Motor Protection Relays

COOPER Power Systems

Electrical Apparatus

150-45

MM30 and MM30D Motor Protection Relays

The MM30 and MM30D Motor Protection relays are members of Cooper Power Systems' Edison® line of microprocessor based protective relays. The MM30 and MM30D relays offer the following functions:

- Thermal image calculation provides pre-alarm warning and inhibits motor restart.
- Motor overload protection provided as a function of time and temperature.
- Locked rotor protection detects mechanical jams.
- Unbalanced current conditions detected using negative sequence quantities.
- Undercurrent detection monitors decreases in motor load.
- Instantaneous overcurrent detection to provide short circuit protection. Independent time delay enhances coordination.
- Sensitive ground fault detection. The MM30D relay has directional ground fault detection.
- Starting limitation protection to avoid over heating of the motor due to excessive number of starts in a specific period of time.
- Start sequence control operates the switch-over of motor starter and verifies successful motor start.
- When enabled, the auto-setting feature updates settings based on actual system parameters.

The MM30 and MM30D also share the following features common to all Edison® relays:

- Simple five button man machine interface (MMI) allows access to all functions, settings, and stored data without the need for a computer.

Figure 1.
Front View of the MM30D Motor Protection Relay

- Bright electroluminescent display easily visible even in brightly lit environments.
- Draw-out design permits relay testing without disturbing connections to case.
- Modbus communication protocol and RS485 terminal on rear.
- Modular design allows the draw-out module to be fitted to a variety of space saving cabinet styles.
- Three programmable Form C (SPDT) output contacts and one Form A/B contact.
- Pick-up (start-time) elements.
- Programmable reset characteristics.
- Dedicated power supply/relay fail output contacts.
- Event records.
- Cumulative trip counters.
- Auto-ranging power supplies.

Applications

The MM30 and MM30D are designed to provide the fundamental protection requirements common to all small, medium, and large size motors. As the size of motors increases, it is recommended that additional protection features available in other Edison® relay models be combined to provide a complete motor protection package. For example, the MD32G relay provides full motor differential protection that is usually provided on only medium or large size motors. This example shows the ability of the Edison® line of relays to provide only the amount of protection required for the specific application, while keeping the same basic relay functions consistent from small motor applications to large motor applications.

The MM30 and MM30D relays provide thermal, overload, locked rotor, current unbalance, loss of load, short circuit, ground fault,

number of start, and starting sequence protection. In addition, the MM30D has a directional ground element. Optional features for both relays include a speed switch input, thermal probe input, and remote trip input. A special auto-setting feature enables the user to program the settings of the relay with actual system parameters.

Thermal Protection (49)

Calculates a thermal model of the heat being produced within the motor using the direct and negative sequence components of the motor current. The user can set a threshold value that when reached will provide the user with a thermal pre-alarm. This function also drives a restart inhibit feature that disables restart of the motor until a safe temperature level is reached.

Overload Protection (49)

Provides overload protection by using the thermal model to detect excessive heating that is present in the motor during overload conditions. An example of an overload condition would be a conveyor belt that was trying to carry more weight than it was designed to handle.

Locked Rotor Protection (50S)

Used to detect situations that have caused the motor rotor to stop turning after normal loading conditions had been established. An example would be a mechanical jam, where a foreign object wedged itself into a conveyor belt preventing it from turning.

Current Unbalance Protection (46)

Calculates the current unbalances in the motor by measuring the negative sequence currents that are present. A main reason for current unbalance is the loss of one of the three phase voltages that are supplied to the motor.

Undercurrent (Loss of Load) (37)

Detects loss of load conditions. Tripping of the motor will occur three seconds after the current falls below the undercurrent level setting.

Short Circuit Protection (50)

Provides an instantaneous overcurrent element that can be used to detect phase faults which can occur in the cables connecting the motor to the system or in the motor itself. An independent time delay is also included.

Ground Fault Protection (50G or 67G)

Provides an instantaneous overcurrent element that can be used to detect ground faults. For systems with grounded motors, the MM30D relay's directional ground fault element can be set to avoid sympathetic tripping. By monitoring the directionality of the ground current, it can be determined whether the fault is on the motor feeder or on an adjacent feeder. An independent time delay is included with each element.

Targets

Eight bright LED targets are provided as follows:

- Four red LEDs for motor undercurrent (loss of load), current unbalance (loss of phase), overcurrent (short circuit), and ground fault elements. The LEDs flash when the element is picked up, and constantly illuminate upon trip.
- One red LED which flashes when the temperature pre-alarm is reached and illuminates on temperature trip.
- One red LED which illuminates after the number of starts limitation has been reached.
- One yellow LED which flashes (after twice the starting time) when motor current exceeds the set level and illuminates upon trip.
- One yellow LED which flashes when motor temperature is above the set restart level, during the set waiting time after the number of starts limitation has been reached, and in programming mode. The LED illuminates constantly upon relay or power supply failure.

Note: Flashing of the targets will stop once the cause has disappeared. Constantly ON targets must be reset by pressing the ENTER/RESET button. The targets will not reset if the cause is still present.

Optional Inputs

There are three optional inputs available on request.

- A remote trip input which is activated by an external contact closure.
- A speed switch input which is activated when the motor fails to reach running conditions in the set start time.
- An RTD input which is activated by shorting of the input terminals.

Reset Characteristics

The four programmable output relays may be programmed to reset in one of two manners.

- Instantaneously upon the input or calculated quantities dropping below the pickup value.
- Manual reset (by front panel or computer command) only.

Measurements

Actual motor temperature rise, each of the three phase currents, the ground current, and the positive and negative sequence components of motor current are available for display on both relays and are accessible by software. The zero-sequence voltage, and zero-sequence angle (angle between ground current and zero-sequence voltage) are available for display in the MM30D relay.

The relay stores the maximum value of all the previous quantities (except motor temperature rise and zero-sequence angle) for both

starting and running conditions. The maximum value of the motor temperature rise is only recorded for running conditions. In addition, the start time and peak value of the zero-sequence voltage (MM30D only) are recorded.

Last Trip Record

The following parameters are stored in non-volatile memory, providing details of the last trip event:

- Which element was the cause of the last trip.
- The magnitudes of the three phase currents at time of trip.
- The magnitudes of the motor temperature, the positive and negative sequence components of motor current, the ground current, the zero-sequence voltage (MM30D only), and the zero-sequence angle (MM30D only).

Diagnostics

Complete memory and circuit diagnostics are run upon powering the relay. The revision level of the firmware is displayed at this time.

During normal operation, the relay suspends operation every 15 minutes for 10 msec and runs a comprehensive set of diagnostics that includes memory checksum, test of the A/D converters by injection of an internally generated reference voltage, and a check of the ALU.

The relay provides two manual test routines which may be run at any time. The first routine performs the same 15 minute test and in addition checks the target LEDs and the control circuitry to the output relays without operating the output relays. The second test is identical but also operates the output relays.

Output Elements

The following functions may be programmed to one or more of the output relays. The only limitation is that pick-up and time delay functions may not be assigned to operate the same output relay(s).

- Thermal pre-alarm element
- Thermal overload element
- Locked rotor element
- Current unbalance element
- Undercurrent (loss of load) element
- Instantaneous overcurrent element
- Time delayed overcurrent element
- Ground fault element (directional in MM30D relay)
- Time delayed ground fault element (directional in MM30D relay)
- Too many starts element
- Starting sequence element

TABLE 1
Catalog Numbers

Description	Catalog Number
Base Relay	MM30 MM30D
To the above add one each of the following applicable suffixes	
Modbus Protocol	J
Power Supply[1]	
24-110V AC/DC	L
90-220V AC/DC	H
Rated CT Input	
1A	1
5A	5
Case Style[2]	
Draw out relay only, no cabinet supplied	D
Single relay case	S
Double relay case	T
19" Rack mount cabinet	N
Mounting Position	
Denotes mounting position in either a double case or 19" Rack along with other relays ordered at the same time.	C2 C3 C4

[1] The power supplies are user replaceable and interchangeable. See Catalog section 150-99.

[2] The relay itself may be drawn out of any of the listed cases and plugged into any of the other case styles. The catalog number specified during ordering denotes the type of cabinet in which the relay will be shipped.

Dimensional and Electrical Specifications

See Catalog Section 150-05 for electrical specifications and dimensional information on all Edison® relays.

Ordering Information

The only ordering options for the MM30 and MM30D relate to the power supply range desired and the mounting cabinet.

If optional input functions are required, please contact factory for correct catalog number.

Construct catalog number from Table 1.

Example: MM30JLS is an MM30 with low range power supply in a single relay case.

If ordering two or more relays to be fit in a common case, the first relay ordered should indicate the case style desired. This relay will be located in the leftmost bay of the case. Subsequent relays should use the C2, C3, or C4 suffixes to denote their position in the case using the leftmost bay as a C1 reference.

Example: An MM30JxN and an IM30AEJxxC2 consists of an MM30 relay in the leftmost bay of a 19” rack case, with an IM30AE relay in the second bay from the left. The third and fourth bays will be empty and will be covered with blank faceplates.

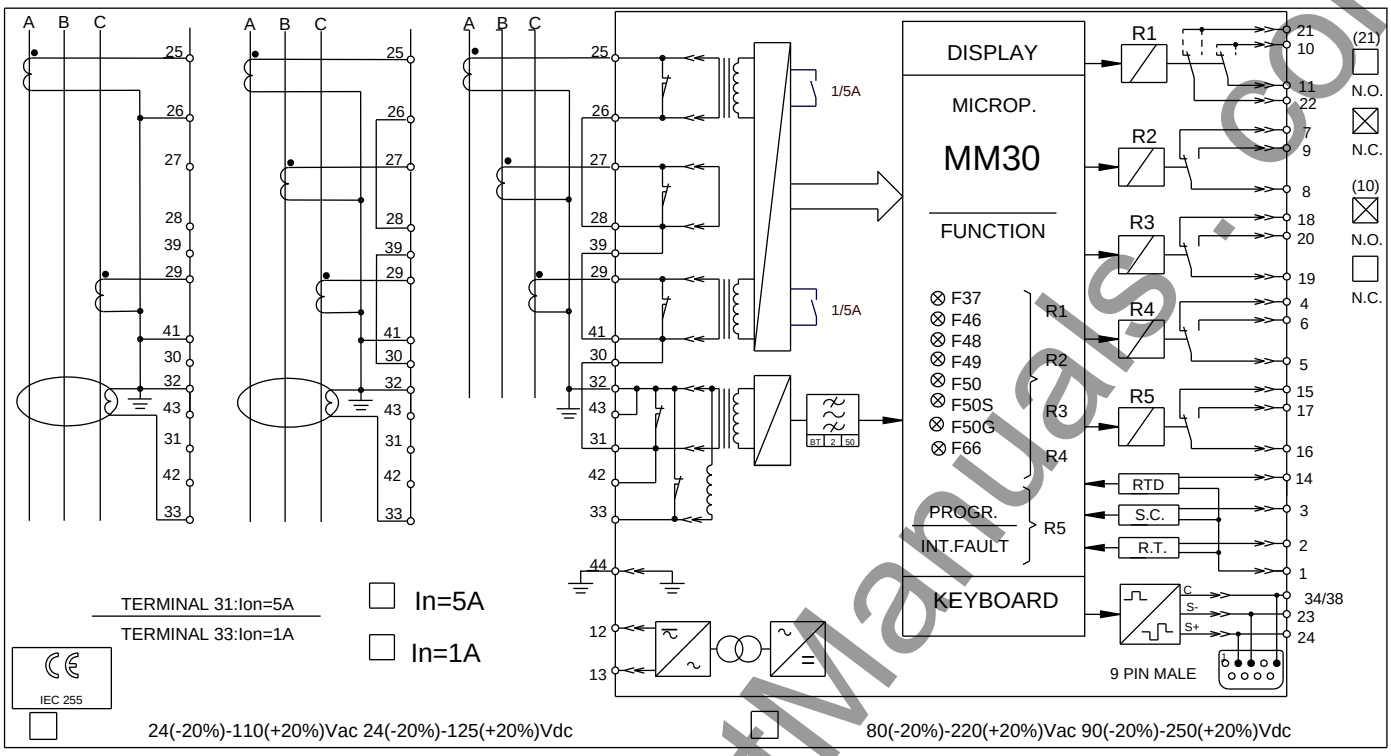

Figure 2.
Wiring Diagram for the MM30 Motor Protection Relay

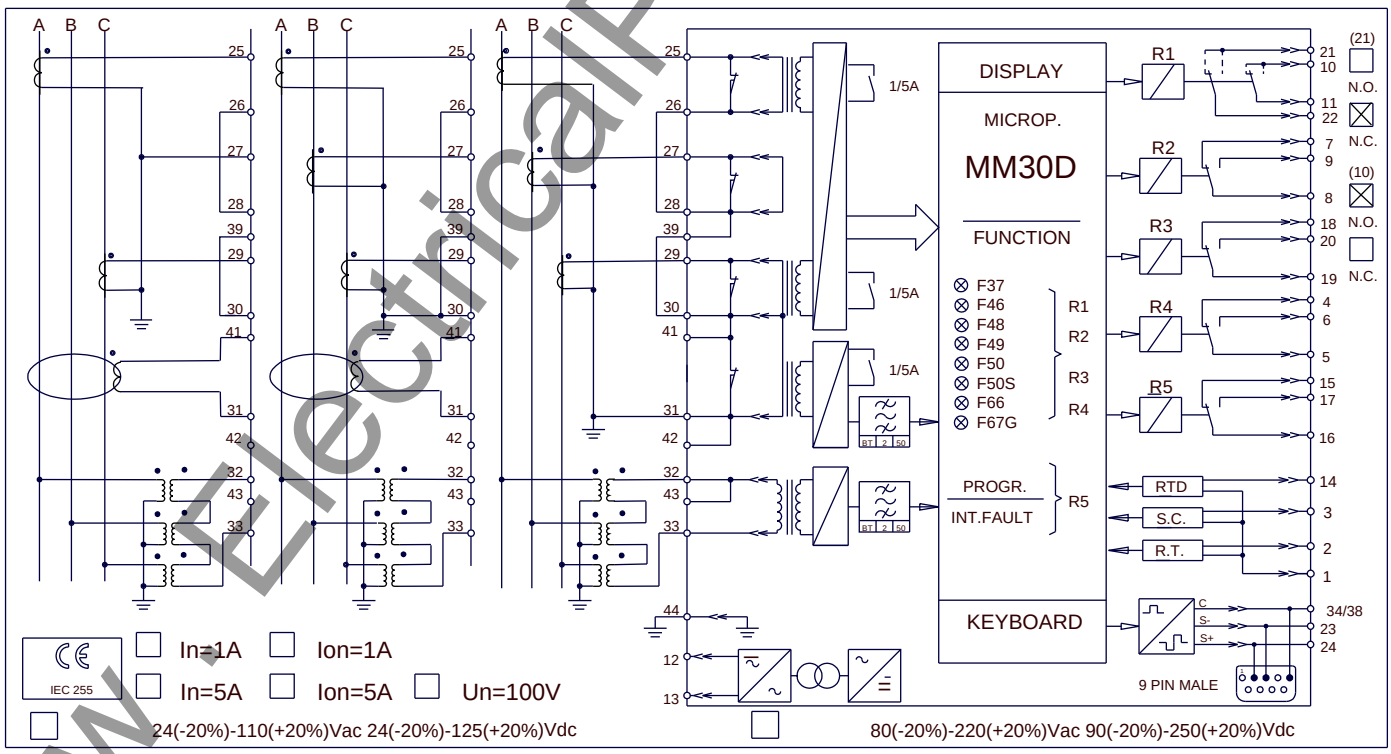

Figure 3.
Wiring Diagram for the MM30D Motor Protection Relay

TABLE 2
Functional Specifications

Nominal system frequency setting range	50 or 60 Hz
Programmable rated primary input current of phase and neutral CTs	1 - 9999A in 1A steps
Motor Characteristics	
Motor full-load current	0.1 - 1.5 pu of phase CT's rated current in 0.01 pu steps
Motor starting current	0.5 - 10 pu of motor full load current in 0.1 pu steps
Motor starting time	1 - 60 seconds in 1 second steps
Motor starter switch-over current	0.1 - 1 pu of motor starting current in 0.1 pu steps, or Disable
Maximum start-up switch-over time	0.5 - 50 seconds in 0.1 second steps
Autoset of all other parameters	Pressing "ENTER" activates this feature
Thermal Element	
Motor running thermal time constant	1 - 60 minutes in 1 minute steps
Motor cooling down time constant	1 - 10 times running thermal time constant in 1 pu steps
Motor pre-alarm heating level	50 - 110% of motor full-load temperature rise in 1% steps
Motor restart heating level	40 - 100% of motor full-load temperature rise in 1% steps
Maximum number of starts	1 - 60 in 1 start steps, or Disable
Time period for max. number of starts	1 - 60 minutes in 1 minute steps
Restart inhibit time	1 - 60 minutes in 1 minute steps or operate manual reset
Locked Rotor Element	
Locked rotor pickup range	1 - 5 pu of motor full-load current in 0.1 pu steps, or Disable
Inhibit Time	2 pu of motor starting time
Current Unbalance Element	
Inverse time curve pick-up level	0.1 - 0.8 pu of motor full-load current in 0.1 pu steps, or Disable
Inverse time curve time delay	1 - 8 seconds in 1 second steps
Undercurrent Element	
Undercurrent pickup level	0.15 - 1.0 pu of motor full-load current in 0.01 pu steps, or Disable
Overcurrent Element	
Overcurrent pickup level	1 - 5 pu of motor starting current in 0.1 pu steps, or Disable
Time delay	0.05 - 1 seconds in 0.01 second steps
Ground Fault Element	
Ground fault pickup level	0.02 - 2 pu of rated ground CT primary current in 0.01 pu steps, or Disable
Time delay	0.05 - 5 seconds in 0.01 second steps
Minimum level of zero-sequence voltage to enable tripping of ground fault element (MM30D relay only)	2 - 25 volts in 1 volt steps
Maximum ground fault current sensitivity direction - zero-sequence angle (MM30D relay only)	0 - 90 degrees in 1 degree steps, or Disable

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