When signals of only a few millivolts are to be measured, the 5A15N provides 1 mV sensitivity and DC to 2-MHz bandwidth. The 5A18N offers the same characteristics with dual-trace capability including the convenient ADD mode. This mode is especially useful when signal differences between two points are to be measured while both points are elevated by a common signal.

Getting down into the difficult microvolt region where the applications call for low noise and high common-mode rejection, the 5A20N and 5A21N differential amplifiers with FET inputs provide stable operation to 50 μV/div. Bandwidth is DC to 1 MHz. Upper bandwidth can be limited to 10 kHz for noise reduction. Common-mode rejection at 50 μV/div, DC coupled, is 100,000:1.

To permit common-mode measurements with the use of attenuator probes, a probe having accurate attenuation has been developed. The P6060 has 10X attenuation and provides common-mode rejection of 400:1 at any deflection factor when used with the 5A20N or 5A21N.

The 5A21N plug-in, while similar to the 5A20N, has the added feature of a current-probe input. Using the P6021 current probe, bandwidth is 15 Hz to 1 MHz with sensitivities from 0.5 mA/div to 0.5 A/div. The normal 100 Hz low-frequency response of the P6021 is extended by low-frequency correction in the amplifier to permit measurements at line frequency. This makes the unit especially useful in power supply design work.

Many low-frequency applications make use of X-Y type displays. As the mainframe has identical vertical and horizontal deflection systems it is possible to make accurate phase measurements using two identical plug-ins. A control on the deflection amplifier board allows phase calibration to better than one degree at specific frequencies up to 1 MHz.

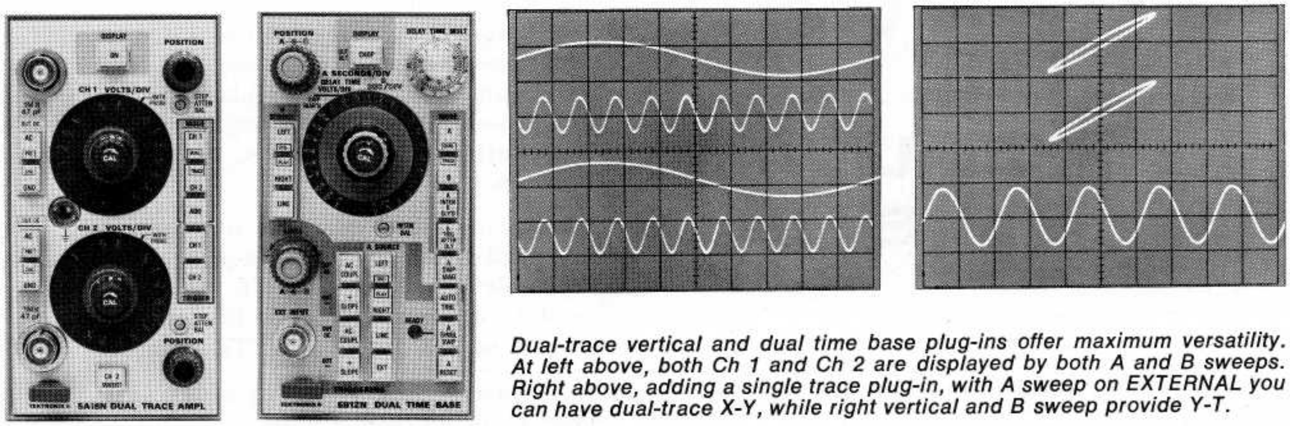
Two more time bases round out the selection of plug-ins available. The 5B10N provides sweep ranges from 1 μs/div to 5 sec/div in a 1-2-5 sequence with a 10X magnifier extending the fastest sweep to 100 ns/div. The unit offers versatile triggering from DC to 2 MHz. Both trigger source and trigger mode are selected by pushbutton. A single-sweep mode simplifies the capturing of single-shot phenomena for photographing or storing displays. Included is an external horizontal mode which provides a convenient means for making simple X-Y measurements. Sensitivity is 50 mV/div with DC to 1-MHz bandwidth.

A dual time base, the 5B12N, covers a wide range of applications. Offering the maximum in versatility, it includes the popular sweep switching introduced in the 547 Oscilloscope. In the dual-sweep mode, the A sweep is slaved to the left plug-in, and the B sweep is slaved to the right plug-in. This gives you, in effect, dual-beam operation for repetitive signals. The two sweeps can also be operated in the conventional delaying-sweep modes with a 10-turn delay multiplier providing accurate delay settings. The 5B12N also includes an external horizontal mode for X-Y operation.

Some applications require a vertical sweep or raster presentation. This is easily accomplished by plugging any of the three time bases into one of the vertical compartments. The 5103N provides convenient front panel access for Z-axis modulation in these applications.

A low-cost camera, the C-5, complements the low-frequency 5100-Series instruments. Its fixed-focus, fixed-aperture design makes waveform photography simple. An access door in the top of the camera allows viewing the CRT without removing the camera.

Some of the areas expected to benefit from the versatility of the 5100 Series are medical research, educational instruction, low-frequency phase work such as servos, mechanical analysis using strain gauges and other transducers, and engine analysis.



Dual-trace vertical and dual time base plug-ins offer maximum versatility. At left above, both Ch 1 and Ch 2 are displayed by both A and B sweeps. Right above, adding a single trace plug-in, with A sweep on EXTERNAL you can have dual-trace X-Y, while right vertical and B sweep provide Y-T.

Now let's see what happens when we push the Manual button on the 26G2. A single pulse, 1 volt in amplitude and 300 μs in duration is generated, followed by an identical pulse 10 ms later. The two pulses are then repeated at 1.5 sec intervals with the time between them reduced 1.5 ms each time they repeat. A reset pulse from the 26G1 prevents the slew ramp from triggering the 26G3 at the peak of its excursion, producing an unwanted pulse.

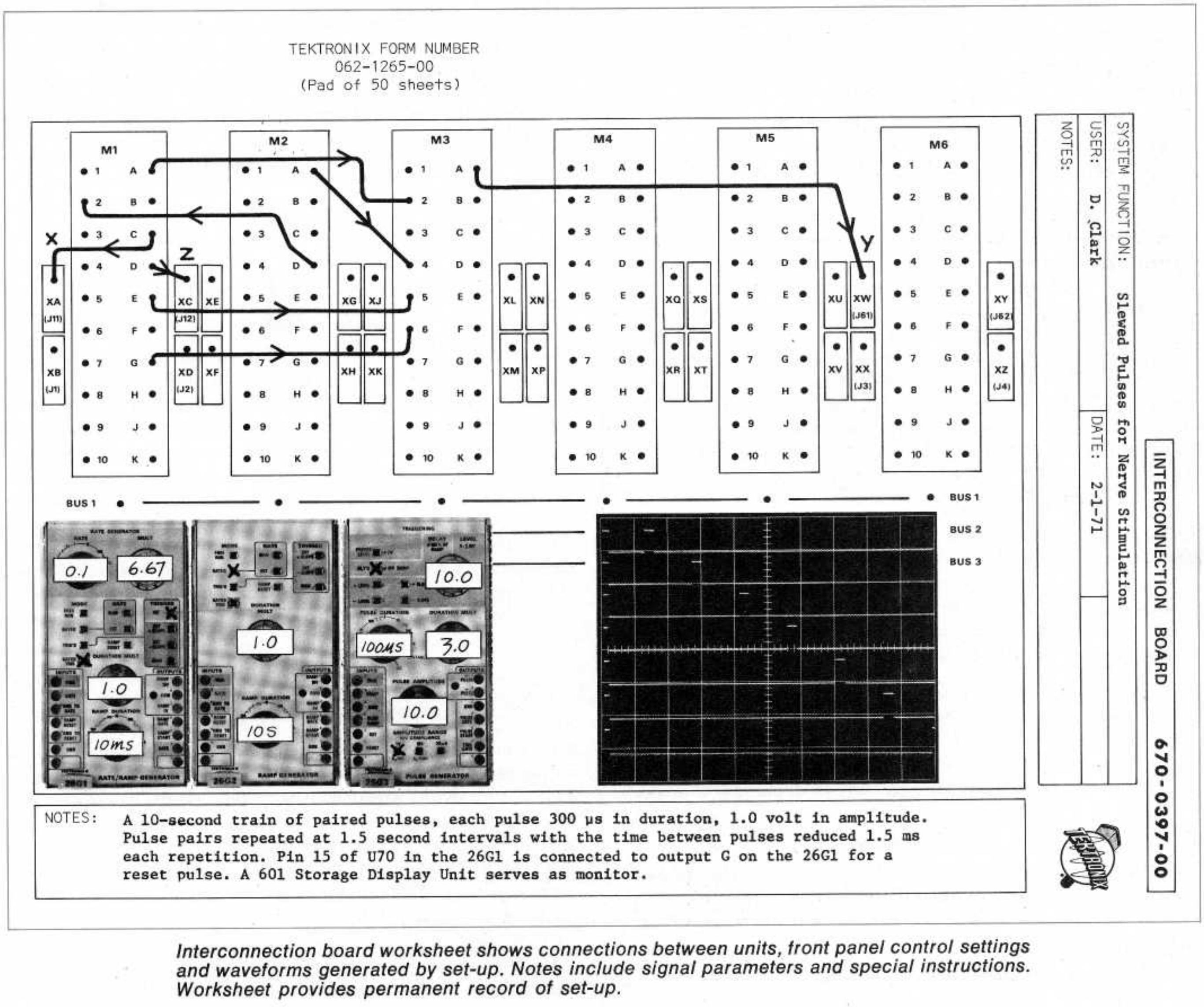
OUTPUT CONDITIONING

One other important plug-in currently available in the 2600 Series is the 26A1 Operational Amplifier. It is a high-power operational amplifier ideal for final processing of signals generated in 2600-Series system. Output capabilities are ±50 V and up to ±50 mA. Open loop gain is 10,000 into a 1 kΩ load with a unity gain bandwidth of 5 MHz.

Access to the operational amplifier inputs and outputs is via a Terminal Access Adapter which plugs into the plug-in unit. The adapter also provides access to the front panel connectors and the regulated +15 and −15 volt supplies. Clips and jacks are mounted on the adapter circuit board so you can easily change the operational amplifier function. A Terminal Access Adapter kit which includes a circuit board with a 0.1 x 0.1 inch grid of plated-through holes is available for constructing circuits to meet your specific needs.

7000-SERIES COMPATIBILITY

The 2600 Series also brings new capabilities to you who own 7000-Series oscilloscopes. Through the use of an adapter, you can operate any of the 2600-Series plug-ins in your 7000-Series mainframe; truly plug-in versatility at its best.



Interconnection board worksheet shows connections between units, front panel control settings and waveforms generated by set-up. Notes include signal parameters and special instructions. Worksheet provides permanent record of set-up.

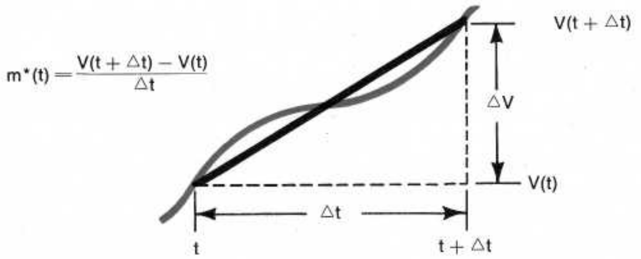


Fig. 1. Resolution limits measurement detail. Components lasting for a time on the order of $\triangle t$ will be smoothed out.

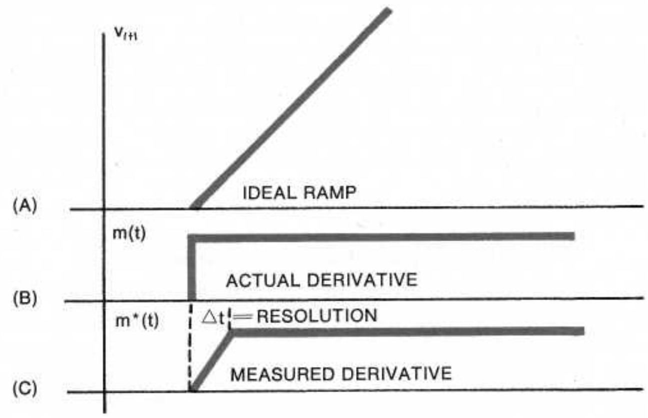


Fig. 2. Measured slope differs from the actual derivative because of the finite resolution time.

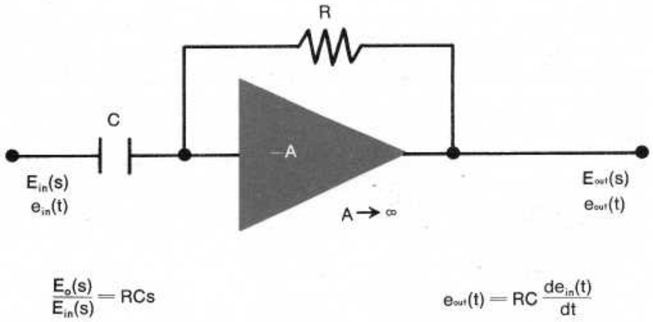


Fig. 3. Analog differentiator is a convenient means of measuring slope and linearity of slower ramps.

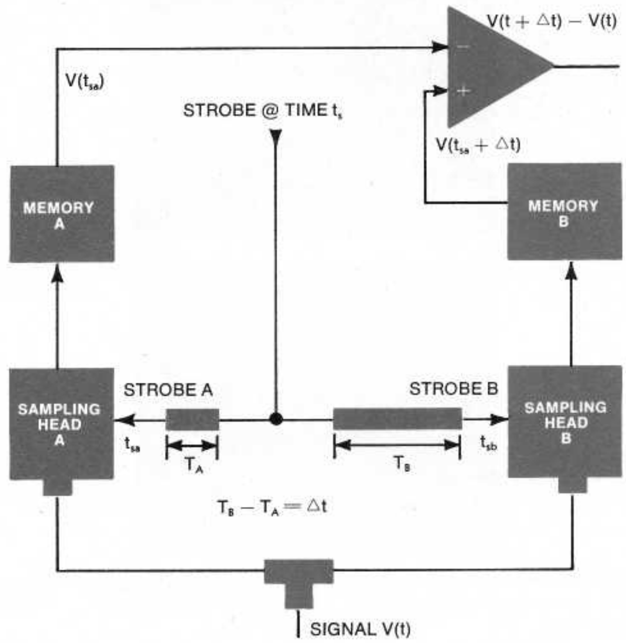


Fig. 4. Block diagram of a sampling system to measure $V(t+\triangle t) - V(t)$. Resolution is set by difference in time of T_A and T_B.

the sampling gate. If the strobe time for channel A (t_{SA}) is made different from that for channel B (t_{SB}) by some time ($\triangle t$) due to unequal delays T_A and T_B, then the voltage measured by the respective sampling heads will be

$$\mathbf{V_{SA} = V\ (t_{SA})} \qquad \mathbf{V_{SB} = V\ (t_{SA} + \triangle t)}$$

We can then substract them at each time t.

$$\mathbf{V\ (t)_{B\text{-}A} = V_{SB} - V_{SA} = (V\ (t + \triangle t) - V\ (t))}$$

If we divide the difference in strobe time $\triangle t$ we have

$$\mathbf{\frac{V\ (t)_{B\text{-}A}}{\triangle t} = \frac{(V\ (t + \triangle t) - V\ (t))}{\triangle t} = m^*\ (t)}$$

A convenient realization of the above technique can be obtained with a sampling system set up as in Fig. 5. The system consists of a 7000-Series four-compartment mainframe, a 7T11, two 7S11's, two S-1 sampling heads and a 7A22. If the signal cannot be loaded by 50Ω then a probe such as the P6034, P6035 or P6051 can be used to couple the signal to the power divider tee. An alternate approach would be to use S-3A or S-5 sampling heads in place of the S-1.

The gains of both sampling channels should be adjusted so that they are equal (note variable front panel control on the 7S11 does not effect the gain of the vert sig out). This can be done by inserting a variable attenuator in the leads from the vert sig out to the 7A22. Comparing the amplitudes of the two vertical signals out is easily done with the 7A22. Just feed both signals differentially into the 7A22 and adjust the gains until the base line is at the same level before and after the ramp.

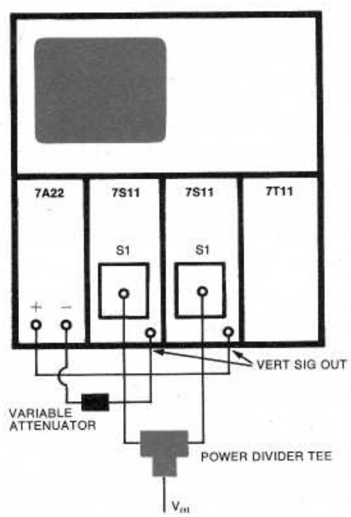


*Fig. 5. 7000-Series system to measure ramp (Vt) and slope (m*t) and display them simultaneously. Attenuator is placed in series with 7A22 input having largest signal so inputs to 7A22 may be set to same amplitude.*