CURRENT TECHNOLOGY®

Quick start guide — MasterMind™

Operational instructions for advanced monitoring options: M3, M4E, M5, M6E

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

DEHN

Warning conventions

⚠ WARNING

Hazardous voltages present:
Improper installation or misapplication may result in serious personal injury and/or damage to electrical system.

- Use only the test instruments and insulated tools rated for the voltage and current specified.
- Always keep one hand in your pocket when anywhere around a powered line-connected or high voltage system.
- Don't wear any jewelry or other articles that could accidentally contact circuitry and conduct current, or get caught in moving parts.
- Perform all possible tests with power off and the equipment unplugged.
- Don't attempt repair work when you are tired.
- Never assume anything without checking it out for yourself! Don't take shortcuts!
- Wear appropriate personal protective equipment for the job being performed. Example: Safety glasses, safety shoes, gloves, welding helmets, etc.

PRÉSENCE DE TENSIONS DANGEREUSES :
Une installation incorrecte ou une mauvaise utilisation peuvent entraîner des blessures graves et/ou des dommages au système électrique.

- N'utilisez que les instruments de test et les outils isolés prévus pour la tension et le courant spécifiés.
- Gardez toujours une main dans votre poche lorsque vous êtes à proximité d'une ligne électrique ou d'un système haute tension.
- Ne portez pas de bijoux ou autres éléments qui pourraient entrer accidentellement en contact avec les circuits et conduire le courant, ou se prendre dans les pièces mobiles.
- Effectuez autant de tests hors tension que possible.
- N'essayez pas d'effectuer des réparations lorsque vous êtes fatigué(e).
- Ne supposez jamais rien sans le vérifier par vous-même ! Ne sautez pas d'étapes !
- Portez l'équipement de protection individuelle approprié pour le travail à effectuer. Exemple : lunettes de sécurité, chaussures de sécurité, gants, casque de sécurité, etc.

Verify proper operation

Verify that only the green indicating lights are illuminated and no red lights are illuminated. Green lights indicate a normal condition for each phase. Orange lights indicate medium MOV % protection and red lights indicate low MOV % protection. Three-phase units have three (3) green indicating lights labeled "A," "B," and "C." Split-phase units should only have lights "A" and "C" illuminated. See Table 1 for LED status condition.

The MasterMind advanced monitoring is equipped with a dual set of Form C contacts (see Figure 1). The relay containing the contacts is in the "alarm condition" (or normally closed) when: the power is off to the unit, when the unit is encountering loss of power to one or more phases, or when the SPD is encountering (40% default) loss of capacity due to internal fuse operation. Test the operation of the Form C contacts by de-energizing the SPD and checking the state of the contacts with a continuity tester or observing the effect of the contacts on the user-provided remote alarm circuits.

The MasterMind advanced monitoring contains an audible alarm that should not operate under normal conditions.
To silence audible alarm, press the ALARM SILENCE button on display.

Table 1: LED and display alarm status conditions

Condition	Corresponding phase LED	Alarm cond.	M3 status message **	Priority *
Phase loss (<80%)	LED off	Y	"Alarm phase x loss"	1A
Phase low (80 to <90%)	LED short blink green (≈25% duty)	Y	"Alarm phase x low"	1B
Phase high (>110%)	LED long blink green (≈75% duty)	Y	"Alarm phase x high"	1C
N-G overvoltage	N/A	Y	"Alarm N-G voltage high"	2
Frequency out of range	N/A	Y	"Alarm: frequency out of range"	3
MOV % protection low	LED on red	Y	"Alarm: protection x low"	4
Filter/cap loss	LED blink red once every 2 seconds	Y	"Alarm: protection filter x loss"	5
Selenium loss	LED blink red twice every 2 seconds	Y	"Alarm: protection selenium x loss"	6
MOV % protection medium	LED on orange	N	"Alarm: protection x reduced"	7

Notes:
* 1 Highest priority takes precedence: I.e., if phase is lost, LED is Off, no blinking even if filter loss. Alarm condition means the audible alarm is ON, dry relay contacts are OFF (de-energized) and system alarm LED is ON.
2 % Protection levels of 40% and 75% are default settings that can be changed by the user (M3 system only). If the surge module or current rating settings are changed, the protection levels will change automatically; the thresholds that are available for MOV% protection depend on the ISM (ISB) that has been selected.
** 3 Subsequent status message will be displayed on M3 character and graphics displays, where "x" is corresponding phase (A, B, C or L1, L2). The highest priority condition will over-write earlier conditions. Messages may be truncated to fit screen area.
4 Red system status LED will remain on after status has returned to normal. User must clear the status by pressing the M3 cancel button.
5 Alarm conditions will also be logged in the events log.

Connecting form C dry contacts

Dry contacts: All SPD models have a dual set of Form C dry contacts available for connection to user-provided remote alarm and monitoring circuits.

The installer must provide the appropriate raceway and wiring for this circuit, observing the restrictions on conduit openings. The installer must route the monitoring conductors to the blue terminal blocks on the door-mounted circuit board (basic/M1 monitor board). Choose the appropriate materials and routing to allow the door to open and close without pinching or stressing wires.

Figure 1 shows the Form C contact configuration. The annotations on the diagram match the markings on the
blue terminal block.

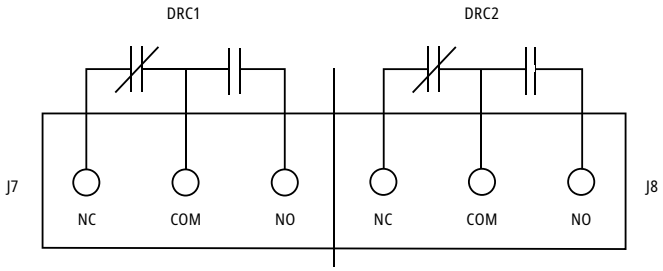


Figure 1 — FCC terminal block
• Rated 250 V 2 A DC, 250 V 5 A AC, 22–14 AWG, 4.4 in.-lbs (0.5 Nm)
• Contacts shown in non-energized state

1.0 Introduction

1.1 Scope and overview

The MasterMind monitoring systems are options available on the SL3™, TG3™ and PX3™ surge protective devices. The advanced monitoring packages in Table 2 are covered in this manual. The primary user interface is through a graphical user interface (GUI) presented on a character LED or optional graphic LCD display. Keypad and LED indications act as a secondary user interface. The M4E and M6E options also provide Ethernet/Modbus communication that can connect the system to a network of many other devices, which allows the system to respond to queries from other systems. Ethernet connectivity supports Web Server and Modbus TCP applications for remote monitoring of the system.

New advanced monitoring features:

- Instantaneous voltage measurements: L-N, L-G, L-L, N-G
- Monitoring the percent protection remaining from the MOVs
- Monitoring selenium presence
- Monitoring filter presence
- Monitoring surge detection
- 3-Phase availability indication (LED) and monitoring

Table 2: Model/description

Model	Description
M3	Advanced monitoring, character display, Modbus RTU
M4E	M3 + Ethernet, Modbus TCP
M5	Advanced monitoring, graphics display, Modbus RTU
M6E	M5 + Ethernet, Modbus TCP

The following parameters are computed from the measurements, which are displayed and logged:

Measured:

- RMS voltages on all modes: L-N, L-G, L-L, N-G (wye, hi-leg, split-phase), L-L (delta)
- Frequency of each phase
- Voltage fundamental (RMS value/nominal value)
- Voltage THD in % (THD = even + odd harmonics)

Measured and logged power quality events:

- Voltage sag and swell
- Temporary overvoltage
- Overvoltage
- Voltage dropout
- Voltage outage
- Transients

1.2 MasterMind™ monitoring options

A full-featured monitoring option for SL3™, TG3™ and PX3™ products

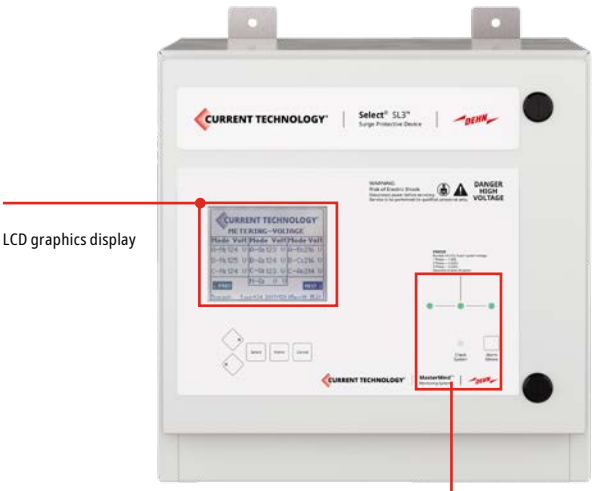


Figure 2: M3-M6E local display

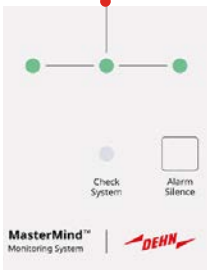


Figure 3: M3-M6E local display

M3 monitoring

- Local character display with membrane switch user interface
- Power quality monitor provides time, date, magnitude and duration of the following:
  - Sags
  - Swells
  - Dropouts
  - Outages
  - THD
  - Frequency
  - Volts RMS per phase
  - Surges
    - Low = 100 A–500 A
    - Med = 500 A–3000 A
    - High = 3000 A+
  - Remaining surge protection percentage
- User-settable alarm thresholds (magnitude and duration)
- Dry relay contacts
- Audible alarm, alarm silence
- Per phase LED indication
- Modbus RTU remote communications capability

M4E monitoring

Includes all M3 features, plus the following:

- Ethernet, Modbus TCP remote communications capability
- Web interface

M5 monitoring

- Large graphics local display with membrane switch user interface
- Power quality monitor provides time, date, magnitude and duration of the following:
  - Sags
  - Swells
  - Dropouts
  - Outages
  - THD
  - Frequency
  - Volts RMS per phase
  - Surges
    - Low = 100 A–500 A
    - Med = 500 A–3000 A
    - High = 3000 A+
  - Remaining surge protection percentage
- User-settable alarm thresholds (magnitude and duration)
- Dry relay contacts
- Audible alarm, alarm silence
- Per phase LED indication
- Modbus RTU remote communications capability

M6E monitoring

Includes all M5 features, plus the following:

- Ethernet, Modbus TCP remote communications capability
- Web interface

2.0 Display navigation screens

2.1 Introduction

For easier screen navigation, it is important to become familiar with this section.

2.2 Keypad

Pressing the HOME KEY at any time during navigation will always bring up the home screen. The NEXT and PREVIOUS keys are used for switching between the various menus on a specific level. The SELECT (or ENTER) key is used to select a sub menu from the present screen, whereas the cancel (CLEAR) key will exit a sub menu and return to the main menu. The following table helps explain the keys and their functions.

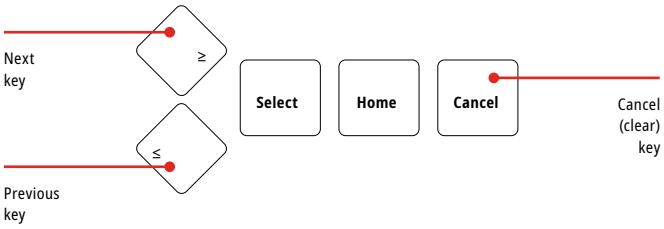


Figure 4: Keypad

Table 3: Keypad

Key	Data mode	Edit mode
Select (enter)	Enter the sub menu	Enter the edit mode
Cancel (clear)	Exit sub menu and enter parent menu	Exit the edit mode
Home	View home screen	View home screen
Right arrow (next)	Next screen in the same menu/sub menu	Select the data to be edited/ incrementing data values
Left arrow (previous)	Previous screen in the same menu/ sub menu	Select the data to be edited/ decrementing data values

* Edit mode is available only on configuration screens

2.3 Character display

Figure 5 depicts the startup or the home screen on the character display. The home screen provides the firmware version, present status of the monitoring board, and the date/time.

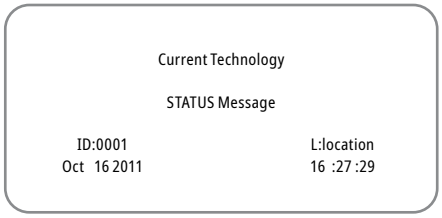


Figure 5: Home screen/startup screen for M3 and M4E

2.4 LCD graphics display

Figure 6 includes images of the main screen/startup screen on the graphic display. The phases displayed on these screens depend on the system type. For example,
a 2-phase, 2-wire system will display L1 and L2, whereas a 3-phase, 3-wire system will display A-B, B-C and C-A and a 3-phase, 4-wire system will display A, B, C. In short, this screen changes depending on the system type selected.

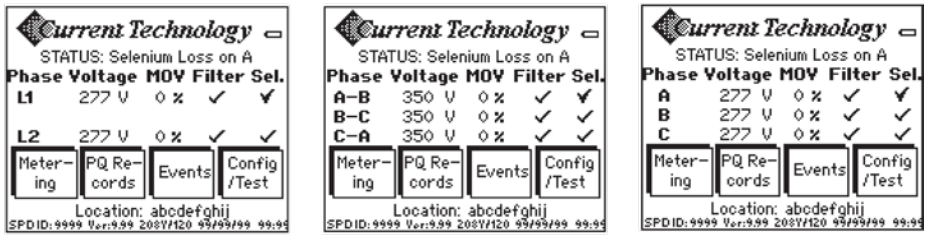


Figure 6: Home screen/startup screen for M5 and M6E

2.5 Login level and password

To perform certain tasks such as change IP configuration, change the login level to “service.”

Login/level	Password
1 – user	“text”
2 – admin	“task”
3 – service	“core”

Note: After entering the last letter of the password, press Home Key. “Login Successful” should appear in the display.

3.0 Web server setup and navigation

3.1 Introduction

This section explains the various webpages available in the SPD unit and the information they contain. Simply connect the Ethernet cable to the Ethernet port. Set the IP addresses of the SPD unit. Navigate to the unit as described in Figure 7.
For more detailed information, please refer to MasterMind Ethernet Guide (PN-750-0119-003).

A detailed description of the menu bar (which is used in navigation), its features and various sections is explained in Figure 8. Brief explanations of various webpages available under each section are provided in subsequent sections.
To navigate to the SPD main webpage, simply enter http://(I.P. address, i.e., 169.192.0.2)/m3_status.html in the address bar. All other webpages can be reached from the main page. Other page names are listed below.

Note: Microsoft Internet Explorer, Google Chrome and Mozilla Firefox are all supported.

3.2 Block diagram

Web server navigation

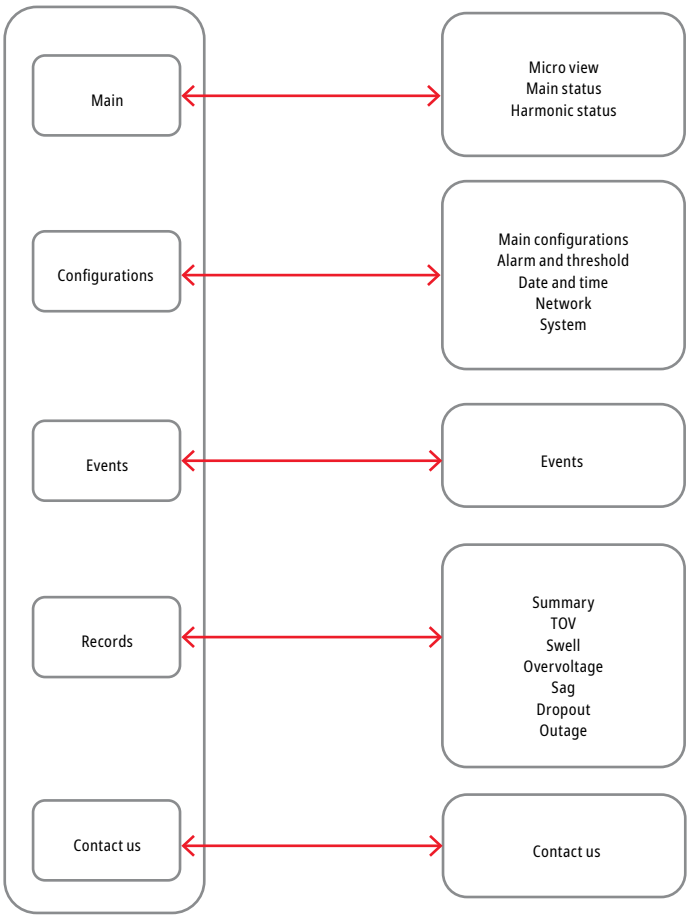


Figure 7: Block diagram of the web server navigation

3.3 Menu bar

A flashing green indicator light displays the communication status between the webpage and SPD unit. The green indicator light will stop flashing when the communication between webpage and SPD unit fails/ disconnects. A login button supports the ability to logon at different levels for configuration changes to the SPD unit. Once logged on, the user can logout from the menu bar itself, as the login button changes to logout from that particular level, service (login level 3), admin (login level 2) or user (login level 1) as shown in Figure 8. Use lower case letters when typing in login level and password. See section 2.5 for login levels and passwords.

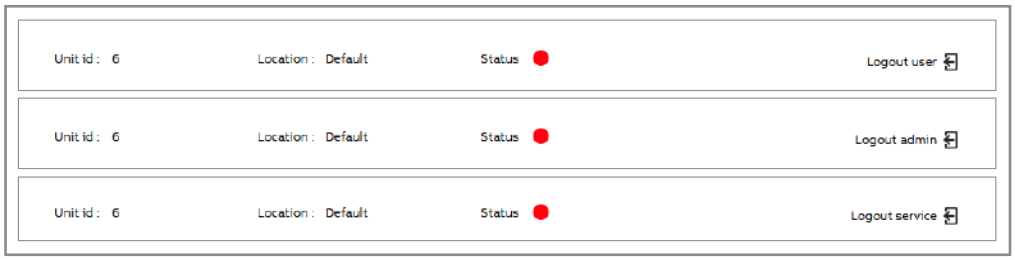


Figure 8: Menu bar when logged on to different levels

3.4 Main status

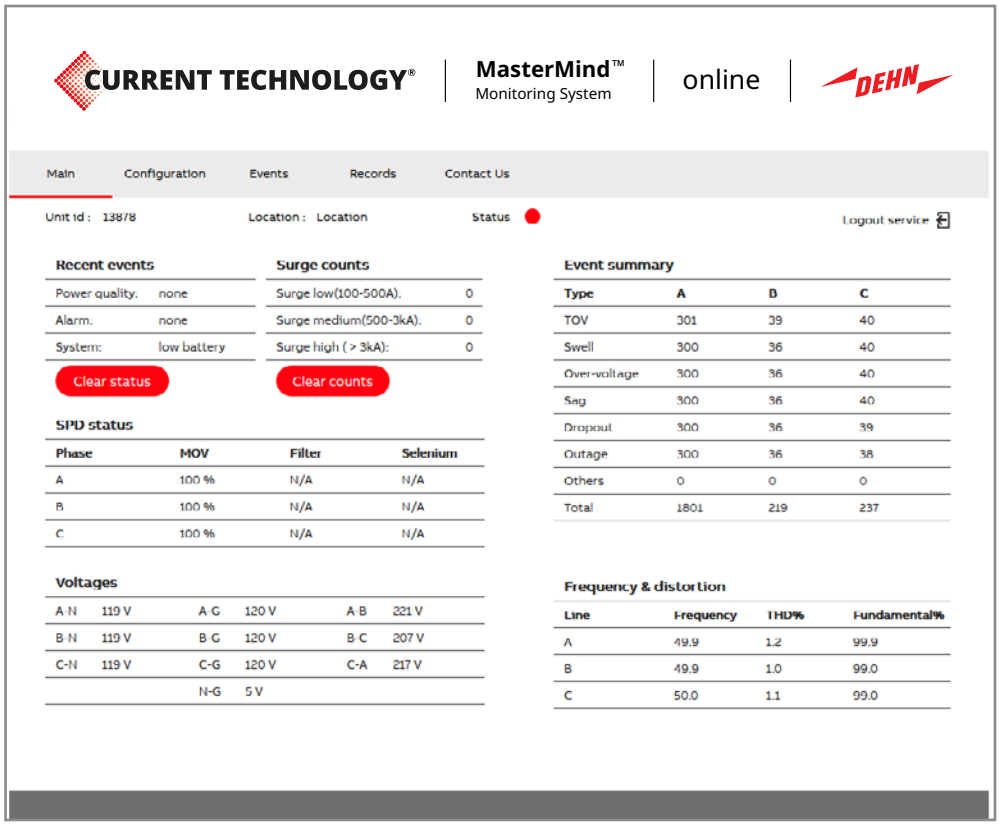


Figure 9: Main status

4.0 Modbus

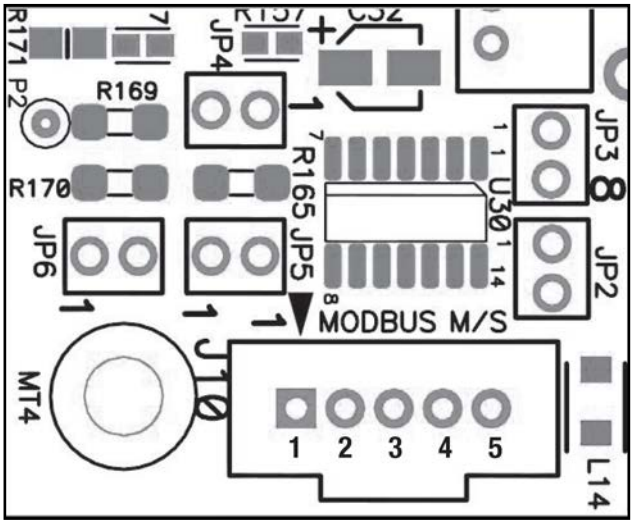
4.1 Modbus RS-485 serial interface settings

The advanced monitoring PCB acts as a Modbus slave, and its communication is initiated through Modbus master using an RS-485 link. It is identified by a unique slave ID by the master. Try the default settings first. Contact factory for additional setup information if required.

Modbus serial options:
- Baud rate = 9600 (default), 19200
- Word length = 8
- Parity = None (default), even, odd
- Stop bits = 1
- Flow control = None

Additional required settings are:
- Reg MAP = 1
- Unit ID = 1 to 247 (each unit must have a unique ID)

4.2 Modbus RS-485 serial jumper settings



Modbus part (2- or 4-wire)
Mating plug number Molex 50-57-9405
Mating pin number Molex 16-02-111x
(Pins are numbered one to five going left to right)

Figure 10: Lower right corner of advanced monitoring PCB board

Option	Jumper	J10 pin out (header)
2-Wire	JP2, JP3 on	1 RX+
4-Wire	JP2, JP3 off	2 RX-
Pull-up/down resistors	JP6, JP4 on	3 TX+
End of line	JP5 on	4 TX-
–	–	5 GND

JP6 and JP4 are optional 2.7k ohm pull-up/down resistors, which may be necessary in some RS-485 configurations.
JP5 is used to terminate the RS-485 line. Use this when the advanced monitoring PCB is at the end of the serial line.

5.0 System, alarm and power quality messages

5.1 System messages

These are messages that indicate what particular part of the monitoring or communications system has incurred a failure. Each message details the exact portion of the system that has the fault.

Condition	Graphic display message	Character display message
Low battery	System low battery	Sys low battery
Memory full	System memory full	Sys memory full
Log memory error	System log memory error	Sys log mem error
EEPROM error	System EEPROM error	Sys EEPROM error
M1 comm loss	System M1 comm loss	Sys M1 comm loss
Modbus error	System Modbus error	Sys Modbus error
Ethernet error	System Ethernet error	Sys Ethernet error
Other error	System other error	Sys:other error

5.2 Alarm messages

These are messages generated by the MasterMind system to indicate conditions of the nine most serious ones that may be experienced. These indicate that the system has encountered a problem either with the input power or the ability of the system to respond to transient events. Each alarm alerts the user to the specific problem encountered
so that it can remedied.

Alarm condition	Graphic screen message	Character screen message
Phase loss (<80%)*	Alarm phase x loss	Alarm phase x loss
Phase low (80 to <90%)*	Alarm phase x low	Alarm phase x low
Phase high (>110%)*	Alarm phase x high	Alarm phase x hi
N-G overvoltage	Alarm N-G voltage high	Alarm N-G volt high
Frequency out of range	Alarm freq high/low	Alarm freq high/low
% Protection <40%*	Alarm % protection x low	Alarm % prot x low
Filter/cap loss	Alarm filter x loss	Alarm filter x loss
Selenium loss	Alarm selenium x loss	Alarm selen x loss
% Protection 40 to 75%*	Alarm % prot x reduced	Alarm % prot x redcd

x = A, B, C, L1 or L2
* Default settings

5.3 Power quality messages

Each message alerts the user to a power quality deviation of actual voltage from nominal voltage.

Power quality event	Graphic screen message	Character screen message
Transient surge	“PQ x surge”	“PQ x surge”
Temporary overvoltage (TOV)	“PQ TOV on y phase”	“PQ TOV y phase”
Swell	“PQ swell on y phase”	“PQ swell y phase”
Overvoltage	“PQ over-V on y phase”	“PQ over-V y phase”
Sag	“PQ sag on y phase”	“PQ sag y phase”
Dropout	“PQ dropout on y phase”	“PQ dropout y phase”
Outage	“PQ outage on y phase”	“PQ outage y phase”

x = Low, med or high
y = A, B, C, L1 or L2

6.0 MasterMind™ system specifications

- Voltage accuracy (1%)
- Voltage sampling rate (3.8 kHz)
- Screen update rate (1/sec)
- Date/time accuracy (1 min/month)
- Date/time resolution (1 ms)
- Number of power quality records (1k), all events (2k), Modbus nodes (247), surge counts (65,535 low, medium and high)
- M3 battery (lithium, 3 V, 235 mAh, CR2032)
- Dimensions (M3 system 11" x 10" x 2.0")
- Weight (M3 system — M1, M3, M3PS – 1.67 lbs.)
- Temperature (storage -40 °C to +60 °C, operation -20 °C to +60 °C)
- Humidity (relative, 5–95%, non-condensing)
- RoHS compliant
- Warranty (see warranty statement at end of manual)
- Certifications (UL 1449 3rd Ed, UL 60950-1)
- RS-485 /RTU specs (2-/4-wire options, 9600–19200 bps)
  See Modbus section for proper setup.

7.0 Monitoring system troubleshooting chart

Common causes

	No heartbeat, and all other green LEDs OFF	Blank LCD graphics display, but has backlight	Blank character display, no backlight	Character display shows main screen ONLY	Graphic display hard to read or not operating	M3 detects that all the phases are lost	Erratic readings from MOV prot %, or selenium, or cap filters	Frequent alarms for volts high./low, freq, or N-G volts	Red alarm LED (M1) stays lit after pressing cancel	M3 acts peculiar after a configuration change	No Modbus communication – serial mode	No Modbus or web server communication via TCP/IP*	No service port communications
No DC power to advanced monitoring system (on J2) or incorrect (between 11–55VDC)	■	■	■										
Advanced monitoring system not configured for correct type system						■	■	■	■				
Need to adjust the contrast on the display					■								
DIP switch SW1 is not set correctly (service only)		■		■							■	■	■
Advanced monitoring system reg map and unit ID don't match PC setting											■		
Com port# on PC doesn't match actual hardware port#											■		■
Baud rate, parity, stop bits and flow control don't match PC config											■		■
AC input on J1 is not present						■			■				
FPC flat graphic display cable not seated correctly or loose		■			■								
Filter and/or selenium weren't disabled in M3 configuration									■				
Cancel MUST be pressed while user is seeing main screen									■				
Wrong type cable used (crossover vs. 1 to 1 patch cable)												■	
M1 20 position ribbon cable not plugged in or needs replug							■		■				
Nominal frequency set wrong on M3								■	■				
Need to delete events log and PQ records after change										■			
Alarm limits are narrow or set incorrectly								■	■				
IP settings on computer not compatible with M3 settings												■	
M1 does not have a good neutral connection to SPD (via 20-pin)							■						
Bad cable or connection	■	■	■		■	■	■	■	■		■	■	■
RS-485 connection has no ground reference											■		■

* Consult your local IT professional for assistance

8.0 5-year limited warranty

DEHN warrants that Equipment (excluding Software) shall be delivered free of defects in material and workmanship. The Warranty Remedy Period for Equipment (excluding Software) shall end five (5) years after the original date of purchase. If a nonconformity to the foregoing warranty is discovered in the Equipment during the applicable Warranty Remedy Period, as specified above, under normal and proper use and provided the Equipment has been properly stored, installed, operated and maintained and written notice of such nonconformity is provided to DEHN promptly after such discovery and within the applicable Warranty Remedy Period, DEHN shall, at its option, either (i) repair or replace the nonconforming portion of the Equipment or (ii) refund the portion of the price applicable to the nonconforming portion of Equipment. If any portion of the Equipment so repaired or replaced fails to conform to the foregoing warranty, and written notice of such nonconformity is provided to DEHN promptly after discovery and within the original Warranty Remedy Period applicable to such Equipment or 30 days from completion of such repair, replacement or re-performance, whichever is later, DEHN will repair or replace such nonconforming Equipment. The original Warranty Remedy Period shall not otherwise be extended. DEHN shall not be responsible for providing temporary power, removal, installation, reimbursement for labor costs or working access to the nonconforming Equipment, including disassembly and re assembly of non-DEHN supplied equipment, or for providing transportation to or from any repair facility, or for any other expenses incurred in connection with the repair or replacement, all of which shall be at Purchaser's risk and expense. DEHN shall have no obligation hereunder with respect to any Equipment which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to DEHN's instructions; (iv) is comprised of materials provided by or a design specified by Purchaser; or (v) has failed as a result of ordinary wear and tear. Equipment supplied by DEHN but manufactured by others is warranted only to the extent of the manufacturer’s warranty, and only the remedies, if any, provided by the manufacturer will be allowed.
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☐ **M3** ☐ **M4E** ☐ **M5** ☐ **M6E**

Model

Date of purchase

Date installed

Installer

Administrator

Administrator contact information

Phone

Email

dehn.us

DEHN Inc.
500 S Main Street, Suite 115
Mooresville, NC 28115
USA

2310US / 07.25 / 3032035