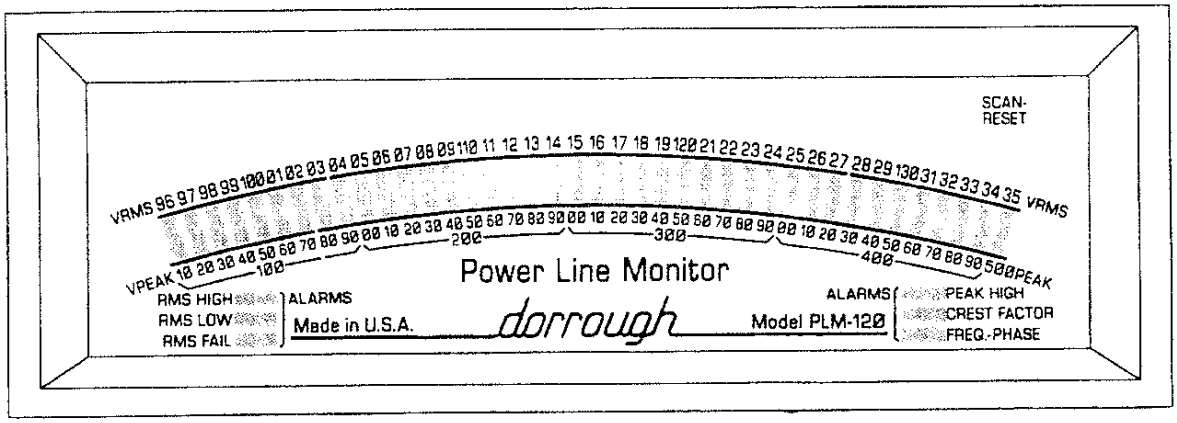
Technical Instruction Manual

DORROUGH
POWER LINE MONITOR
MODEL PLM-120



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Introduction

If you are involved in an industry that utilizes electronic, line-powered equipment you know that the quality of your power source can have a large impact on the operation and life span of your equipment.

You probably rely on an uninterrupible power system (UPS) to protect your computer or server against disturbances e.g. undervolltage, overvoltage, power cuts, sags, surges, etc. You may also use line conditioners to "smooth" the bumps from the AC source; however, how do you know how well your UPS or line conditioner is performing? The Power Line Monitor Model PLM-120 will provide that information.

Overview

The PLM-120 functions like a plug-in meter. It displays the true Root Mean Square (RMS) value of the power line with a windowed LED display (1volt/LED) bar graph similar to that of an analog AC line meter. The LED display is updated once per line cycle, therefore it can reveal the dynamic nature of an AC source in real time. Sags and surges are readily apparent with this format.

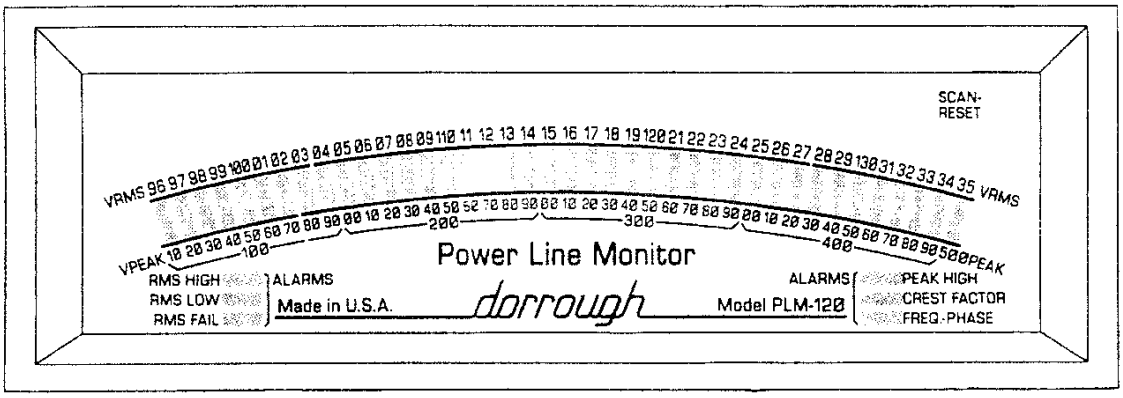

Figure 1. Power Line Monitor Model PLM-120

The PLM-120 shows fast peak transients simultaneously with the RMS value-- something that no other meter does. Fast transients can cause erratic operation of sensitive electronic equipment and/or damage it. The minimum/maximum RMS and maximum peak are recorded over time and can also be displayed.

Six alarm LEDs indicate when important AC line parameters have been exceeded. They include: RMS High, RMS Low, RMS Fail, Peak High, Crest Factor and Frequency Phase. These alarms are explained in greater detail in the Technical Description section.

Along with these metering functions the PLM-120 provides a PC or terminal accessible RS-232 console port that allows the user to access the extensive logging functions of the meter. All AC line anomalies that are monitored by the PLM-120 can trip event counters that log the total number of line anomaly events.

An event stack will log a particular event with a time/date stamp from its internal real time clock. The duration of the event and minimum/ maximum voltage values are also recorded. A set of programmable alarm relay contacts connect with user annunciators or PCs to alert the user that an AC line parameter setpoint has been exceeded.

The PLM -120 is a powerful AC line monitor and diagnostic instrument that should be in every installation with sensitive electronic equipment.

About This Manual

The Technical Instruction Manual is divided into five sections: Introduction, Installation, Technical Description, Console Port and Appendices. We recommend that you read through the entire manual to fully understand the capabilities of the Power Line Monitor Model PLM-120.

Installation

Follow these simple instructions to install your DORROUGH Power Line Monitor Model PLM-120:

Unpacking

Your DORROUGH Power Line Monitor Model PLM-120 was carefully packed at the factory. Take a moment to examine the unit for any signs of shipping damage. If damage is evident retain the carton and notify the transit carrier and your local distributor about your claim.

Once you are satisfied with the physical integrity of the unit you are ready for set-up.

Initial Set-up

1. Place the DORROUGH Power Line Monitor Model PLM-120 in a location that offers easy observation of the meter movement and access to the Scan-Reset button.

2. Plug the AC cord into a nominal AC line, preferably one that shares the same branch circuit with your other electronic equipment. Observe that the panel lights illuminate.

The Power Line Monitor Model PLM-120 has extensive logging functions that can be accessed by plugging in a terminal or terminal emulating PC to the console port. To use these functions:

3. Connect cables to the user port and communications port on the back of the unit and into your computer ports.

4. Install software. See Console Port specifications listed below.

Console Port Specifications

RS-232, DB-9M, configured as DCE, PC compatible port.

Handshaking:	None
Baud Rate:	9600
Format:	8N1
Data Format:	ASCII text, Wyse 50 terminal emulation
System prompt:	: >
Wake up/Back up:	<Esc>

Technical Description

Front Panel Display

1. The upper scale above the LED row specifies the Root Mean Square or **RMS Value** of the AC line (see Figure 2).

RMS is displayed as a solid bar across the scale. The RMS range is 95 to 135 volts with each LED indicating one volt per step. Note that the range and color-coding of the LEDs are chosen to overlay the Computer and Business Equipment Manufacturer's Association (CBEMA) recommendations for nominal operating RMS values.

The red LED indicators show the CBEMA upper and lower static thresholds for this range. Normally, the RMS bar stays in the green area and moves no more than a few volts in the short term with a good AC line; however, in some environments (e.g. industrial) the RMS bar can become quite dynamic, showing the sags and surges caused by the environment.

2. The lower scale below the LED row specifies the **Fast Peak Value** of the AC line (see Figure 2).

This is indicated by one of the flashing LEDs (at a 1Hs rate) in the LED row. The lower scale range is 120 to 500 volts peak with 10 volts per LED/step. At a 170 Vpeak the fast peak indicator normally shows the crest of the AC wave shape (assuming a reasonable low distortion of sine wave AC waveform).

If a fast peak occurs this indicator is pushed to the value of the AC peak and then decays slows back down to the nominal crest of the AC waveform. The other flashing indicator you may see shows the most positive fast peak value captured and held by the PLM-120. Both of these indicators can be enabled/disabled by the user.

3. The minimum and maximum value of RMS, as well as the most positive fast peak value encountered is captured and stored by the Power Line Monitor Model PLM-120. To display these values press the **Scan-Reset button** momentarily, located in the upper right corner of the front panel (see Figure 2).

The PLM-120 clears the current display and then shows in sequence RMS Low, RMS High and Fast Peak High on the main display. Each Min/Max value on the main display is tallied by the appropriate alarm indicator, e.g. when the RMS Low is displayed, the RMS indicator will be illuminated. After six or seven seconds the display will resume displaying the current AC line values. Minimum/Maximum values can be cleared by holding in the Scan-Reset button at the same time that the scan sequence is about to expire.

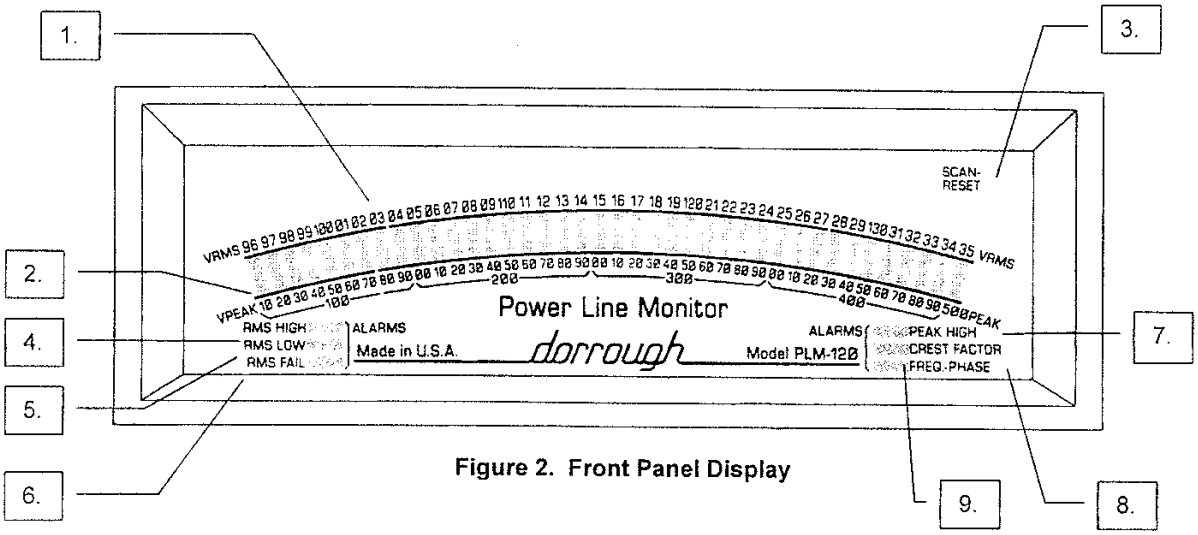

Figure 2. Front Panel Display

Front Alarm Panel

Six auxiliary LED indicators record and illuminate when any important parameter thresholds have been exceeded. The indicators are latching and can be reset along with the min/max values previously discussed. Each alarm indicator can be selectively enabled to trip an alarm relay (see Figure 2).

	ALARM	FUNCTION
4.	RMS High	• Illuminates if the RMS value has exceeded the CBEMA static upper rail.
5.	RMS Low	• Illuminates if the RMS value has exceeded CBEMA static lower rail.
6.	RMS Fail	• The PLM-120 assumes a power fail state if the RMS value drops below 85 VRM. This indicator illuminates when power resumes.
7.	Peak High	• Illuminates if a fast peak transient has a value high enough to be potentially damaging.
8.	Crest Factor	• Illuminates if the ratio between the RMS and crest of the AC source becomes too low. A voltage crest factor error may indicate that the line source is "flat-topping" or becoming excessively distorted. This could be due to an overload or malfunctioning line conditioner for example.
9.	Freq/Phase	• Illuminates if the nominal line frequency is out of rails or if the source jitters excessively. For example, generator sources may "wander" or jitter causing some power factor corrected power supplies to malfunction. Other frequency sensitive equipment may also malfunction.

Note: On RMS Fail events the RMS Low, Peak High, Crest Factor and Freq/Phase alarms may trip. This is due to the unpredictable nature of the AC source under power fail conditions. Please refer to Specifications in Appendix B for the thresholds and setpoints for these alarms.

User Port and Alarm Relay

The Power Line Monitor Model PLM-120 user port allows connections to the dry contact alarm relay. The user port is a DB-9F style connector. The pinouts are shown in Figure 3.

The alarm relay is controlled in the "deadman" mode, i.e., the relay is de-energized under an alarm condition. Parameters that control the alarm relay are enabled by the DIP switch located in the rear panel. The DIP Switch Assignment Table is described below in Figure 4.

RMS fail will always de-energize the alarm relay. Alarms are latching in nature and can be reset by pressing the Scan-Reset button located on the front panel. Alarms can also be reset through the parameter edit function using parameter 00. This is described in the Console Port section of this manual.

User Connector, Pin Assignments and Functions: (DB9-F)

Pin	Function	Description	Activate
1	User 1	Show min/max, reset alarms	Pin 1 to 6 *
2	User 2	Not assigned	Pin 2 to 6
3	User 3	Not assigned	Pin 3 to 6
4	User 4	Not assigned	Pin 4 to 6
5	User 5	Not assigned	Pin 5 to 6
6	User Com	Common/gnd, user functions	
7	Relay NO	De-energize state	
8	Relay NC	------	
9	Relay Com	-----	

** It has the same function as the Reset-Scan button. It should be a momentary switch type.*

Figure 3.

DIP Switch Assignment Table

Position	Mode
1	Peak display enable
2	Peak hold display enable
3	RMS High alarm enable
4	RMS Low alarm enable
5	Freq/Phase alarm enable
6	Crest factor alarm enable
7	Peak High alarm enable
8	Not assigned

Figure 4.

Insert Mike's explanation of the schematic.

Insert Figure 5. Schematic

Key Components

Along with the DIP switch, user port, communications port and the Reset-Scan button discussed in the previous section, the remaining key components of the Power Line Monitor Model PLM-120 include the power transformer, battery and calibration button (see Figure 6).

The power transformer...

The lithium-Ion battery ...

The calibration button...

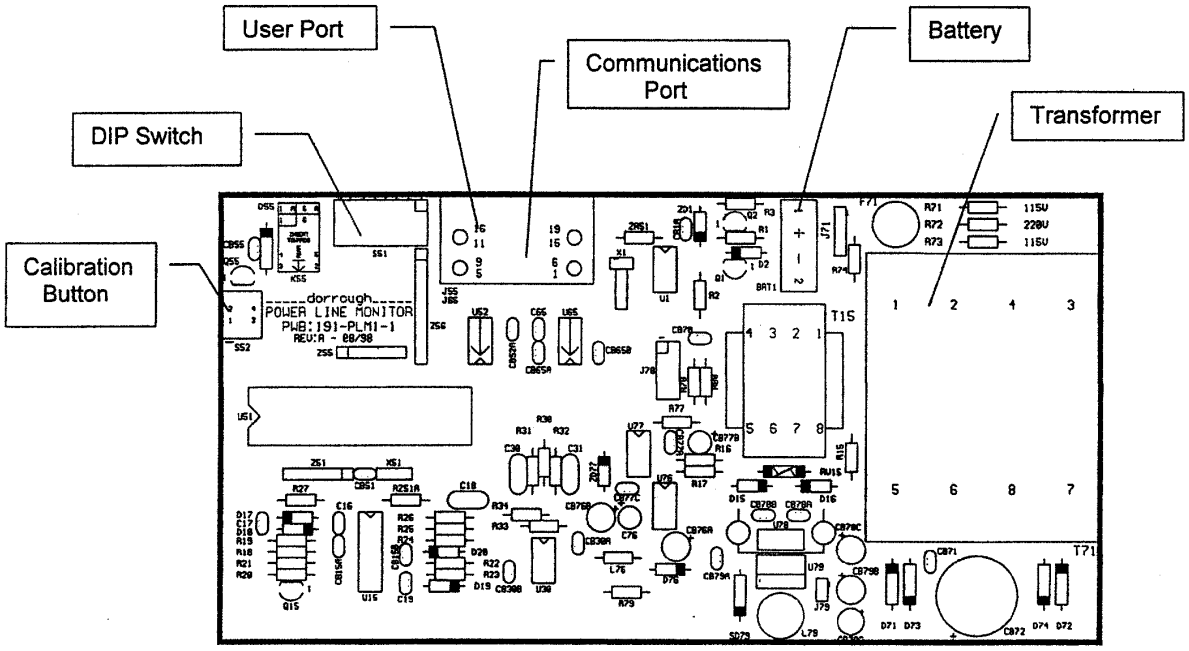

Figure 6. Key Components

Console Port

Communication is straight ASCII terminal emulation. A more sophisticated PC graphic user interface will be offered at a later date.

The console software has a simple two-level structure: The bottom level is indicated by the command line prompt " : > ".

When on another level, to return to the command line:

Action **Press** the *Esc* key.

Use the Escape key to establish initial contact with a PLM-120.

Parameter Edit

To invoke the parameter editor:

Action **Press** the < E > key.

The screen will look like this:

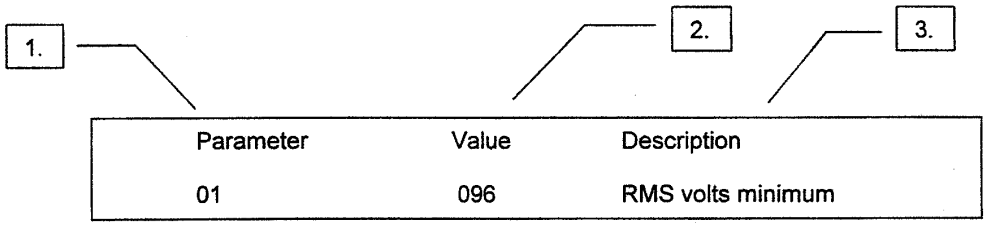

Figure 7. Parameter Edit Screen

1. The left column is the parameter (see Figure 7).

2. The center column indicates the current value of the parameter at the time the parameter was called up for display.

3. The right column is a text description of the parameter.

Most of the parameters are clearable. For example, if you are displaying maximum VRMS, you can clear the maximum RMS value to the current measured value.

To clear a parameter:

Action **Press** < Ctrl C >.

To select a new parameter:

Action **Scroll** through the list using the *up/down* keys on your console to view the parameters (see Figure 8).

Parameter List

Parameter	Description	Notes
00	Clear alarms	
01	RMS volts minimum	Range: 0 - 135 VRMS
02	RMS volts maximum	Range: 0 - 135 VRMS
03	Fast peak volts maximum	Range: 0 - 500 Vpeak
04	RMS fail event count	255 count max
05	RMS low event count	255 count max
06	RMS high event count	255 count max
07	Fast peak event count	65,535 fast peak line cycles
08	Glitch event count	65,535 glitched line cycles
09	Crest factor	255 count max
10	RMS fail event count	255 count max

Parameters 00 - 10 are clearable. Parameters 11 and 12 are programmable.

11	RTC date	Format: MM/DD/YY
12	RTC time	Format: HH:MM

Figure 8. Parameter List

NOTE: *RTC time is set to the nearest minute when programmed.*

Log Records

The PLM-120 records a more complete picture of three of the most important parameters: RMS Fail, RMS Low and RMS High.

To access these records:

Action **Press** the < L > key on your console from the command level.

The screen will look like this:

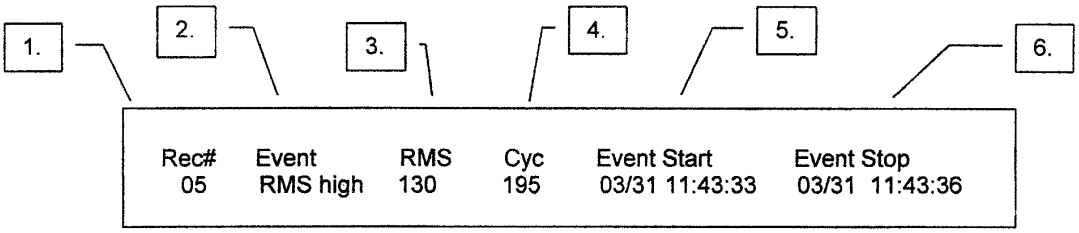

Figure 9.

1. The record number **(Rec#)** column indicates the most recent record when the log screen was invoked. Every time a new record is added to this "stack" by the PLM-120, the oldest record is discarded and written over by the new one.

To look at the next oldest event in the event stack:

Action **Press** the < ↓ > key.

To advance the record to the next newest event in the stack:

Press the < ↑ > key.

2. The **Event** column indicates the nature of the event.
3. The **RMS** column indicates the minimum or maximum RMS voltage for that event.
4. The cycle **(Cyc)** column indicates the duration of the event up to 255 line cycles. If the event length is longer than 255 line cycles the numbers will be replaced by three right carets (>>>). Reference the start stop/stop times for the event duration.
5. The **Event Start** column indicates the start date and time of the event.
6. The **Event Stop** column indicates the stop date and time of the event.

The number of records in the log is currently set at 40.

Appendix A

Glitch Count

Parameter 08 in the parameter list may not be familiar to some people. In the uninterruptible power system industry this method is used as a fast-responding line loss detector, determining if the AC source instantaneous value is an amplitude adequate to power the load. The DORROUGH Power Line Monitor Model PLM-120 borrows this technique to provide another indicator of the relative quality of the AC source.

Normally the AC source is a relatively low distortion sinewave. Software in the PLM-120 generates a reference or virtual ideal sinewave internally with its amplitude set approximately 30% below the amplitude of the AC source.
The PLM-120 samples the AC waveform 64 times per line cycle. At each sample period the AC source instantaneous waveform amplitude is compared to the internal reference waveform. If the AC source amplitude is less than the reference value for that sample period (approximately 260 uS), a glitch counter (parameter 08) is incremented once per line cycle.

Some line loss detector schemes may even adjust the wave shape of the reference waveform to the wave shape of the AC source, thereby adapting to statically distorted AC wave shapes. For the most part the RMS value of the AC source is the most important parameter in terms of load sensitivity. The glitch count technique provides a method for detecting sub-cycle "sags" that may not be revealed in the RMS value as a problem. But could trigger a malfunction in some sensitive line-powered equipment.

Appendix B

Power Line Monitor Model PLM-120 Specifications (120-V, 60Hx model)

RMS Scale:	96 to 135 VRMS, 1 V/step LED
Peak Scale:	110 to 500 VPK, 10 V/step LED
RMS/Peak Accuracy:	+/- 1% over full display range
RMS/Peak Drift:	Less than 0.1%, 0 to 40 degrees C ambient
Peak Response:	10 uS, from peak nominal to full scale +/- 2 dB, 40 Hz to 100 kHz

The PLM-120 uses a software RMS computing technique that samples the AC line source at 64 times the line rate. RMS display is centered and color-coded over the CBEMA recommended operating range for RMS.

Alarm and Event Count Thresholds (CBEMA Static Thresholds)

RMS High:	128 VRMS
RMS Low:	103 VRMS
RMS Fail:	85 VRMS
Peak High:	200% nominal, 340 VPK
Glitch Threshold:	Approximately 30% below ideal sinwave waveshape Ref peak = sampled peak
Crest Factor:	1.3
Freq/Phase:	Rails: +/- 2 Hz @ 60 Hz Jitter: 10 Hz/sec