for easy readability.

1.3.2. Standard Measurements

The EPM 2000 can measure, locally display and remotely transfer over MODBUS RTU, the following electrical parameters over the input range with an accuracy of 0.5% or better for Volts and Amps and 1% for Power and Energy functions:

Amps: 50mA – 6A, Overload: 10A continuous, 50A for 3 seconds.

Volts: 80- 600V Phase - Phase and 48 - 347 V Phase – Neutral

Burden (Load): 0.2VA per Volts / Amps input

Frequency: 45 – 65 Hz

- True RMS voltage phase to neutral and 3phase average.
- True RMS voltage phase to phase and 3phase average.
- True RMS current per phase and 3phase average.
- Real Power and Energy.
- Reactive Power and Energy.
- Apparent Power and Energy.
- Power Factor.
- Frequency.

The EPM 2000 provides all single phase (per-phase) Real, Apparent, Reactive Power and Power Factor values. Positive (Inductive) and Negative (Capacitive) Reactive Energy is separately accumulated for Lead / Lag analysis.

1.3.3. Accuracy

| Measurement | Class 1.0, % of reading |
|--|-------------------------|
| • Voltage LN, per phase | 0.5 |
| • Voltage LL, per phase | 0.5 |
| • Voltage LN, avg | 0.5 |
| • Voltage LL, avg | 0.5 |
| • Amp, per phase | 0.5 |
| • Amp, avg | 0.5 |
| • Amp, Phase Angle per phase | 2° |
| • Frequency | 0.1 |
| • Real Power, (kW) Per Phase & Total | 1.0 |
| • Reactive Power, (kVAR) Per Phase & Total | 2.0 |
| • Apparent Power, (kVA) Per Phase & Total | 1.0 |
| • Power factor, Per Phase & average | 1.0 |
| • Active Energy, (kWh) Import/Export | 1.0 |
| • Reactive Energy, (kVARh) (Ind / Cap) | 2.0 |
| • Apparent Energy, (kVAh) | 1.0 |

* Additional error of 0.05 % of full scale for meter input current below 100 mA.

1.3.4. Auxiliary (Control) Power Supply

The meter needs a single phase AC or DC supply to power its internal electronics.

- ac 80v – 270v, 45 – 65 Hz
- dc 80v – 270v
- Burden (load) 3VA

1.3.5. Front Panel Display

- Brilliant 3 lines 4 digit (digit height 14.2 mm) per line, LED display with auto scaling capability for Kilo, Mega, Giga.
- The display provides the user access to all phase Voltages (phase to neutral and phase to phase), Currents (per phase and total), Watts, VARs, VA, Power Factor, Frequency and kWh, kVAh and kVARh.
- The EPM 2000 displays total volts, amps and frequency simultaneously.
- Load bar graph for the indication of the consumption in terms of %Avg.
- Easy setup for common configuration parameters through keys located on the faceplate.
- Password protection on setup parameters

1.3.6. Dimensions & Shipping

- Basic unit installed depth 80 mm behind bezel with 90x90 mm panel cutout, flush mount. The Protection cover affixed over the rear Terminal Block extends the depth to 82 mm.
- Bezel dimension 96 x 96 mm,. Panel Cutout 91 x 91 mm
- Weight 400 grams approx Unpacked 500 grams approx Shipping

1.3.7. Environmental Conditions

- Sealed dust-proof construction. Meets IP51 for the front panel
- Temperature Operating: – 10 to 60° C, 14°F to 140°F
Storage : – 25 to 70°C, -13°F to 158°F
- Humidity: Below 5% to 95%, non-condensing

1.3.8. Installation & Input Ratings

- Auto-ranging voltage inputs allow direct connection up to 347 VLN/600 VLL AC systems (no PTs required up to 600 VLL phase to phase).
- Supports (field configurable) direct 4-Wire Star (Wye), 3-Wire Star (Wye), 3- Wire Delta configurations and single phase via Star (Wye) Phase 1.
- 3-phase voltage and current inputs
 - Volts: 48 – 347 VLN Phase–Neutral, 80 – 600 VLL Phase-Phase, Overload – Continuous 600 VLL with full accuracy, 750 VLL MaxHz. 50 / 60 ,
 - Amps: 50mA – 6A, Overload: 10 A continuous, 50A for 3 seconds
 - Field configurable for 5 Amp or 1 amp secondary CTs
 - Burden (Load): Less than 0.2VA per Volts / Amps input
 - Frequency: 50 / 60Hz 45 – 65 Hz

1.3.9. Safety Construction

- Self extinguishable V0 plastic, double insulation at accessible area.
- Pollution Degree II
- Measurements Category III

See Chapter 4: Mechanical Installation.

2. QUICK START GUIDE

This Chapter shows at a glance, how to view the following pages:

- Viewing Three-Phase Total values
- Viewing Per-phase Values
- Viewing Energy Values (Intg)
- **Viewing the % of average load bar graph**
- Clearing (Resetting) Energy Values
- Setting-up (Program) the meter before use.

The EPM 2000 displays:

- **Voltage:**
Three voltage measurements Line-to-Line: 1-2, 2-3, 3-1 and one Average,
Three voltage measurements Line-to-Neutral: 1-4, 2-4,3-4 and one Average.
- **Current:**
Three current measurements phase-wise: A, B, C, one average current of all three phases and three current phase angles A°_A , A°_B , A°_C w.r.t. the corresponding Voltage Line-Neutral vector.
- **Frequency:**
Measured from whichever phase is active.
- **Power:** VA, W, VAR, PF. Per phase and Total. Per-Phase W readings provide a quick CT Polarity Check. A negated W phase reading indicates CT reversal.
- **Energy:**
VAh, Wh, +VARh (Ind), -VARh (Cap), Run Hrs, On Hrs, Supply Interruptions (outages)
- **% average Load Bar graph:**
Load Bar graph indicates consumption in terms of %Aavg. Now user can quickly estimate the load by viewing the display without operating any keys. The bar graphs consists of 12 segments. Each segments indicates 10% of average load.
- **Kilo, Mega, Giga indication** for the above parameters.

2.1. Keypad Operation

The Table below is quite simple to use. Look at the shaded left half, under the parameter “Name”: Follow these simple steps.

- First take a quick look at [what the Keys do](#). Try the simple [example](#).
- Now, try getting around to other parameters, by moving Up, Down, Right and Left. For viewing readings in different display pages you will normally be within (to the right of) the “RMS” and “INTG”.
 - You cannot go Down or Up through the thick horizontal lines- you must navigate Left, around them
 - The “Kilo”, “Mega” and “Negative” [Indicators](#) are automatic. “Kilo” and “Mega” light up together to show “Giga”.
- To go Left into the Main Menu (“RUN”) enter Code- See [Table 2.1 Note 1](#)
- Once in the Main Menu (“RUN”), you can go Down to “CLR” or “SET”. You can then clear the integrator or Setup Meter Settings by going right. When done, go left back to the Main menu, go Up to Run then go Right in to RMS to view the Display Pages again.

Figure 2-1: The Run Mode Flow chart

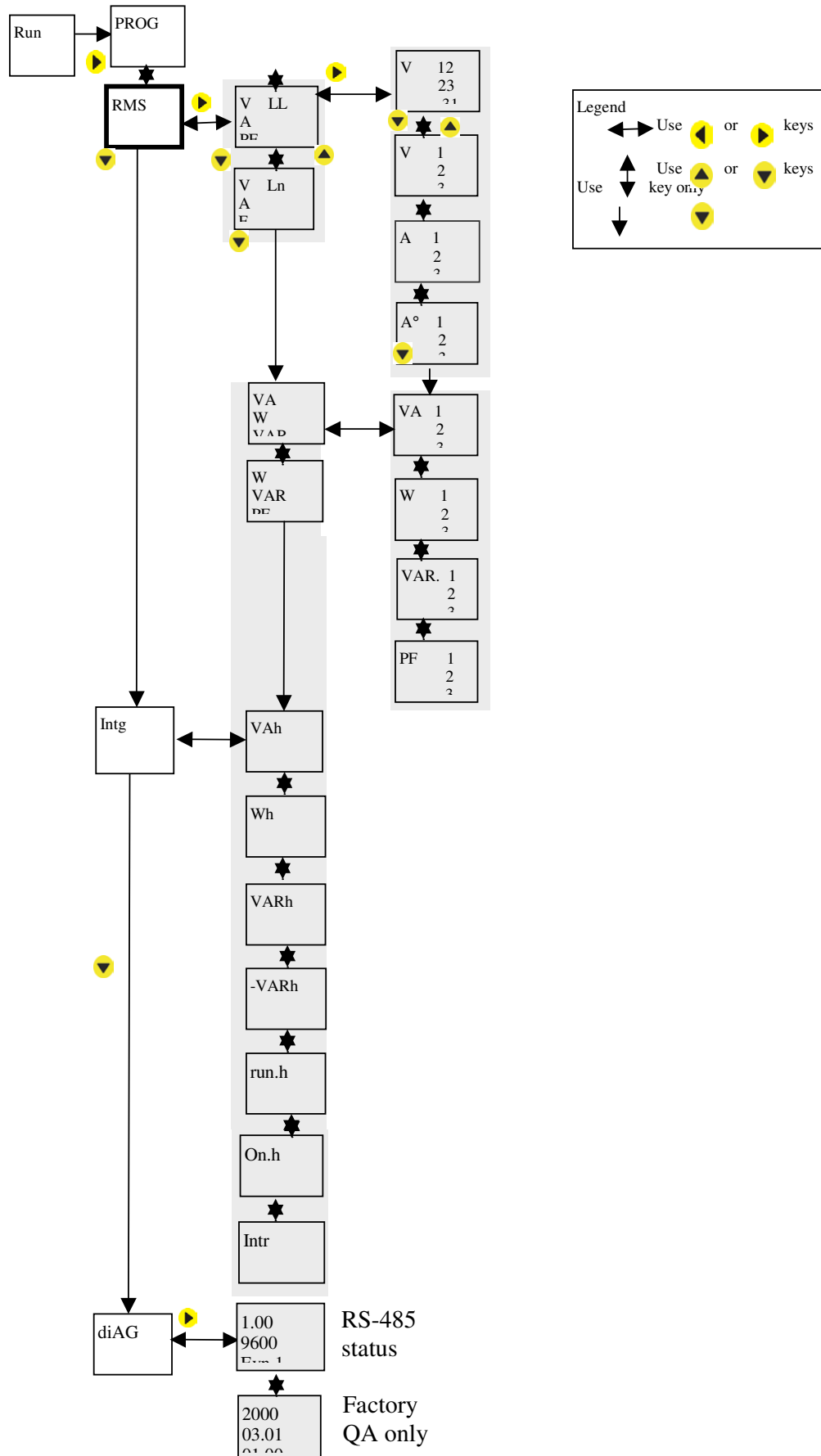


Table 2-1: Meter Function Map

| | | Code Note 1. | Name | Description |
|--|--------------------------------------|-----------------|------------------|--|
| | Run | Prog | | |
| | RmS Start Here | V LL A PF | V 12 23 31 | V LL = Voltage, Line to Line, Average. V 12 = Voltage, RMS Phase 1 to Phase 2 A = Current, Average. 23 = Voltage, RMS phase 2 to phase 3 PF = Power factor, Average 31 = Voltage, RMS phase 3 to phase 1 |
| | M a i n M e n u | | V 1 2 3 | V 1 = Voltage, RMS phase 1 to Neutral 2 = Voltage, RMS phase 2 to Neutral 3 = Voltage, RMS phase 3 to Neutral |
| | | V Ln A F | A 1 2 3 | V Ln = Voltage, Line to Neutral, Average. A 1 = Current, RMS phase 1 A = Current, phase wise, Average. 2 = Current, RMS phase 2 F = Frequency in Hertz. 3 = Current, RMS phase 3 |
| | | | A° 1 2 3 | A° 1 = Current, Phase Angle of phase 1 in degrees. 2 = Current, Phase Angle of phase 2 in degrees. 3 = Current, Phase Angle of phase 3 in degrees. |
| | | VA W VAR. | VA 1 2 3 | VA = Volt-amperes, Total. VA 1 = Volt-amperes, phase 1 W = Watt, Total 2 = Volt-amperes, phase 2 VAR = VAR, Total. 3 = Volt-amperes, phase 3 |
| | | | W 1 2 3 | W = Watt, Total. W 1 = Watts, phase 1 VAR = VAR, Total. Note : "-" Watts = reverse current. 2 = Watts, phase 2 PF = Power factor, Average 3 = Watts, phase 3 |
| | | VA W PF | PF 1 2 3 | PF 1 = Power factor, phase 1. 2 = Power factor, phase 2. Note : "-" Indicates Lead (Capacitive) Power factor. 3 = Power factor, phase 3. |
| | | | Var. 1 2 3 | Var. 1 = VAR, phase 1. 2 = VAR, phase 2. Note: "-" Indicates Lead (Capacitive) VAR. 3 = VAR, phase 3. |
| | Intg | VA.h | | VA.h = Volt-ampere-hours. All integrators clear automatically at 9999 Giga value of any Integrator. |
| | | W.h | | W.h = Watt-hours. If watts is negative, VA.h, W.h, VAR.h, -VAR.h do not Integrate. |
| | | VAR.h | | VARh = VAR-hours, Inductive. |
| | | -VARh | | -VARh = Negative VAR-hours, Capacitive. |
| | | run.h | | run.h = Run hours. Total hours the Load was On. Accumulates when current is present. |
| | | On.h | | On.h = ON hours. Total hours the meter was ON. Accumulates if auxiliary supply is present (irrespective of input signals). |
| | | Intr | | Intr = Auxiliary interruption. Accumulates the auxiliary interrupt. |

| | Name | | | | Description |
|--|-----------------|------|--|------------|---|
| | Code Note 1. | | | | |
| | Clr | Intg | Intg y / n | o Clear | Clr = Clear. If "y", Clears all integrator parameters (above) to zero. |
| | Set | | 2000 03.01. 01.00 SYS StAR V.PRI 415.0 V.SEC 415.0 A.PRI 100.0 A.SEC 5.000 LABL 123 VA.Fn 3d baud 9600 PrtY EVn.1 Id 1.000 | | Model = 2000. non editable. Version = 03.01.01. non editable. SYS = Power system's configuration* : Star (3E 4V3A), Delta (3E 3V2A) V.PRI = Voltage primary winding(PT) * : Line to Line: 100V to 999kV(415.0) V.SEC = Voltage secondary winding(PT)* : Line to Line : 50V to 601V (415.0) A.PRI = Current primary winding.(CT)* : 1A to 99kA (0100) A.SEC = Current secondary winding.(CT)* : 1A to 6.5A. (5.000) LABL = Phase labeling formats. : 123, ryb, rst, Pqr, Abc. VA.Fn = VA function selection : 3d, Arth baud = Baud rate : 1200, 2400, 4800, 9600, 19200. PrtY = Parity and Stop bit settings : EVn.1, EVn.2, Odd.1, Odd.2, no.1, no.2 Id = RS485 Device ID number : 001 to 247. (Evn.1 = Even. 1 stop bit) *changing these values while the device in use, is not recommended |
| | | dIAG | Id baud 9600 PrtY Evn.1 | | For factory testing only |
| | | dIA2 | Mdl 2000 Ver 03.01. Ver 01.00 | | For factory testing only |

NOTES:

- To “Clear” Integrated values or “Set” meter settings, you must first enter the Main Menu.
 - Go Left to the “RUN” page from "PROG".
 - You must now enter the Factory Set code of 1000, to proceed.
 - "Code y", followed by the entry of the Code “1000” is required.
 - To enter the code, edit the blinking digit value Up or Down to get “1000”.
 - Keep going Left.
 - Without entering the code, you may view the settings, but you can’t change them.
- Within the “SET” page options, the Factory settings are shown Bold Text in the right side column above.


2.1.1. Auto-Scroll

Auto-Scroll allows you to monitor a group of Display Pages sequentially, every 5 seconds, without constant key pressing. This is convenient for viewing from a distance. Since the EPM 2000 displays the Parameter Name(1sec) followed by the Value(4 sec) on the same large displays, both are equally readable from a distance. No more squinting at a clutter of parameter indicators.

To enter auto-scroll, go to the desired display page and keep the Up ▲ or Down ▼ key pressed for minimum 3 seconds. The display flashes “Auto” and then automatically scrolls through other pages at the same level (column in the above table). Press any key to revert to Manual Scrolling.

- The Up ▲ key enters Limited Auto-scroll – within the same Group, eg only “RMS” or only “INTEG”.
- The Down ▼ key enters Full Auto-scroll- down the entire column of pages.

2.1.2. TURBO key

- The TURBO key  scrolls thru the following pages: RMS, VLL,A,PF VLN,A,F VA,W,VAR W,VAR,PF PF1,PF2,PF3 VAh Wh . This gives simple one-touch access to the most commonly used parameters, even for unskilled operators. “One-touch” does not operate in the Setup (Program) Mode. Optional parameters are in blue color.
- **If you’re lost, the TURBO key is a quick way to get back to the RMS home page.**
- Continuous pressing for 3 seconds initiates Auto-scrolling through the above Fav pages.

2.2. Setup (Program)

The Meter must be Set (programmed/configured) to match the application settings, before use. Otherwise, the readings will be wrong. All the Setup values can be re-programmed at any time, upon entering "SET". However, the settings: Sys (Star/wye or Delta), Vpri, Vsec, Apri, Asec critically determine the scaling of measured readings. While the scaling may be used to tune out Instrument Transformer errors, wrong settings will upset the readings of running systems. It is the user's responsibility to ensure that only qualified personnel correctly Set-up the Meter.

| Action | Display | Remarks |
|--|-----------------|--|
| From the "RMS" or "INTG" page, go Up ▲ | Prog | |
| Then go Left ◀. | "Code y" | The meter is about to enter the Main Menu. "y" blinks. |
| "Code y" is displayed. "y" blinks. | | To proceed with Code Entry, we need to enter the Main Menu. <ul style="list-style-type: none"> Go Left ◀. <p>Or, to abort and re-enter RMS:</p> <ul style="list-style-type: none"> Press ▶. <p>Or, to only view setup, (no edit):</p> <ul style="list-style-type: none"> Press ▲ or ▼ to toggle "y" to "1". Press ◀ to enter Main Menu. "Fail" is flashed, then "run" is displayed. |
| To proceed with Code Entry: | "000 0" | The blinking digit indicates the cursor. |
| The code is Factory Set to 1000. Press ◀ to enter each digit. Three times totally. | "2 000" | We have now entered the Units, Tens and Hundreds digits. The Thousands digit needs to be changed from 2 to 1. |
| Press ▼ to decrement "2". | "1 000" | Now the Code of 1000 is almost in. |
| Press ◀ to enter the Main Menu. | " 0000" | Notice that a "0" quickly hides each code-digit you enter. |
| | "Pass" "run" | "run" indicates a successful entry into the Main Menu. Congratulations! |
| | Or, "Fail" | If you were not successful, don't despair; you can have another go from the top of this Table! Briefly switching off the Meter will easily return you to the RMS page, the starting point. |
| Now press ▼ | "CLR" | |
| Again press ▼ | "SET" | You are at the Setup page. |
| Press ▶ to get into "SET" | "2000" | You've now entered the Setup Menu. The first two entries are the Model Number and firmware version for easy identification. Go ▼ to see other Settings. Go ▶ to see and change their values. |
| Once you're done, re-trace your path: ◀ and ▲. Remember "Save Y" | "run" | You're now back to the top of the Main Menu. Go ▶. You'll see RMS. You can now go ▶ or ▼ to view all the display pages. |

2.2.1. Editing the Setup

First, take a look at the [Keypad Operations Table](#). Locate the Shaded, Bold display pages below.

To enter “SET” and change a Setting value, the sequence (shown below) is: 1, 2, 3, 4. Along the way, the following must be observed:

- The Password Code must be entered to change the Setup. The code offered will read “0000”. Edit (▲,▼) the blinking Digit to achieve “1000”. Press ◀ when done with each digit, to keep moving towards the “RUN” page. The Meter accepts each digit entered, but masks it with “0000” so someone watching doesn’t steal the password.

After changing the desired Setup values (Step 4), the sequence to get back to the RMS page is: 5, 6, 7, 8.

- Exiting Setup requires you to Save the settings (Step 6). “SAVE Y”, press ◀.
- To Discard the changes, toggle Up▲ or Down▼ to get “SAVE N” before pressing ◀.
- Going forward from 7 (RUN) to 8 (PROG) does not require any Code. You go ▶, straight through.
- **Entering into the setup on power up**
 - 1.1.1 During power on, press the **Turbo** key continuously for 2sec and displays SET.
 - 1.1.2 Press the ▶▶ key. Displays the desired value to be changed.
 - 1.1.3 Follow the above procedure.

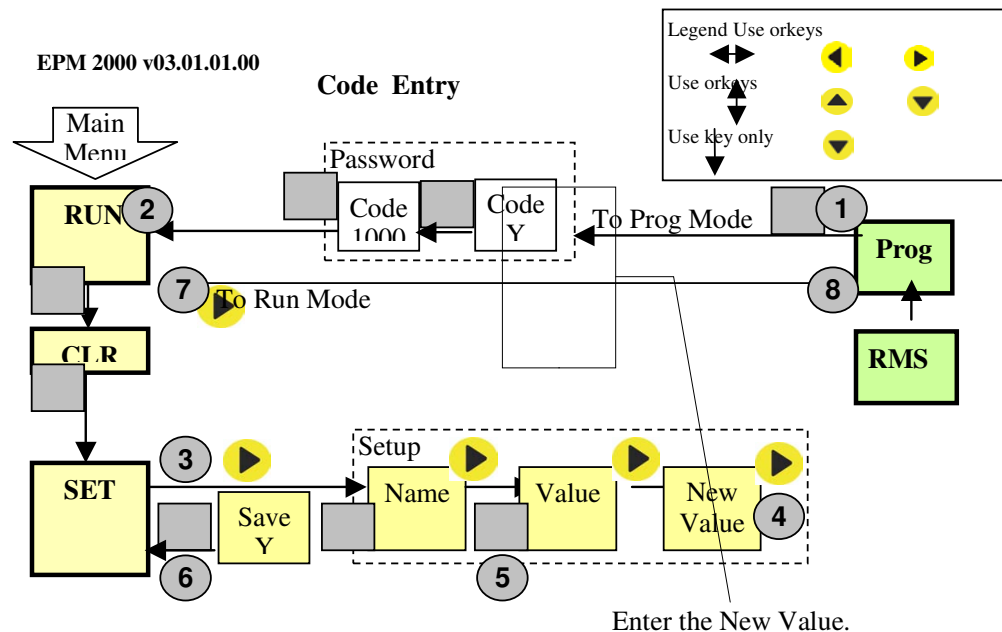


Figure 2-2a: Entering and Exiting Setup

Code Entry

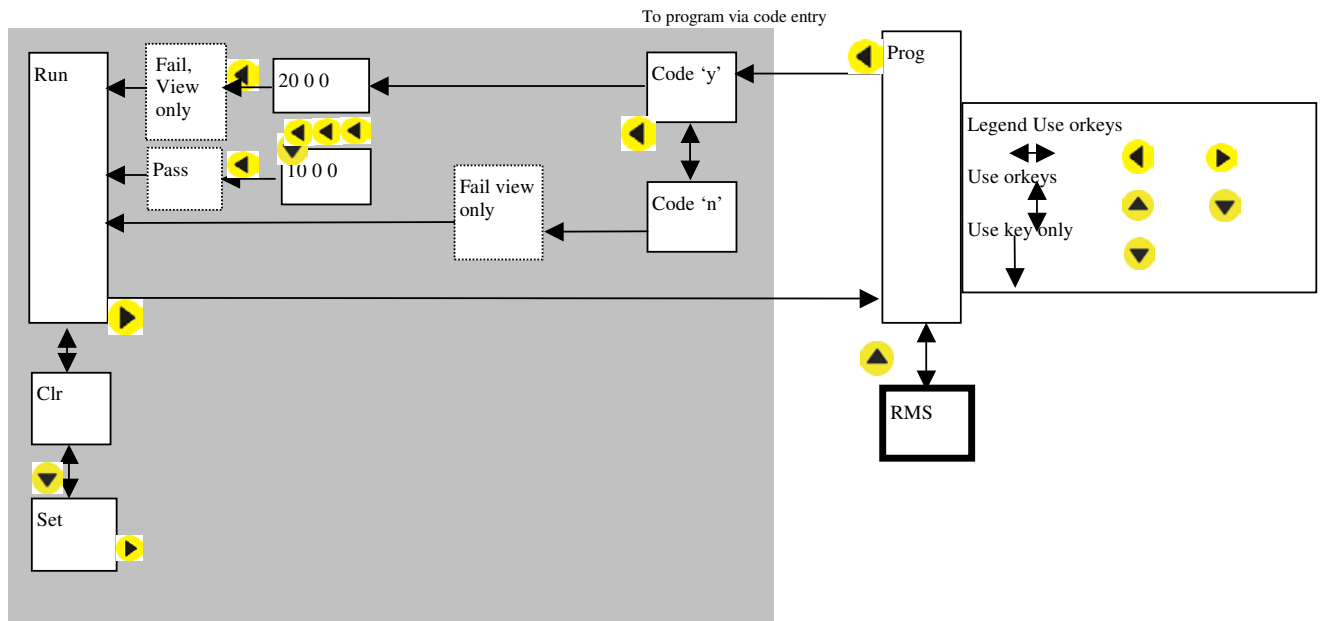


Figure 2-2b: Code entry for Entering Setup

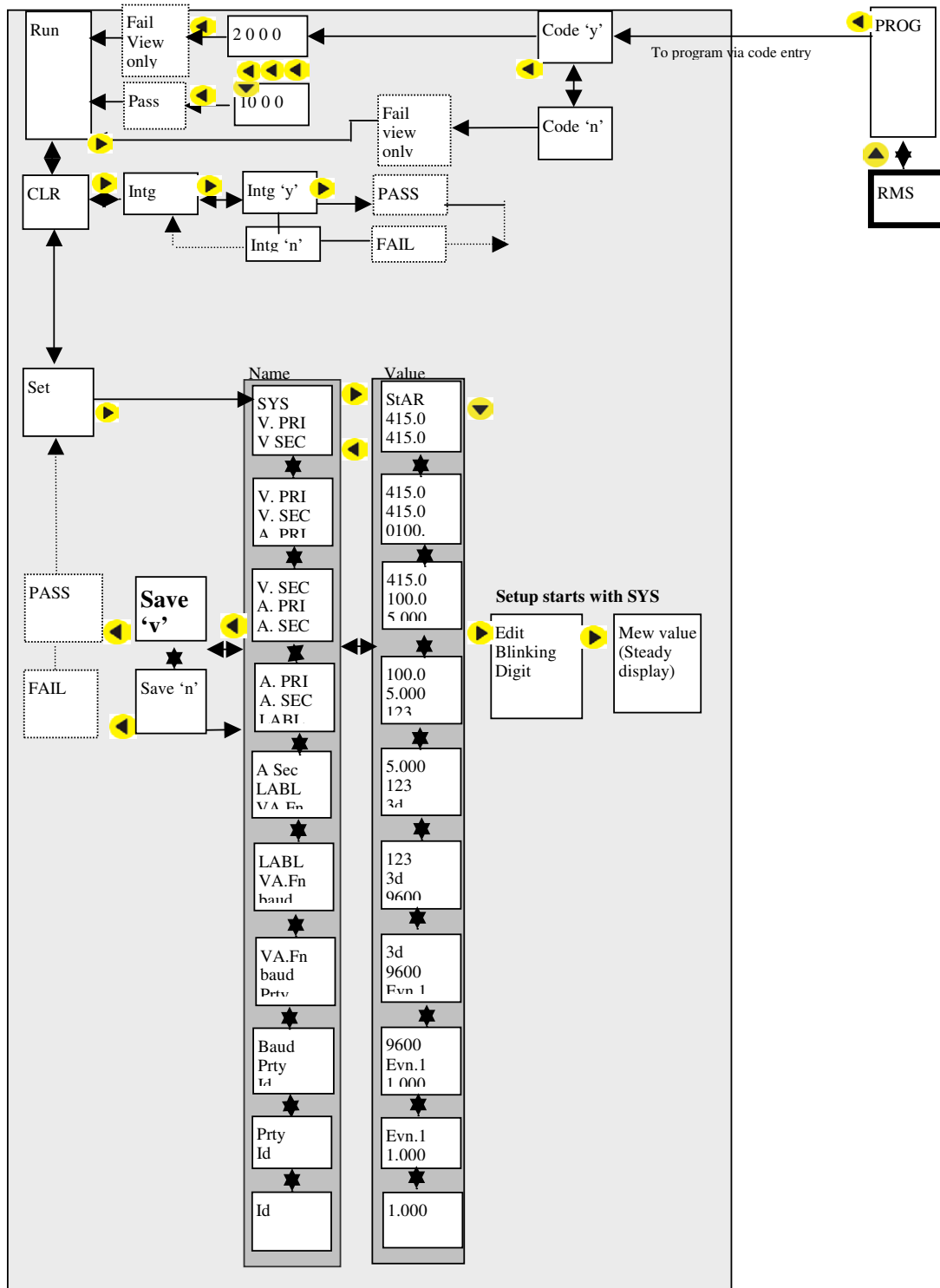



Figure 2-2c: The complete Setup (Program) menu

Table 2-4: Editing the Setup Values

First, you must enter the Main Menu and reach “SET” using the previous Table. This example illustrates changing System Mode (SYS) from “Star” to “Delta”.

| Action | Display | Remarks |
|--|------------------------------------|--|
| | "Set" | You're in the Main Menu. |
| Press ► to enter SET | SYS V.PRI V.SEC | Wiring System. Voltage primary. Voltage secondary. |
| Press ► to edit | "StAR" 415.0 415.0 | Wiring System = Star 3E Voltage primary = 415v. Voltage secondary = 415v. |
| We have now reached SYS (top row) for editing. Press ► to view Value. | "StAR" 415.0 415.0 | Wiring System = Star 3E Voltage primary = 415v. Voltage secondary = 415v. |
| Press ► to edit SYS value. The value blinks. | " Star " 415.0 415.0 | Blinks. Only Top Row is edited Ignore Ignore |
| Press ▼ to change to Delta 2E. | " Delta " 415.0 415.0 | Blinks. Note: To discard the change: • Press ◀. • Restores the previous value. |
| Press ► to accept the value. | "Delta" 415.0 415.0 | Steady. SYS is now set to Delta. Press ▼ to scroll down, and ► to change other values. |
| We're done. Press ◀ to head back. | " SYS " Blinks | |
| Press ◀ again. | "Save" " y " | NOTE: To discard present changes, press ▼ to show "Save n ". |
| Press ◀ to accept "y" (yes, save) | "PASS" "Set" | Stores the Setup changes. Now, you're back in the Main Menu and can go ▲ to "RUN" and ► to "RMS". |

Table 2-6: Clearing the Energy Integrator (W.h, VA.h, VAR.h, -VAR.h, etc.)

| Action | Display | Remarks |
|---|---|--|
| Use Table 2-2 to enter the Main Menu. Press ▼ to reach “CLR” | "Clr" | You’re in the Main Menu. |
| Press ► to enter CLR mode. | "intg" | |
| Press ► to proceed with CLR | "Intg  " | Clear Integ? Yes! NOTE: ◀ escapes back to Main Menu |
| Press ► to Clear. | "Pass" "intg" | Integ Cleared. |
| To head back, press ◀ | “Clr” | Now, you’re back in the Main Menu and can go ▲ to “RUN” and ► to “RMS” |

Clearing the Integrator

EPM2000 v03.01.01.00

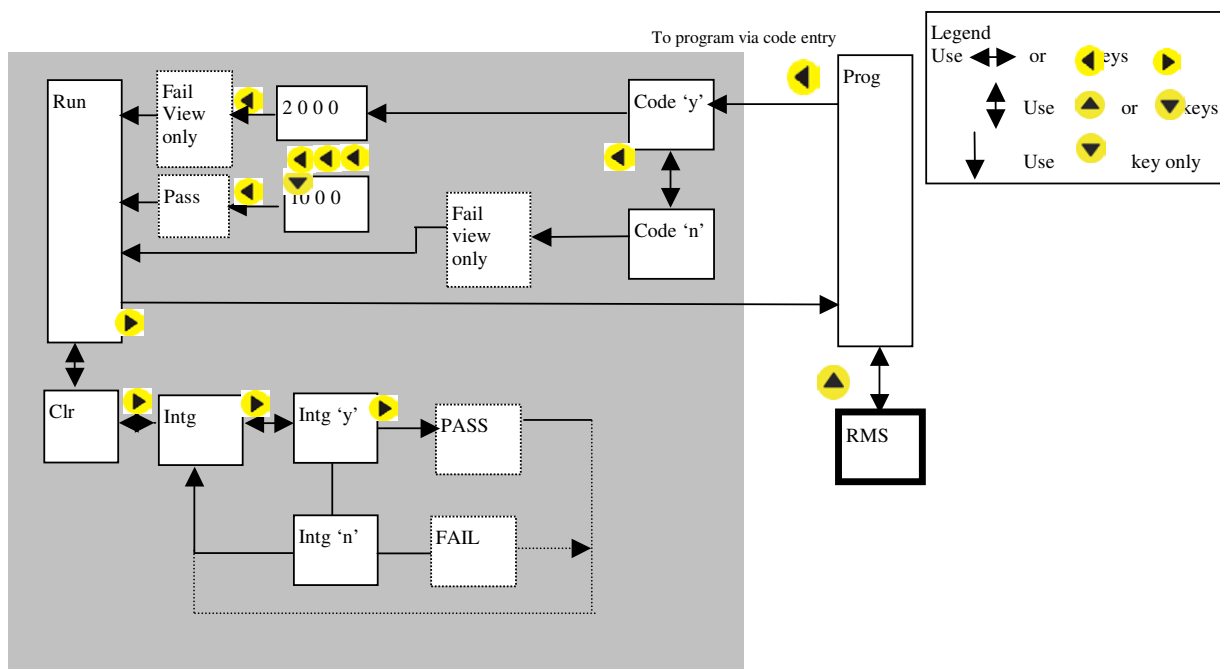


Figure 2-2d: Clearing the Integrator

Alternate quick way to enter in to SET is to press the TURBO key during the power ON, in this method there is no need of entering the code.

2.2.2. Notes on the Energy Integrator

Your EPM 2000 meter is equipped with an Energy Integrator function which provides several parameters for Energy Management: VAh, Wh,VARh, -VARh, RunHrs, On Hrs, Interruptions (outages). A few of these need explanation:

Run Hrs: Indicates the period the Load is On and has Run. This counter accumulates as long as any one Amps phase has more than 11mA thru the meter terminal.

ON hrs: The period for which the meter (supply) is On.

Interruptions: Number of Supply Outages. Measured at the Auxiliary Supply of the Meter. If the meter Aux Supply is from a UPS then the Number of interruption will be zero (as long as the UPS stays ON), even if the Voltage Signals did die out from time to time.

2.2.2.1. Integrator Overflow

Your EPM 2000 meter contains a comprehensive “Integrator” to support Energy Management. It accumulates several parameters over time, as explained above. All values are Direct Reading and have a high resolution. This is necessary for accurate energy analysis over short intervals of time. It also means that the readings max out and reset sooner or later as given below. Since the Integrator contains counters for several parameters (VAh, Wh,VARh, -VARh, RunHrs, On Hrs, Interruptions), they all reset together whenever any one of them (usually VAh) overflows. This makes energy management calculations such as Average PF very easy.

The maximum number that the Meter handles is 9,999 Giga for RMS and Energy values. This means that the Energy readings of the meter will overflow between approximately 2 months to 3 years depending upon the PT and CT ratios programmed. See Table 2.4 “Integrator Overflow Period” below.

The Overflow Period below, depends on the Product of the PT Ratio and CT Ratio that you’ve programmed for your application.

$$\text{where, PT Ratio} \times \text{CT Ratio} = \frac{V_{pri}}{V_{sec}} \times \frac{A_{pri}}{A_{sec}}$$

Table 2-4 Integrator Overflow Period

| PT Ratio x CT Ratio | Max Reading | Overflow Period (Months) | |
|---------------------|------------------------|--------------------------|------|
| | | Max | Min |
| 1 to 1.999 | 9.999x10 ⁶ | 3.85 | 1.92 |
| 2 to 10.999 | 9.999x10 ⁷ | 19.29 | 3.51 |
| 11 to 100.999 | 9.999x10 ⁸ | 35.07 | 3.82 |
| 101 to 1000.999 | 9.999x10 ⁹ | 35.07 | 3.82 |
| 1001 to 10000.999 | 9.999x10 ¹⁰ | 35.07 | 3.82 |
| 10001 to 100000.999 | 9.999x10 ¹¹ | 35.07 | 3.82 |
| Greater than 100001 | 9.999x10 ¹² | 35.07 | 3.82 |

2.3. Summary

We've now learned

- to operate the EPM 2000 products.
- to configure its Setup and
- to Clear its Integrator.

3. AC POWER MEASUREMENT

This Chapter describes the following:

1. Fundamentals of Three-Phase Measurements

3.1. *Three-Phase Systems*

A three-phase system delivers higher levels of power for industrial and commercial applications; the three phases correspond to three potential lines. A 120° phase shift exists between the three potential lines.

A typical configuration has either a Delta connection or a Wye (Star) connection (see **Figure 3-1**, below).

In a three-phase system, the voltage levels between the phases and the neutral are ideally defined by $V_1 = V_2 = V_3 = V_{12} / \sqrt{3} = V_{23} / \sqrt{3} = V_{31} / \sqrt{3}$. In practice, there will be some unbalance (difference).

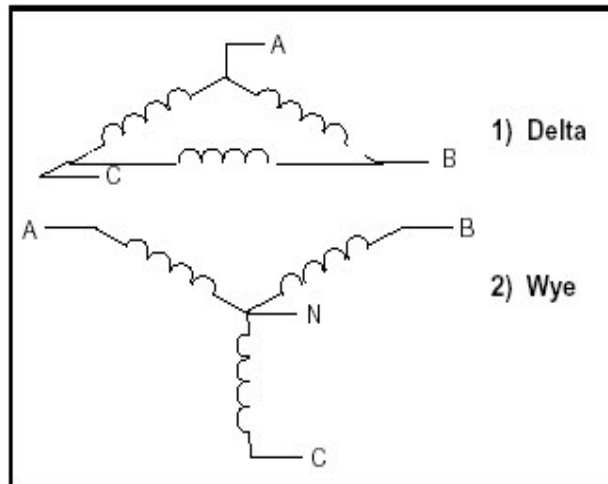


Figure 3-1: Three-Phase System: (1) Delta, (2) Star (Wye)

Voltages between the phases vary depending on loading factors and the quality of distribution transformers.

Power measurement in a poly phase system is governed by **Blondel's Theorem**. Blondel's Theorem states that in a power distribution network which has N conductors, the number of measurement elements required to determine power is N-1. A typical configuration of poly phase system has either a Delta connection or a Star (Wye) connection (see **Figure 3-2**, below).

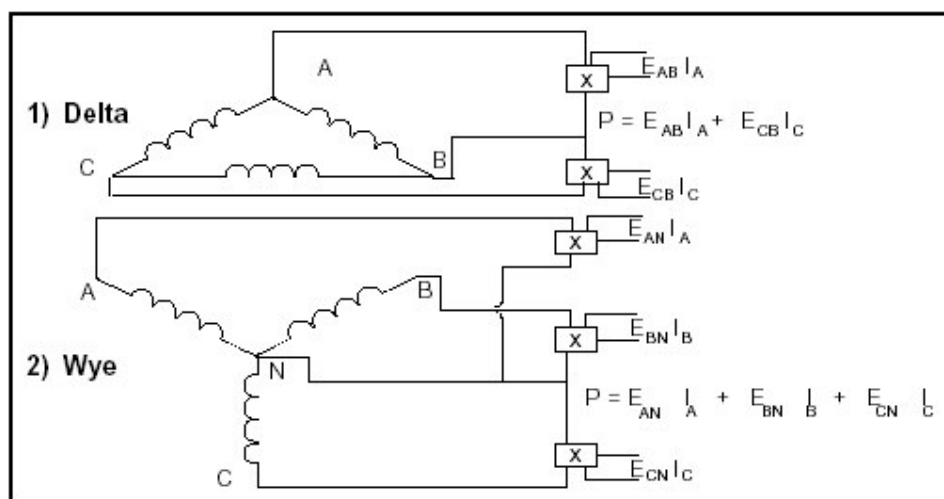


Figure 3-2: Poly Phase System: (1) Delta, (2) Star (Wye)

3.2. Consumption & Poor PF

CONSUMPTION: $WH = W \times T$, where W = instantaneous power T = time in hours

The total electric energy usage over a time period is the consumption of WH.

Typically, the unit in which consumption is specified is the kilowatt-hour (KWH): one thousand watts consumed over one hour. Utilities use the WH equation to determine the overall consumption in a billing period.

POOR POWER FACTOR: Results in reactive power consumption. Transferring reactive power over a distribution network causes energy loss. To force consumers to correct their Power Factor, utilities monitor reactive power consumption and penalize the user for Poor Power Factor.

3.3. “3D” kVA Measurement

The EPM 2000 is equipped with 3D Measurement of kVA. This advanced method provides the most accurate and predictable measurement under unbalanced as well as distorted waveform conditions.

However, in case the EPM 2000 needs to match the reading of older or simpler meters which use the Arithmetic kVA definition, this too is available as a Set-up option.

Table 3-1: VA Function Set up Options

| kVA Function | Formula | Other Names | Which one ? |
|----------------------|---|-------------------------|---|
| 3D (Factory setting) | $kVA_{3D} = \sqrt{\sum W^2 + \sum VAR^2 + \sum D^2}$ where D = Distortion Power per IEEE 100 | U, Apparent, Vector kVA | Best, all around |
| Arith | | Arithmetic, Scalar kVA | Good under Low unbalance, to match simpler meters without 3D capability |

4. MECHANICAL INSTALLATION

The EPM 2000 is panel-mounted and has reliable, rear-mounted terminal strips rated at 600v. The 91 mm x 91 mm cut-out and 96 mm x 96 mm bezel dimensions adhere to DIN 43700. Depth required behind the Bezel is 80 mm, plus space for wiring. Two side clamps are provided for firm mounting.

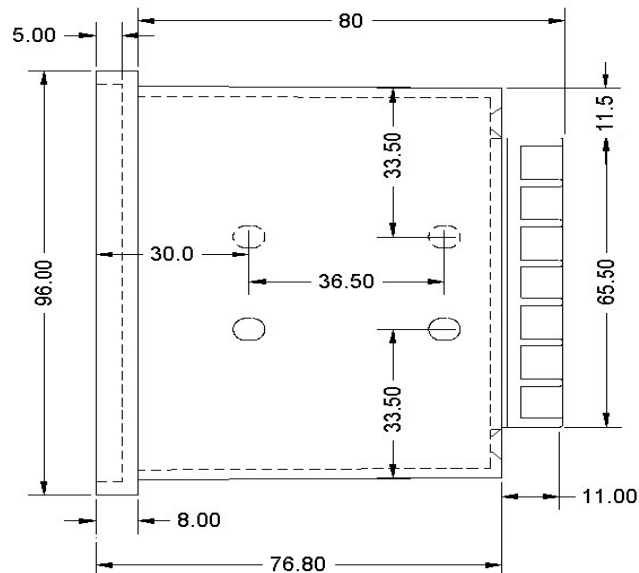
CAUTION :

All Installation, wiring and maintenance instructions to be carried out by qualified personnel only.

Please read this and the following chapter completely, before proceeding

These diagrams display the various dimensions of mechanical installations.

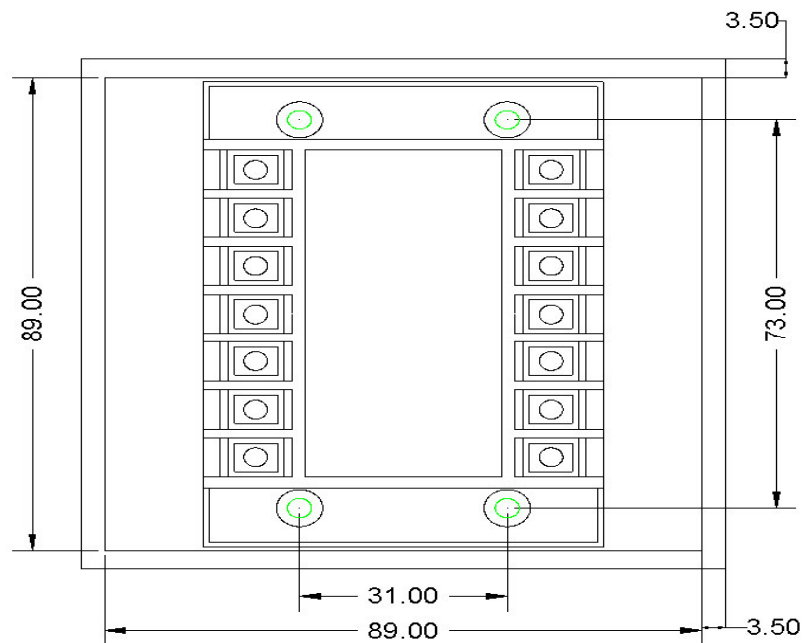
SIDE VIEW



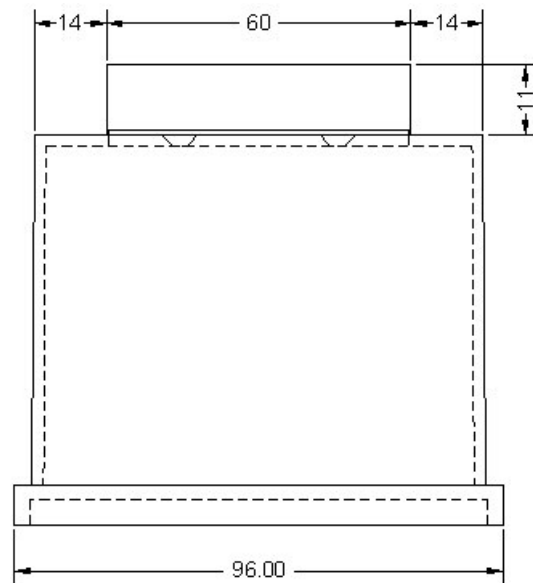
FRONT VIEW



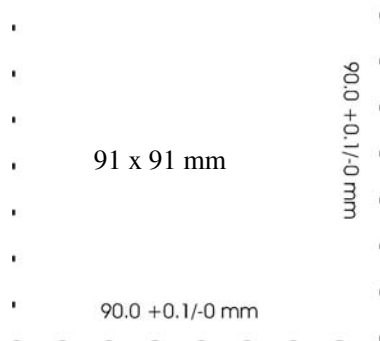
REAR VIEW



TOP VIEW



RECOMMENDED CUTOUT



4.1. Installation Process

4.1.1. Panel Mounting for New Installations

This section describes the following:

1. Selecting the EPM 2000 location

DANGER ⚡:

All Installation, wiring and periodic maintenance of the EPM 2000 as well as its associated circuits involves high voltages and currents. While this manual suggests several safety and reliability steps, it must be used in conjunction with the safety codes in force at your location. Failure to practice safe working procedures is likely to cause damage to the installation, severe injury and / or death. All work including handling of electrical circuits during Installation, wiring and periodic maintenance, must be done only by qualified personnel.

Neither GE nor its agents may be held responsible for damage or death arising out of the wiring and / or PT, CT or other external circuits.

The covers of the EPM 2000 should never be dismantled or opened. There are no user-serviceable parts inside. The EPM 2000 contains high-precision components which require special handling available only at authorized GE service locations. High voltages are likely to be present inside even after the EPM 2000 has been switched off. Opening the covers of the EPM 2000 and/or any attempts to dismantle, service, repair or modify the unit by unauthorized persons may cause severe injury, will damage the unit and will also render GE's warranty void.

2. Location and Mounting considerations.

4.1.2. Location

4.1.2.1. Usage

First, decide on how the EPM 2000 is going to be used. If you do not already have an Energy Management program in operation, then your Energy Consultant should be able to help you identify which load(s) offer maximum savings potential. This will help you decide: Which point is to be monitored, where the readings will be viewed from, who must have access to the instrument and how often. For best performance, choose a location which provides all the required signals with minimum wiring lengths.

4.1.2.2. Panel Considerations and Environment

The EPM 2000 is a high - precision measuring instrument and its operating environment is of utmost importance. For maximum performance, the instrument should be mounted in a dry, dust-free location, away from the heat sources and strong electromagnetic fields. To operate reliably, the following conditions must be met:

Storage Temperature: -25°C to 70°C. -13°F to 158°F

Operating Temperature: -10°C to 60°C. 14°F to 140°F

Relative Humidity: Less than 5% to 95%, non-condensing.

The EPM 2000 should be separated from other equipment and sufficient space must be provided all around for cooling air to rise vertically past the instrument. The cooling air temperature must be below the specified operating temperature.

The panel or housing in which the EPM 2000 is mounted, should protect it from dust, moisture, oil, corrosive vapors, etc.

The panel doors must be easily opened to provide easy access to the EPM 2000 wiring for trouble-shooting. Allow clearance if the unit is going to swing out, as well as adequate slack in the wiring. Allow space for terminal blocks, CT shorting blocks, fuses, auxiliary contractors and other necessary components.

4.1.2.3. Viewing

For ease of operation, in the location should be preferably at, or slightly above, eye-level. For viewing comfort, minimize glare and reflections from strong light sources.

4.1.3. Mounting

Before Mounting and Wiring, the [Setup procedure](#) should have been completed.

The EPM 2000 is panel mountable.

| | |
|------------------------------|---|
| Panel cutout | :90 ^{+1.0} -0 mm (w) x 90 ^{+1.0} -0 mm(h) DIN 43700 |
| Panel Thickness | : 0.5 mm to 4.0 mm. |
| Instrumental Bezel dimension | : 96 mm x 96mm |
| Depth behind Bezel | :80 mm. Leave clearance for wires. 82 mm with Terminal Cover |
| Mounting Clamp Screws | : Slotted, 2 nos. |
| Terminal Screws | :Combination Phillips & Slotted head |

The cut-out should be punched with the proper tool and should be free from burrs.

Before Wiring, insert the EPM 2000 into the cut-out from the front. Then, fasten the two side clamps from the rear. While supporting the EPM 2000 from the front, tighten both side clamp screws in a criss-cross pattern till all slack is taken up, then apply one full turn. Do not over-tighten.

5. ELECTRICAL INSTALLATION

This Chapter describes the following:

1. The Need and selection of Potential Transformers (PTs) and Current Transformers (CTs)

DANGER ⚡:

All Installation, wiring and periodic maintenance of the EPM 2000 as well as its associated circuits involves high voltages and currents. While this manual suggests several safety and reliability steps, it must be used in conjunction with the safety codes in force at your location. Failure to practice safe working procedures is likely to cause damage to the installation, severe injury and / or death. All work including handling of electrical circuits during Installation, wiring and periodic maintenance, must be done only by qualified personnel.

Neither GE nor its agents may be held responsible for damage or death arising out of the wiring and / or PT, CT or other external circuits.

The covers of the EPM 2000 should never be dismantled or opened. There are no user-serviceable parts inside. The EPM 2000 contains high-precision components which require special handling available only at authorized GE service locations. High voltages are likely to be present inside even after the EPM 2000 has been switched off. Opening the covers of the EPM 2000 and/or any attempts to dismantle, service, repair or modify the unit by unauthorized persons may cause severe injury, will damage the unit and will also render GE's warranty void.

2. Auxiliary Supply, PT and CT Connections

NOTE: For best wiring results with the new Terminal cover, please ensure the following specs:

Improper wire-manship will damage the Terminals and require Factory Replacement.

This does not indicate defective manufacture and is not covered by product warranties.

- Power Driver preferred, Hand Screw-Driver OK.
- TIP: Phillips preferred, DO NOT USE POZIDRIV TIPS. Flat OK



Screw Head Dia = 3.5mm, TIP Shaft Dia < 5mm.

IMPORTANT - Driver Shafts inserted angularly or of Dia 5mm or more WILL GET STUCK in the Safety Cover

Tightening Torque : 25 to 60 Ncm

Loosening Torque : 55 to 60 Ncm

Screw Travel : 6 mm less wire thickness

Torque greater than 60 Ncm may strip the screw or break the Safety Cover.

Worn-out bits and insufficient hold-down pressure while torquing will cause the bit to ride on the screw head thus stripping and damaging it..

5.1. Auxiliary (Control) Power Supply

The EPM 2000 requires a Single-phase AC / DC Auxiliary (Control) Power Supply to supply power to its internal electronic circuitry. The [Setup](#) procedure must first be completed, with only the Auxiliary Supply connected.

External surge suppressors are necessary in the Auxiliary Supply Circuit for proper operation, for extreme surge conditions, where the Voltage surges exceed the Auxiliary Supply limits (Eg Rural areas and outlying areas prone to lightning strikes).

Auxiliary Supply Range:

- Standard: 80 to 270VAC 45 – 65Hz or 100 to 270VDC.
- Optional: 44 to 300V ac dc
- Burden (load) < 3VA(Auxiliary)

NOTE 1: The Auxiliary Power Supply may be derived from the voltage signals.

NOTE 2: If you have a 440 v Three-Wire Delta system and a reliable Neutral is not available, a 440v : 240v Supply transformer should be used to provide the standard 240v Auxiliary Supply.

DANGER ⚡: Do not feed the EPM 2000's auxiliary power supply terminals with a voltage greater than the rating marked on the label. The EPM 2000 will be permanently damaged and GE's Warranty shall be void.

5.2. Potential Transformers and Current Transformers

Large electrical installations have high voltages and currents which may exceed the direct connection rating of the meter. In this case, Potential and Current Transformers are used to precisely “step down” or reduce the voltage and current level to suit the meter rating. Potential Transformers usually have a full-scale output of 110v ac rms line-line and Current Transformers, a full scale output of 5A or sometimes 1A.

The PTs (Potential Transformers) and CTs (Current Transformers) must be planned, installed and tested by a qualified electrical contractor before wiring the meter. The accuracy of the measurement is determined by the accuracy and phase - shift of the PTs and CTs. Instrument Class 1 or better PTs and CTs are recommended. Do not use Protection Class (10P10, etc.) CTs to feed the EPM2000; they have poor accuracy and phase characteristics.

Ensure that the CT Primary rating has been selected so that your normal load variation lies between 40% and 80% of its full scale. If your CT is over-rated, say if the load is always less than 10% of the CT Primary rating, accuracy suffers. On the other hand, if the CT is under-rated, then you may exceed its full-scale and burn out both the CT and the EPM 2000.

5.2.1. PT, CT Wiring Considerations

The PTs and CTs must have adequate VA rating to support the burden (loading) on the secondaries. You may want to support the Auxiliary supply burden from one of the PTs. CT wiring can impose additional burden (loading) on the CT. For example, if the CT has a 5 Amp secondary and the wire resistance is 1.0 Ohm, then the CT has to support an additional burden of 5VA. If the wiring distance from the CT secondary is greater than stated in Table 3.1, then the CT could get over-burdened and give large errors. Choosing a 1 Amp CT secondary can reduce this error. The CT Secondary value must be user programmed into the meter.

The EPM 2000 should be conveniently located for easy connections of voltage (PT) and Current (CT) signals, the auxiliary (control) supply.

NOTE 1: The EPM 2000's Field Programmable PT and CT Primary or secondary Settings may be utilized to Calibrate out the PT and CT amplitude error, for improved accuracy.

5.3. Voltage Signal Connections

For proper meter operation, the voltage connection *must* be maintained. The voltage must correspond to the correct terminal. The cable required to terminate the voltage sense circuit should have an insulation rating greater than 600V AC and a current rating greater than 0.1 A.

There are 4 Voltage input terminals marked V1, V2, V3 and Vn. See the wiring diagrams that follow, for details. **For Delta connection, the Vn terminal should be left un-connected.**


5.3.1. PT Connections

The EPM 2000 directly accepts LT voltage inputs of up to 600 V ac rms Line to Line (347 V L-N). Voltages greater than this, typically HT systems, must be connected through Potential Transformers (PTs). The EPM 2000 allows Field Programming of both PT Primary and Secondary voltages. See the voltage input overload graph for more detail

| | |
|---------------------------------------|--------------------------------|
| Field Programmable PT Primary range | : 0.1 kV to 999 kV AC RMS L-L. |
| Field Programmable PT Secondary range | : 100v to 600v AC RMS L-L. |
| EPM 2000 Voltage Input burden | : 0.2 VA per input. |

See the [Setup \(Field Programming\) section](#) for programming details.

IMPORTANT: The PT Primary and Secondary values must be User Programmed before using the Meter. Otherwise, the readings will be wrong.

| |
|--|
| CAUTION  : Before wiring, de-energize the PT secondary by opening the circuit or removing the fuse. Do not short the PT secondary. |
|--|

5.3.2. Selecting the Voltage Fuses

We strongly recommend using fuses on each of the sense voltages and the control / auxiliary power, although connection diagrams often do not show them. Use a 1 Amp fuse on each voltage input.

5.4. Current Signal Connections

The meter accepts up to 6 A AC rms per channel directly. Above that, a Current Transformer must be interposed to scale down the current.

There are three pairs of Current Input terminals marked A1₁-A1₂, A2₁-A2₂ and A3₁-A3₂. For proper measurements, the phase identification as well as the polarity of the current signals must be correct. The Forward flow (Import by consumer) current direction must be into the A1₁ terminal and the exit from the A1₂ terminal. Please maintain the correct sequence and polarity to avoid wrong readings.

Any unused current input terminals (eg A2₁, A2₂ for Delta) must be shorted together. The shorted terminals do not need to be grounded.

Install the wiring for the current circuit at 600V AC insulation as a minimum. The cable connection should be rated for 7.5 Amps or greater and have a cross-sectional area of 16 AWG minimum.

5.4.1. CT Connections

CAUTION  : Before wiring, de-energize the CT secondary by shorting it via a shorting block.

Under no circumstances must the CT secondary be left open-circuited, even momentarily, when primary current is flowing. This causes high voltages that will overheat and explode the secondary of the CT and damage the instruments as well.

Mount the current transformers (CTs) as close as possible to the meter for best accuracy. The following table illustrates the maximum recommended distances for various CT sizes, assuming the connection is via 16 AWG cable.

Table 5-1: CT Size and Maximum Distance

| 5A CT Size | Maximum Distance (CT to Meter) |
|------------|--------------------------------|
| 2.5 VA | 10 Feet |
| 5.0 VA | 15 Feet |
| 7.5 VA | 30 Feet |
| 10.0 VA | 40 Feet |
| 15.0 VA | 60 Feet |
| 30.0 VA | 120 Feet |

Field Programmable CT Primary range : 1A to 99k A AC RMS.
CT Secondary : 1A or 5A AC RMS (programmable)
Other values are also programmable to compensate CT errors if desired.
EPM 2000 CT burden : 0.2 VA max. per input.
See the [Setup \(Field Programming\) section](#) for programming details.

IMPORTANT: The CT Primary and Secondary values must be User Programmed before using the Meter. Otherwise, the readings will be wrong.

NOTE 1: With Dual - Range CTs, select the best range for programming the EPM 2000. Do not change the range thereafter without re-programming the EPM 2000; the EPM 2000 will read erroneous values.

5.4.2. CT Polarity

When the meter is connected using the CTs, you must maintain the correct CT polarities. CT polarities are dependent upon correct connections of CT leads, and upon the direction the CTs are facing when clamped around conductors. The dot on the CT must face the line side; the corresponding secondary connection must connect to the appropriate input on the meter.

Failure to connect CTs properly results in inaccurate power readings. If your meter is not reading power properly, it is more than likely the CT is incorrectly wired. If one or two CTs are reversed, then Energy parameters accumulate only one phase value. If two or all the phases of the CT are reversed, Energy will not accumulate. (Note that EPM 2000 does not have the export energy option).

5.4.2.1. CT Connection Reversal

To check the polarity of the CT after the monitor has been installed, simply look at the phase-wise W (Watt) readings to see that each of the readings are positive (assuming you are consuming power). If one of the W readings is negative, that particular phase CT is reversed and must be corrected. On the other hand if you're Exporting power, all three phase-wise W readings must be negative.

5.5. Setup – System Type

The EPM 2000 needs to know what type of 3-phase system it is connected to. This is programmed in the [Setup procedure](#), before using the meter. The meter does allow you to change this setting while it is running; however, this capability is meant for correcting a gross error, or for training or educational purposes, not to be changed regularly. The options are:

- Star (Wye). For Three Phase Four Wire, “Three Watt-meter” or “Three Element” circuits. Here, all three voltage Phase signals, the Neutral voltage connection and all three current input signals need to be wired in. Which means that all the 4 voltage terminals and 6 current terminals described in the following section, need to be wired.

This setting is also used for Single Phase Circuits. Here, the V1 and VN terminals as well as the A11 and A12 terminals will be used to sense a single voltage and a single current.

- Delta. For Three Phase, Three Wire, “Two Watt-meter” or “Two Element” circuits.

5.6. Phase Labels

The Phase Labels shown on the display are programmable via the EPM 2000 Front Panel Set up menu. The choices available are: 123 (factory set), ryb, rst, Pqr, Abc

5.7. Connection Diagrams

Choose the diagram below that best describes your application. You must ensure that the CT phase and corresponding PT phase are identical and that the CT polarity is correct as explained in “[CT Polarity](#)” above. Follow the outlined procedure to verify correct connection.

5.7.1. EPM 2000 Rear Panel

The meter terminals are located on the rear panel. 14 terminals are provided, 7 terminals on each side:

- Six terminals for current, one “in” and one “out” per phase,
- Four terminals for voltage, for three phases and neutral
- Two terminals for meter Auxiliary Power Supply and
- Two terminals for the RS 485 communications port.

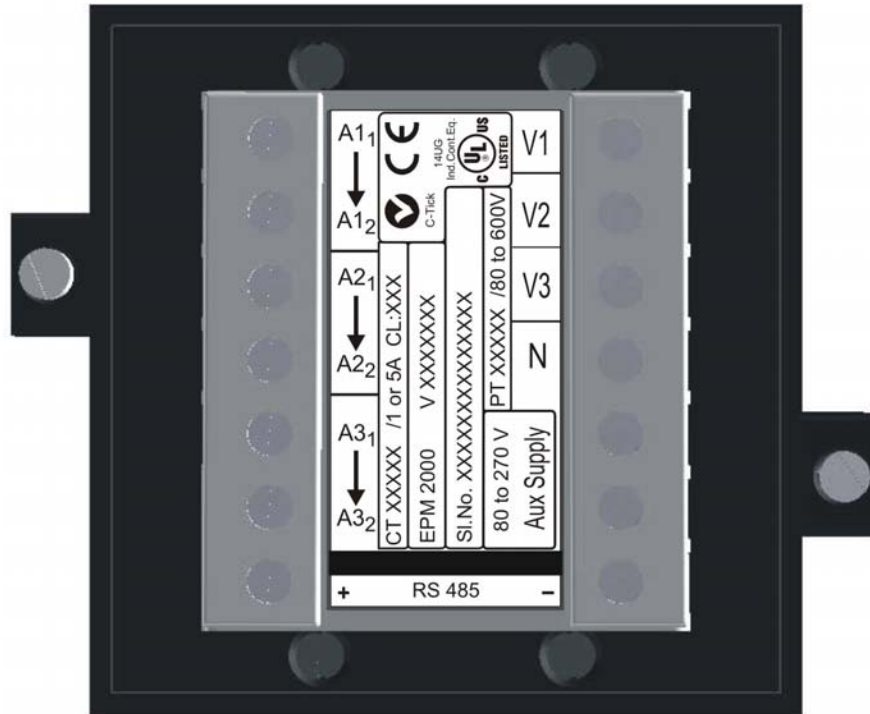
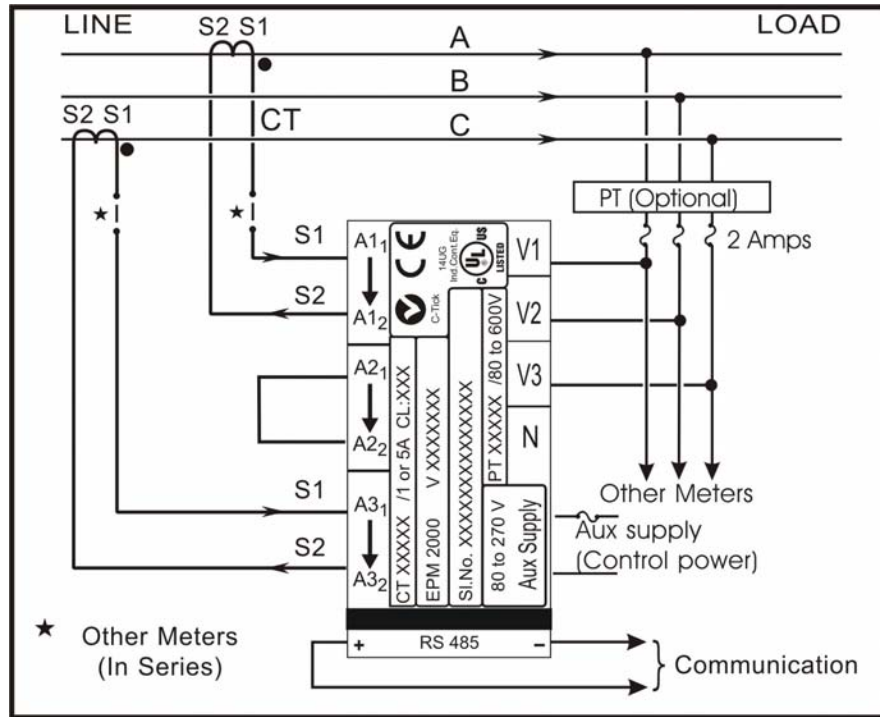


Figure 5-1: Meter Rear panel

5.7.2. Three Phase 3 Wire Delta

With 2 CTs. Direct Voltage Connections if Voltages are less than 600v AC L-L. Otherwise, 3 PTs for Closed Delta or 2 PTs for Open Delta.

Note: Remember to make sure Delta is programmed in the meter Setup. Leave the Vn terminal un-connected.

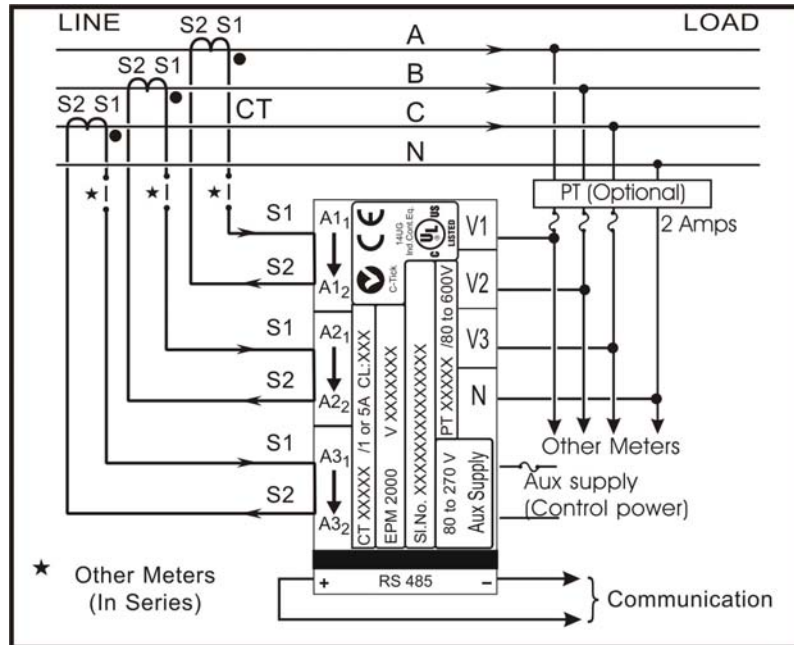


Delta: Three Phase Three Wire Systems

Figure 5-2: The Delta Connection Diagram

5.7.3. Three Phase 4 Wire Star (Wye)

3 CTs. Direct Voltage Connections if Voltages are less than 600v AC L-L. Otherwise, 3 PTs.
For Single Phase, the same diagram is used except that only Phase 1 connections exist and Phase 2 and Phase 3 are unused. The unused current terminals must be shorted together to reduce noise picked up in the meter.



Star: Three Phase Four Wire Systems

6. COMMUNICATION INSTALLATION

6.1. RS-485

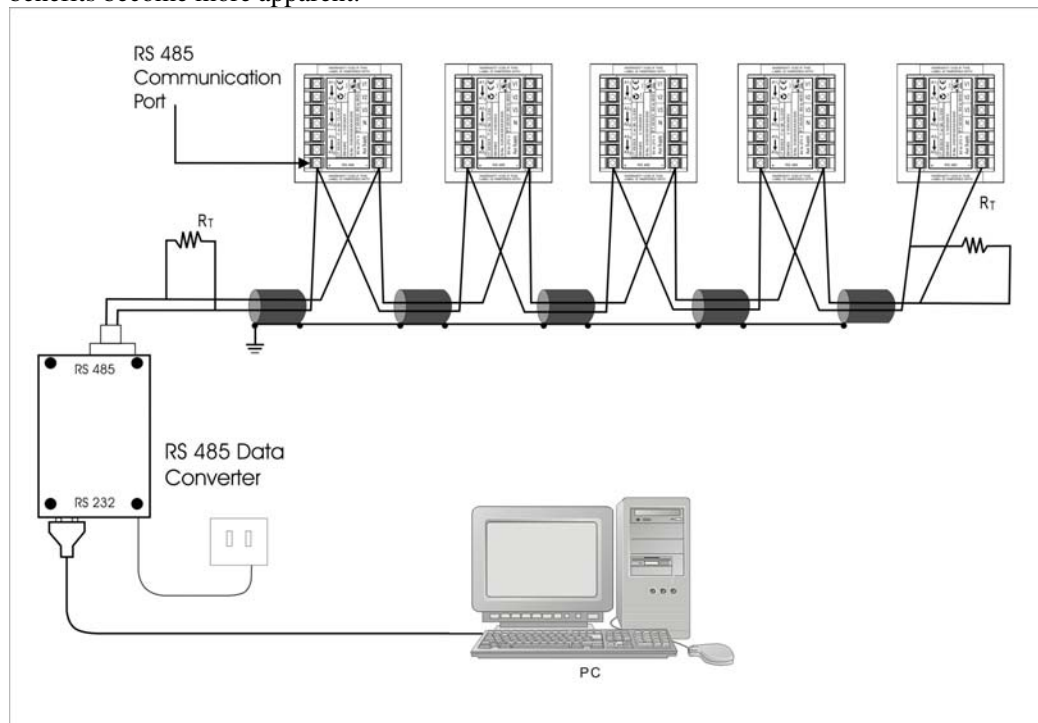
Each EPM 2000 series instruments has a unique address up to three digits long. The range of the instrument address is 1 to 247. This allows the user to communicate with up to 247 instruments on one COM port of the PC. However, each RS485 segment allows only 32 loads(nodes). Therefore, Data Repeaters are necessary to amplify the signal between segments.

Available standard baud rates are 1200, 2400, 4800, 9600 and 19200. To select the proper baud rate, apply the following rules:

- For best results under normal conditions, leave the meter factory-set at 9600 baud.
- For a smaller number of instruments over a long distance, use a low baud rate 4800 / 2400 / 1200.
- In noisy EMI, RFI conditions, try 4800 or 2400 baud.
- With short cable runs (< 300 meters or 975 feet), 19200 baud speeds up data transfers.

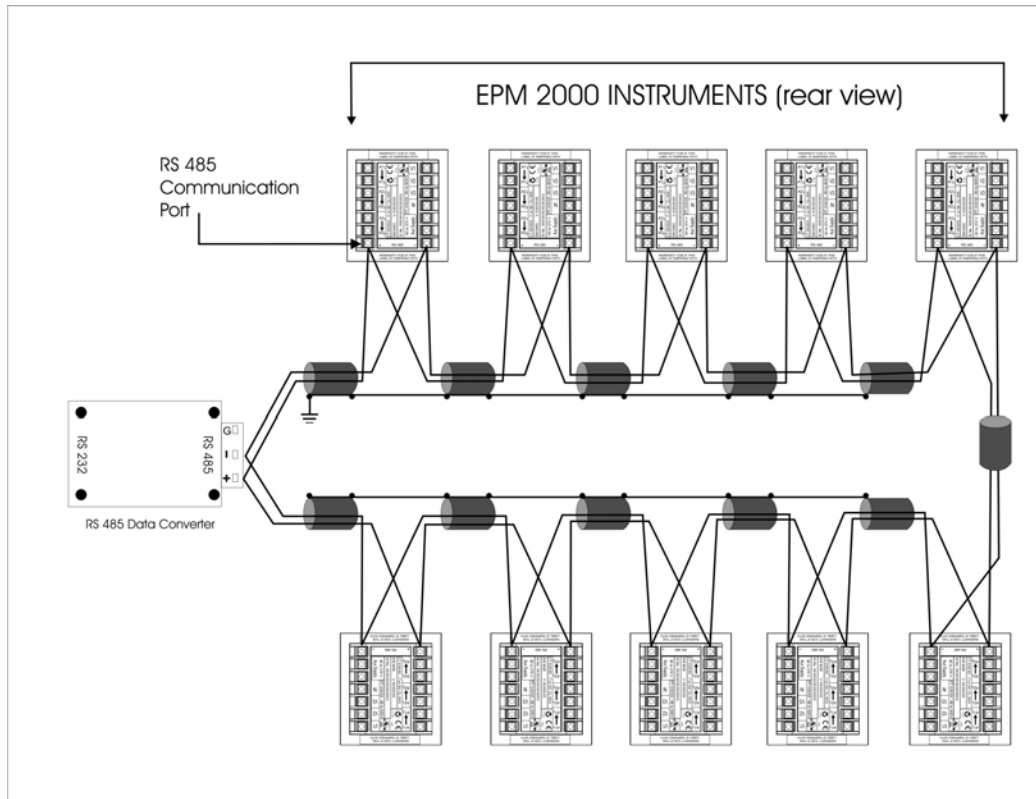
The connection diagrams show one Termination Resistor (RT) across the cable-pair at each end of the cable. This is a 1 Watt resistor, 5% or better. Its value should approximately equal the Impedance of the Data Cable, as specified by the cable manufacturer. If you're not sure, a value of 120 Ohms might just work fine.

The termination resistors help absorb the data signal reflections off the ends of the cable, reducing data packet defects and the corresponding data packet re-transmissions. In cable runs longer than say 200 meters (650 feet), and with baud rates higher than 9600 baud, these benefits become more apparent.



EPM 2000 Instruments (rear view)

Figure 6-1: 2 Wire Half Duplex Communication Connection



*Figure 6-: Closed Loop, 2 Wire Half Duplex
RS485 Communication Connection*

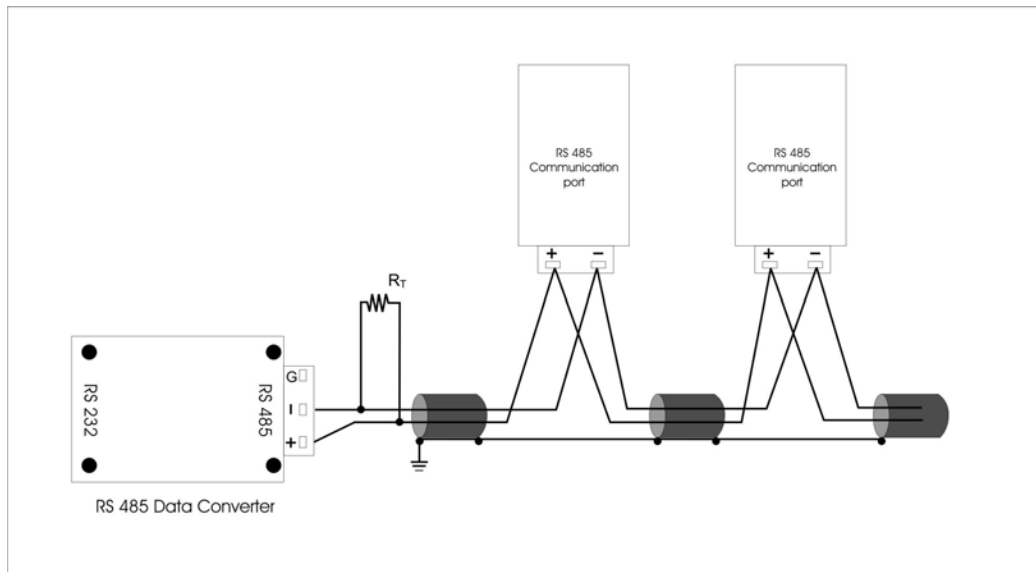


Figure 6-3: Detail of Closed Loop, 2 Wire Half Duplex RS485 Communication Connection

6.2. Repeaters

RS-485 Transceivers (Repeaters) are required for large networks of instruments.

- In a two-wire connection, a maximum of 247 instruments on one COM port of the PC can be included in the same network.
- One RS 485 Segment can accommodate only 32 Devices.

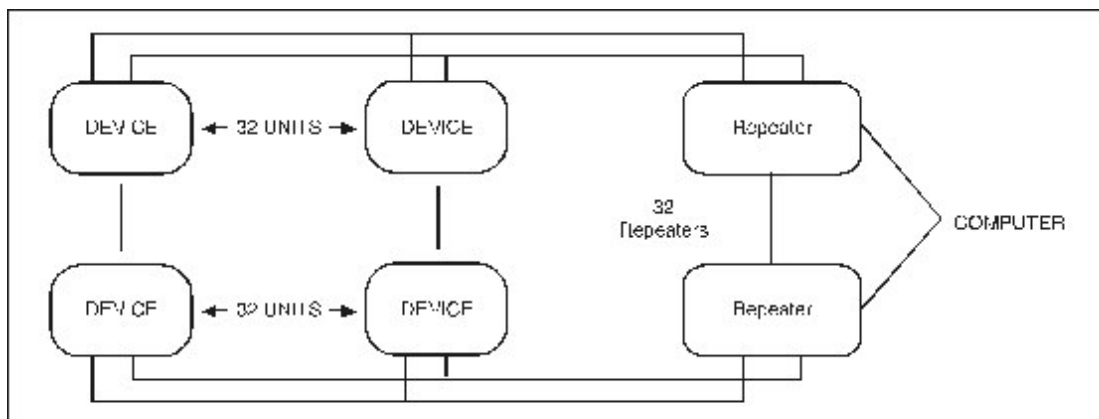


Figure 6.4: 2-Wire RS-485 Communication Installation Connection with Repeaters

6.3. Factory Settings

- Communication Protocol: Modbus – RTU
 - Baud Rate: 9600 bps
 - Data bits: 8
 - Stop bits: 1
 - Parity: Even
- Data type: 32-bit Float (Real) for all parameters unless otherwise specified.
 - Except for parameter:
 - Intr (Number of interruptions (Outages) in RMS parameter blocks) – unsigned 32-bit integer data type.
 - RunSec (Run Seconds in Integrated block) – unsigned 32-bit integer data type.
- Data Format: Direct reading from the meter, no scaling is required.
- Modbus Function code: 03 (Read)

6.4. Modbus Registers

- Before integrating the Meters into your SCADA network, your SCADA software must be configured for Modbus RTU communication, for the Address Blocks below, **by a qualified technician who understands your SCADA software**. Typically, the Device Address, Block Start Address, Number of Registers (20 registers per EPM 2000 Data block of 10 x 32 bit values), must be configured to suit the meter. Additionally, related SCADA settings for polling priority, logging and viewing the Data must also be made. Refer your SCADA software instructions on how to do this.
- Serial data from the Meter is available via the Modbus RTU protocol on the Serial RS485 port. The Unit ID which is unique to each meter is programmed via the “Set-Up” Menu thru the Front Panel keys.
- All addresses are in Decimal. However, check your SCADA Program’s Modbus driver specs such as an offset of 40,001. In this case of EPM 2000, Address 3000 must be treated as Modbus Register Address 43,001.
- The EPM 2000 supports the transfer of whole block and also of individual Data values (2 Registers are used for storing single Data value)
 - In transfer of whole block, it basically treats each block as an object with the starting address (e.g. 3000) considered as the object name. This enables fast block-transfers, since Energy Management usually requires a block of related readings as of the same point of time. This method also eliminates time-skew within readings of that Block.
 - In Transfer of individual Data values, it basically treats 2 registers as an object with the starting address (e.g. 3900) considered as the object name. This enables to transfer required Data values for Energy management.
- Most of the Data are in 32bit format (IEEE Single Precision Float). 2 registers are used for storing a single Data value. A float (or real) setting on your SCADA Driver will usually suffice for automatic conversion. A few values are in Unsigned Long (32 bits).
- Your SCADA software must support Register Blocks consisting of different Data Types (Integers and Floats) to transfer of Whole Block.
- Each Modbus register size is 16-bits. All EPM 2000 readings are 32 bits. Therefore, each EPM 2000 reading occupies TWO consecutive Modbus Registers.
- Most advanced SCADA packages will provide these capabilities.

6.5. Register Map

6.5.1. RMS Total/Average Block

- Start Address: 3000
- Block Size: 20 Registers
- Modbus Read Function Code: 03
- Always transfer the Whole Block.

| Address | Parameters | Description | Data Type |
|---------|------------|-----------------------------------|----------------------|
| 3000 | VA | Total RMS Apparent Power | 32-bit Float |
| 3002 | W | Total RMS Active Energy | 32-bit Float |
| 3004 | VAR | Total RMS Reactive Energy | 32-bit Float |
| 3006 | PF | Total RMS PF | 32-bit Float |
| 3008 | VLL | Total RMS Line to Line Voltage | 32-bit Float |
| 3010 | VLN | Total RMS Line to Neutral Voltage | 32-bit Float |
| 3012 | A | Total RMS Current | 32-bit Float |
| 3014 | F | Total RMS Frequency | 32-bit Float |
| 3016 | RESERVED1 | Reserved for future use | 32-bit Unsigned Long |
| 3018 | INTR | Number of Power Interruptions | 32-bit Unsigned Long |

6.5.2. RMS Phase A Block

- Start Address: 3030
- Block Size: 20 Registers
- Modbus Read Function Code: 03
- Always transfer the Whole Block.

| Address | Parameters | Description | Data Type |
|---------|-------------------|-------------------------------------|----------------------|
| 3030 | VA _A | RMS Phase A Apparent Power | 32-bit Float |
| 3032 | W _A | RMS Phase A Active Energy | 32-bit Float |
| 3034 | VAR _A | RMS Phase A Reactive Energy | 32-bit Float |
| 3036 | PF _A | RMS Phase A PF | 32-bit Float |
| 3038 | V _{AB} | RMS Phase A Line to Line Voltage | 32-bit Float |
| 3040 | V _A | RMS Phase A Line to Neutral Voltage | 32-bit Float |
| 3042 | A _A | RMS Phase A Current | 32-bit Float |
| 3044 | F _A | RMS Phase A Frequency | 32-bit Float |
| 3046 | RESERVED2 | Reserved for future use | 32-bit Unsigned Long |
| 3048 | INTR _A | Number of Power Interruptions | 32-bit Unsigned Long |

6.5.3. RMS Phase B Block

- Start Address: 3060
- Block Size: 20 Registers
- Modbus Read Function Code: 03
- Always transfer the Whole Block.

| Address | Parameters | Description | Data Type |
|---------|------------|-------------------------------------|----------------------|
| 3060 | VA_B | RMS Phase B Apparent Power | 32-bit Float |
| 3062 | W_B | RMS Phase B Active Energy | 32-bit Float |
| 3064 | VAR_B | RMS Phase B Reactive Energy | 32-bit Float |
| 3066 | PF_B | RMS Phase B PF | 32-bit Float |
| 3068 | V_{BC} | RMS Phase B Line to Line Voltage | 32-bit Float |
| 3070 | V_B | RMS Phase B Line to Neutral Voltage | 32-bit Float |
| 3072 | A_B | RMS Phase B Current | 32-bit Float |
| 3074 | F_B | RMS Phase B Frequency | 32-bit Float |
| 3076 | RESERVED3 | Reserved for future use | 32-bit Unsigned Long |
| 3078 | $INTR_B$ | Number of Power Interruptions | 32-bit Unsigned Long |

6.5.4.

6.5.5. RMS Phase C Block

- Start Address: 3090
- Block Size: 20 Registers
- Modbus Read Function Code: 03
- Always transfer the Whole Block.

| Address | Parameters | Description | Data Type |
|---------|------------|-------------------------------------|----------------------|
| 3090 | VA_C | RMS Phase C Apparent Power | 32-bit Float |
| 3092 | W_C | RMS Phase C Active Energy | 32-bit Float |
| 3094 | VAR_C | RMS Phase C Reactive Energy | 32-bit Float |
| 3096 | PF_C | RMS Phase C PF | 32-bit Float |
| 3098 | V_{CA} | RMS Phase C Line to Line Voltage | 32-bit Float |
| 3100 | V_C | RMS Phase C Line to Neutral Voltage | 32-bit Float |
| 3102 | A_C | RMS Phase C Current | 32-bit Float |
| 3104 | F_C | RMS Phase C Frequency | 32-bit Float |
| 3106 | RESERVED4 | Reserved for future use | 32-bit Unsigned Long |
| 3108 | $INTR_C$ | Number of Power Outages | 32-bit Unsigned Long |

6.5.6. Forward Integrator Block

- Start Address: 3120
- Block Size: 20 Registers
- Modbus Read Function Code: 03
- Always transfer the Whole Block.

| Address | Parameters | Description | Data Type |
|---------|----------------|---|----------------------|
| 3120 | VAh (Fwd) | Forward Apparent Energy | 32-bit Float |
| 3122 | Wh (Fwd) | Forward Active Energy | 32-bit Float |
| 3124 | VARh_L (Fwd) | Forward Reactive Inductive Energy | 32-bit Float |
| 3126 | RESERVED5 | Reserved for future use | 32-bits |
| 3128 | RESERVED6 | Reserved for future use | 32-bits |
| 3130 | VARh_C (Fwd) | Forward Reactive Capacitive Energy | 32-bit Float |
| 3132 | RESERVED7 | Reserved for future use | 32-bits |
| 3134 | RESERVED8 | Reserved for future use | 32-bits |
| 3136 | RESERVED9 | Reserved for future use | 32-bits |
| 3138 | RUN_SECS (Fwd) | Forward Seconds Meter Load was connected since last Reset | 32-bit Unsigned Long |

6.5.7.

6.5.8. Favorite Block

- Start Address: 3900
- Block Size: 100 Registers
- Modbus Read Function Code: 03
- Transfer the Whole Block or Individual Parameter

| Address | Parameters | Description | Data Type |
|---------|------------------|-------------------------------------|--------------|
| 3900 | VA | Total RMS Apparent Power | 32-bit Float |
| 3902 | W | Total RMS Active Energy | 32-bit Float |
| 3904 | VAR | Total RMS Reactive Energy | 32-bit Float |
| 3906 | PF | Total RMS PF | 32-bit Float |
| 3908 | VLL | Total RMS Line to Line Voltage | 32-bit Float |
| 3910 | VLN | Total RMS Line to Neutral Voltage | 32-bit Float |
| 3912 | A | Total RMS Current | 32-bit Float |
| 3914 | F | Total RMS Frequency | 32-bit Float |
| 3916 | VA _A | RMS Phase A Apparent Power | 32-bit Float |
| 3918 | W _A | RMS Phase A Active Energy | 32-bit Float |
| 3920 | VAR _A | RMS Phase A Reactive Energy | 32-bit Float |
| 3922 | PF _A | RMS Phase A PF | 32-bit Float |
| 3924 | V _{AB} | RMS Phase A Line to Line Voltage | 32-bit Float |
| 3926 | V _A | RMS Phase A Line to Neutral Voltage | 32-bit Float |
| 3928 | A _A | RMS Phase A Current | 32-bit Float |
| 3930 | VA _B | RMS Phase B Apparent Power | 32-bit Float |
| 3932 | W _B | RMS Phase B Active Energy | 32-bit Float |
| 3934 | VAR _B | RMS Phase B Reactive Energy | 32-bit Float |
| 3936 | PF _B | RMS Phase B PF | 32-bit Float |
| 3938 | V _{BC} | RMS Phase B Line to Line Voltage | 32-bit Float |
| 3940 | V _B | RMS Phase B Line to Neutral Voltage | 32-bit Float |
| 3942 | A _B | RMS Phase B Current | 32-bit Float |
| 3944 | VA _C | RMS Phase C Apparent Power | 32-bit Float |
| 3946 | W _C | RMS Phase C Active Energy | 32-bit Float |
| 3948 | VAR _C | RMS Phase C Reactive Energy | 32-bit Float |
| 3950 | PF _C | RMS Phase C PF | 32-bit Float |
| 3952 | V _{CA} | RMS Phase C Line to Line Voltage | 32-bit Float |
| 3954 | V _C | RMS Phase C Line to Neutral Voltage | 32-bit Float |
| 3956 | A _C | RMS Phase C Current | 32-bit Float |
| 3958 | VAh (Fwd) | Forward Apparent Energy | 32-bit Float |
| 3960 | Wh (Fwd) | Forward Active Energy | 32-bit Float |

| | | | |
|------|-----------------|---|----------------------|
| 3962 | VARh_L (Fwd) | Forward Reactive Inductive Energy | 32-bit Float |
| 3964 | VARh_C (Fwd) | Forward Reactive Capacitive Energy | 32-bit Float |
| 3966 | VAh (Rev) | Reverse Apparent Energy | 32-bit Float |
| 3968 | Wh (Rev) | Reverse Active Energy | 32-bit Float |
| 3970 | VARh_L (Rev) | Reverse Reactive Inductive Energy | 32-bit Float |
| 3972 | VARh_C (Rev) | Reverse Reactive Capacitive Energy | 32-bit Float |
| 3974 | Present Demand | Present Demand | 32-bits Float |
| 3976 | Rising Demand | Rising Demand | 32-bits Float |
| 3978 | Max Demand | Maximum Demand | 32-bit Float |
| 3980 | RESERVED 44 | Reserved for Future use | 32-bits Float |
| 3982 | RESERVED 45 | Reserved for Future use | 32-bits Float |
| 3984 | RESERVED 46 | Reserved for Future use | 32-bits Float |
| 3986 | RESERVED 47 | Reserved for Future use | 32-bits Float |
| 3988 | RESERVED 48 | Reserved for Future use | 32-bits Float |
| 3990 | RESERVED 49 | Reserved for Future use | 32-bits Float |
| 3992 | Max Demand Time | Maximum Demand occurrence time | 32-bit Long |
| 3994 | RUN_SECS (Fwd) | Forward Seconds Meter Load was connected since last Reset | 32-bit Unsigned Long |
| 3996 | RUN_SECS (Rev) | Reverse Seconds | 32-bit Unsigned Long |
| 3998 | INTR | Number of Power Outages | 32-bit Unsigned Long |

6.5.9.

Register Map Notes

- Favorites : These parameters can be read individually or as a block of maximum 50 parameters at a stretch
- Advisable to configure all the parameters of every blocks (except for Favorites) even if you want to read just one parameter.
- The Power Outages (Intr) parameter in Total RMS Block, RMS Phase A Block, RMS Phase B Block and RMS Phase C Block gives power outages at the meter Auxiliary (Control Power) Supply and not for individual phases. Therefore all the values will always be same. If the meter is powered off of a UPS, then these values will remain Zero, even if the Voltage signals were interrupted.
- All the RESERVED parameters will return a Zero value. All RESERVED parameters must therefore be ignored..
- RunSecs Parameter in Integration block is a high resolution representation of the Run Hours available on the Meter Front Panel Display. Divide RunSecs by 3600 to get Run Hours.
- No scaling or multiplication factor required. All values are already pre-scaled with the PT and CT scaling programmed into the meter.

6.5.10. Display-Only Parameters

Parameters Available on the Front Panel Display but not available on the RS485 communication port:

| SI No | Parameters available on Front Panel Display only |
|-------|--|
| 1. | Phase A Current Phase Angle |
| 2. | Phase B Current Phase Angle |
| 3. | Phase C Current Phase Angle |
| 4. | On Hours |

END OF DOCUMENT