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TEKSCOPE

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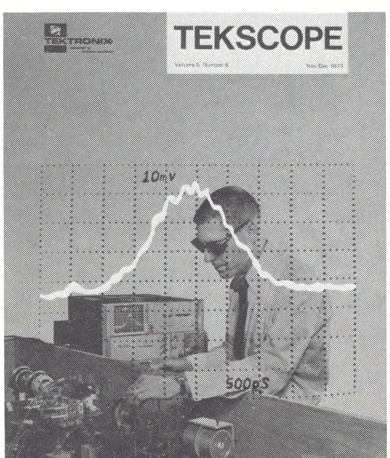
Contents

Cover: Dr. Gail Massey of the Oregon Graduate Center makes adjustments to a Q-switched neodymium YAG laser using the R7912. The dot pattern is the electronically-generated graticule and the waveform is typical of a detector output from a pulsed laser.



which produces one Z-Axis intensifying pulse for each clock input.

The Vertical Dot Counter (÷ 45) produces an output after 45 clock pulses, which serves as a reference to the phase-locked Vertical Integrator. Operation of this ramp generator is similar to the Ramp Generator described previously. As the vertical ramp is reset, it triggers the Horizontal Staircase Generator which moves the next trace one step or 0.2 division to the right. At the same time, the output of the Major Division Counter (÷ 5) changes state, causing the Dot Multiplexer to switch from the direct vertical dots input to the Vertical-Dots-Divided-by-5 Input. During this vertical ramp, a dot is displayed every fifth clock pulse to define a major division.

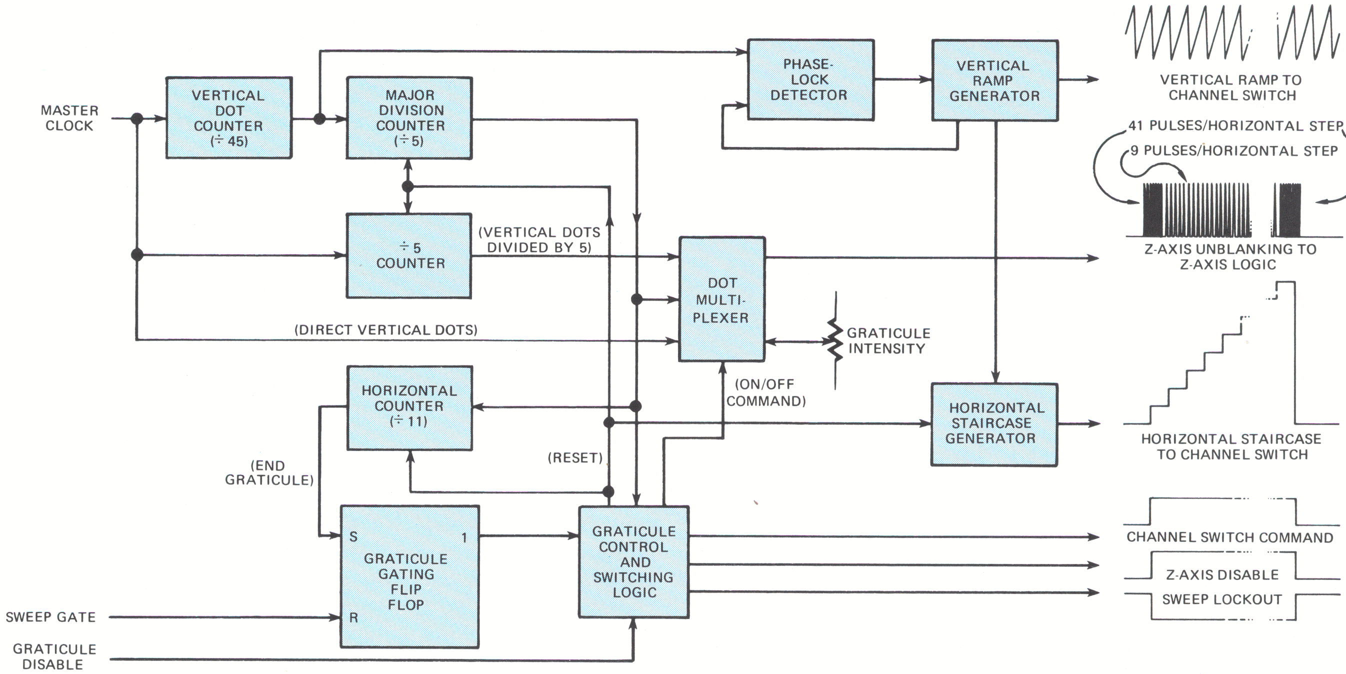


Fig. 4. Block diagram of Electronic Graticule Generator.

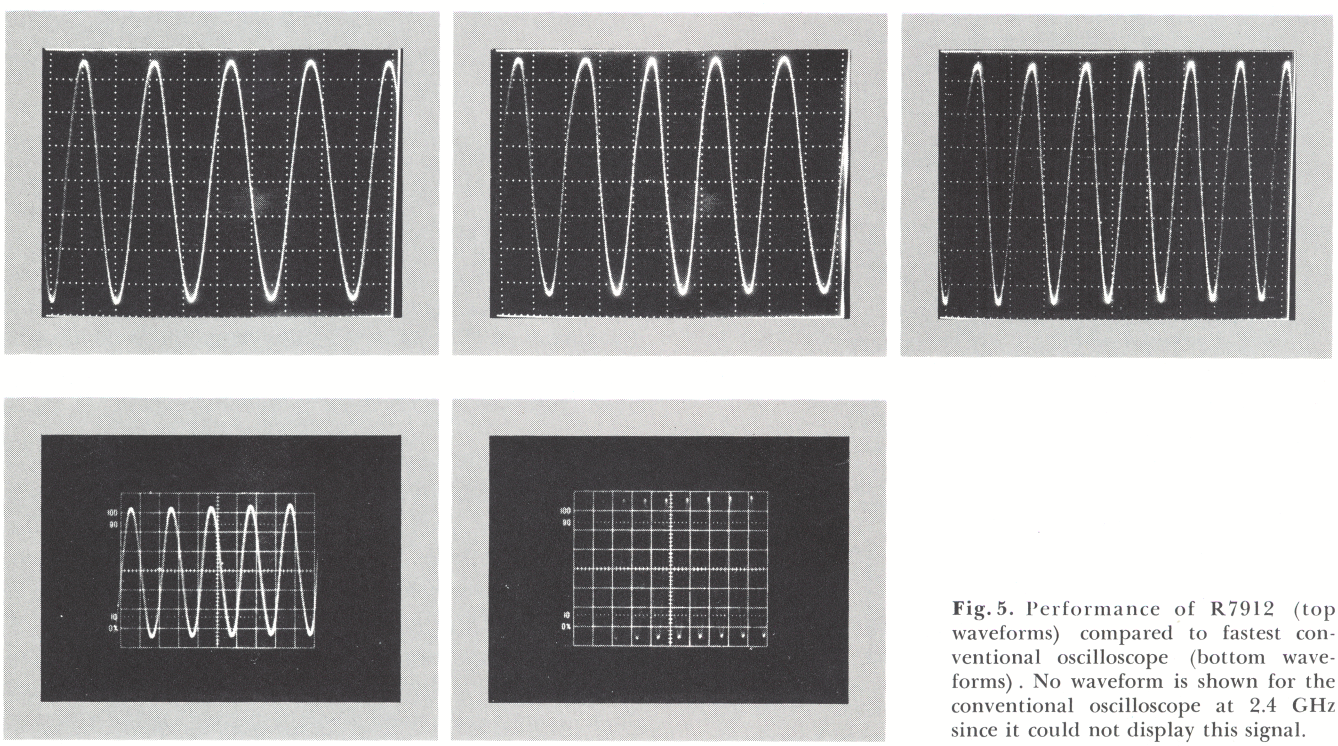


Fig. 5. Performance of R7912 (top waveforms) compared to fastest conventional oscilloscope (bottom waveforms). No waveform is shown for the conventional oscilloscope at 2.4 GHz since it could not display this signal.

t_0 - t_1—When a trigger pulse arrives at t_0, the A/D Stand-by Start-Ramp Generator produces an A/D stand-by pulse to switch the states of SW1, SW2, SW3, and SW6 through the A/D Stand-by Logic circuit. The input of the $|G_M|$ converter is now connected to V_{Hi}. The input voltage V_{IN} is equal to V_{Hi} minus V_{Lo}.

t_1 - t_2—After 2 milliseconds, a start-ramp pulse is produced at t_1 to turn SW4 on through the Start Ramp Logic, to start integrating the input current, I_{IN}, and the counter is started by the clock pulse from the Clock Synch. and Control Section.

t_2 - t_3—At 20,000 counts of the counter at t_2, SW4 is opened, and SW5 is closed to start integrating down by the reference current, I_{REF}. At t_2, the auto-zeroing circuit is activated again by turning SW1 off and SW2 and SW3 on through the A/D Stand-by Logic.

After t_3—When the output of the integrator reaches the zero level, a stop-count pulse is produced, and the reference current is turned off at t_3. The counter stops. The content of the counter is then transferred to memory where the output is converted to an analog readout signal. SW6 is turned on again to prepare the integrator for the next measurement. The digital readout is equal to (I_{IN}/I_{REF}) x 20,000. I_{IN} is equal to $|V_{IN}|/R_{IN}$ where R_{IN} is a discrete resistor in the $|G_M|$ converter, and I_{REF} is equal to V_{REF}/R_{REF}. The readout can be expressed by the following equation:

$$\text{Readout} = \left(\left(|V_{IN}|/R_{IN} \right) / \left(V_{REF}/R_{REF} \right) \right) \times 20{,}000 \quad \text{Eq. 1}$$

With the use of the auto-zeroing circuit, the $|G_M|$ converter cannot drift more than 100 microvolts for the instrument's operating range of +15°C to +40°C. By using a precision input amplifer with high gain and high common-mode-rejection, V_{IN} in Eq. 1 is made equal to the voltage input to the 7D12. V_{REF} is a temperature-compensated zener diode with a temperature coefficient of 5 p.p.m./°C. The ratio of R_{IN} and R_{REF} can be tightly controlled by using matched resistors whose temperature tracking is better than 2 p.p.m./°C. Therefore, total maximum temperature coefficient is 7 p.p.m./°C. The required accuracy of ±0.01% over a ±5°C temperature range is easily achieved.

Now let's take a closer look at the plug-in modules.

The M1 Multifunction Module

The M1/7D12 combination forms a 4½-digit voltmeter and ohmmeter, and a 3½-digit temperature indicator. The DC voltmeter measures from 0 to 1000 V in four ranges with a resolution of 100 μV on the 2 V range. System accuracy is ±0.03% of reading ±0.005% of full scale over the ambient temperature range of 20°C to 30°C, or ±0.04% of reading ±0.005% of full scale from 15°C to 40°C. Either input connector can be elevated 1 kV above ground, and the input impedance is 10 MΩ on all ranges.

Resistance from 0 to 20 MΩ is measured in six ranges, with a resolution of 10 milliohms on the 200 Ω range. The accuracy is ±0.09% of reading plus ±0.01% of full scale from 15°C to 40°C.

Both temperature and DC voltage can be measured using the convenient P6058 voltage/temperature probe. Temperature from −55°C to +150°C can be measured with a resolution of 0.1°C and an accuracy of ±1°C up to 125°C and ±2°C up to 150°C. A pair of terminals on the M1's front panel provides an analog output of 10 mV/°C (0°C = 0 volts). This output is available regardless of the Mode/Range switch setting.

The M2 Sample/Hold Module

The M2/7D12 combination provides a unique measurement capability for the 7000 Series. You can measure voltage amplitudes from ground to a selected point, or the difference voltage between any two selected points with an accuracy of ±0.35% or better. The sample points can be triggered automatically, manually, or externally, with one of the most convenient sources being the delayed gate from a 7000-Series Time Base. With the delayed gate applied to the trigger Ext In connector, the leading edge of the gate determines the S_1 sample point, and the trailing edge determines the S_2 sample point. Fig. 4 shows a typical measurement using the S_2-S_1 mode. The reading at the upper left is the voltage difference between S_2 and S_1, upper center is the TIME/DIV, and the lower left reading is the vertical deflection factor for the displayed signal. The signal display is intensified during the delayed gate; however, at sweep rates of about 100 ns/div and faster, the intensified portion will not coincide with the displayed gate because of the delay line in the oscilloscope vertical amplifier. The time interval between S_1 and S_2 can be as short as 30 ns and as long as 5 ms. For single-shot S_2-S_1 measurements, the time interval must be 150 μs or longer.

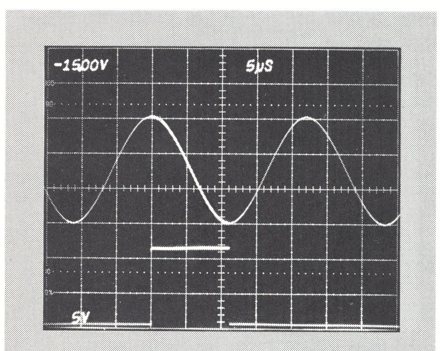


Fig. 4. Typical S2-S1 measurement showing peak-to-peak voltage of AC waveform. Reading is at upper left.