JENNINGS
A LEAR SIEGLER COMPANY

MODEL 13200 VOLTAGE DIVIDER APPLICATION NOTES

HOW TO MAKE ACCURATE HIGH VOLTAGE AC MEASUREMENTS

The need to measure high voltages up to 50 and 100 kV peak led to the development of voltage dividers using Jennings high voltage vacuum capacitors. With such dividers it is possible to tap off a voltage that is a small but accurately known percentage of the total voltage. Then, standard high impedance oscilloscopes, digital voltmeters or VTVM's can be used to observe waveforms or make measurements accurate to within ±1%.

The Model 13200 AC Vacuum Capacitor Voltage Divider consists of a shielded high voltage vacuum capacitor in series with a suitable padding capacitor to provide the desired division ratio. Additional capacitors are used in parallel with the low voltage unit to provide the accuracy required and to permit minor adjustments later if recalibration becomes necessary. The result is a low inductance divider that minimizes problems of resonance at high frequencies and distortion of steep wave fronts. Depending upon the input impedance of the measuring instrument (see Figure 2), measurements obtained are linear over a frequency range of less than 50 Hz up to 10 MHz.

Applications include:

- Measuring rf tank and transmission line voltages.
- Viewing output wave shape and timing of high voltage pulse generators.
- Viewing the wave front of transients that occur when switching inductive or capacitive loads.
- Measuring percentage of modulation and output of audio circuits.

Figure 1. Model 13200 Voltage Divider

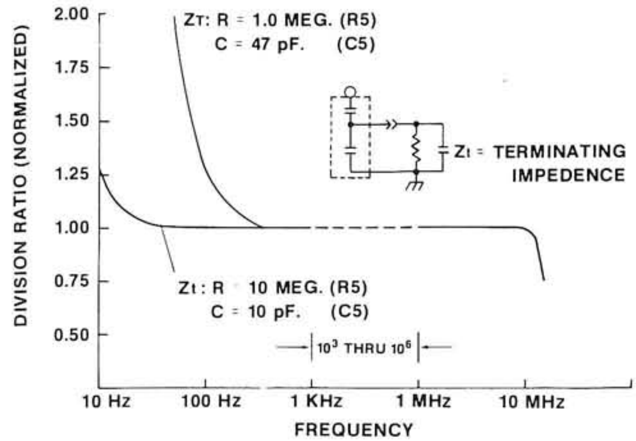
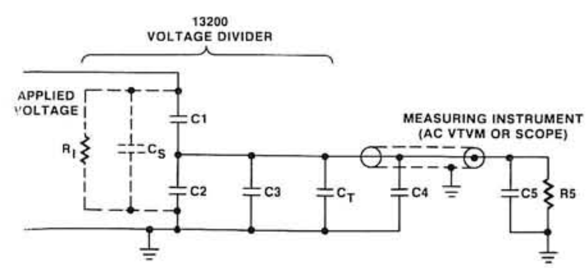


Figure 2. Model 13200 Probe frequency response

Unless otherwise specified, the Model 13200 voltage divider is supplied with a ratio of 325:1. Other ratios within the range of 300:1 to 2000:1 can be specified. All dividers are supplied with six-feet of RF-58 A/U coaxial cable terminated with a BNC connector. Cables up to 15-feet long can be supplied on special order.

VOLTAGE MEASUREMENT

The accuracy of the probe is only as good as the accuracy of the capacitance measurements. Jennings supplies these dividers with accurate division ratios because all capacitance values involved in the probe and cable are measured accurately using a 3-terminal capacitor bridge. Figure 3 is a simplified circuit diagram showing the capacitances measured and typical values for a divider with a 325:1 ratio.



C_1 - High Voltage Vacuum Cap. (typ. 2.8 pF)
C_2 - Low Voltage Vacuum Cap (typ. 25 pF)
C_S - Capacitance of Shielding Electrode (typ. 4 pF) Note: C_S - does not affect div. ratio
R_I - 10^{12} ohms
C_3 - Low Voltage Padding Cap. (typ. 700 pF, for 325:1 div. ratio)
C_4 - Capacitance of Coaxial Cable (180 pF for 6' cable)
C_5 - Capacitance of Oscilloscope Input (dependent upon scope)
R_5 - Input Resistance of Oscilloscope
C_T - 5-50 pF Trimming Capacitor

Figure 3. Typical capacitance values for 325:1 Voltage Ratio

The voltage ratio is determined from the value of C_1 and the sum of C_2, C_3, C_4 and C_T in parallel. The value of C_S, shielding electrode capacitance is ignored because it does not affect the ratio. In the values given in Figure 2, $C_2 + C_3 + C_4 + C_T$ equals 25 + 700 + 180 + 23 for a total capacitance of 928 pF when the trimming capacitor is set at its midpoint. The voltage across C_1 and C_2 is inversely proportional to the capacitance values. Therefore, the voltage ratio is 928:2.8 or 331:1. Note that this does not take into account the input capacitance of the measuring instrument which is in parallel with the other low voltage capacitors. Assuming an oscilloscope with a 47 pF input capacitance, the low voltage capacitance becomes 975 and the ratio is now 348:1. If a VTVM with an input capacitance of 10 pF were used, the ratio would become 335:1. Since the above noted capacitance values are typical, C_T is factory adjusted to obtain 325:1 division ratio.

To obtain the accuracy required, be sure to consider the instrument input capacitance.

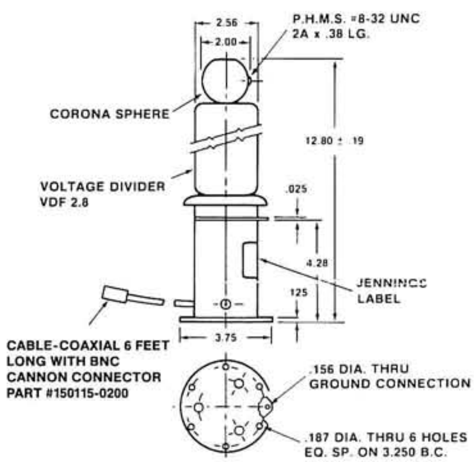


Figure 4. Model 13200 Dimensions

EXTENDING THE VOLTAGE RANGE

To extend the range of the Model 13200 Voltage Divider, Jennings offers the Model JCD-5 vacuum capacitor which is designed to be attached to the high voltage end of the Model 13200.

MODEL JCD-5

To install the JCD-5 series vacuum capacitor, remove the corona sphere from the 13200 and install it in the corresponding position on the series capacitor. Insert the series capacitor on the divider in the same manner as the sphere was originally installed, with the larger cylinder within the glass envelope at the top. The shielding of the connection between the JCD-5 and the voltage divider to which it is attached effectively eliminates stray pickup as long as other circuitry is kept 12 inches away from the connecting link.

The JCD-5 is rated at 60 kV peak and doubles the peak voltage measuring capability. With a capacitance of 5 pF (typical) and taking into account the stray capacitance C_S that parallels C_1 and C_2, the original voltage ratio is approximately doubled. The exact range multiplying factor may be determined by applying some convenient voltage to the voltmeter and noting the voltage reading. Then physically add the series capacitor, apply the original voltage to the instrument and note the reading. The first reading divided by the second reading will give the multiplying factor.

SPECIFICATIONS

Model 13200-Ratio*	
Voltage:	50 kV peak
Current:	12.5 A (rms) max, through voltage divider
Input Impedance:	10^{12} ohms, 4 pF
Divider Ratio:	Available on order from 300:1 to 2000:1 When not specified, standard unit with 325:1 ratio will be shipped.
Cable:	6′ RG-58A/U. Lengths up to 15′ available on special order.
High Frequency Response:	Ratio is linear to 10 MHz at 50 kV peak
Low Frequency Response Into Shunt Resistance Of:	
1 megohm	1,000 Hz
10 megohm	100 Hz
(See Figure 2)	
Length:	12.8″
Diameter (base):	3.75″
Weight:	2 lbs. 4 oz.

Model JCD-5	
Voltage:	60 kV Peak
Capacitance:	5 pF
Length:	5.9 inches
Diameter:	2.6 inches
Weight:	8 ounces