PRELIMINARY INSTRUCTION MANUAL

TYPE M

Ser. Nr. 000117

This instruction manual is not complete and it may contain errors. We are sending it with your instrument so you will have something to use until the permanent manual is completed. Please put your name and address on the post card and mail it to us. We will send you a permanent manual just as soon as they are ready.

SN 117

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

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070-295

CHARACTERISTICS

General Information

The Type M Plug-In Preamplifier Unit contains four identical amplifier channels that can be used separately or electronically switched to produce single- or multi-trace displays. Thus the unit provides a convenient means for viewing four signals, either separately or in any combination, as desired, reducing cable switching to a minimum. Each amplifier in the unit has its own attenuator, mode, variable gain, and vertical position controls which enables the display to be adjusted for optimum viewing and information.

When using the channels separately without electronic switching, the M Unit is useful in all single-trace applications within its frequency-response and sensitivity capabilities.

During alternate mode of operation when the oscilloscope is set for free-running operation, one to four alternate traces appear. The number of traces that appear depends upon the setting of the MODE switches. Each channel in use operates at a synchronous rate.

In the alternate mode of operation when the oscilloscope is set for triggered operation, stationary displays of four signals unrelated in frequency can be obtained. The signals internally trigger the sweep which, in turn, switches the channels to produce alternate displays. Because the sweeps are identical and time-delay characteristics of the four channels are closely controlled, time comparisons accurate within 4 nanoseconds can be made between signals.

In chopped mode of operation, channel switching occurs at a rate of approximately 1 mc divided by the number of channels in use, making it possible to view any combination of one to four simultaneous transients. The number of displayed waveforms depends on the setting of the MODE switches and the number of inputs used. Transients of as little as ten-millisecond duration can be well delineated, with about one hundred elements in each trace. For many purposes, shorter transients can be adequately observed.

Amplifier Sensitivity

Nine calibrated steps, are provided for each channel: 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5 and 10 volts/div. Accuracy is within 3% of panel reading. Variable controls for each channel permit continuous adjustments (uncalibrated) from 0.02 volts/div to 25 volts/div.

Amplifier Transient Response and Bandwidth

See Table 1-1.

TABLE 1-1

TRANSIENT RESPONSE AND BANDWIDTH

	Risetime	X	Bandwidth (at -3db points)
	MODE switch in any position except OFF	MODE switch in either DC position	MODE switch in either AC position
541, 541A, 543, 543A, 545, 545A, 555, 581* or 585*	17 nsec	dc to 20 mc	2 cps to 20 mc; 0.2 cps to 20 mc with P6000 Probe or equivalent
551	18 nsec	dc to 19 mc	2 cps to 19 mc; 0.2 cps to 19 mc with P6000 Probe or equivalent
531A, 533A or 535A	25 nsec	dc to 14 mc	2 cps to 14 mc; 0.2 cps to 14 mc with P6000 Probe or equivalent

*Type 81 Plug-In Adaptor is required for use with Types 581 and 585.

Table 1-1 (Cont'd)

536	35 nsec	dc to 10 mc	2 cps to 10 mc; 0.2 cps to 10 mc with P6000 Probe or equivalent
532	70 nsec	dc to 5 mc	2 cps to 5 mc; 0.2 cps to 5 mc with P6000 Probe or equivalent

Your instrument was adjusted at the factory for optimum transient response. The above table summarizes the risetime and approximate bandwidths available when the M Unit is used in combination with various oscilloscopes.

Operating Modes

Channel A, B, C, or D only.

Chopped -- Sequential electronic switching of channels at a 1-mc rate.

Alternate -- Triggered electronic switching of channels at the end of each sweep, during retrace intervals.

Front-panel switches, in conjunction with the chopped or alternate modes of operation, permit viewing any combination of one to four channels.

Polarity Inversion

Polarity of any channel selected can be inverted for comparison of signals 180° out of phase.

AC-DC

Choice of ac or dc coupling. In the AC position a coupling capacitor is inserted limiting the low-frequency response to approximately 2 cycles at 3 db down.

Input Impedance

1 megohm +or- 1% paralleled by 47 pf.

Maximum Allowable Combined DC and Peak AC Input

600 volts.

Construction

Aluminum-alloy chassis.

Finish

Photo-etched anodized aluminum front-panel.

Net Weight

5 Pounds.

OPERATING INSTRUCTIONS

FRONT PANEL CONTROLS AND CONNECTORS

Functions of the channel A front panel controls, channel A connectors, and the ALTERNATE/CHOPPED switch are described in Table 2-1. The functions of the front-panel controls and input connectors for the other channels are the same as for channel A.

TABLE 2-1

Input Connector	Connector for coupling dc or ac input voltages to the channel A amplifier.
VOLTS/DIV.	Nine-position switch to select the calibrated vertical-deflection factors.
MODE	Five-position switch to provide a choice of ac or dc coupling, operational in-phase (normal) or out-of-phase (inverted) output, or an "off" position.
GAIN ADJ.	Screwdriver adjustable potentiometer to permit the gain of the amplifier to be accurately set.
VAR. GAIN	Potentiometer to provide continuously variable attenuation between the calibrated sensitivities and to extend the attenuation to a sensitivity of 25 volts/div.
"A" SIGNAL OUT	Output signal from channel A. Amplitude is 2 volts for each division of display. Bandwidth of the internal channel A Signal Output Amplifier is 1 mc at -3 db with gradual rolloff.
DC BAL	Screwdriver adjustable potentiometer to provide for setting the amplifier dc levels so the trace does not shift position when the VAR. GAIN control is varied.
POSITION	Potentiometer to provide for shifting the position of the trace vertically.
ALTERNATE/ CHOPPED	Slide switch to select either the alternate or chopped mode of operation. When used in conjunction with the MODE switches, the ALTERNATE/CHOPPED switch permits viewing any combination of channels.

FIRST TIME OPERATION

Plug the M Unit into a Type 530-, 540-, 550-, or 580-Series Tektronix oscilloscope and turn the power on. Allow the instrument to reach operating temperature, about 2 to 3 minutes, and free run the sweep at 1 millisec/div. Set the front-panel controls of the M Unit as follows:

VOLTS/DIV (all channels)	.02
MODE (channel A)	DC NORM.
MODE (channel B, C and D)	OFF
VAR. GAIN (all channels)	Fully clockwise (CALIB.)
POSITION (all channels)	Centered
ALTERNATE/CHOPPED	ALTERNATE

1. Position the trace two major divisions above the horizontal centerline with the channel A POSITION control.

2. Place the channel B MODE switch to the DC NORM. position and position the B trace one major division above the horizontal centerline with the channel B POSITION control.

3. Place channel C MODE switch to DC NORM. and position the C trace one major division

below the horizontal centerline with the channel C POSITION control.

4. Place channel D MODE switch to DC NORM. and position the D trace two major divisions below the horizontal centerline with channel D POSITION control. This makes a total of four traces which appear on the crt screen. For each sweep cycle one channel is conducting and the others are cut off. The channels are switched alternately at the end of each sweep cycle, during retrace intervals.

5. To observe the alternate trace switching cycle in slow motion decrease the sweep rate to 10 millisec/div.

6. To observe the CHOPPED mode of operation set the ALTERNATE/CHOPPED switch to the CHOPPED position. Connect a test lead from the "A" SIGNAL OUT connector on the M Unit to the External Trigger input connector on the oscilloscope.

7. Set the oscilloscope triggering controls for external triggered-sweep operation. Notice that all four traces seem to start simultaneously and continue on across the screen.

8. Increase the sweep rate to 10 μsec/div. Notice that each trace is composed of several short-duration elements with switching traces existing between the channels. (To ~~reduce the amplitude of~~ BLANK out the switching transients, place the Crt Cathode Selector switch located at the rear of the oscilloscope to the Dual-Trace Shopped Blanking position; i.e., if your instrument has this switch.)

All four channels are now being switched successively at a rate of approximately 1 mc. Each channel conducts for about 1 μsec and then is cut off for 3 μsec while the three other channels conduct for 1 μsec each. Chopping rate of each channel is 250 kc (1 mc divided by the number of channels in use). Approximate switching time between channels is 0.1 μsec.

9. Now set channel B and D MODE switches to OFF. Notice that the M Unit switches between channels A and C only. Each channel conducts for about 1 μsec and then is cut off while the other channel conducts for an equal time. Switching rate for each channel is now 500 kc.

GENERAL OPERATION

Any of the four identical amplifier channels can be used independently by rotating the appropriate MODE switch to one of the DC or AC positions and connecting the signal to be observed to the appropriate input. The following remarks apply equally well to each channel.

Signal Connections

The signal(s) to be displayed is applied to the appropriate input connector on the front panel of the M Unit. For best results here are some precautions you should observe when making the connections.

1. It is often possible to make signal connections to the M Unit with short-length, unshielded test leads. This is particularly true for high-level, low-frequency signals. When such test leads are used, you must also use a ground connection between the M Unit or oscilloscope chassis ground and the chassis of the equipment under test. Position the leads away from any stray electric or magnetic field source to avoid obtaining erroneous displays.

2. In many low-frequency applications, however, unshielded leads are unsatisfactory for making signal connections because of unavoidable pickup resulting from magnetic fields. In such cases, shielded (coaxial) cables should be used. Be sure that the ground conductors of the cables are connected to the chassis of both the oscilloscope and the signal source.

3. In broadband applications, it might be necessary to terminate the coaxial cable with a resistor or an attenuator presenting a resistance equal to the characteristic impedance of the cable. This is to prevent resonance effects and ringing--that is, high-frequency damped oscillation. It becomes more necessary to terminate the cable properly as the length of the cable is increased. The termination is generally placed at the oscilloscope end of the cable, although many sources require an additional termination at the source end of the cable as well.

4. As nearly as possible, simulate actual operating conditions in the equipment under test. For example, the equipment should work into

a load impedance equal to that which it will see in actual use.

5. Consider the effect of loading upon the equipment under test due to the input circuit of the M Unit. The input circuit can be represented by a resistance of 1 megohm shunted by a capacitance of 47 picofarads. With a few feet of shielded cable, the capacitance may well be 100 picofarads. Where the effects of these resistive and capacitive loads are not negligible, you might want to use a probe in the manner described next.

Use of Probes

An attenuator probe having a standard length cable (42" long) lessens both capacitive and resistive loading, at the same time reducing sensitivity. The attenuation introduced by the probe permits measurements of signal voltages in excess of those that can be accommodated by the M Unit alone. When making amplitude measurements with an attenuator probe, be sure to multiply the observed amplitude by the attenuation of the probe (marked on the probe).

An adjustable probe capacitor compensates for variations in input capacitance from one plug-in to another. To assure the accuracy of pulse and transient measurements, this adjustment should be checked frequently.

To make this adjustment, set the oscilloscope calibrator controls for a calibrator output signal of suitable amplitude. Place the MODE switch for the channel in use to DC NORM. Touch the probe tip to the calibrator-output connector and adjust the oscilloscope controls to display several cycles of the waveform. Adjust the probe variable capacitor for best square-wave response.

Deflection Factor

The amount of vertical deflection produced by a signal is determined by the signal amplitude, the attenuation factor (if any) of the probe, the setting of the VOLTS/DIV. switch, and the setting of the VAR. GAIN control. Calibrated deflection factors indicated by the settings of the VOLTS/DIV. switch apply only when the VAR. GAIN control is set fully clockwise. Serious errors in display measurements may result if the setting of this control is unintentionally moved away from the fully clockwise position.

The range of the VAR. GAIN control is approximately 2.5 to 1 to provide continuously variable (uncalibrated) vertical-deflection factors between calibrated settings of the VOLTS/DIV. switch.

Voltage measurements may be made directly from the oscilloscope screen by noting the appropriate VOLTS/DIV. switch setting and the amount of vertical deflection of the screen. Then multiply the deflection on the screen by the setting of the VOLTS/DIV. switch and the attenuation factor, if any, of the probe.

MODE Switch

The MODE switch has five positions: DC NORM., AC NORM., OFF, DC INV. and AC INV. To display both the ac and dc components of an applied signal, set the MODE switch to one of the DC positions; to display only the ac component of a signal, set the MODE switch to one of the AC positions.

In the AC positions of the MODE switch, the dc component of the signal is blocked by a capacitor in the input circuit. In addition, the lower frequency limit (3-db point) of the M Unit is about 2 cps (0.2 cps if you are using a 10X attenuator probe). Therefore, some low-frequency distortion of signals with components below this frequency will result if the AC positions are used.

At times, it is desirable to invert the displayed waveform, particularly when using the multi-trace feature of the M Unit. With the MODE switch you can choose either a normal or inverted display, as desired, via dc or ac coupling. In the DC- or AC-NORM. positions the displayed waveform has the same polarity as the input signal. In the DC- or AC-INV. positions the displayed waveform is inverted.

Placing the MODE switch to the OFF position turns the channel "off" and excludes it from the electronic switching cycle.

Multi-Trace Triggering

Multi-trace operation can be divided into the following order: (1) External triggering using ALTERNATE and CHOPPED modes, (2) Internal triggering using ALTERNATE mode, and (3) Internal triggering using CHOPPED mode.

1. External triggering using ALTERNATE and CHOPPED modes. For multi-trace operation, it is usually best to trigger the time base with an external triggering signal which bears a fixed time relationship to the applied signals. A convenient source for obtaining the external trigger signal is from the "A" SIGNAL OUT connector. With an external triggering signal a stable display is more easily obtained and the true time or phase relationship between input signals can be determined.

To trigger from the channel A signal, simply connect a test lead between the "A" SIGNAL OUT connector on the M Unit and the Trigger Input connector on the oscilloscope. Then set the oscilloscope triggering controls for external triggered-sweep operation. As stated above, to obtain a stable display the signals applied to the other channels must be related to channel A.

If the trigger signals have components above 10 kc, use the AC Fast or AC LF Reject triggering mode (if your oscilloscope has these positions). For lower frequency signals, use the AC or AC Slow triggering mode.

2. Internal triggering using ALTERNATE mode. If the time or phase relationship between signals is not critical, you can use internal triggering of the time base when the ALTERNATE/CHOPPED switch is set to ALTERNATE. In this mode of operation, the signals applied to the individual channels can be either related or unrelated in frequency. The oscilloscope Trigger Level control must be set at a point where the sweep will trigger on the display having the lowest amplitude. If the signals have components above 10 kc, use the AC Fast or AC LF Reject triggering mode (if your oscilloscope has these positions). For lower frequency signals, use the AC or AC Slow triggering mode. In the AC Fast or AC LF Reject position, an rc filter is inserted into the circuit of the oscilloscope allowing the circuit to recover quickly from the dc level changes encountered with ALTERNATE sweep.

3. Internal triggering using CHOPPED mode. For multi-trace CHOPPED mode of operation, internal triggering should not be used unless the input signals are related to the chopped switching rate. If the signals are not related to the switching rate, then the sweep will try to trigger on the switching waveform rather than on the applied signals and this will result in an unstable display. To obtain stable displays trigger the sweep from the channel A signal. To do this, use the "A" SIGNAL OUT connector and set the oscilloscope controls for external triggered-sweep operation.

ALTERNATE-CHOPPED Switch

Basic operation of this switch has been described partly in earlier portions of this manual. However, some supplemental information can be helpful.

In general, the ALTERNATE position is usually used with Sweep rates above 10 μsec and the CHOPPED position with the lower sweep rates. The ALTERNATE position is useful for observing signals of high repetition rate (usually above 100 kc) and making phase comparison measurements while the CHOPPED position is most useful for observing single transients and low-frequency signals.

In either the ALTERNATE or CHOPPED mode of operation the control of each amplifier in the M Unit is independent. You can position, attenuate, or invert the signals as necessary to compare their shape, relative amplitudes, etc.

Gain Adjustments

The gain adjustments should be checked periodically to assure correct vertical deflection factors, particularly when the M Unit is transferred from one oscilloscope to another. To check the gain of all channels proceed as follows:

1. Set the M Unit front-panel controls as given below.

VOLTS/DIV (all channels)	.05
MODE (channel A)	DC NORM.
MODE (channel B, C and D)	OFF
VAR. GAIN (all channels)	Fully clockwise (CALIB.)
POSITION (all channels)	Centered
ALTERNATE/CHOPPED	Either position

2. Set the oscilloscope sweep rate and triggering controls for a 1-millisec/div. free-running sweep.

3. Apply a 0.2-volt peak-to-peak calibrator signal from the oscilloscope to all four channels.

4. Set the channel A GAIN ADJ. control for a deflection of exactly four major divisons. (You may have to vary the A POSITION control to align the display with the horizontal graticule lines.)

5. Place the channel A MODE switch to OFF and set the channel B MODE switch to DC NORM. Repeat step 4 using the channel B GAIN ADJ. and POSITION controls.

6. Follow the same pattern as described in step 5 to adjust the gain of channels C and D.

DC Balance Adjustments

After the M Unit has been in use for a period of time, you will notice that the trace will change position as the VAR. GAIN control is rotated. This is caused by component aging and resultant shift in operating potentials. To correct this condition in one or all channels proceed as follows:

1. Set the front-panel controls of the channel to be dc-balanced to these settings:

VOLTS/DIV.	Any position
MODE	DC NORM.
VAR. GAIN	Fully clockwise (CALIB.)
POSITION	Centered
ALTERNATE/CHOPPED	Either position

2. Set the oscilloscope sweep rate and triggering controls for a 1-millisec/div. free-running sweep.

3. With the POSITION control, position the trace to the approximate center of the graticule.

4. Set the channel's DC BAL. adjustment to the point where there is no trace shift on the screen as the VAR. GAIN control is rotated.

5. To adjust the dc balance of the other channels follow steps 1 through 4.

Positioning Adjustments

The VERT. POS. RANGE control balances the dc output level so the full range of the front-panel positioning controls can be utilized. This control is accessible when the left side panel on the oscilloscope is removed. To make the adjustment, proceed as follows:

1. Set the front-panel controls for all channels as given below.

VOLTS/DIV.	Any position
MODE	DC NORM.
VAR. GAIN	Fully clockwise (CALIB.)
POSITION	Centered
ALTERNATE/CHOPPED	Either position

2. Set the oscilloscope sweep rate and triggering controls for a 1-millisec/div. free-running sweep.

3. Adjust the VERT. POS. RANGE control to bring the four traces into the center of the graticule viewing area.

BASIC APPLICATIONS

The following paragraphs describe procedures for making voltage, phase and time delay measurements with the Type M Plug-In Unit and associated Tektronix oscilloscopes. No attempt has been made to describe any but the most basic techniques. Familiarity with the unit will enable the operator to apply the essence of these techniques to a wide variety of applications, depending upon the problem at hand.

Voltage Measurements

We describe here three categories of voltage measurements with the Type M Unit: (1) how to measure the peak-to-peak voltage of a displayed waveform, (2) how to measure the dc level at some point on a signal, and (3) how to make voltage comparison measurements. The specific examples that follow are intended to show the general procedure. These examples can be modified to suit any particular application.

How to measure the peak-to-peak voltage of a displayed waveform. To measure the peak-to-peak voltage of a displayed waveform the M Unit MODE switch should usually be set to one of the AC positions. In these positions only the ac components of the input waveform are displayed on the oscilloscope screen. However, when the ac component of the input waveform is of very low frequency, it is necessary for you to make voltage measurements with the MODE switch in one of the DC positions to prevent errors. After you have selected the MODE switch position for your particular application, proceed as follows:

1. Display the waveform over as large a portion (vertically) of the screen as possible by adjusting the appropriate VOLTS/DIV. switch.

2. With the aid of the graticule, measure the vertical distance in centimeters between the two points on the waveform at which the voltage measurement is desired. Make sure the appropriate VAR. GAIN control is set to the CALIB. position.

In measuring signal amplitudes, it is important to remember that the width of the trace may be an appreciable part of the overall measurement. For this reason, you should consistently make all measurements from one side of the trace. This is particularly true when measuring signals of small amplitude.

3. Multiply the vertical distance between the two points by the setting of the appropriate VOLTS/DIV. switch and by the attenuation factor, if any, of the probe. This is the voltage between the two points of the waveform.

As an example of this method, assume that using a 10X probe and a VOLTS/DIV. switch setting of .02, you measure a vertical distance of 4 major divisions. In this case then, 4 major divisions multiplied by 0.02 gives you an indicated 0.08 volt. The indicated voltage multiplied by the probe's attenuation factor of 10 then gives you the true peak-to-peak amplitude of 0.8 volts.

How to measure the dc-level at some point on a signal. The method used to measure the dc level at some point on a signal is virtually identical to the method described previously for the measurements of the peak-to-peak voltage of a waveform. However, for dc-voltage measurements the M-Unit MODE switch must be placed to the DC NORM. position. Also dc voltages are measured with respect to some potential (usually ground).

To measure the dc level at some point on a signal with respect to ground, proceed as follows:

1. Place the MODE switch of the channel to which the signal is applied to the DC NORM. position.

2. Set the corresponding VOLTS/DIV. switch such that the expected voltage (at the channel input connector) is approximately one to four times the setting of the switch. Make sure the VAR. GAIN control is set to the CALIB. position.

3. Set the oscilloscope triggering controls to produce a free-running trace.

4. Touch the oscilloscope probe tip to a ground point, and with the appropriate POSITION control position the trace so that it lies along one of the horizontal lines of the graticule. This line will be used as a ground reference line; its position in any given case will depend upon the polarity and amplitude of the input signal or dc level to be measured. Do not adjust the POSITION control after the reference line has been established.

As an alternative method, you could use the trace of an unused channel as the reference line instead of the graticule line. To do this, superimpose the trace of an unused channel on the trace of the channel to be used. After establishing the reference, do not move the POSITION controls for these channels.

5. Remove the probe tip from ground and connect it to the signal. Adjust the triggering controls for a stable display.

6. Measure the distance, in major divisions, from the ground reference line established in step 4 to the point at which the dc voltage level is desired.

7. Multiply this distance by the setting of the appropriate VOLTS/DIV. switch and the attenuation factor, if any, of the probe. This is the dc level of the point measured.

As an example, suppose the vertical distance between a and b is 4 major divisions when a 10X probe is used and the VOLTS/DIV. switch is set to .5. Multiply the distance between a and b (4 div.) by the VOLTS/DIV. setting (0.5 volts/div.) and by the probe attenuation ratio (10). This shows the peak voltage level of the waveform with respect to ground to be 4 volts.

How to make voltage comparison measurements. In some applications you could establish a set of sensitivity values other than those selected by the VOLTS/DIV. switch. This is useful for comparing signals which are exact multiples of a given reference. In the following procedure, we describe how to set sensitivity values for channel A. The same basic procedure can be used for the other channels. To establish a set of sensitivity values based upon some specific reference amplitude, proceed as follows:

1. Apply a reference signal of known voltage amplitude to channel A and, with the corresponding VOLTS/DIV. switch and its VAR. GAIN control, adjust the amplitude of the display for an exact number of graticule divisions. Do not move the VAR. GAIN control after you have obtained the desired deflection.

2. Divide the amplitude of the reference signal (in volts) by the product of the deflection in major divisions (established in step 1) and the VOLTS/DIV. switch setting. The result is the sensitivity conversion factor.

$$\text{Sens. Conv. Factor} = \frac{\text{Reference signal amplitude in volts}}{\text{(Deflection in div.) (VOLTS/DIV. setting)}}$$

3. To calculate the trace sensitivity at any setting of the VOLTS/DIV. switch, multiply the VOLTS/DIV. switch setting by the sensitivity conversion factor obtained in step 2.

True Sensitivity =

(VOLTS/DIV. setting) (Sens. Conv. Factor)

True sensitivity values obtained for any setting of the A VOLTS/DIV. switch apply to this one channel, and only as long as the VAR. GAIN control is not moved from the position to which it was set in step 1.

As an example, suppose the voltage amplitude of the reference signal applied to channel A is 30 volts, and the VOLTS/DIV. switch setting is 5. The VAR. GAIN control is adjusted to decrease the amplitude of the display to exactly 4 major divisions. With the above values substituted in the formula for Sensitivity Conversion Factor and True Sensitivity, we have,

$$\text{Sens. Conv. Factor} = \frac{30}{(4)\,(5)} = 1.5$$

$$\text{True Sensitivity} = (5)\,(1.5) = 7.5 \text{ volts/div.}$$

As proof that the true sensitivity value thus obtained is correct we can take the product of 7.5 volts/div and 4 major divisions of deflection. The result is 30 volts which checks with the known amplitude of the reference voltage we started with.

To make a comparison measurement, for example, suppose that a signal of unknown peak-to-peak amplitude is applied to channel A and the 30-volt reference signal is removed. Suppose that signal to be compared causes a deflection of 2.7 divisions at a VOLTS/DIV. switch setting of 2. Then the peak-to-peak amplitude of the signal can be determined as follows:

P-P Signal Amplitude =

(Sens. Conv. Factor) (Deflection in div.) (VOLTS/DIV. setting)

Substituting values just given we have

P-P Signal Amplitude = (1.5) (2.7) (2) = 8.1 volts

Phase Measurements

Phase comparisons of two to four signals of the same frequency can be made by making use of the multi-trace feature of the Type M Plug-In Unit. To make phase comparisons, proceed as follows:

1. Apply the reference signal to channel A; apply the signals to be compared to the other channels.

2. Connect a test lead between the " A" SIGNAL OUT connector on the M Unit and the External Trigger input on the oscilloscope. Set the oscilloscope triggering controls for external-triggered sweep operation.

3. Set the MODE switches to AC or DC NORM. depending on the type of coupling desired.

4. Place the ALTERNATE/CHOPPED switch to the ALTERNATE or CHOPPED position. In general, the ALTERNATE position is more suitable for high-frequency signals and the CHOPPED position is more suitable for low-frequency signals.

5. Set the VOLTS/DIV. switches for the desired amplitude display. Carefully center the signals vertically on the graticule using the POSITION controls.

6. Set the oscilloscope time-base controls (includes the Variable Time/Div. control) so that one cycle of the reference signal occupies exactly 9 major divisions horizontally. Thus, each division represents 40° of one cycle at this time-base setting.

7. Measure the horizontal distance, in major divisions, between the reference waveform and each of the other waveforms. Note the distance for each channel and whether they are leading or lagging. To make the measurements of one channel easier, switch the non-applicable channel waveforms to "off" with the MODE switch.

8. For each distance measured, multiply the distance by 40° per division to obtain the phase difference when compared to the reference waveform.

For more precise measurements, you could increase the vertical sensitivity and the sweep rate established in steps 5 and 6 but do not change the setting of the oscilloscope Variable Time/Div. control. However, when you increase the sweep rate, you must take this into consideration in your calculations.

For example, if you increase the sweep rate by a factor of 5, and then measure the distances between waveforms, each major division will represent 8° (40 ÷ 5) of a cycle. By doing this, you can measure phase angles up to 80° more accurately. When preparing to make the measurement, horizontally position the waveforms to points where the graticule markings aid in determining the exact distance.

Time-Delay Measurements

The calibrated sweeps of Tektronix oscilloscopes cause any horizontal distance on the screen to represent a definite known interval of time. Using this feature in combination with the multi-trace feature of the M Unit, you can measure the time lapse or delay between events displayed on the oscilloscope screen. This is done by the following method:

1. Follow the same procedure as given in the first five steps of "Phase Measurements".

2. Set the oscilloscope time-base controls for a calibrated sweep rate which will allow you to measure the distance between waveforms accurately.

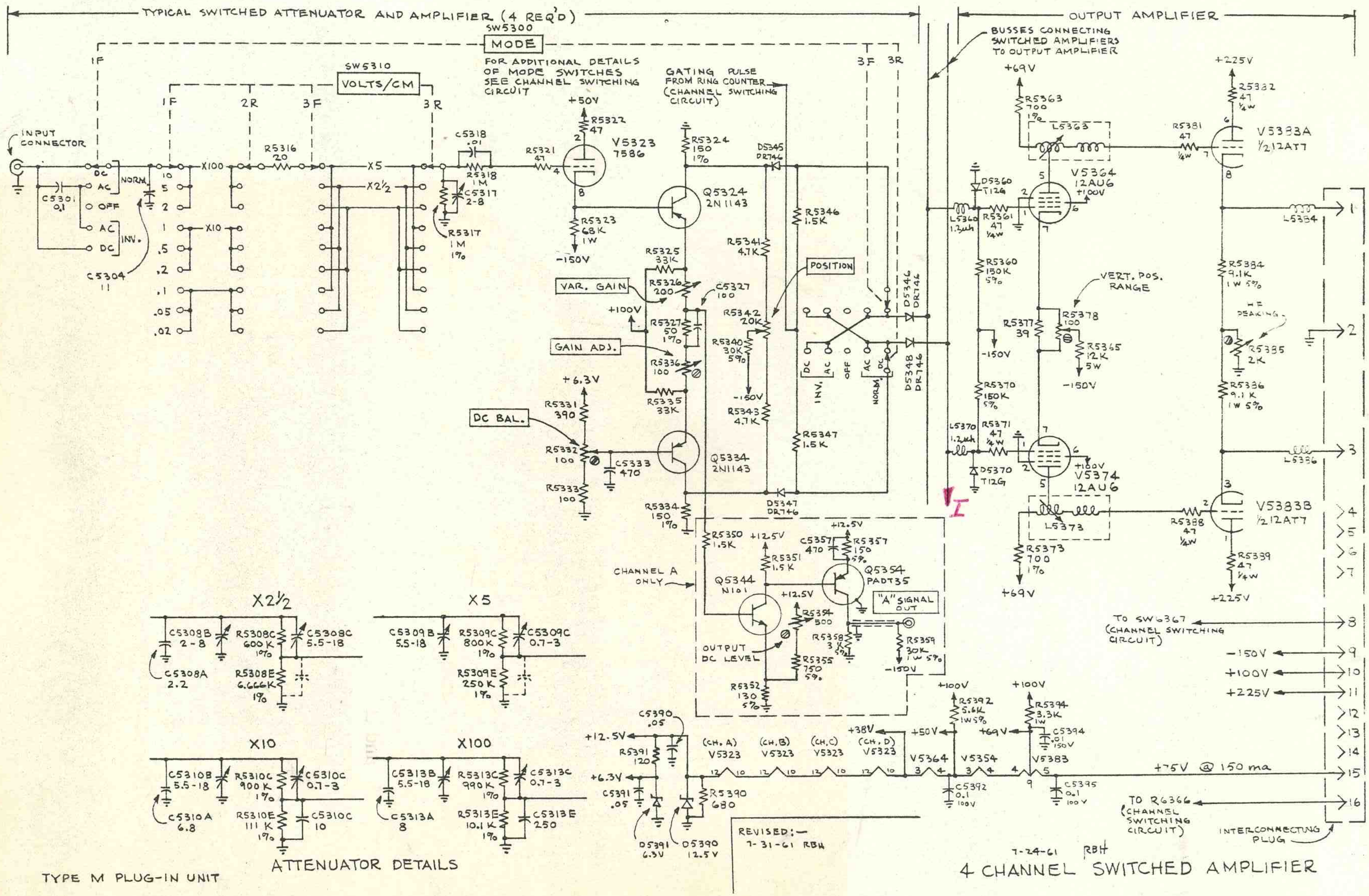
3. Using the graticule, measure the horizontal distance between the reference waveform and each of the other waveforms. For most measurements the distance is usually measured between 50% amplitude points on the rising portion of the waveform. To make the measurements between waveforms easier, switch the waveforms not being measured "off" with the MODE switches.

4. Multiply the distance measured for each channel by the setting of the oscilloscope Time/Div. control to obtain the apparent time interval.

5. Divide the apparent time interval by 5, if 5X sweep magnification is used, and 1 if sweep magnification is not used, to obtain the actual time interval.

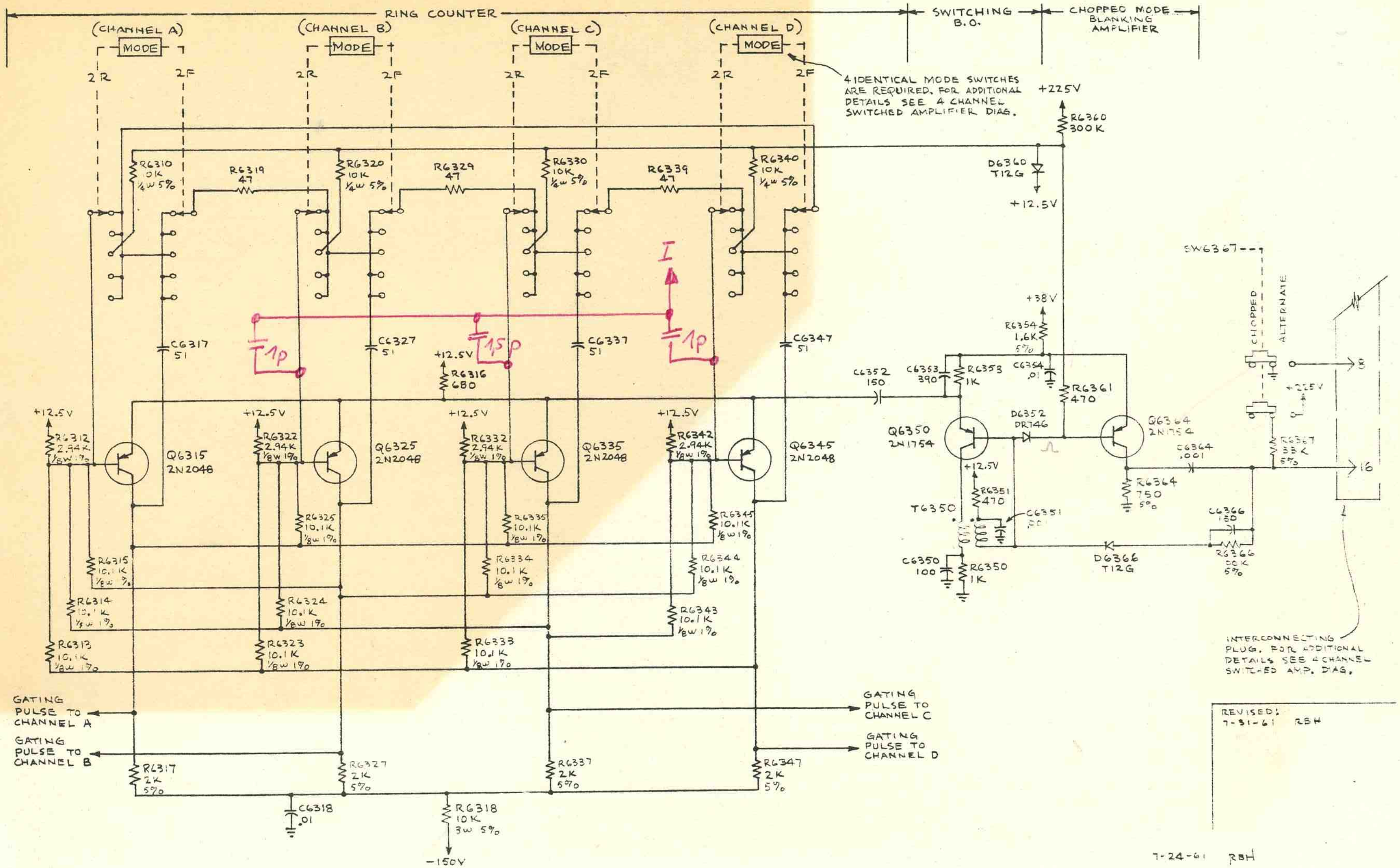
$$\text{Time Delay} = \frac{\text{Time/Div. switch setting} \times \text{Distance in div.}}{\text{Sweep magnification}}$$

For example, assume that the Time/Div. switch setting is 2 μsec, the Magnifier is set for 5X magnification, and that you measure a horizontal distance of 5 divisions between the leading edge of the reference waveform and the leading edge of the waveform displayed on another channel. In this example then, 5 divisions multiplied by 2 microseconds per division gives you an apparent time delay of 10 microseconds. The apparent time delay divided by 5 then gives you an actual time delay of 2 microseconds.



TYPE M PLUG-IN UNIT

4 CHANNEL SWITCHED AMPLIFIER



7-24-61 RBH

CHANNEL SWITCHING CIRCUIT

TYPE M PLUG-IN UNIT

Mod. 22.1.62 Friese

Tektronix Type M Plug-In Unit Serial 000 ~~103~~ 117

Änderungen:

1. Dunkeltastpuls verlängert C1 (30 pF) an Basis Q 6364.

2. Masse-Leitung Ltg 1 vom Schalter SW 6367 (Chopped - Alternate) an den zu Q 6364 gehörigen Masse-Punkt geführt, um Stromfluß des Dunkeltastpulses über das ganze Chassis zu vermeiden.

3. Basis der Transistoren Q 5334 über C3 (10 nF) an Masse, vermindert die Einstreuung von Störpulsen.

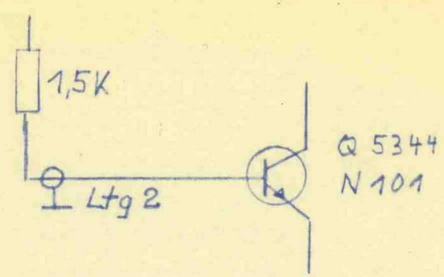
4. Signal-Leitung Ltg 2 an Basis Q 5344 abgeschirmt. Störpulse an "A"-Signal out dadurch ~~um 20 dB~~ verkleinert.

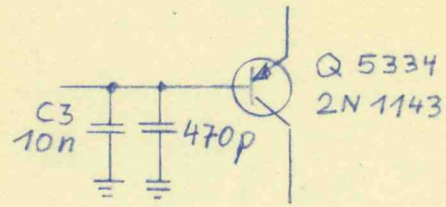
5. Kompensations-Kondensator C2 (~~10~~ 15 pF) zwischen "A"-Signal-out und Emitter-Signal Q 6350 kompensiert Störpulse an "A"-Signal-out um weitere ~~10~~ 6 dB.

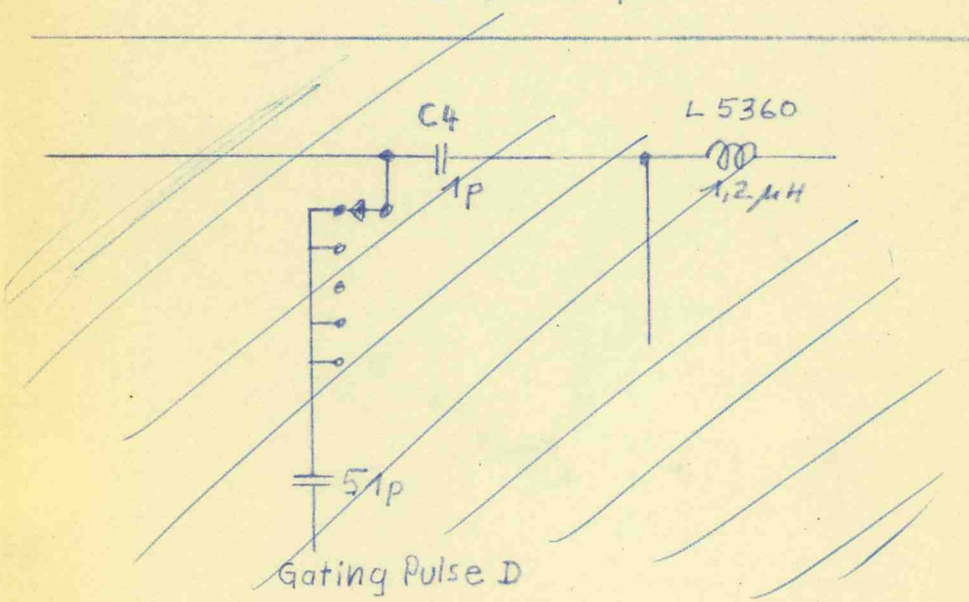
6. Schräge der Ausgangspulse Kanal ~~D~~ A,B,C ~~durch C4 (1 pF) zwischen Gating-Pulse D und L 5360~~ kompensiert. (s. Manual)

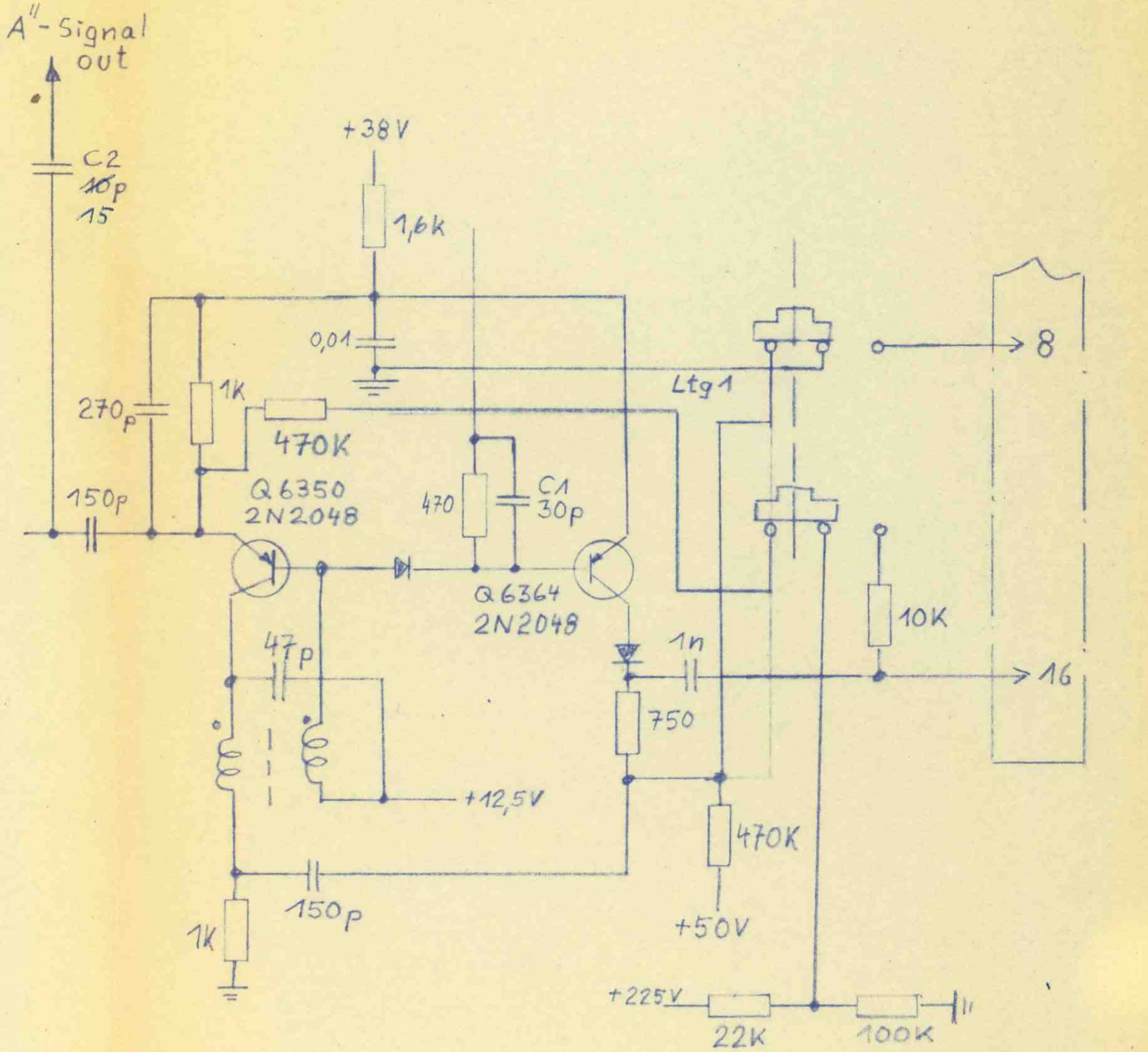
7. Röhre V 5383 abgeschirmt, da Dunkeltastpuls sonst stört.

22.1.62









Tektronix Type M Plug-In Unit
Se.-Nr. 000103
Änderungen

Friese