POWER QUALITY MEASUREMENT WITH CAPACITOR VOLTAGE TRANSFORMERS

The PQSensor™ offers a unique, convenient and cost effective method of faithfully reproducing harmonic content using Capacitive Voltage Transformers (CVT) without the need for Resistive-Capacitor Dividers (RCD).

- The PQSensor™ offers a practical and economical solution for wide bandwidth measurements using CVTs.
- Eliminates the need for special high voltage instrument transformers or wide bandwidth voltage dividers.
- Can be retrofitted to in-service CVTs or installed in new units.
- CVTs can continue to be used in normal ways to feed relays and other standard devices and at the same time to be used for power quality monitoring.
- It can be used to detect CVT internal ferroresonance.

GENERAL DESCRIPTION

A power quality sensor is available to very accurately measure power quality parameters such as harmonics and flicker over a wide bandwidth from subsynchronous to high frequencies. The PQSensor™ current probes are installed in capacitor voltage transformers (CVTs) at the ground connection points in the secondary terminal box. The PQSensor™ signal-conditioning unit can be mounted on the CVT support structure making the retrofit installation simple.

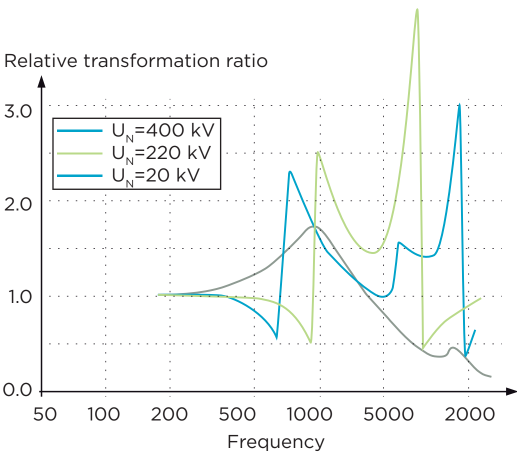
BACKGROUND

Power quality assessment has become an increasingly important requirement in the management of electric supply systems. This recognition has led to the introduction of several standards for power quality measurement and monitoring. All standards such as IEEE 519, IEC 61000-4-30 and 61000-4-7 and UK. Engineering Recommendation G5/4 require measurements up to the 50th harmonic. Flicker standard IEC 61000-4-15 require measurement of modulating frequency between 0.5 Hz to 33 Hz.

OPTIONS FOR MEASURING HARMONICS

If utilities and users are to monitor ferroresonance oscillations, power quality and other wideband transients in high voltage systems, there is a need for cost effective and accurate means to do so. Sophisticated power quality monitors are now available from various manufacturers. The challenge, however, is to provide inputs to these monitors which accurately reflect the phenomena occurring on the monitored system in a cost effective and safe way. The best performance from a conventional device in terms of a wide bandwidth frequency response is of offered by a resistive-capacitor divider (RCD), which is very expensive, has a very limited output and would not normally be present in a substation environment and does not meet safety requirements for isolation between high voltage and low voltage parts. Most power quality monitors are currently receiving their inputs from wound or inductive type voltage transformers (VTs). The advantage with VTs is that they can also provide inputs into conventional revenue meters and relays and therefore may already be present if harmonic measurement is being considered as an add-on. What is not well understood is that wound VT's have a limited frequency range. **Graph** shows the performance of typical wound VT (Reference: CIGRE Working Group 36). It can be seen that the frequency response becomes unacceptable around 500 Hz, well below the frequency limit established in the major standards. The upper limit increases for lower voltage class units but worsens for higher voltage class units. Capacitor voltage transformers have become the dominant technology for voltage measurement at transmission voltage levels because they provide reliable and accurate performance at reasonable cost.

CVTs, because they are essentially tuned to the system frequency, are not in themselves capable of harmonic measurement. Because of the prevalence and reasonable cost of this technology, much effort has been expended to add the functionality of harmonic measurement. There is a solution for employing CVTs for harmonic measurement. A power quality sensor, to be used in conjunction with CVTs, has been developed and patented which overcomes the aforementioned objections. One of the important advantages of the technology, in addition to its cost effectiveness, is the speed of installation in in-service CVTs.

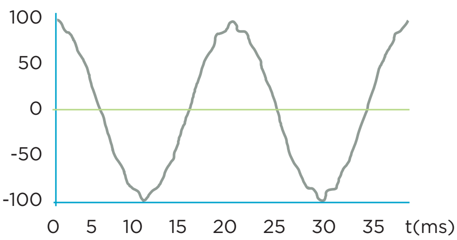


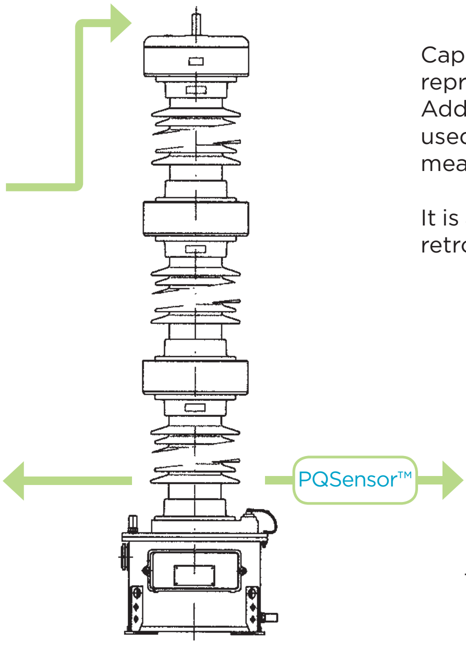
TECHNICAL DATA

ABSOLUTE GAIN ERROR	0.5% at operating frequency, measured at either outputs into 75 Ω terminations
GAIN STABILITY OVER OPERATING TEMPERATURE RANGE, AT OPERATING FREQUENCY, (MEASURED AT “DIFF OUTPUT” WITH 75 Ω TERMINATION)	0.3% of full-scale output
GAIN STABILITY OVER OPERATING TEMPERATURE RANGE, AT OPERATING FREQUENCY, (MEASURED AT THE INTEGRAL OUTPUT WITH 75 Ω TERMINATION)	0.4% of full scale output. This does not include any effects of the CVT
FREQUENCY RESPONSE	5 Hz up to 20 kHz
FREQUENCY RESPONSE MEASURED OF “DIFF OUTPUT”	-0.17 dB max at 5 kHz with respect to gain at operating frequency
FREQUENCY RESPONSE OF “OUTPUT”	-0.25 dB max. It will not have DC response
PHASE ERROR	Less than 1.5 degrees at 3 kHz and less than 3 degrees at 5 kHz. Improved phase response is offered on request for special applications
MAXIMUM BURDEN	150 Ω pure resistive. This corresponds to a maximum voltage at the measurement device (e.g. power quality monitor) of 3 V rms at a current of 20 mA. The burden may be selected to be any value up to the maximum to suite the measurement device (the monitor). All figures related to accuracy and error mentioned in this document would also apply for burdens up the maximum values
OUTPUT CURRENT LEVELS	Differential current output of 20 mA rms, driving 75 Ω through 300 meters of cable. Cable capacitance is typically 100pF/m
OPERATING TEMPERATURE RANGE	-40 to +55 °C
POWER SUPPLY INPUT VOLTAGE	48 Vdc ±10% or 85-260 Vdc/Vac ±10%. The unit can be supplied from the CVT nominal output of 69 Vac. Power consumption 200 mW
SIZE	**Signal conditioning module**: 10.2X6.3X3.6 inches (260x160x92 mm) **Current transformers**: outer and inside diameters of 2 inches (50 mm) and .8 inches (20 mm), a depth of .8 inches (20 mm)
OUTDOOR SPECIFICATION	Conform to IP65

European Patent Number: EP 1295133. US Patent Number: US 6,919,717.

CVT Input

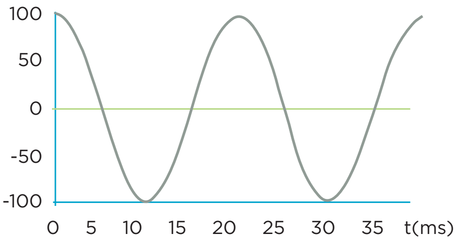




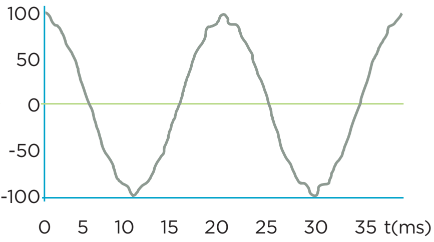
Capacitive voltage transformer cannot faithfully reproduce harmonic content on their output. Addition of PQSensor™ allows CVTs to be used in power quality and high frequency measurements.

It is as simple as Kirchoff’s law. Easy and quick to retrofit to in service CVTs.

CVT Output



PQSensor Output



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Moving together

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Version: A1