

# Multifunction Overcurrent Relays

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Cooper Power Systems

Electrical Apparatus

## Directional and Nondirectional Overcurrent Relays IM30AE, IM30BE, IM30DE and DM30E

150-10

The IM30AE, IM30BE, IM30DE, and DM30E overcurrent relays are members of Cooper Power Systems' Edison® line of protective relays. All four relays offer three phase and ground fault overcurrent elements, differing primarily in the directional or non-directional nature of these elements.

- IM30AE - Nondirectional phase and ground overcurrent with automatic cold load pickup.
- IM30BE - Nondirectional phase and ground overcurrent with automatic cold load pick-up and two setting groups.
- IM30DE - Nondirectional phase overcurrent, and directional ground overcurrent elements.
- DM30E - Directional phase and ground overcurrent elements.

In addition, these relays also offer the following common functions:

- User selectable time current curves that may be programmed to match those of common electro-mechanical relays, or IEC standard curves. Definite time characteristics are also available.
- Time overcurrent and instantaneous elements.
- Harmonic filtering on neutral inputs.
- Separate phase and ground element blocking inputs.
- Breaker fail element.

As members of the Edison® relay family, these relays also share the following features:

- Simple five button man machine interface (MMI) allows access to all functions, settings, and stored data without the need for a computer.
- Bright electroluminescent display easily visible even in brightly lit environments.



**Figure 1.**  
Front View of the DM30E Overcurrent Relay

- 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.
- Four fully programmable output contacts. Three are Form C (SPDT) 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.

### Interchangeable

The IM30AE and IM30BE are direct plug-in interchangeable, and except for certain input current and voltage input connections, the IM30DE and DM30E are also plug-in interchangeable.

### Applications

Any utility or industrial application requiring three phase and ground overcurrent protection. If only phase or ground protection is desired, the other elements may be disabled. Both time overcurrent and instantaneous elements are provided.

The programmable time current curves provide for coordination with practically any type of electro-mechanical or electronic overcurrent relay. The relay may also be set with definite time overcurrent elements, thereby acting as a single or dual current level detector for phase or ground elements.

The IM30BE offers dual setting groups for all elements and functions. Selection between these groups is accomplished via an external input. Typical applications for dual setting groups include the implementation of different protection practices during storm conditions, adapting to different fault levels based upon system configuration, compensating for peculiar cold load pickup conditions, and coordination with downstream devices upon reconfiguration of the network or feeder.

The voltage polarized directional elements on the IM30DE and DM30E relays make them ideal for overcurrent protection where coordination requiring the ability to sense the direction of fault current flow is required. If desired, the directional element(s) may be programmed as non-directional. In addition, the directional phase elements of the DM30E may be used for current based control applications.

### **Cold Load Pickup**

The IM30AE and IM30BE offer an automatic cold load pickup mode in which one the circuit breaker's auxiliary contacts is connected to an external input on the relay. Upon closing of the breaker, the relay monitors the value of the inrush current. If within the first 60 msec of the breaker closing, the current exceeds 1.5 pu of the CTs rated primary current, the settings for the instantaneous phase overcurrent element are doubled until the phase current drops below 1.25 pu.

### **Directional Overcurrent Elements**

The IM30DE relay offers a directional ground overcurrent element, and the DM30E offers both phase and ground directional elements. The maximum torque angle of the directional elements is adjustable from 0- 359°.

The recommended settings for the ground overcurrent element for both the IM30DE and DM30E relays is 270° for ungrounded systems, 0° for resistance or reactance grounded systems, and 300° (i.e., 60° lag) for solidly grounded systems. For the ground overcurrent element, an adjustable definite time zero-sequence voltage threshold must first be exceeded to enable the overcurrent element.

In addition to a directional ground overcurrent element, the phase overcurrent elements of the DM30E are also directional. This is a voltage polarized element which will operate down to 2% of bus voltage.

Along with sensing reverse fault overcurrent flow, the directional phase element of the DM30E may be used to sense forward current (power), reverse current (power), inductive reactive current and capacitive reactive current. The recommended settings for sensing are as follows:

- 0° for forward active power, 180° for reverse active power.
- 300° for forward fault overcurrent, 120° for reverse fault overcurrent.
- 270° for forward inductive reactive current, 90° for reverse inductive reactive current.
- 90° for forward capacitive reactive current, 270° for reverse capacitive reactive current.

### **Breaker Fail**

A programmable time delay is set equal to the breaker clearing time. If the fault is not cleared (i.e., the trip element has not dropped out), before this timer expires, a breaker fail is indicated. This element may be programmed to one or more of the output relays.

### **Targets**

Eight bright LED targets are provided as follows:

- Four red LEDs, one each for phase and ground time overcurrent, and phase and ground instantaneous. The LEDs flash when the element is picked up and constantly illuminate upon trip.
- A red LED which flashes if the operation of any of the elements is blocked via the external blocking inputs.
- A red LED illuminates if the breaker fail function is activated.

In addition, one yellow LED is provided which illuminates when any function has been disabled via programming. A second yellow LED flashes when the relay is in programming mode, and illuminates constantly upon relay or power supply failure.

### **Blocking Inputs**

Two blocking inputs are provided. One input is dedicated toward blocking all phase overcurrent functions, and one dedicated to blocking ground overcurrent functions. Each input is programmable so that when activated, either the time overcurrent, instantaneous overcurrent, or both, elements may be blocked.

While the blocking inputs are active, the pickup of any element associated with the blocking input(s) is prevented. Sensing of the input quantities and the countdown of any timers begins only when the blocking is removed.

The operation of each of the blocking inputs may be further programmed so that blocking is effected for as long as the blocking input is activated, or so that the effect of the blocking will expire after an adjustable time delay of .05 to .25 seconds. This latter function is particularly useful in implementing backup protection for downstream or adjacent bus devices.

All inputs are opto-isolated.

## Reset Characteristic

Each of 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

Phase and ground (zero sequence) current are available for display on all of the relays. The IM30DE adds zero sequence voltage and the angle between the zero sequence voltage and current. The DM30E adds the angle between the phase

currents and voltages. All measurements are available for display at the relay and are accessible by software.

## Maximum Values

Each relay has available for review the highest currents and zero sequence voltages (as applicable) recorded during the first 100 msec after breaker closing (inrush) and after 100 msec (maximum demand).

## Last Trip Record

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

- Which element was the cause of the last trip.
- Currents, voltages, and phase angles at time of trip.

In addition the relays keep a running total of the cause of all breaker trips.

**TABLE 1**  
**Functional Specifications**

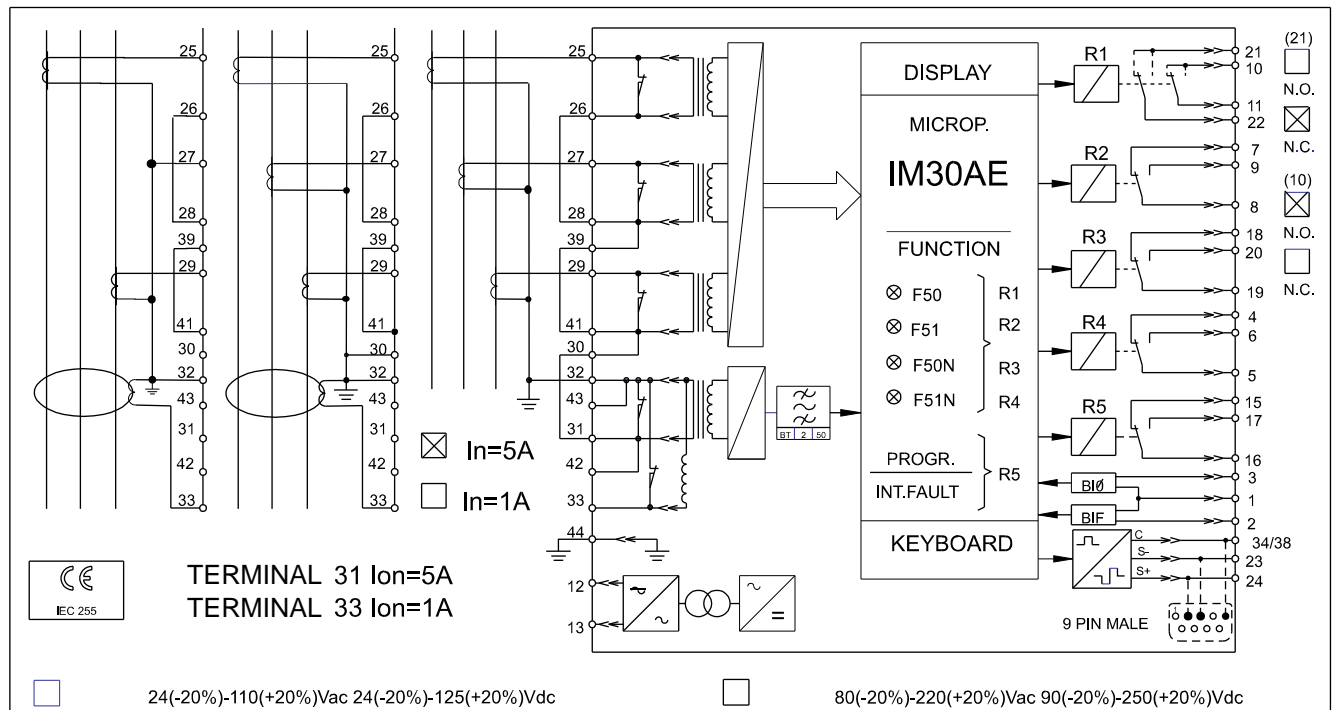
<b>Nominal system frequency setting range</b> .....	50 or 60 Hz
<b>Programmable rated primary input current of phase and neutral CT</b> .....	1 - 9999A in 1A steps
<b>Phase and Ground Overcurrent (51/51N) time curve characteristics</b>	
Phase element (51) pickup range .....	0.5-4.0 pu rated input current in 0.01 pu steps, or Disable
Ground element (51N) pickup range .....	0.02 - 0.40 pu of rated input current in 0.01 pu steps, or Disable
Time delay in Definite time mode .....	0.05 - 30.00 seconds in 0.01 second steps
In Curve Mode offers the following curve shapes .....	US Normal Moderate Inverse <sup>1</sup>
.....	US Normal Short Inverse
.....	US Normal Very Inverse <sup>1</sup>
.....	US Normal Inverse
.....	US Normal Extremely Inverse <sup>1</sup>
.....	IEC A - Inverse <sup>2</sup>
.....	IEC B - Very Inverse <sup>2</sup>
.....	IEC C - Extremely Inverse <sup>2</sup>
Time Dial range for US Normal Curves .....	0.2 - 100.0 in 0.01 steps
Time Dial range for IEC Curves .....	0.02 - 10.00 in 0.01 steps
<b>Phase instantaneous (50) characteristic</b>	
Pickup range .....	0.5 - 40.0 pu of rated input current in 0.1pu steps, or Disable
Definite time delay .....	0.05-3.0 seconds in 0.01 second steps
<b>Ground instantaneous (50N) characteristic</b>	
Pickup range .....	0.02-0.40 pu of rated input current in 0.1 pu steps, or Disable
Definite time delay .....	0.05-3.00 seconds in 0.01 second steps
Breaker Fail delay range .....	0.05-0.25 seconds in 0.01 second steps
<b>For IM30DE and DM30E relays only</b>	
Ground fault polarizing voltage enabling threshold setting range .....	2-25 V in 1 V steps
Maximum ground fault torque angle setting range .....	0-359° in 1° steps, or Disable <sup>3</sup>
<b>For the DM30E relay only</b>	
Phase current maximum .....	0-359° in 1° steps, or Disable <sup>4</sup>

<sup>1</sup> As defined in IEEE C37-118 Draft Standard.

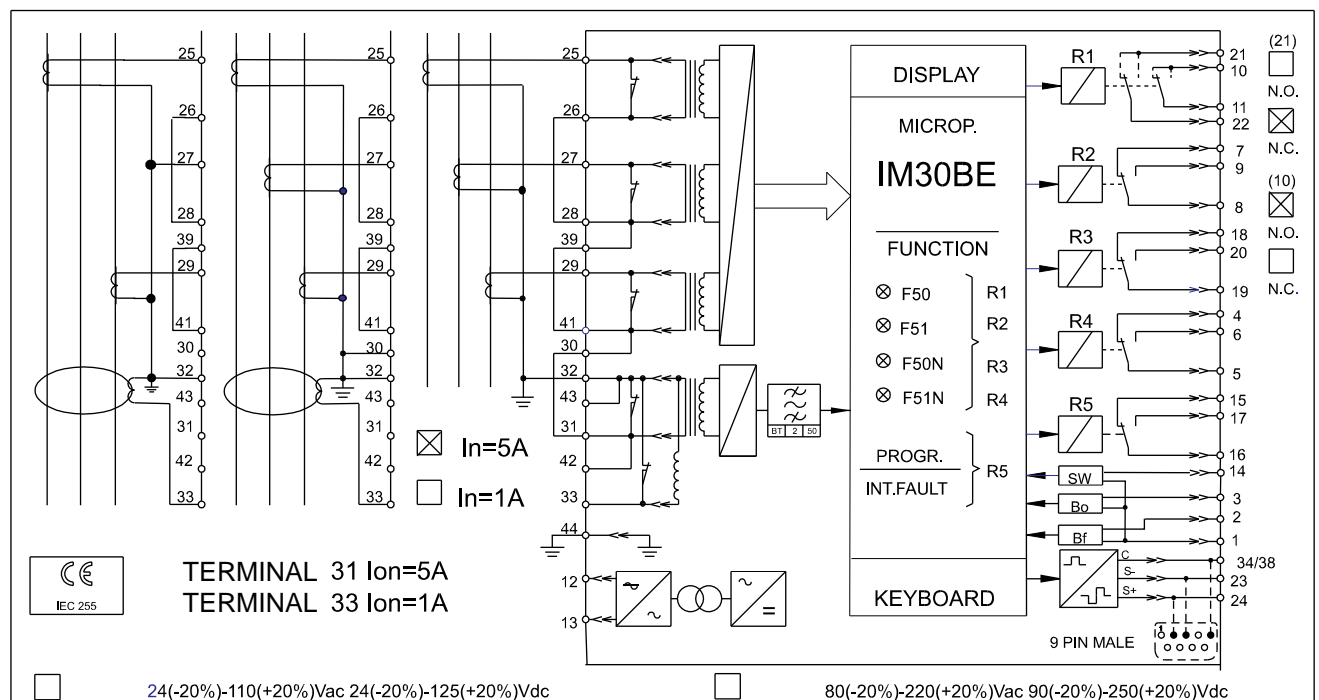
<sup>2</sup> As defined in IEC Standards 255-3, 255-4.

<sup>3</sup> Disabling the ground fault torque angle setting converts the ground overcurrent characteristic to be non-directional in nature.

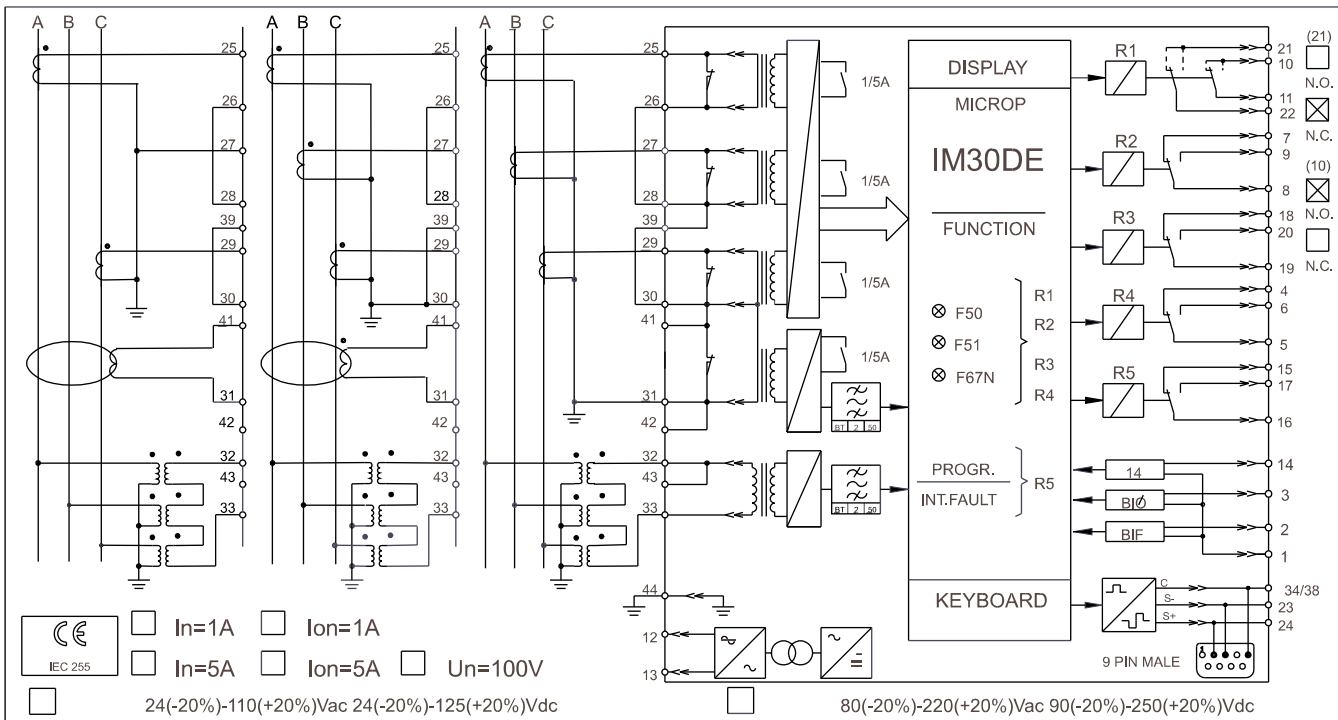
<sup>4</sup> Disabling the phase current torque angle setting converts the phase overcurrent characteristic to be non-directional in nature.



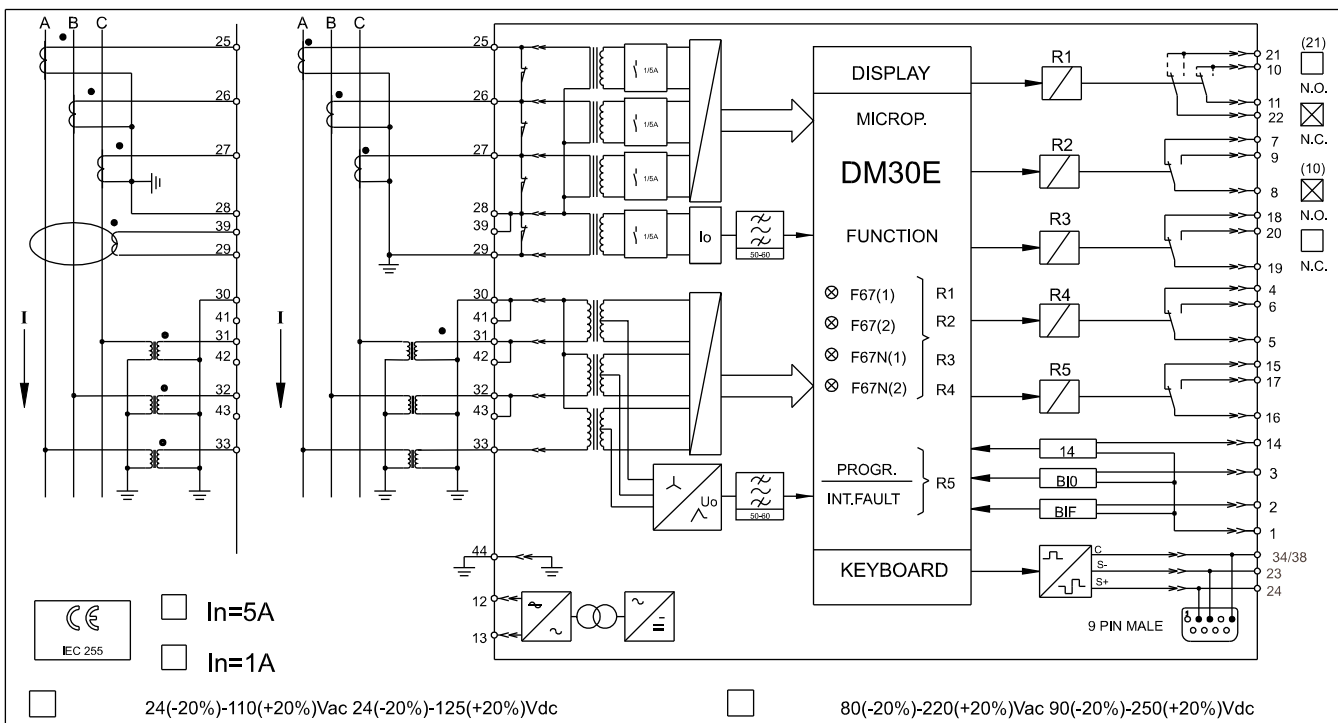
**Figure 2.**  
**Wiring Diagram of the IM30AE Relay**



**Figure 3.**  
**Wiring Diagram of the IM30BE Relay**



**Figure 4.**  
**Wiring Diagram of the IM30DE Relay**



**Figure 5.**  
**Wiring Diagram of the DM30E Relay**

## Diagnostics

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

The relay runs a comprehensive set of diagnostics every 15 minutes 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.

## Dimensions and Electrical Specifications

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

## Ordering Information

Construct catalog number from Table 2.

Example: IM30EAL5JS is an IM30AE with low range power supply, 5A CT inputs, 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 IM30DExxJN and an IM30AExxJC2 consists of an IM30DE 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.

**TABLE 2**  
**Catalog Numbers**

Description	Catalog Number
<b>Base Relay</b>	IM30AE IM30BE IM30DE DM30E
<b>To the above add one each of the following applicable suffixes</b>	
<b>Power Supply</b> <sup>5</sup> 24-110V AC/DC 90-220V AC/DC	L H
<b>Rated CT Input</b> 1A 5A	1 5
<b>Modbus Protocol</b>	J
<b>Case Style</b> <sup>6</sup> Draw out relay only, no cabinet supplied Single relay case Double relay case 19" Rack mount cabinet	D S T N
<b>Mounting Position</b> Denotes mounting position in either a double case or 19" Rack along with other relays ordered at the same time.	C2 C3 C4

<sup>5</sup> The power supplies are user replaceable and interchangeable. See Catalog section 150-99.

<sup>6</sup> 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.



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