Multifunction Voltage/Frequency Relay

COOPER Power Systems

Electrical Apparatus

150-23

UM30SV Vector Jump/Islanding Relay

The UM30SV three phase voltage/frequency relay is a member of Cooper Power Systems' **Edison**® Series of microprocessor based protective relays. The UM30SV relay offers the following functions:

- Vector Jump element which detects the step change in frequency that occurs when a generator and local load is suddenly disconnected, or islanded, from the rest of the power system.
- Two frequency levels each programmable to be under (81<), over (81>), or over and under (81<>) definite time frequency elements.
- Two definite time voltage elements each configurable as either under (27), over (59), or over and under (27 and 59) elements.
- One positive (direct) sequence voltage level configurable as either an under (27pos), over (59pos), or under and over (27pos + 59 pos).
- One negative sequence overvoltage element (59neg).
- Two zero sequence overvoltage levels (59zero) with indication of the faulted phase.
- Overexcitation (24).protection provided by a low set inverse time and high set definite time elements.
- Three blocking inputs to control operation of the various protective elements.

The UM30SV also shares the following features common to all 'M' 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.
- Modbus communication protocol and RS485 terminal on rear.
- Modular design allows the draw-out module to be fitted to a variety of 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.

Figure 1 - Front View of the UM30SV Load Shed Relay

APPLICATIONS

The UM30SV is ideally suited for use on utility systems for the detection of generator islanding through the use of a vector jump, or vector surge, element.

The UM30SV may also be used as a general purpose voltage and frequency relay. Because of the many functions included in the UM30SV, it can easily be used in many protection schemes including:

- Frequency based load shedding for industrial or co-gen environments where the need to

shed internal plant load, or to break ties to the supply utility, is required in order to protect local generation or critical processes.

- Automatic sectionalizing or deadline throw-over,
- Generator or motor bus under and overvoltage conditions.
- Single phasing of motors.
- Grounding of one phase on a delta or ungrounded system.

Additionally the two levels of overexcitation (V/Hz) combined with the voltage functions make the UM30SV suitable as part of a generator protection package.

Although the UM30SV is intended as a three phase relay, it may be used as a single phase relay with only the A-phase input connected. Certain functions will not be operable in this mode, specifically the vector jump element in three phase mode, and the positive, negative, and zero sequence voltage elements.

VECTOR JUMP FUNCTION

In the case of a generator operating in parallel with a distribution network, when the network is suddenly disconnected, the generator becomes "Islanded" and is left to supply the all of the remaining connected load, including the share of load formerly supplied by the network.

The UM30SV relay includes an element designed to detect the disturbance produced by the sudden variation of the load at the terminals of a generator. This disturbance results in a proportional variation of the angular displacement "α" between the generator's Electromotive Force "E" and the voltage at its terminals or point of relaying, "V". See Figures 2 and 3.

The resulting "$\Delta\alpha$" of the angle α h is referred to as a "Vector Jump" or vector surge. If the circuit breaker connecting the islanded generator to the rest of the network is automatically reclosed, it is possible that the voltage displacement between the generator's bus and the network can be too large for safe paralleling of the generators.

Rapid detection of this condition provides the opportunity to:

- Trip the generator's circuit breaker or the utility tie breaker before the reclosing of the tie utility's breaker occurs thus avoiding possible serious damages to the generator itself.
- Tripping of non-critical local load in order to match the generator's output to supply critical processes in an industrial environment.

The relay can detect a Vector Jump adjustable from 2° to 30° giving out a trip signal in less than 3 cycles. See Figure 4. The UM30SV uses a moving average of the last 5 cycle's periods as a comparison value in order to reduce spurious operations.

The detection of the disturbance can be made in either 1-phase or 3-phase modes.

- In the 1-phase mode tripping takes place as soon as a measured $\Delta\alpha$ exceeding the set level is detected on one of the three phase voltages.
- In the 3-phase mode tripping takes place only if the a value of $\Delta\alpha$ above the set level is detected on all the three phases at the same time.

Single-phase mode is more sensitive than three phase mode to detecting Vector Jump conditions, however it is also more sensitive to spurious disturbances.

An undervoltage element blocks the "Vector Jump" function if the voltage drops below an adjustable level threshold, Vb.

A contact input operated by a normally open auxiliary contact (52a) of a Circuit Breaker blocks the Vector Jump functions when the Circuit Breaker is open as well as for 5 seconds after closing the breaker.

The value of $\Delta\alpha$ as a function of the power variation of the generator (ΔP) as it passes from the normal situation to an "islanded" situation may be approximated as:

$$\Delta\alpha = (0.3 – 0.4)\ \Delta P$$

Where the 0.3 multiple is generally more applicable to large generators, and the 0.4 multiple to small generators.

The use of a computer based transients analysis program to accurately determine the $\Delta\alpha$ setting is recommended to avoid spurious trips.

OVER-EXCITATON

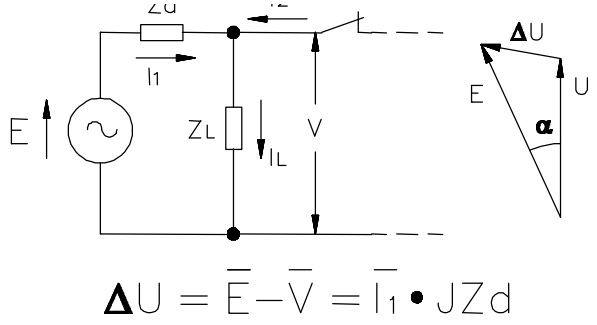
The UM30SV uses a two level over-excitation element where the low set level follows an inverse time characteristic, and the high set element is definite time. See Figure 5.

TARGETS

Eight bright LED targets are provided. One LED each is provided for the frequency elements (81), the two voltage control elements (27, 59), the positive sequence overvoltage element (59pos), the negative sequence (59neg) and vector jump elements, the V/Hz elements (24) and the two zero sequence voltage elements (59neg).

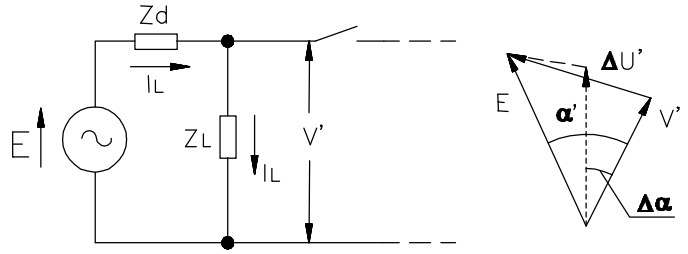
For all of the above, the LEDs flash when the element is picked up, and constantly illuminate upon trip. In addition, one yellow LED is provided which illuminates when the blocking input is active. A second yellow LED flashes when the relay is in programming mode, and illuminates constantly upon relay or power supply failure.

Figure 2: Normal α Between Generator and Measured Voltages



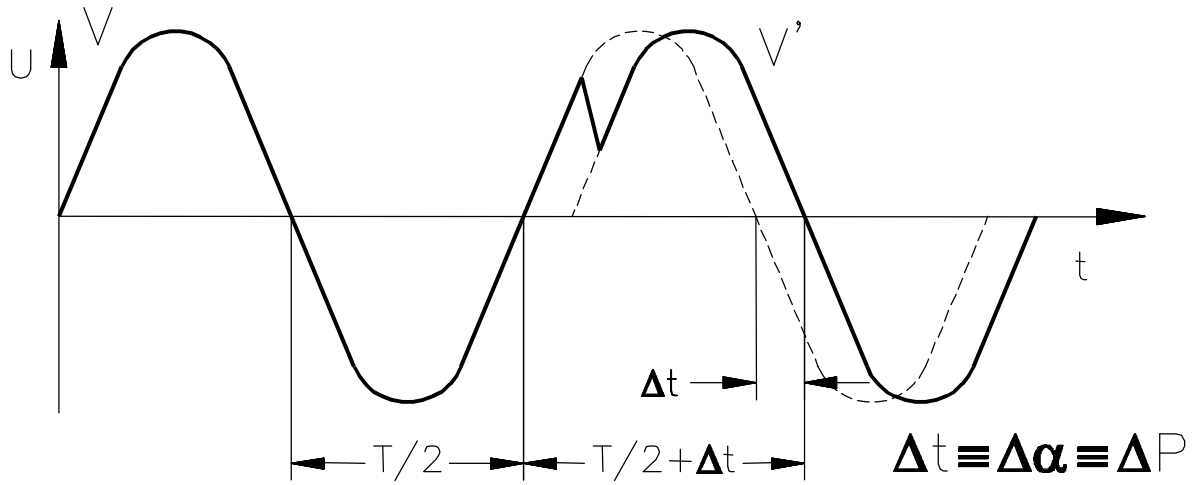
$$\Delta U = \bar{E} - \bar{V} = \bar{I}_1 \bullet JZd$$

Figure 3: Resulting Δα Between Generator and Measured Voltages During Islanding



$$\Delta U' = \bar{E} - \bar{V}' = \bar{I}_L \bullet JZd = (\bar{I}_1 + \bar{I}_2)JZd$$

Figure 4: Effect on System Voltage as Seen by Relay Due to Vector Surge (Δα)



BLOCKING INPUTS

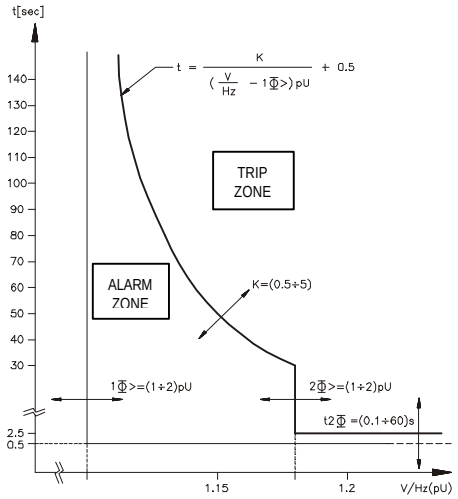
Two blocking inputs are provided. One each dedicated toward blocking all “over” level elements, and one dedicated to blocking all “under” level elements.

OUTPUT FUNCTIONS

The following list summarizes all of the output functions available which may be assigned to any or all of the programmable output contacts. Note that pick-up and time delayed elements may not be assigned to operate the same output contact(s).

- Vector Jump element
- 1st frequency element pickup
- 1st frequency element time delayed trip
- 2nd frequency element pickup
- 2nd frequency element time delayed trip
- 1st voltage element pickup
- 1st voltage element time delayed trip
- 2nd voltage element pickup
- 2nd voltage element time delayed trip
- Low set zero sequence voltage element pickup
- Low set zero sequence element time delayed trip
- Low set zero sequence voltage element pickup
- Low set zero sequence element time delayed trip
- Negative sequence voltage element pickup
- Negative sequence element time delayed trip
- Positive sequence voltage element pickup
- Positive sequence element time delayed trip
- 1st V/Hz element pickup
- 1st V/Hz element time delayed trip

Figure 5: Overexcitation Element Characteristic



- 2nd V/Hz element pickup
- 2nd V/Hz element time delayed trip

RESET CHARACTERISTICS

Each of the four programmable output relays may be programmed to reset in one of three manners.

- Instantaneously upon the input or calculated quantities dropping below the pickup value.
- Automatically, but with a time delay adjustable between 0.01 and 99.99 seconds in 0.01 second steps.
- Manual reset (by front panel or computer command) only.

MEASUREMENTS

System frequency, phase-to-phase and phase-to-neutral voltages, and positive, negative, and zero sequence voltage magnitudes are available for display on the relay and are accessible by software.

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.
- Frequency, phase-to-phase voltage, positive, negative, and zero sequence voltage magnitudes.
- Value of $\Delta\alpha$ as monitored by the Vector Jump element

DIAGNOSTICS

Complete memory and circuit diagnostics are run upon powering the relay.

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 an 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.

Table 1: FUNCTIONAL SPECIFICATIONS

Nominal Frequency Setting Range .... 50 or 60Hz

Programmable Φ-Φ primary voltage.. 0.10 - 1.00 kV in 0.01kV steps
..... 1.1 - 9.9 kV in 0.1 kV steps
..... 1 - 655 kV in 1 kV steps

Programmable secondary voltage ..... 100-125V in 1V steps

Vector Jump Element
- Operating Modes ..... Single phase, three phase and Disable
- Trip level ..... 2° to 30° in 1° steps
- Undervoltage block level ..... 10-100% V_{RATED} in 1% steps

Frequency Elements (81)
- Quantity..... 2
- Characteristic ..... Selectable between Under (81<), Over (81>), Under/Over (81<>), or Disable
- ΔFrequency setting[1] (change)... 0.05 - 9.99 Hz in 0.01 Hz steps
- Time Delay..... 0.05-99.9 sec. in 0.01 sec. steps

Overexcitation Elements (24)
- Quantity..... 2, Low set and High set elements
- Characteristic ..... Low set element is inverse time. See Figure 5
- ..... High set element is definite time. See Figure 5.
- Pick-up range ..... 1.0 – 2.0 per unit rated V/Hz for both elements or Disable
- Time delay of low set element .. 0.5 – 5.0 in 0.1 steps
- Time delay of high set element. 0.1 – 60.0 seconds in 0.1 second steps

RMS Voltage Elements (27, 59)
- Quantity..... 2
- Characteristic ..... Each selectable between under (27), over (59), or over and under (27+59) or Disable
- Trip Level ..... 5 – 90% V_{RATED} in 1% steps
- Time Delay..... 0.1 – 60.0 sec. in 1 second steps

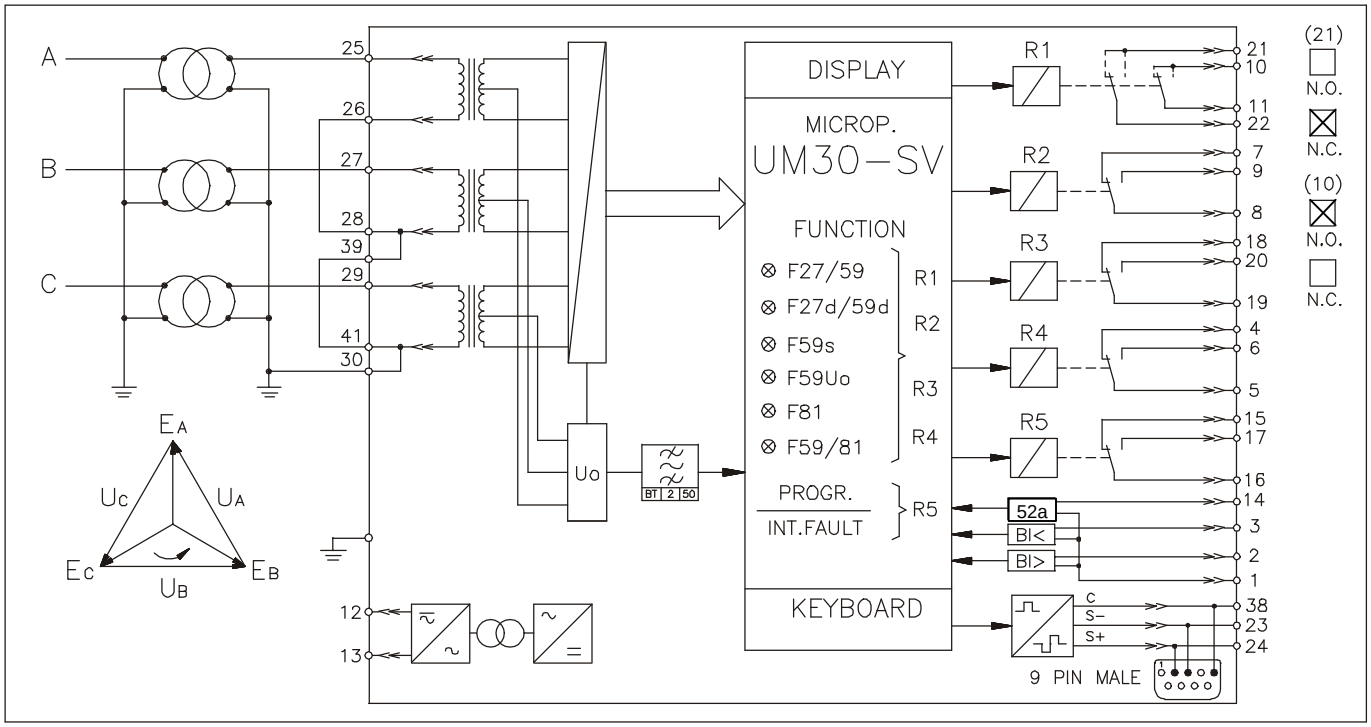
Positive Sequence Voltage Element (27pos, 59pos)
- Characteristic ..... Selectable between under (27pos), over (59pos), or over and under (27pos+59pos) or Disable
- Trip Level ..... 5 – 90% V_{RATED} in 1% steps
- Time Delay..... 0.1 – 60.0 sec. in 1 second steps

Negative Sequence Voltage Element (59neg)
- Characteristic ..... Definite time
- Trip Level ..... 5 – 90% V_{RATED} in 1% steps or Disable
- Time Delay..... 0.1 – 60.0 sec. in 1 second steps

Zero Sequence Voltage Elements (59zero)
- Quantity..... 2 (low set and high set)
- Characteristic ..... Definite time
- Trip Level ..... 1–99% V_{RATED} in 1% steps or Disable
- Low Set Time Delay ..... 0.05 – 60.0 sec. in 0.05 second steps from 0.05 to 9.9 seconds, and in 0.1 steps from 10 to 60 seconds
- High Set Time Delay..... 0.05 – 9.9 sec in 0.05 sec steps

[1] The setting is made based upon the change from the programmed system base frequency. Whether a positive, negative, or absolute value change is acted upon is dependent upon the over, under, or over/under setting selected.

Figure 6: Wiring Diagram for the UM30SV Relay



ORDERING INFORMATION

Construct the catalog number from the following table:

Base Relay Model	Power Supply[1]		Case Style[2]	
	Code	Description	Code	Description
PRUM30SVJ	L0	24-110V AC/DC	D	Draw-out relay only, no case supplied (for spare only)
	H0	90-220V AC/DC	S	Single case
			T	Double case
			N	19” rack mount
			C2 C3 C4	Denotes mounting position in either a double case or 19” rack along with other relays ordered at the same time.

Example: A UM30SV with low range power supply in a single case is a PRUM30SVJL0S.
Note: 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.

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

[3] 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.