BVM Systems

BVM Systems Limited

PQSensor™ Broadband Voltage Transducer

The Only Practical Solution For Accurate Monitoring Of Transmission Network Transients And Harmonics

PQSensor™ Broadband Voltage Transducer

The PQsensor™ offers a unique and cost effective method to accurately measure high frequency transients and harmonic content using Capacitior Voltage Transformers (CVTs).

Measurement Challenges

- Inherent CVT inaccuracies make their use impractical for measurement of harmonics, ferroresonance and sub-synchronous resonance.
- High speed voltage transients cannot be accurately recorded using CVTs.
- Wound VTs also introduce large harmonic measurement errors.
- Alternative solutions are prohibitively expensive and often unsuitable for permanent installation.

Measurement Requirements

- Accurate measurement of harmonic levels on transmission networks is an essential aspect of assuring compliance with grid codes and the operating license.
- Increasing deployment of FACTS systems, and mechanically switched capacitor banks, HVDC convertor stations and SVC systems are changing the harmonic profile of transmission networks.
- The growing number of wind farm and other embedded generation connections at the transmission level is significantly increasing harmonic levels.
- Accurate harmonic profiles of the transmission system are essential to enable adequate designs to be carried out for new HVDC interconnectors and transmission embedded generation connections.
- Transmission system studies frequently require the on-site measurement of switching transients.
- Measuring and understanding transients in today's increasingly complex transmission networks is of growing importance.

The Solution

- The PQSensor™ is a transducer that can be fitted to a CVT allowing it to be used to accurately measure harmonics, resonance effects and high speed transients.
- An additional output signal is provided for making broadband and transient measurements and has no impact on normal CVT measurements.
- The PQSensor™ has many years of proven field experience with an extensive library of measurement results testifying to its proven accuracy.

The PQSensor™ in Practice

- The PQSensor™ offers a practical and economical solution for wide bandwidth measurements using CVTs
- The PQSensor™ eliminates the need for special high voltage instrument transformers or wide bandwidth voltage dividers.
- The PQSensor™ can be retrofitted to in-service CVTs or supplied (factory fitted) with new installations.
- PQSensor™ solutions are available from all major CVT suppliers
- A PQSensor™ installation has no impact on the normal operation and measurement capabilities of the CVT.
- Installation is straight forward and involves three basic steps
    1. Installing a measurement interface in the secondary terminal box of the CVT.
    2. Connecting the Measurement Interface to a Signal Conditioning Module (SCM). The SCM is usually mounted on the structure of the CVT.
    3. Providing an ac or dc supply and connecting the output wiring from the SCM to the power quality monitor or recorder.

For In Service CVTs or New Installations

Background

Power Quality assessment has become an increasingly important requirement in the management of electric supply networks. The worldwide introduction of electricity industry deregulation and the unbundling of generation, transmission and distribution have been major contributors to the demand for improved power quality information. The growing installation of embedded generation (including wind farms) and the increasing deployment of FACTS systems, mechanically switched capacitor banks, convertor stations and SVC systems are changing the harmonic profile of transmission networks which in turn increases the importance of accurate power quality monitoring.

The need for more power quality information has in turn led to the introduction of many national and international standards for power quality measurement and monitoring. All such standards including IEEE 519, IEC 61000-3-6, IEC 61000-4-7 and the UK Engineering Recommendation G5/4 require measurements up to the 50th harmonic. The Flicker standard IEC 61000-4-15 requires the measurement of modulating frequencies between 0.5Hz to 33Hz. The limits for permissible harmonic levels specified in these standards require the ability to make measurements across the harmonic spectrum to an accuracy of better than ± 5%.

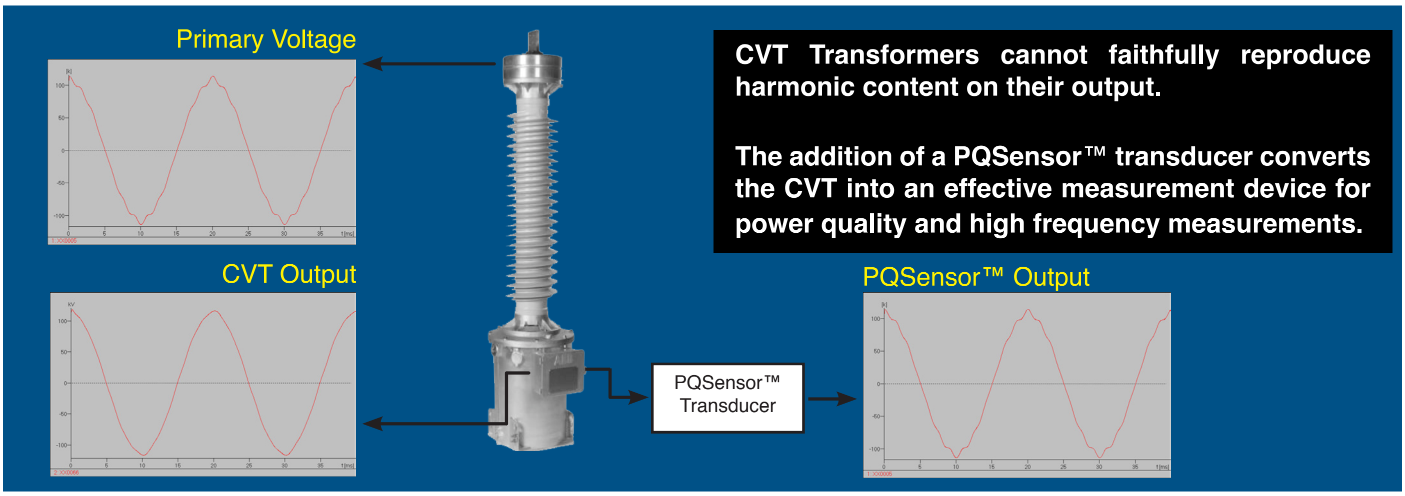
General Description

The PQSensor™ is a factory or field installable transducer that equips a CVT with a low voltage output that faithfully reproduces the complete harmonic spectrum of the primary h.v. voltage input. This output enables CVTs be used with any power quality monitoring device to accurately record power system harmonics and transients.

The PQSensor™ can also be used with multifunction recorders to provide enhanced fault recording and phasor measurement functions. It also provides the ability to use CVTs to make accurate measurements of sub-synchronous resonance and ferroresonance phenomena that can occur on transmission systems.

Field Experience

The product has many years of field experience at voltages from 115kV to 400kV - the PQSensor™ is applicable at any voltage where CVTs are installed. PQSensor's™ have been field retrofitted to a variety of different designs of CVT and have also been supplied 'factory fitted' by all of the major manufacturers of CVTs. Applications have included power quality recording, fault and disturbance recording and monitoring of high speed transients on transmission systems. The PQSensor™ has been used to accurately measure power qality parameters such as harmonics and flicker over a wide bandwidth from subsynchronous harmonics to high frequencies. The PQSensor's™ current sensors are installed in the secondary terminal box of the CVT in the ground connection circuits of the C_2 capacitor and the electromagnetic unit (EMU). These are in turn connected to the signal conditioning module (SCM) which is usually mounted on the CVT support structure making for a straight forward retrofit installation.



A Field Proven, Cost Effective Solution

Measuring Harmonic Voltages

Sophisticated power quality monitors are now available from a variety of suppliers however if utilities and users are to accurately monitor the high order harmonics, flicker, ferroresonance oscillations, power quality and other wideband transients, then a signal source must be used that faithfully reflects the levels of these quantities on the high voltage system.

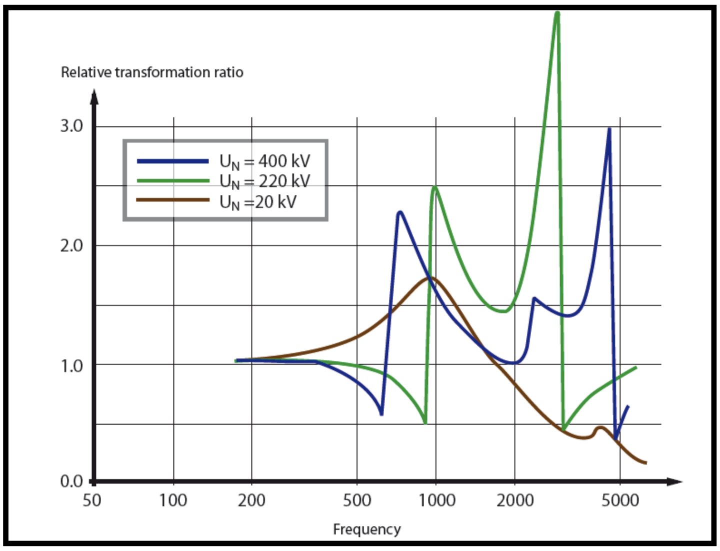
Capacitor Voltage Transformers (CVTs) are the dominant technology for voltage measurement at transmission levels because they provide reliable and accurate performance at reasonable cost. However, this accuracy is restricted to in or around the nominal system frequency and at frequencies above or below nominal very significant errors are the norm. CVT's, because they are essentially tuned to the system frequency, are not in themselves appropriate for harmonic measurement. It is also important to note that CVT characteristics can change significantly with burden and vary widely from one model to another.

The unsuitability of CVTs for use in power quality measurement was summarised in a recent IEC publication as follows:-

6.3.1.2 Frequency Response Behaviour:

The CVT is calibrated in that way that the capacitive voltage divider and the electromagnetic unit are in resonance at rated frequency. Due to this fact, a small shift from the rated frequency causes big errors both in amplitude and in phase. The linear portion of frequency response is limited to ±10 Hz from the rated frequency (CIGRE) and the frequency response becomes unacceptable at above the second harmonic order:

Many currently installed power quality monitors are supplied with input signals from wound or inductive voltage transformers (IVT). These transformers are often used to provide inputs for conventional revenue meters and protection relays and therefore are often already present in transmission substations. However, what is not well understood is that inductive VT's have a limited frequency range. Consider the performance of a typical 220kV inductive VT (Reference: CIGRE Working Group 36) as shown in the graph. It can be seen that the upper limit of acceptable frequency response only extends to around 500 Hz, well below the upper harmonic frequency limit required by the majority of power quality standards. The acceptable upper frequency limit increases for lower voltage class VTs but is even lower for higher voltage class units. The IEC's assessment of the use of IVTs for power quality measurements is as follows:-



6.1.1.2.1.4 Impact to the Measurements of PQ Parameters:

For high voltages, instrument transformers response deteriorates for frequencies above 500 Hz. Common inductive transformers do not give accurate information for frequencies above the 5th harmonic.

The best performance from conventional devices in terms of wide bandwidth frequency response is offered by a resistive-capacitor divider (RCD). These devices which are not installed as standard in the majority of substations, are expensive, have a limited output and have to be installed in addition to the more conventional capacitor or inductive voltage transformer. There are also important safety considerations in the use of RCDs for continuous measurements due to the lack of isolation between HV and LV.

However, by using a combination of conventional CVT technology (new, or legacy installed equipment) together with the PQSensor™ transducer all of the limitations of the above measurement methods are overcome. This solution represents a safe, accurate and cost effective solution for transmission system broadband measurements.

Specification

Input signal	From measurement interface in CVT earth connections
Output Signal (typical)	16 mA into 75R (1.2V) @ nominal voltage
Output Signal (maximum)	16 mA into 150R (2.4V) @ nominal voltage
Output Signal (optional)	63.5V @ nominal voltage
Output signal absolute gain error	0.5% at nominal frequency
Operating Temperature Range	-10 to +55°C
Supply Voltage	110, 220Vac (±10%), 85-260 V dc
Enclosure environment	IP65
Harmonic Measurement Error	Error < 3% to 2.5k Hz; < 5% to 5.0 kHz
Frequency Response	5 Hz to 20 kHz
Phase Angle Error	Less than 6°
Size (Measurement Interface)	60mm x 60mm x 60mm
Size (Signal Conditioning Module)	260mm x 160mm x 92 mm

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