

Multifunction Overcurrent Relay



Cooper Power Systems

Electrical Apparatus

150-15

IM30DRE Feeder Protection Relay

The IM30DRE Feeder Protection relay is a member of Cooper Power Systems' Edison® Series of micro-processor based protective relays and provides all of the functions necessary for the protection of a distribution feeder. The IM30DRE relay offers the following functions:

- Three phase time overcurrent and instantaneous elements.
- Time and instantaneous ground fault elements. The ground fault element is selectable between non-directional, true directional, and directional supervision modes.
- Automatic cold load pickup option for phase elements.
- Time delayed negative sequence element.
- Four shot programmable reclosing element with dual setting groups.
- Reclose block input.
- Sequence coordination.
- Time stamped event records.
- Breaker fail.
- IRIG-B time synch input.
- Harmonic filtering on neutral input.

The IM30DRE also shares the following features common to all Edison Series relays:

- 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.
- Draw-out design permits relay testing without disturbing connections to case.



Figure 1.
Front View of the IM30DRE Feeder Protection Relay

- 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 IM30DRE is ideal for the protection of distribution feeders protected by circuit breakers. Three phase and ground over-current, negative sequence, and reclosing elements provide a comprehensive package of protection for all applications. Any of the elements may be disabled if not required for a given application.

Phase Overcurrent

The IM30DRE offers low and high set (50/51) phase overcurrent elements. The low set element may be set to definite time or inverse time modes. When inverse mode is selected, eight inverse curves are available; three standard IEC and five IEEE format curves. Additional pick-up functions are available and may be assigned to output contacts.

Ground Overcurrent

Both low set and high set (50N/51N) overcurrent elements are provided with the same curve selections as available for the phase overcurrent elements.

The ground fault elements may be applied in one of three operating modes:

- Non-directional mode.
- True directional mode.
- Directional supervision mode.

In non-directional mode, the elements respond to any zero sequence current input.

In true directional mode, the elements respond only to the component of the zero sequence current that is in phase with a vector in the direction of the maximum torque (i.e., maximum sensitivity) angle.

In directional supervision mode, the elements respond to any signal that is $\pm 90^\circ$ of the set maximum torque angle.

The maximum torque angle is adjustable from 0 - 359°. When used in either directional mode, an adjustable definite time zero sequence voltage threshold must be first exceeded to enable the overcurrent element.

Automatic Cold Load Pick-up

When selected, the automatic cold load pickup mode senses when the breaker has closed (via an external contact). If during the first 60 msec of the breaker closing, the current exceeds 1.5 pu of the CTs rated primary current, the settings for the phase instantaneous (high set) element are doubled until such time that the phase current drops below 1.25 pu of the rated CT primary current. This prevents nuisance trips associated with extended term cold load pickup situations.

Negative Sequence

A low set negative sequence element (46) is provided to sense faults on the low side of wye-delta connected transformers where the zero sequence current does not pass through the transformer. The element may be selected to operate in either definite time mode, or with any of eight selectable inverse time curve characteristics.

Programmable Reclosing

The IM30DRE provides a fully programmable four shot to lockout reclosing function. Each of the four shots may be initiated by different overcurrent elements, and the timing of each reclose operation may also be varied. The operation of the reclose function involves the following external signals:

- Circuit breaker status (52A).
- Reclose block (forced lockout mode).

Each of the reclose sequences is initiated only if one of the overcurrent elements enabled for that reclosing sequence has tripped. For each reclose shot any combination of the following elements may be programmed as elements which enables a reclose shot:

- Low and/or high set phase overcurrent.
- Low and/or high set ground overcurrent.
- Negative sequence overcurrent.

If an element other than a reclose enabled element trips, the relay goes immediately to lockout.

By not setting any elements as being enabling elements for a given reclose shot, it is possible to shorten the reclosing cycle. For example, by not defining any overcurrent elements for the 3rd and 4th reclose shots, then any fault sensed after the second shot will cause a lockout condition. In this manner it is possible to set up one, two, three, or four shot to lockout reclose sequences.

In addition to this flexibility, the reclose element has two setting groups. Selection between which setting group is active is made via the serial communications bus. Two setting groups enables the two different reclose sequences to be made available for changing system conditions. For example, for "storm" and "clear weather" conditions.

Reclose Block

An external input is provided which may be used to inhibit the operation of the reclose function. When activated, the tripping of any element will result in an immediate lock-out condition.

Sequence Coordination

When selected, sequence coordination allows the reclose element to count downstream recloser operations as its own, thereby preventing unnecessary operations of the back-up device for a fault beyond the downstream device. This is particularly useful when the backup breaker feeds several branch reclosers, only one of which is experiencing a fault.

Breaker Failure

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

Targets

Eight bright LED targets are provided as follows:

- Five red LEDs, one each for phase and ground time overcurrent, phase and ground instantaneous, and negative sequence elements.

For all of the above, the LEDs flash when the element is picked up, and constantly illuminate upon trip.

- One red LED illuminates if the breaker fail function is activated.
- One yellow LED is provided which flashes when the reclose timer is running between any pending reclose operations. This LED constantly illuminates when the breaker has gone to a lockout condition.

A second yellow LED flashes when the relay is in programming mode, and illuminates constantly upon relay or power supply failure.

Reset Characteristics

The 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

Each of the three phase currents, negative sequence current, zero sequence current, the phase angle between the phase and ground currents, and zero sequence voltage are available for display on the relay and are accessible by software.

In addition the relay stores the maximum phase load and inrush currents since the last energization.

Event Records

The IM30DRE event records provide important information about fault event. Event records for the previous ten events are kept using first in, first out (FIFO) memory. Each record contains:

- A date and time stamp. (An IRIG-B time synchronization signal input is provided allowing the use of an external satellite clock to synchronize all relays on the system.)

- Each 1/4 cycle for 10 cycles (2 pre-fault, 8 post-fault), the following data is recorded:

- The magnitudes of the three phase currents, ground current, negative sequence current, and the zero sequence voltage.
- Pick-up and trip status of the low and high set phase and ground element, the negative sequence elements, and the reclose element.
- Operating status of the five output relays.

This detailed data is only available from the relay via the RS485 port. Access from the front panel provides the user with an event summary report, consisting of:

- Which element was the cause of the last trip.
- The magnitudes of the three phase currents, ground current, negative sequence current, and the zero sequence voltage at the time of trip.

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).

- Pick-up function of low set overcurrent element.
- Time delayed function of low set overcurrent element.
- Pick-up function of high set overcurrent element.
- Time delayed function of high set overcurrent element.
- Pick-up function of low set ground overcurrent element.
- Time delayed function of low set ground overcurrent element.
- Pick-up function of high set ground overcurrent element.
- Time delayed function of high set ground overcurrent element.
- Pick-up function of low set negative sequence overcurrent element.
- Time delayed function of low set negative sequence overcurrent element.
- Close breaker command from reclose element.
- Breaker failure.

Dimensional and Electrical Specifications

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

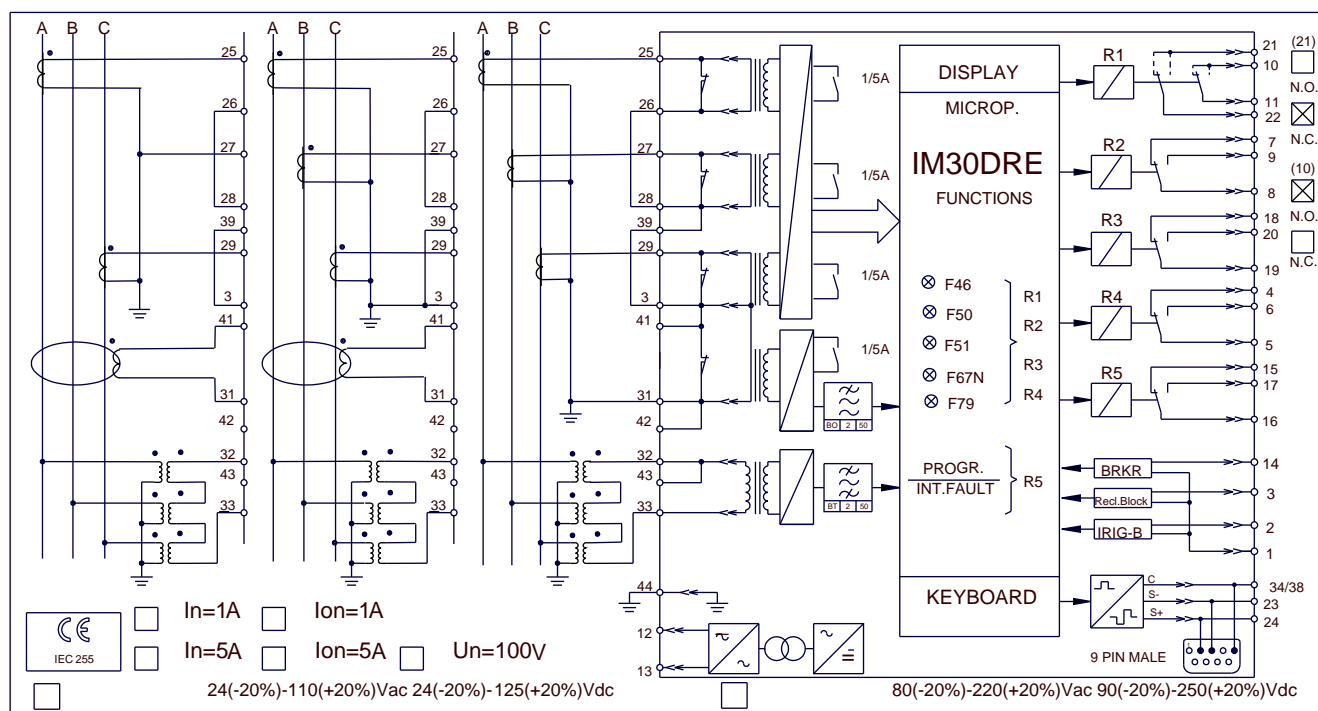


Figure 2.
Wiring Diagram for the IM30DRE Relay

Ordering Information

Construct catalog number from Table 1.

Example: IM30DREJL5S is an IM30DRE 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: A IM30DREJxxN and an IM30AEJxxC2 consists of an IM30DRE 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 1
Catalog Numbers

Description	Catalog Number
Base Relay	IM30DRE
To the above add one each of the following applicable suffixes	
Modbus Protocol	J
Power Supply¹ 24-110V AC/DC 90-220V AC/DC	L H
Rated CT Input 1A 5A	1 5
Case Style² Draw out relay only, no cabinet supplied Single relay case Double relay case 19" Rack mount cabinet	D S T 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.

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
Phase and Ground Overcurrent Element (51/51N) Characteristics	
Phase element (51) pick-up range	0.5 - 4.0 pu rated input current in 0.01 pu steps, or Disable
Ground element (51N) pick-up range.....	0.02 - 0.40 pu of rated put current in 0.01 pu steps, or Disable
Time delay in Definite time mode	0.05 - 30.0 seconds in 0.01 second steps
In curve mode, the following curves are available	US Moderate Inverse ³
.....	US Short Inverse
.....	US Very Inverse
.....	US Normal Inverse
.....	US Extremely Inverse
.....	IEC A - Inverse ⁴
.....	IEC B - Very Inverse
.....	IEC C - Extremely Inverse
Time dial range ⁵ for IEEE curves	0.7 to 123
Time dial range ⁵ for IEC curves.....	0.6 - 10.1
Phase Instantaneous (50) Characteristic	
Pick-up range.....	0.5 - 40.0 pu of rated input current in 0.1 pu steps, or Disable
Definite time delay	0.05 - 3.0 seconds in 0.01 second steps
Ground Instantaneous (50N) Characteristic	
Pick-up range.....	0.02 - 4.00 pu of rated input current in 0.01 pu steps, or Disable
Definite Time delay	0.05 - 3.0 seconds in 0.01 second steps
Ground overcurrent element operational modes	Non-directional
.....	True directional
.....	Directional supervision
Directional Mode Ground Fault Characteristics	
Polarizing voltage threshold setting.....	2 - 25 V in 1 V steps
Maximum torque angle setting	0 - 359° in 1° steps
Negative Sequence (46) Overcurrent Element	
Negative sequence element (46) pick-up range.....	0.5 - 4.0 pu rated input current in 0.01 pu steps, or Disable
Time delay in Definite time mode	0.05 - 30.0 seconds in 0.01 second steps
In curve mode, the following curves are available	Same as for the phase overcurrent element (51)
Time dial range ⁵ for IEEE curves	Same as for the phase overcurrent element (51)
Time dial range ⁵ for IEC curves.....	Same as for the phase overcurrent element (51)
Breaker Failure Time Delay Range.....	0.05 - 0.25 seconds in 0.01 second steps
Reclose Element (79)	
Number of selectable reclose shots	4
Time delay between reclose operation (independently selectable for each reclose shot)	0.1 - 99.9 seconds in 0.1 second steps
Reclose sequence timeout timer ⁶	1 - 200 seconds in 1 second steps
Number of independently programmable reclose sequence setting groups ...	2

³ All IEEE curves follow the formula as defined in IEEE Standard C37-112.

⁴ All IEC curves follow the formula as defined in IEC Standards 255-3, 255-4.

⁵ Absolute time dial ranges vary for each curve shape. The ranges shown are the ranges common to all curve types.

⁶ This timer determines when a new trip event starts a new reclose cycle, or if the event is a continuation of the existing reclosing sequence.



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