2.5 Voltage transformer supervision (VTS)

The voltage transformer supervision (VTS) feature is used to detect failure of the ac voltage inputs to the relay. In the case of the P144, supervision of the residual voltage input is not provided, as there will be no reliable voltage to measure under healthy system conditions. This may be caused by internal voltage transformer faults, overloading, or faults on the interconnecting wiring to relays. This usually results in one or more VT fuses blowing. Following a failure of the ac voltage input there would be a misrepresentation of the phase voltages on the power system, as measured by the relay, which may result in

mal-operation.

The VTS logic in the relay is designed to detect the voltage failure, and automatically adjust the configuration of protection elements whose stability would otherwise be compromised. A time-delayed alarm output is also available.

There are three main aspects to consider regarding the failure of the VT supply. These are defined below:

1. Loss of one or two-phase voltages
2. Loss of all three-phase voltages under load conditions
3. Absence of three-phase voltages upon line energization

The VTS feature within the relay operates on detection of negative phase sequence (nps) voltage without the presence of negative phase sequence current. This gives operation for the loss of one or two-phase voltages. Stability of the VTS function is assured during system fault conditions, by the presence of nps current. The use of negative sequence quantities ensures correct operation even where three-limb or 'V' connected VT's are used.

C

Negative Sequence VTS Element:

The negative sequence thresholds used by the element are V_2 = 10V (or 40V on a 380/440V rated relay), and I_2 = 0.05 to 0.5In settable (defaulted to 0.05In).

2.5.1 Loss of all three-phase voltages under load conditions

Under the loss of all three-phase voltages to the relay, there will be no negative phase sequence quantities present to operate the VTS function. However, under such circumstances, a collapse of the three-phase voltages will occur. If this is detected without a corresponding change in any of the phase current signals (which would be indicative of a fault), then a VTS condition will be raised. In practice, the relay detects the presence of superimposed current signals, which are changes in the current applied to the relay. These signals are generated by comparison of the present value of the current with that exactly one cycle previously. Under normal load conditions, the value of superimposed current should therefore be zero. Under a fault condition a superimposed current signal will be generated which will prevent operation of the VTS.

The phase voltage level detectors are fixed and will drop off at 10V (40V on 380/440V relays) and pickup at 30V (120V on 380/440V relays).

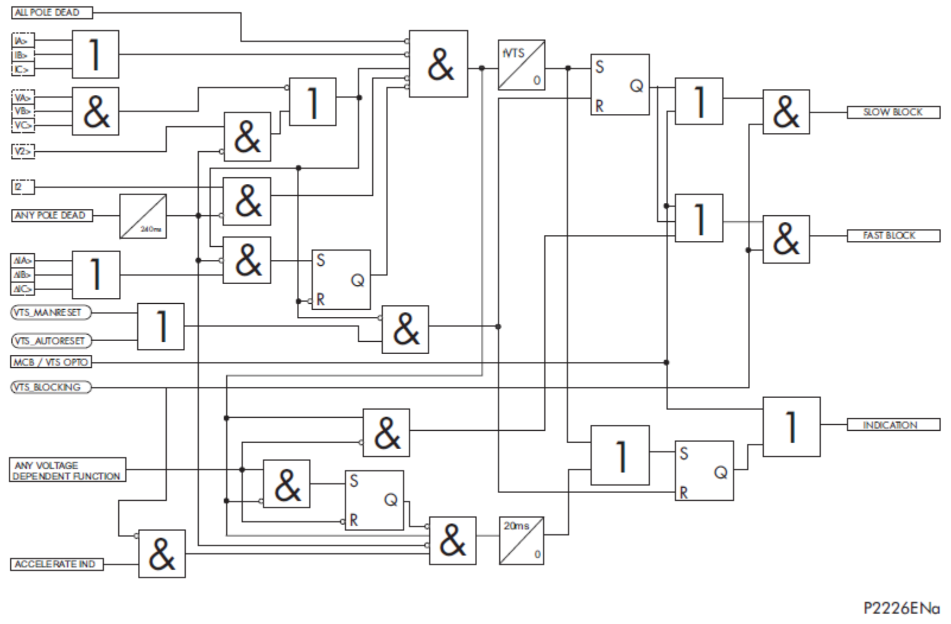
The sensitivity of the superimposed current elements is fixed at 0.1In.

2.5.2 Absence of three-phase voltages upon line energization

If a VT were inadvertently left isolated prior to line energization, incorrect operation of voltage dependent elements could result. The previous VTS element detected three-phase VT failure by absence of all 3-phase voltages with no corresponding change in current. On line energization there will, however, be a change in current (as a result of load or line charging current for example). An alternative method of detecting three-phase VT failure is therefore required on line energization.

The absence of measured voltage on all three phases on line energization can be as a result of 2 conditions. The first is a three-phase VT failure and the second is a close up three-phase fault. The first condition would require blocking of the voltage dependent function and the second would require tripping. To differentiate between these 2 conditions an overcurrent level detector (VTS I> Inhibit) is used which will prevent a VTS block from being issued if it operates. This element should be set in excess of any non-fault based currents on line energization (load, line charging current, transformer inrush current if applicable) but below the level of current produced by a close up three-phase fault. If the line is now closed where a three-phase VT failure is present the overcurrent detector will not operate and a VTS block will be applied. Closing onto a three-phase fault will result in operation of the overcurrent detector and prevent a VTS block being applied.

This logic will only be enabled during a live line condition (as indicated by the relays pole dead logic) to prevent operation under dead system conditions i.e. where no voltage will be present and the VTS I> Inhibit overcurrent element will not be picked up.



Note: The Accelerated Ind. input is not used in the Feeder Protection.

Figure 52: VTS Logic

Required to drive the VTS logic are a number of dedicated level detectors as follows:

- IA>, IB>, IC> these level detectors operate in less than 20ms and their settings should be greater than load current. This setting is specified as VTS current threshold
- I2> this level detector operates on negative sequence current and has a user setting
- ΔIIA>, ΔIB>, ΔIC> these are level detectors operating on superimposed phase currents and have a fixed setting of 10% of nominal
- VA>, VB>, VC> these are level detectors operating on phase voltages and have a fixed setting Pickup level 30V (Vn 100/120V), 120V (Vn 380/440V), Drop Off level 10V (Vn 100/120V), 40V (Vn 380/440V)
- V2> this level detector operates on negative sequence voltage, it has a fixed setting of 10V/40V depending on VT ratio (100/120 or 380/440)

.1 Outputs

Signal Name	Description
VTS Fast Block	Used to block voltage dependent functions
VTS Slow block	Used to block the Any Pole dead signal
VTS Indication	Signal used to indicate a VTS operation