# INSTRUCTION MANUAL

# HIGH VOLTAGE DIVIDER

# HVT 80 RCR


HILO-TEST GmbH, Hennebergstr. 6, D-76131 Karlsruhe, Tel. 0721 931 09-0, Fax 0721 931 09-39

# 1. Functional description

The Broad-band high-voltage divider series HVT...RCR are state-of-the-art measuring equipment whose excellent high-frequency transmission characteristics can be fully exploited only if properly operated and if all aspects typically encountered in the nanosecond regime, e.g. appropriate grounding, transmission line characteristics of leads, are fully considered.

Before using the HVT...RCR dividers, this instruction manual should be careful read in order to avoid operating errors and waste time. Comprehensive information regarding the problem of impulse voltage measurements in the nanosecond regime can be found in the literature listed in the appendix.

Broad-band high-voltage dividers series HVT..RCR are designed for measuring high ac- dc- and pulse voltages, Fig. 1.

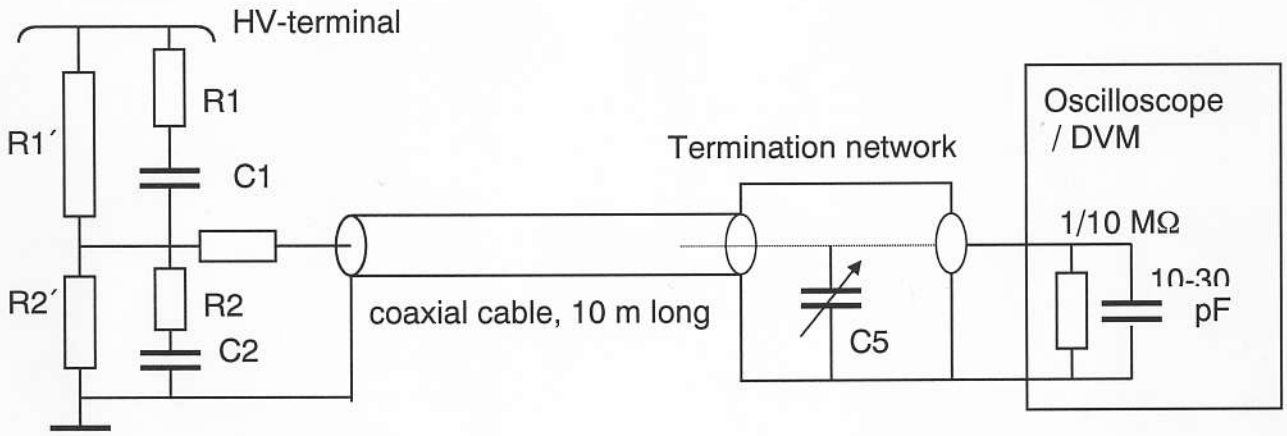


Fig 1 : Broad-band high-voltage divider HVT..RC, schematic

The high-voltage impedance Z1 consists of a precise metal film resistor and a high-voltage capacitor with series damping resistor in parallel. The low-voltage impedance Z2 has the same time constants as the impedance Z1. Therefore the divider ratio is constant from dc up to the upper frequency limit.

The low-voltage output signal is connected to the scope input via a coaxial cable and a termination network. Low-voltage impedance is adjusted for an oscilloscope input impedance of 1 MΩ // 20 pF. Adjusting capacitor C5 allows compensation of scope input capacitance from 10 pF to 30 pF.

The measuring cable with the termination network is an essential part of the divider. The length of the coaxial cable may not be varied. The termination network mainly reduces refections on the coaxial cable (burch effect).

The divider can also be used for high-voltage dc measurement with a digital voltmeter, DVM. If the DVM has 10 MΩ input impedance, please connect a resistor Rp = 1.1 MΩ in parallel to the input terminals of the DVM in order to get 1.0 MΩ load resistance at the divider output.


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# 2. FUNCTIONAL TEST OF THE VOLTAGE DIVIDER

If the measurement of a known clean voltage step, for instance a square wave of an oscilloscope or of a special pulse generator, does not result in a Gaussian step response, first of all, the measuring set up must be checked. Oscillations on the oscilloscope screen can originate from many sources and, usually do not result from the divider. Most frequently, the input signal is not a clean voltage step, the connection of the divider is not correct or the oscilloscope itself possesses a ringing step response. Moreover, electrical interference due to radiation, coupling, or conducted interference cause pulse distortions. The proper operation of the voltage divider can be checked in the following test circuit.

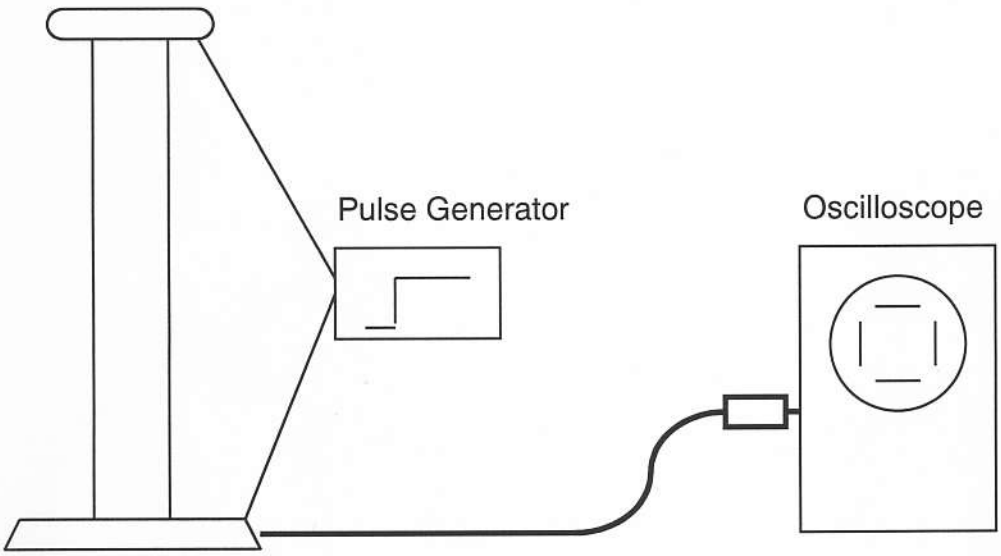


Fig. 2 Circuit for testing the divider's step response

The high-voltage measuring circuit, composed of the pulse generator voltage divider, and the ground return lead must be periodically damped by the generators source impedance. In the set-up shown in Fig. 2 this is the case for a generator source impedance Ri = 50 Ω.
For different set-ups an additional resistor between generator output and divider input may be required. The low-voltage signal of the divider should be recorded by compact and well screened oscilloscopes with low mutual transfer impedance which are comparatively immune against electromagnetic interference. Other oscilloscopes can be used but may require a Faraday cage. A properly adjusted divider, a compensated network and oscilloscope will yield to a Gaussian step response waveform.

The total ripple must stay below 5%, where the ripple of the oscilloscope itself of 4%pp must be considered. If pulse distortions are observed first of all, the oscilloscope step response should be checked with a clean step voltage. Because of their special circuitry, modern oscilloscopes themselves possess in their vertical paths various components which are used for pulse distortion compensation.

Frequently, one will recognise that the distortion in the voltage divider's step response can already be found on the oscilloscope display, even without connecting the voltage divider. Comprehensive information regarding the problem of impulse voltage measurements in the nanosecond regime can be found in the literature listed in the appendix.

## 3. Technical specifications HVT 80 RCR

| | | |
|---|---|---|
| max. input voltage : | dc-voltage | 80 kV |
| | ac-voltage | 60 kV≈, 50 Hz |
| | surge voltage | 160 kVs, 1.2/50µs |
| DC-ratio | | 5 000 : 1 ± 1% |
| input impedance, appr. | | 270MΩ//(75pF+1350Ω) |
| rise time | | 35 ns |
| band width, appr. | | 0-10 MHz |
| dimensions : | socket, appr. | 260 mm∅ |
| | height, appr. | 680 mm |
| incl. measuring cable | | 10 m long |
| | with termination network for scope input impedance | 1 MΩ//10-30pF |

## 4. Literature


Schwab, A.: High-Voltage Measurement Technique
M.I.T. Press Cambridge Mass. USA 1972

Schwab, A.: Hochspannungsmeßtechnik , Springer Verlag 1981

Schwab, A. Pagel, J.: Precision Voltage Divider for Impulse Voltage Measurements
IEEE Trans.PES vol. 91 (1972)

Schwab, A., Herold, J.: Electromagnetic Interference in Impulse Measuring Systems
IEEE Trans. on Power Apparatus and Systems
Vol. PAS-93 No. 1 Jan./Febr. 1974



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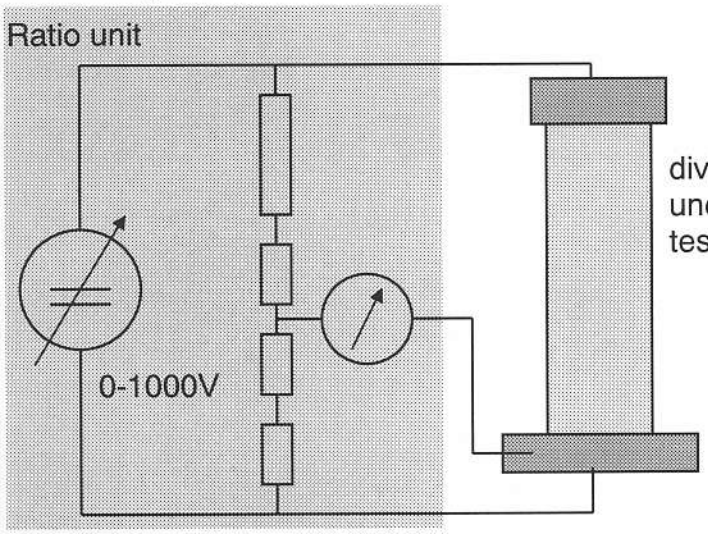
# 5. FINAL TESTING: HVT 80 RCR, Serial No.: [2006 3187 ]

## 5.1 Verification of dc-ratio

Test equipment used: Ratio Unit, HILO-TEST
Digital voltmeter, 34401a, Agilent

Test Set-Up:




ratio setting [ 1000 : 0.2 ]
ratio unit reading [ 30 mV]
amplification 30 mV/ [ 50 ]
=absolute ratio error [ 0.6] mV
DC ratio error < 0.5 % [ x ] OK

Ratio error [ 0.6mV/200mV ] = [ $3*10^{-3}$ ]

## 5.2 Verification of step response

Test equipment used: Oscilloscope TDS 380, Tektronix, # 490037
Impulse generator IPG 250, HILO-TEST
Digital voltmeter, 34401a, Agilent

Test Set-Up according to Fig. 2

Pulse amplitude adjusted in dc-mode of the impulse generator and measured by use of the digital voltmeter:

DVM reading: [ 250 V ]

Step response captured with scope: 50ns/DIV .... 5 ms/DIV, print-out enclosed

Amplitude of output voltage: [ 50 mV ]

Divider ratio: [ **5 000 : 1** ]

Rise time ( 10% - 90 %) [ **< 40 ns** ]

Final testing carried out on 12.12.06 by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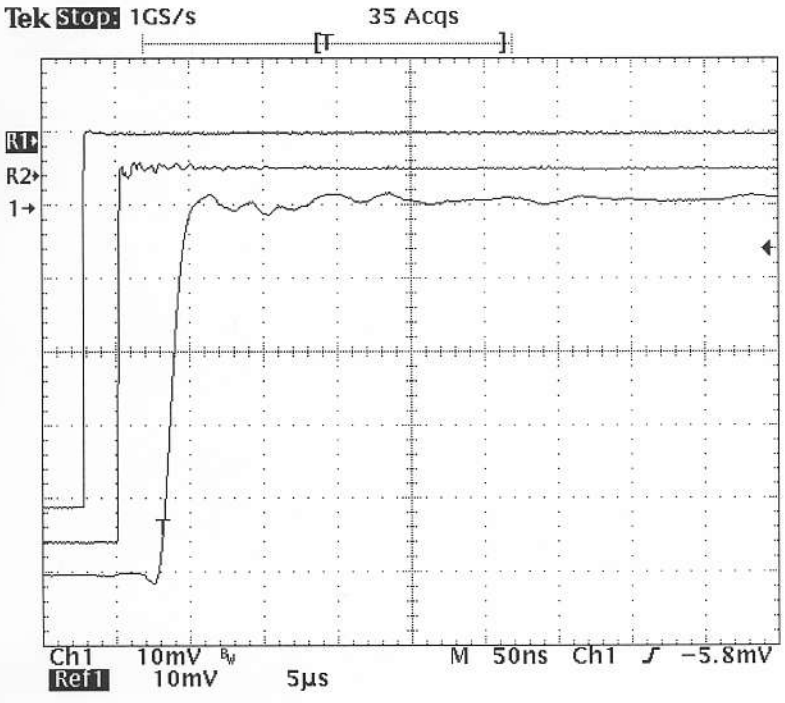
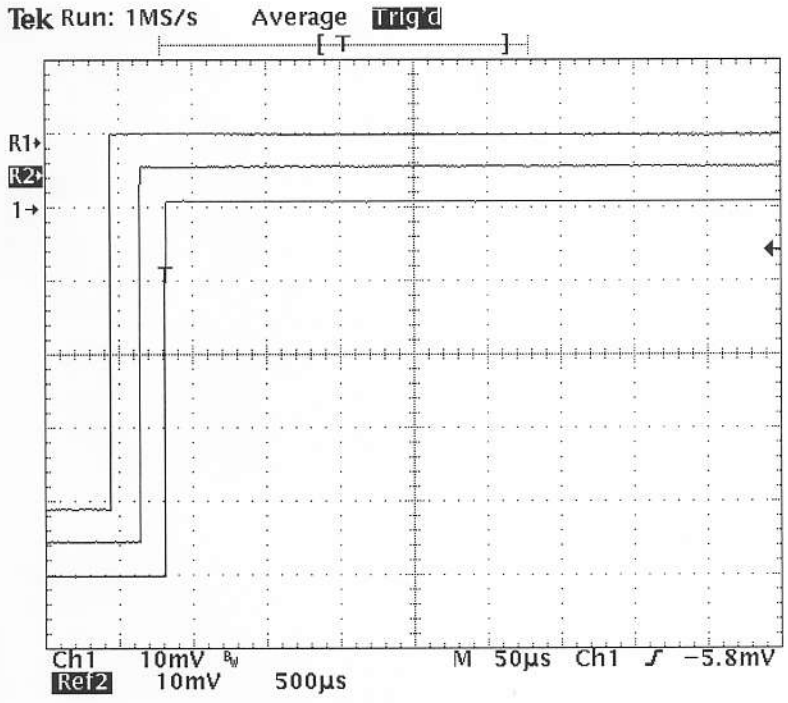
STEP RESPONSE MEASUREMENT: # 2006 3187




5.0 µs/DIV
500 ns/DIV
50 ns/DIV




5.0 ms/DIV
500 µs/DIV
50 µs/DIV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