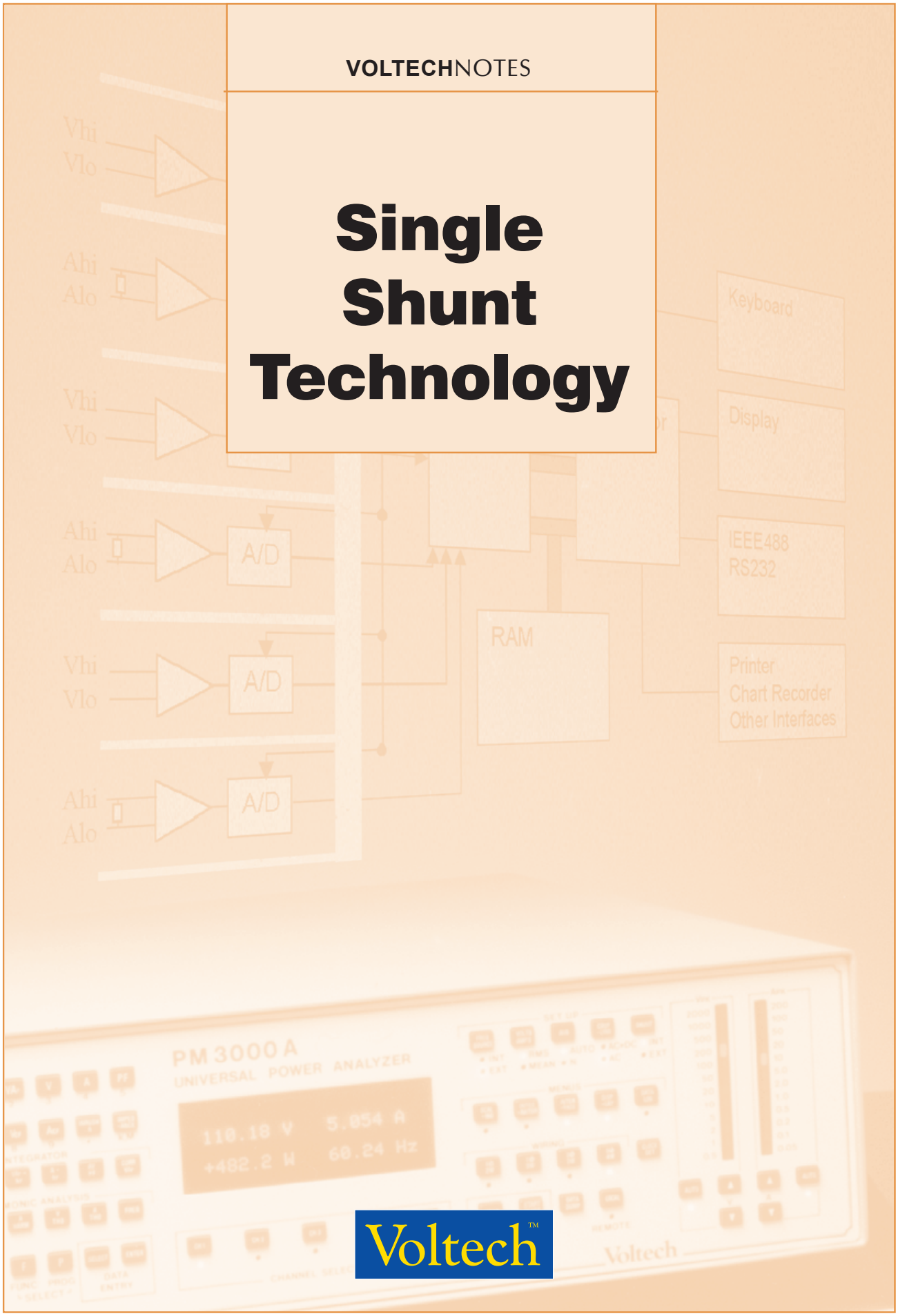
VOLTECHNOTES

Single Shunt Technology



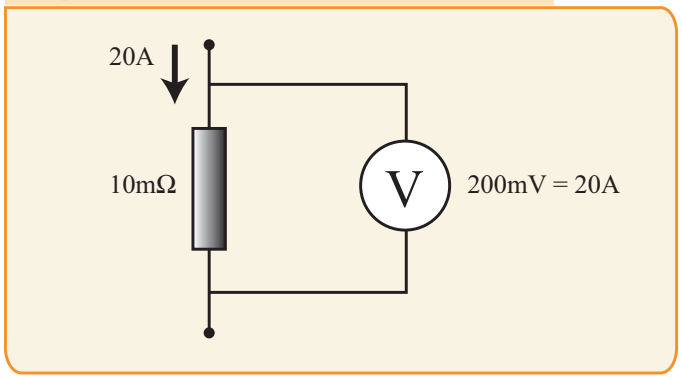
VPN 104-114/3

SINGLE SHUNT TECHNOLOGY

What is a shunt?

The word 'shunt' is used in electronics to describe an impedance that is connected in parallel with a circuit in order to divert, or 'shunt', some current away from the circuit. When a suitable shunt impedance is placed in parallel with a voltmeter, the voltmeter can be calibrated as an ampmeter, which measures the total current flowing in the circuit.

Simple shunt



What are the important characteristics of a shunt?

1. Impedance value

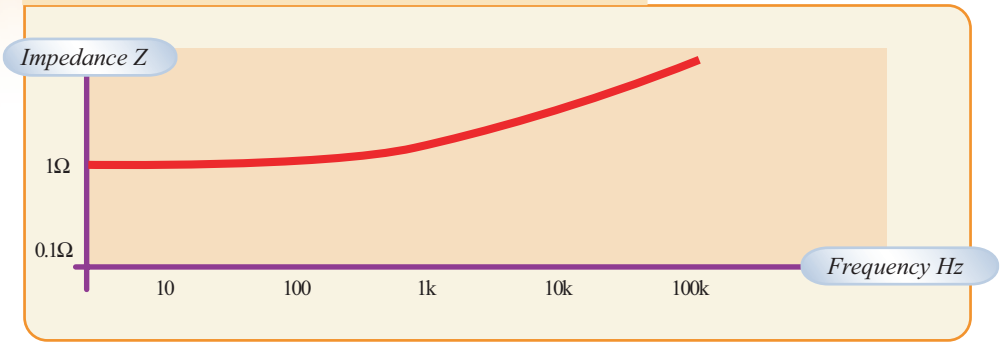
The shunt should have as low an impedance as possible to minimize the effect that it has on the circuit being measured. For example, the IEC specifies that the shunt should be less than 3.5mΩ when measuring harmonics to IEC61000-3-2.

However, the shunt should have a sufficiently high impedance, so that the voltage across it can be measured accurately by the voltmeter. (In the example above, a current of 20mA would produce a voltage of only 200μV).

2. Frequency response

When measuring AC power components at different frequencies, the shunt should have the same impedance at all frequencies, or the current measured (I = V/R) will be inaccurate.

Frequency response showing varying shunt impedance



3. Stability

The value of the shunt should not change with time, temperature or humidity.

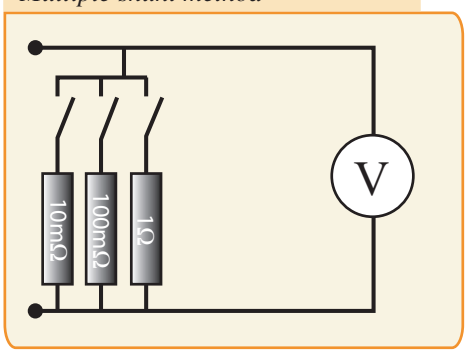
How does Voltech achieve the optimum characteristics?

1. Impedance value

The low value for minimum effect on the circuit vs. high value for 'ease of measurement' compromise.

One method of achieving this compromise is to use a number of different shunt values that are tied to different current ranges. The shunts are either manually selected (by changing the power connections), or switched by power relays.

Multiple shunt method



Shunt	Current Range	Voltage Measured
10mΩ	1A to 100A	10mV to 1V
100mΩ	0.1A to 10A	10mV to 1V
1Ω	10mA to 1A	10mV to 1V

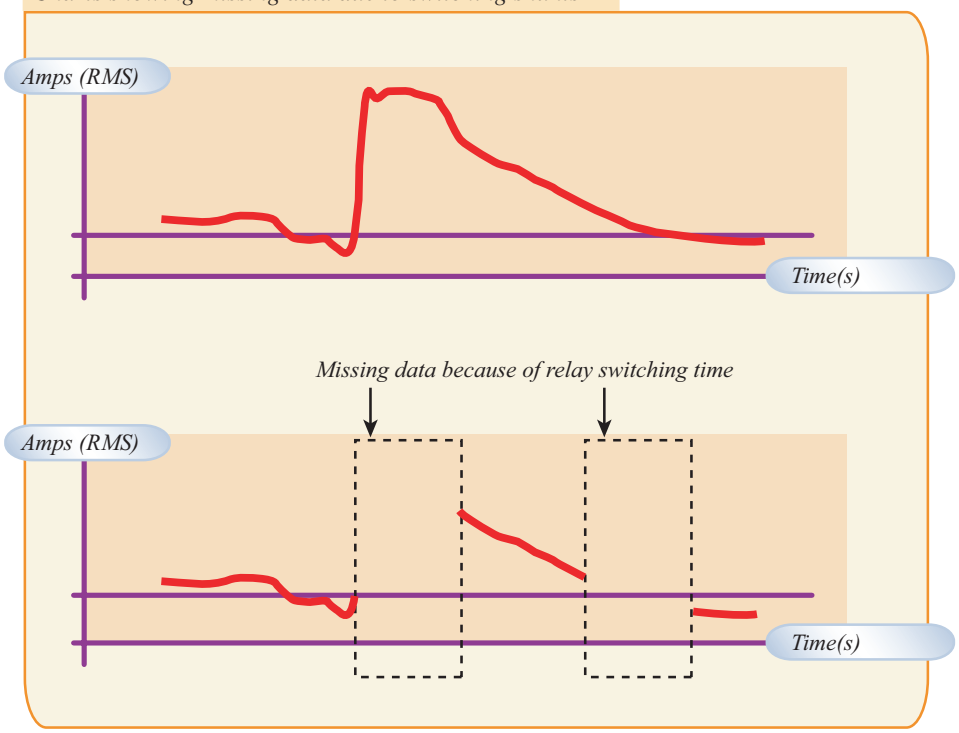
Benefits:

- Different shunts for different current ranges reduce the dynamic range required by the voltmeter. The dynamic range is the range of values over which the meter can continuously make measurements, in this case 100:1.
- Low value of shunt on high current (100A) range.

Drawbacks:

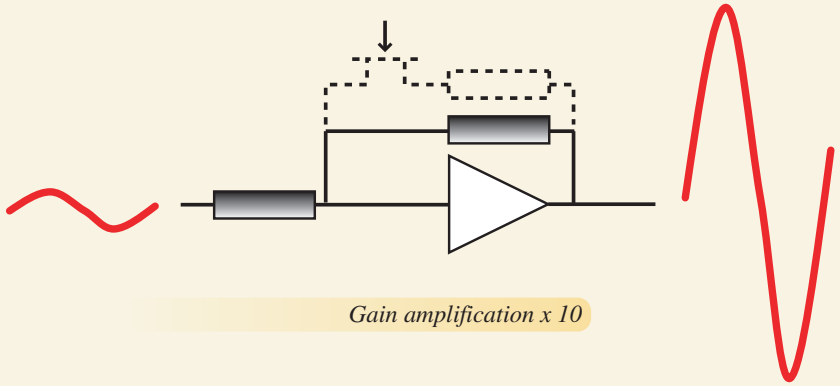
- Relay contact wear.
- Mechanical reliability of the relays.
- Dynamic range of the current input is limited. For example, measurements will be interrupted if the current changes from 50mA to 500mA.

Charts showing missing data due to switching shunts



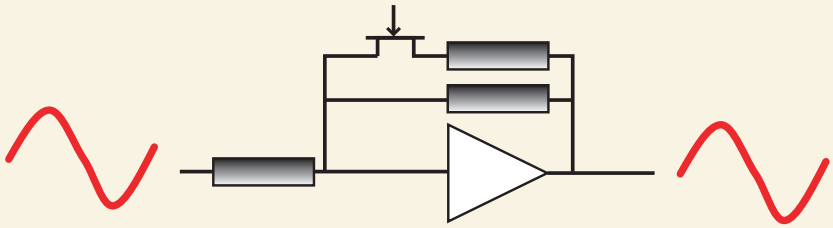
The design of the Voltech PM3000A overcomes this problem by using precision, low-noise, switched-gain amplifiers. The gain of the amplifier is changed (rather than the value of the shunt) to ensure that the optimum range is used to provide the best accuracy. High-speed, solid-state switches in the synch path, instead of relays in the power path, ensure that the loss of data due to relay switching times is eliminated.

Smaller signal amplified



Gain amplification x 10

Larger signal, less amplification required



Gain amplification x 1

2. Frequency response

An ideal shunt is purely resistive at all frequencies. That is, it has no self-inductance or stray capacitance. The PM3000A's shunt is of a 'co-axial' pattern, and it is precisely mounted inside the analyzer to minimize the effects of external magnetic fields and stray capacitance.

The remaining high-frequency errors are measured by Voltech and stored within the analyzer to provide a measurement system, compensated for amplitude and phase, over the specified 1MHz bandwidth.

3. Stability

The shunts are formed from a single strip of manganin to ensure that the resistance does not change with temperature. After initial testing, the shunts are annealed at 30A rms and at high ambient temperature before calibration. This minimizes any changes to the impedance during the life of the instrument.

Benefits of single shunt technology:

THE 'NO-COMPROMISE SOLUTION' PROVIDES:

- None of the mechanical reliability problems associated with multiple shunts switched by power relays.
- No damage or overheating caused by misconnection or applying the test current when the analyzer is off.
- A wide range of current that can be measured dynamically with full accuracy without:
  - reconnecting different shunts,
  - interruptions due to relay-switched shunts.
- Very high crest factor measurements at full accuracy.
- Precise frequency compensation of one shunt only. No further errors are caused by different shunts having different phase responses.

NOTES

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