

Vector Voltage Meter - VV-Tester

VECTOR VOLTAGE METER (VV - TESTER)



The VV-Tester is designed for in-field periodical bushing insulation test while a transformer is in operation. The meter will measure the bushing power factor and C1 capacitance as well as partial discharge level. The VV-Tester must be connected to pre-installed sensors. Typically these sensors are connected to the test tap on the bushings EDI provides two different devices designed for diagnosing insulation of HV bushings (transformers, CTs, shunt reactors and etc.) – periodical and continuous. The devices for periodical measurements use permanently installed sensors with appropriate termination enclosures. For the most critical equipment,

EDI recommends the use of the Bushing Health Monitor (BHMW). Continuous monitoring is more effective method to ensure reliable equipment operation. The VV-Tester is a multi-channel vector meter and allows one to make periodical measurements more reliable, informative and simple. Using three pre-installed sensors (one per bushing/phase) the meter determines insulation condition of all three bushing. Data and settings stored in the device memory allow not for only detection of the current status but will also trend the data. It is suggested to equip all HV apparatus with permanent sensors and termination enclosures. This will allow the use of the VV-Tester on a periodical bases.

Technical Specifications

Input channels from bushings for power factor and C1 measurements	3
Input for power frequency reference signal (PT for example)	1
Phase angle accuracy, Deg	<0.01
PD inputs from primary bushing sensor	3
Inputs for temperature measurements	3
Inputs for current signals (sensor in the secondary of load CT)	3
Memory depth, measurements	> 5000
Operating temperature, °C	-20°C - +50°C
Weight with transportation case, lbs	25

Overview of methods for on line power factor measurements

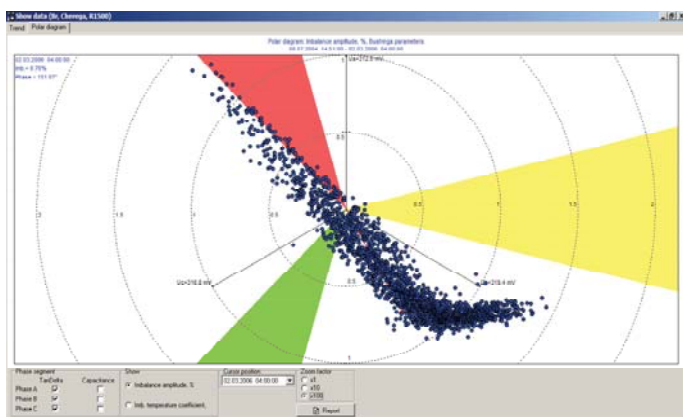
Periodical measurements with pre-installed sensors is not new. Two channel vector meters have been available for several years. These meters require a reference signal from a PT or another bushing and this can become very time consuming and complex. The VV-Tester is a multi-channel vector meter (MVM), and overcomes these limitations and allows for simultaneous measurements of all three phases with no requirement for an external reference.

The universal MVM should allow for a use the use of an external reference signal from a PT (real power factor measurement) or perform measurements without reference signal from a PT (relative power factor measurement). The second approach is frequently more practical due to difficulties in obtaining a signal from a metering PT. Standards for on line bushing diagnostics (sum of currents, power factor and capacitance) recommend using rate of change as a diagnostic parameter rather than absolute parameter value. In this regard (as it different from off line tests) absolute value has less effect on results of diagnostics. The reference signal may have a value in situations when system voltage has very high level of variations in both magnitudes and relative phase angles between phases.

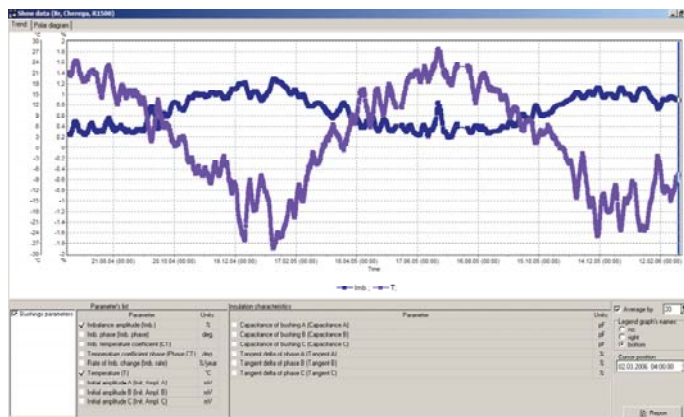
Another item to account for when considering vector meters is the difference between off line and on line insulation behavior. Power factor may vary up to two times in a bushing due to changes in temperature and applied voltage (10 kV vs. Operating voltage). Even bushings from the same manufacturer and the same type may perform differently. It is not unusual that power factor will vary by 20-30% during day-night temperature change. This questions the value of absolute on line power factor measurements. The only practical way to diagnose bushing insulation condition is a relative power factor relative to another object.

The factors affecting the temperature of different objects are multiple and difficult to make suitable evaluations. It is necessary to use the balancing method in order to make a valid decision on bushing condition. This method is used in the EDI Bushing Health and Winding Monitor (BHWM) The BHWM sums bushing currents in three-phase transformers. The BHWM balances the sum of three currents close to zero and will go off balance when insulation in a bushing deteriorates. Temperature effect in such a method is compensated by the method itself.

The above analysis drives the conclusion that a multi channel vector meter with a minimum of 4 channels is required. Four channels allow for all modern diagnostic methods without limitations. Four-channel MVMs must have an auto-balancing option. Balancing settings must be stored in the device memory and accurately restored when performing consequent tests on the same object. VVtester-4 uses high accuracy digital potentiometers that are adjusted during the initial balancing procedure to achieve near zero output. All data is stored in the device memory and is restored when consequent measurement to ensures accurate data trending.



Screenshot of the polar plot
Polar plot is an effective way of presenting vector type information. This type of plot is used in the IHM software for imbalance signal and imbalance temperature characteristics.



Screenshot of the trending plot
Trending display allows for viewing historical data and correlation between various measured characteristics.