

## IM30C Double Wye Capacitor Bank Relay

The IM30C Capacitor Unbalance relay is a member of Cooper Power Systems' Edison® line of microprocessor based protective relays. The IM30C relay offers the following functions:

- Two levels of capacitor bank unbalance protection (alarm and trip).
- Two levels of phase overcurrent protection. The high set level is ideal for phase faults and the low set level is ideal for series reactor current overload protection.
- Undercurrent protection to sense open breaker poles or low line voltage conditions.
- Programmable reclose timer.
- Breaker fail logic.
- Separate unbalance and overcurrent element blocking inputs.

The IM30C also shares 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.
- 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.



**Figure 1.**  
**Front View of the IM30C Double Wye Capacitor Bank Relay**

- 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 IM30C is ideal for the protection of capacitor banks connected in a double wye (split star) arrangement. The IM30C is suitable for use with externally or internally fused and fuseless capacitor banks.

The IM30C provides capacitor bank unbalance, phase overcurrent, reactor overload, open pole, and reclose timer protection in one unified relay.

Single wye capacitor banks equipped with neutral voltage transformers may also be protected by the addition of a

resistor in series with the output of the VT in order to develop an appropriate input current for the unbalance elements.

### Unbalance Protection

Two levels of unbalance protection are provided. The first level is typically used to sense when the first fuse operation in an externally or internally fused capacitor bank, or the first winding (pack) failures occur in a fuseless bank. The output of this element is typically used for alarm purposes.

The second unbalance level is set to operate after sufficient fuse operations or winding failures have occurred where the steady state overvoltage on the remaining capacitors in the bank become too high, typically 110% of the capacitor unit's rated voltage.

Due to capacitor manufacturing tolerances, a steady state unbalance current usually flows between the two wye legs. The IM30C provides an inherent

unbalance compensation feature which allows this normal unbalance current to be zeroed out. This fixed bias feature increases the sensitivity of the relay compared to conventional overcurrent elements which must be set high enough to ignore the inherent unbalance.

### **Instantaneous Overcurrent Protection**

This element provides a definite time protection characteristic to protect against phase faults leading from the CTs to the capacitor bank. This protects against bus faults, inter-rack and arcing faults within the capacitor bank.

### **Low Set Overcurrent Protection (Reactor Overload)**

This element provides an inverse time overcurrent characteristic for the protection of series connected shunt reactors. Unlike capacitors, which are relatively unaffected by current overloads, series reactors, often used for inrush limiting or filter tuning, are sensitive to RMS current overloads. This element accurately measures the RMS current through the ninth harmonic.

### **Undercurrent Protection and Reclose Timers**

The undercurrent element monitors the current flowing into the capacitor bank. If it drops to a preset level for a preset period of time, the element trips the bank off-line. This element may be set to trip the bank off-line in case of an open pole on the circuit breaker (.86 pu), or to sense low bus voltage where the capacitor bank may not be desired to remain on-line.

After this element trips, a programmable reclose timer must expire before the element is reset. In this manner, if placed in series in the circuit breaker close circuit, this element can be used to prevent

the capacitor bank from being re-energized before the capacitor units have had sufficient time to discharge. If the capacitor bank current drops to zero, indicating the bank has been switched off-line, the reclose timer begins immediately without waiting for the undercurrent timer to expire.

### **Breaker Fail**

Breaker fail logic may be implemented by using the automatic drop-out feature of the pick-up elements. After a time delayed element has tripped, if the operating quantity has not dropped below the trip value after a programmable delay, the pick-up element associated with that time delayed element drops out. This may be used to either alarm or trip a back-up breaker.

### **Targets**

Eight bright LED targets are provided as follows:

- Six red LEDs for each phase overcurrent, reactor overload, both unbalance level, undercurrent, and breaker fail elements.

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

- One yellow LED is provided which illuminates when either of the blocking inputs is active or any of the protective functions are disabled.
- 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 all unbalance functions. The inputs may be programmed to block either, both, or neither of the applicable elements. While the blocking inputs are active, the

tripping of any element associated with the blocking input(s) is prevented. Continued sensing of the input quantities and the countdown of any timers continues however, so that when the blocking is removed, any picked up elements will either trip instantaneously, or will trip after any remaining time delay.

### **Reset Characteristics**

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**

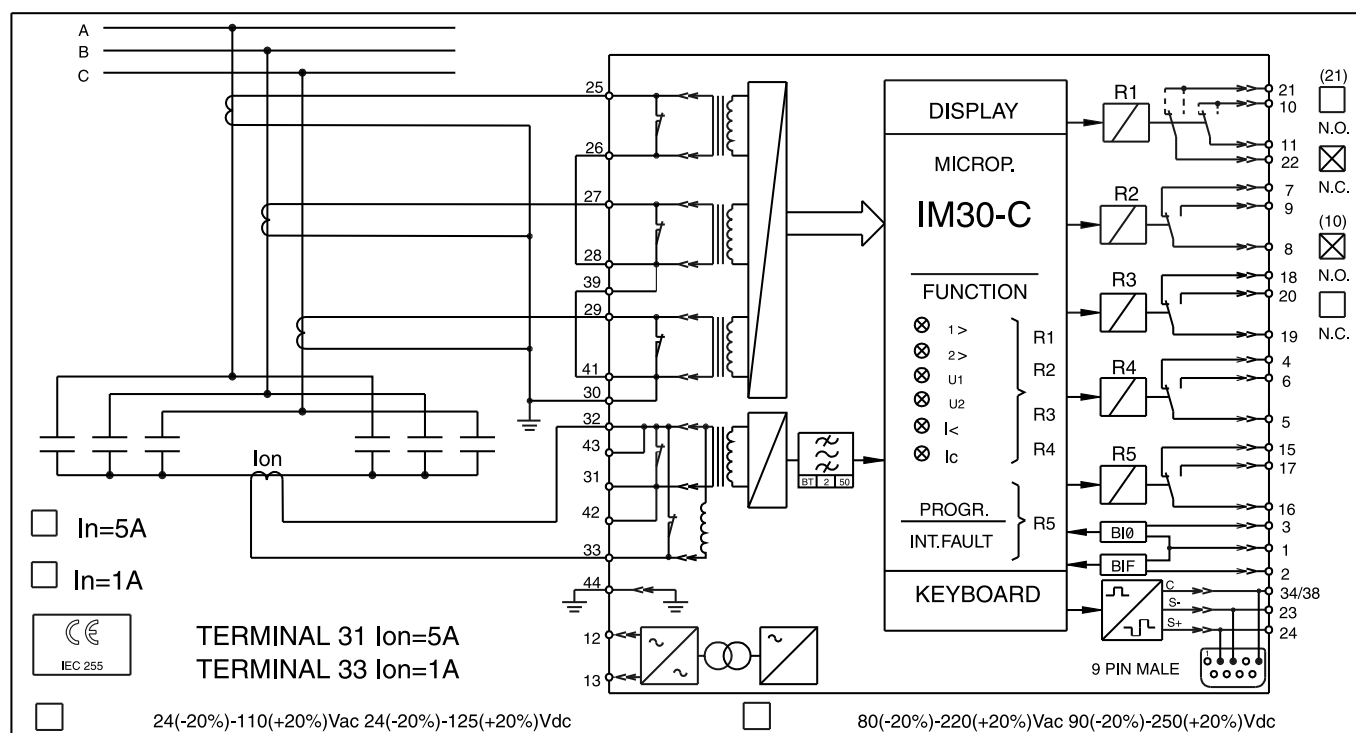
Each of the three phase currents, the unbalance current, the phase angle between the unbalance current and the phase A current (giving an indication of the faulted phase), and the magnitude of the fixed bias current from the inherent unbalance compensation feature are available for display on the relay and are accessible by software.

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

### **Last Trip Record**

The following parameters are stored in non-volatile memory, providing the following 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 magnitude of the unbalance current and the phase angle between the unbalance current and the phase A current. This allows discrimination of the faulted phase.



**Figure 2.**  
**Wiring Diagram for the IM30C Double Wye Capacitor Bank Relay**

**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 CTs</b> ..... | 1 - 9999A in 1A steps                                                  |
| <b>Programmable rated secondary current of the unbalance CT</b> .....          | 1 or 5A                                                                |
| <b>Unbalance Element characteristics</b>                                       |                                                                        |
| First level characteristics                                                    |                                                                        |
| Definite time or inverse pickup range .....                                    | 0.02 - 0.80 pu rated unbalance CT current in 0.01 pu steps, or Disable |
| Time delay in Definite time mode .....                                         | 1 - 30 seconds in 0.1 second steps                                     |
| Second level characteristics                                                   |                                                                        |
| Definite time pickup range .....                                               | 0.01 - 1.00 pu rated unbalance CT current in 0.01 pu steps, or Disable |
| Time delay in Definite time mode .....                                         | 0.1- 300 seconds in 0.1 second steps                                   |
| <b>Inherent Unbalance compensation</b>                                         |                                                                        |
| Compensation level .....                                                       | 0 - 20% of rated unbalance CT current in 1% steps                      |
| Compensation angle .....                                                       | 0 - 359° in 1° steps                                                   |
| <b>Overcurrent Element characteristics</b>                                     |                                                                        |
| Low set characteristics                                                        |                                                                        |
| Definite time or inverse pickup range .....                                    | 0.3 - 1.5 pu rated CT current in 0.01 pu steps, or Disable             |
| Time delay in Definite time mode .....                                         | 1 - 30 seconds in 0.1 second steps                                     |
| High set characteristics                                                       |                                                                        |
| Definite time pickup range .....                                               | 0.2 - 2.00 pu rated CT current in 0.01 pu steps, or Disable            |
| Time delay in definite time mode .....                                         | 0.5- 99.9 minutes in 0.1 minute (6 second) steps                       |
| <b>Undercurrent Element</b>                                                    |                                                                        |
| Pick-up level .....                                                            | 0.1 - 1.0 pu of phase CT current in 0.01 pu steps                      |
| Time delay .....                                                               | 1 - 99.9 seconds in .1 second steps                                    |
| Capacitor reclose timer .....                                                  | 0.5 - 100 minutes in 0.1 minute (6 second) steps                       |

## 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 Element

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 unbalance element
- Time delayed function of low set unbalance
- Pick-up function of high set unbalance
- Time delayed function of high set unbalance element
- Time delayed function of the undercurrent element

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

| Description                                                                                                                                   | Catalog Number   |
|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| <b>Base Relay</b>                                                                                                                             | IM30C            |
| <b>To the above add one each of the following applicable suffixes</b>                                                                         |                  |
| <b>Power Supply<sup>1</sup></b><br>24-110V AC/DC<br>90-220V AC/DC                                                                             | L<br>H           |
| <b>Rated CT Input</b><br>1A<br>5A                                                                                                             | 1<br>5           |
| <b>Modbus Protocol</b>                                                                                                                        | J                |
| <b>Case Style<sup>2</sup></b><br>Draw out relay only, no cabinet supplied<br>Single relay case<br>Double relay case<br>19" Rack mount cabinet | D<br>S<br>T<br>N |
| <b>Mounting Position</b><br>Denotes mounting position in either a doublecase or 19" Rack along with other relays ordered at the same time.    | C2<br>C3<br>C4   |

<sup>1</sup> The power supplies are user replaceable and interchangeable. See Catalog section 150-99.

<sup>2</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.

## Dimensions and Electrical Specifications

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

## Ordering Information

Construct the catalog number from Table 2.

Example: IM30CL5JS is an IM30C 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 IM30CxxJN and an IM30AExxJC2 consists of an IM30C 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.

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