PRELIMINARY
INSTRUCTION MANUAL

TYPE ML

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.

TYPE ML

PLUG-IN PREAMPLIFIER

S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon ● Phone MI 4-0161 ● Cables: Tektronix

80-0006-00

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.

Specifications and price change privileges reserved.

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SPECIFICATIONS

GENERAL INFORMATION

The Type ML Preamplifier is a fast-rise, high-gain calibrated plug-in preamplifier of rugged construction, designed for use with the Type 945 Oscilloscope. This preamplifier meets military test equipment specifications, therefore it will survive extreme shipping and storage conditions and will perform with accuracy and reliability in severe environments. Most components are standard military parts, minimizing the problem of stocking spare parts.

The Type ML Preamplifier contains a fast-rise dc-coupled main amplifier section producing two-times amplification by converting a single-ended input to a push-pull output. In addition to the dc amplifier, the Type ML has an ac-coupled ten-times amplifier which, in operation, is cascaded with the main amplifier section. The ten-times amplifier gives the preamplifier a maximum sensitivity of 0.005 volts per centimeter.

TABLE 1, ELECTRICAL SPECIFICATIONS when used with Type 945 Oscilloscope

CHARACTERISTICS	REQUIREMENTS (20 minute warm-up for rated accuracies)		
DEFLECTION FACTOR	0.005 volt/cm to 50 volts/cm		
	DC	AC	X10 GAIN AC
Abs. Accuracy	Adjustable to 0% error, at maximum sensitivity		
Calibrated Range	0.05v/cm to 20v/cm in nine cal. steps. 1, 2, 5, 10 sequence		0.005v/cm to 2.0v/cm in nine cal. steps. 1, 2, 5, 10 seq.
Variable Range	2.5:1 VARIABLE atten. extends range to 50v/cm (uncalibrated)		2.5:1 VARIABLE atten. extends range to 5.0v/cm (uncal.)
Attenuator Accuracy	+or-3% from -20°C to +55°C, +or-5% from -40°C to -20°C, +or-5% after Vibration and Shock tests		+or-3% from -20°C to +55°C, +or-5% from -40°C to -20°C, +or-5% after Vibration and Shock tests
Compensation	Within +or-1%		Within +or-1%
FREQUENCY RESPONSE	DC-30MC +3/-0 MC	5cps-30MC +3/-0 MC	5cps-24MC +3/-0 MC
Low-Frequency Response	No greater than 2.5% down from 1kc to DC	No greater than 15% down from 1kc to 5cps	No greater than 15% down from 1kc to 5cps
High-Frequency Response	No greater than 30% (3db) down from 50kc to 30MC, at .05 VOLTS/CM +or- 3MC after Humidity, Fungus and Shock tests		No greater than 30% (3db) down from 50kc to 24MC, at .005 VOLTS/CM
RISETIME	12nsec or less at .05 V/CM		15nsec or less at .005 V/CM
TRANSIENT RESPONSE	No greater than +or-1% overshoot, rolloff or ringing at max. sensitivity. +or-2% after Humidity test; +or-3% after Fungus, Vibration and Shock tests.		
LINEARITY	+or-2.5% from 2 cm to 4 cm		+or-2.5% from 2 cm to 4 cm
TRACE DRIFT	+or- 1 mm from -20°C to +50°C		
MICROPHONICS	5 mm, Vibration test only		15 mm, Vibration test only

INPUT IMPEDANCE	1 Megohm +or-5%, 20 pF +or-5%	
MAX. INPUT VOLTAGE	600 volts, DC plus peak AC	
TYPE P6003 or TYPE P6945, with 42-inch Cable, used with 945/ML combination		
ATTENUATION RATIO	10 to 1, +or-5%	
FREQUENCY RESPONSE	See FREQUENCY RESPONSE above; H. F. response: +3/-3 MC	
RISETIME	12 nsec at .05 VOLTS/CM, AC or DC.	15 nsec at .005 VOLTS/CM, X10 GAIN AC
MAX. INPUT VOLTAGE	600 volts, DC plus peak AC.	
INPUT IMPEDANCE	10 Megohms +or-5%, 10 pF +or-5%.	

TABLE 2, ENVIRONMENTAL SPECIFICATIONS

TYPE 945/TYPE ML COMBINATION	Meets MIL-T-945A specifications as described in Instruction Manual of Type 945 Oscilloscope.

TABLE 3, MECHANICAL SPECIFICATIONS

CONSTRUCTION	Aluminum-alloy chassis.
FINISH	Photoetched, painted front panel.
DIMENSIONS	Overall size, including handle: length-- 11.3", height-- 7.4", width 6.7".
WEIGHT	Approximately 5 pounds.
CONTROLS, EXTERNAL	On front panel. Knob material, construction and design follow MIL-K3926 and MS 91531.
CONNECTORS	BNC for all front-panel jacks.

TABLE 4, FUNCTIONS OF CONTROLS AND CONNECTORS

INPUT	Signal input connector to the preamplifier.
X10 GAIN-AC-DC	Three-position switch providing dc input coupling in DC position, ac input coupling in AC and X10 GAIN AC positions. X10 GAIN AC position also switches an amplifier with gain of ten into circuit.
VOLTS/CM	Nine-position switch used to select the calibrated vertical deflection sensitivities indicated on panel. Black numbers used in AC and DC; white numbers used in X10 GAIN AC.
VARIABLE	Control concentric with VOLTS/CM switch, provides continuously variable attenuation between calibrated sensitivities. Extends attenuation to 50 volts/cm in AC and DC; to 5.0 volts/cm in X10 GAIN AC.
VERTICAL POSITION	Control positions the display vertically.

GAIN ADJUST	Screwdriver-adjustable control sets gain of main-amplifier section of Type ML Preamplifier.
X10 GAIN ADJUST	Screwdriver-adjustable control sets gain of X10 amplifier section.
VARIABLE ATTEN BAL	Screwdriver-adjustable control balances main-amplifier section so that use of VARIABLE control does not shift oscilloscope display.
X10 VARIABLE ATTEN BAL	Screwdriver-adjustable control balances X10 amplifier output so that use of VARIABLE control does not shift oscilloscope display.

OPERATING INSTRUCTIONS

FIRST-TIME OPERATION

Insert the Type ML Preamplifier into the plug-in compartment of the Type 945 Oscilloscope and fasten it with the securing handle. Set the front-panel controls as follows (controls not listed may be in any position):

Type 945 Oscilloscope:

POWER	off
HORIZONTAL DISPLAY	MAIN SWEEP NORMAL
5X MAG.	OFF
TIME/CM (MAIN SWEEP)	.1 mSEC
MULTIPLIER	5
TRIGGER SLOPE (MAIN SWEEP)	INT. +
TRIGGERING MODE (MAIN SWEEP)	AC
STABILITY (MAIN SWEEP)	fully clockwise
TRIGGERING LEVEL (MAIN SWEEP)	fully clockwise
INTENSITY	fully counter-clockwise

Type ML Preamplifier:

X10 GAIN-AC-DC	AC
VOLTS/CM	.05 (black numbers)
VARIABLE	CALIBRATED, fully clockwise

Connect the power cord to the source of power. Turn ON the POWER switch. Allow two or three minutes preliminary warm-up. Using the Beam Indicator neons as a guide, center the trace vertically and horizontally with the VERTICAL POSITION and the HORIZONTAL POSITION controls. Rotate the INTENSITY control clockwise until the free-running trace appears on the crt. Adjust the FOCUS, ASTIGMATISM and INTENSITY controls to obtain a sharp trace with adequate intensity. Before making any accurate observations or any adjustment changes, allow 20 minutes for the instrument to warm up.

GENERAL OPERATION

Checking Variable Attenuator Balance Adjustment

The need for adjustment of the VARIABLE ATTEN BAL controls is indicated by a vertical shift in the trace position as the VARIABLE control is rotated.

Each of the two amplifiers in the Type ML has a VARIABLE ATTEN BAL adjustment on the front panel of the unit. The control in the main-amplifier section sets the dc balance in the phase inverter section. The adjustment in the X10 amplifier adjusts the dc level of the output to match that of the First Cathode Follower, so that in switching the X10 amplifier in and out of the circuit, the dc balance is not upset. The main-amplifier VARIABLE ATTEN BAL adjustment must be made first.

Install a shorting-type BNC cover on the INPUT connector. Set front-panel controls as in First-Time Operation and freerun the sweep with the STABILITY and TRIGGERING LEVEL

controls fully clockwise. Set the X10 GAIN-AC-DC switch at AC. Rotate the VARIABLE control back and forth, watching the crt screen for a vertical shift in trace position. If the trace moves when the control is rotated, adjust the upper VARIABLE ATTEN BAL control until the trace position is no longer affected by the VARIABLE control.

Turn the AC-DC switch to X10 GAIN AC. Check the output balance of the X10 amplifier by rotating the VARIABLE control back and forth. If the trace shifts, adjust the X10 VARIABLE ATTEN BAL control until rotation of the VARIABLE control no longer affects the position of the trace. Return the VARIABLE control to the CALIBRATED position, fully clockwise.

Checking Gain Adjustment

Adjustment of the vertical gain should be checked frequently. Aging of tubes and other components causes a slight change in the gain characteristics of the Type ML Preamplifier. Correct adjustment of the gain is necessary for making accurate voltage measurements.

Gain is adjusted with the two screwdriver adjustments on the front panel of the unit, labeled GAIN ADJUST and X10 GAIN ADJUST. Because the X10 amplifier, in use, is cascaded with the main amplifier section, it is necessary to adjust the gain of the main amplifier first.

With front-panel controls positioned as in First-Time Operation, set the AMPLITUDE CALIBRATOR switch for 100 mVOLTS. Be sure the VARIABLE control is in CALIBRATED position. Connect a lead from the CALIBRATOR OUT connector to the INPUT connector on the Type ML Unit. Adjust STABILITY and TRIGGERING LEVEL controls of the MAIN SWEEP for a stable display of the AMPLITUDE CALIBRATOR square wave. The peak-to-peak vertical deflection should be exactly two major graticule divisions (2 cm). If incorrect, adjust the upper GAIN ADJUST control with a small screwdriver to obtain the proper amplitude.

Turn the AMPLITUDE CALIBRATOR to 10 mVOLTS and set the AC-DC switch in the X10 Gain AC position. Adjust STABILITY and TRIGGERING LEVEL controls to obtain a stable square-wave display. Check the waveform for exactly two major graticule divisions (2 cm) of vertical deflection. If the amplitude is not correct, adjust the X10 GAIN ADJUST control until exactly 2 cm peak-to-peak is observed. Remove the lead from the INPUT connector.

Recheck both VARIABLE ATTEN BAL adjustments.

INPUT coupling

For measuring dc voltage levels or peak-to-ground voltages, it is necessary to have dc-coupling throughout the measuring instrument. With the X10 GAIN-AC-DC switch in DC position, the Type 945/Type ML combination is entirely dc-coupled.

However, it is often neither necessary nor desirable to display the dc component of the input waveform. A capacitor connected in series with the INPUT connector when the AC-DC switch is in AC or X10 GAIN AC position blocks the dc component. This permits viewing of the ac part of a large input signal, as well as detailed viewing of the ac part of any signal having a dc component.

Connecting to the Signal Source

Stray electric and magnetic fields picked up by an unshielded connecting cable often change the appearance of a displayed waveform. This type of distortion occurs even in the audio-frequency range, except when making measurements of low-impedance circuits. In general, unshielded leads of appreciable length are not suitable for connecting the input signal to the vertical INPUT connector. Shields should be grounded to the chassis of the instrument in use. For most purposes coaxial cables are recommended.

In broadband applications, it is usually necessary to terminate a coaxial cable with a resistor which presents a resistance equal to the characteristic impedance of the cable. Proper termination becomes more important as the length of the cable is increased. The termination is placed at the oscilloscope end of the cable, although many sources require an additional termination at the source end as well.

For large amplitude signals an attenuator may be included in the connective system to provide an oscilloscope display having a more

desirable amplitude than would be possible with no attenuation.

When checking the operation of the instruments, actual operating conditions should be simulated as nearly as possible. For example, the oscilloscope should work into a load impedance similar to that which is encountered in actual use.

Loading of the signal source is sometimes produced by the input circuit of the plug-in preamplifier. At the INPUT connector of the Type ML, the impedance of the input circuit is equivalent to a resistance of 1 Megohm shunted by a capacitance of 20 picofarads. With a few feet of shielded cable, the capacitance may well be increased to 100 picofarads. Where the effects of these resistive and capacitive loads are significant, a probe may be used to introduce the input signal.

Use of Probes

An attenuator probe reduces both capacitive and resistive loading of the signal source and decreases apparent sensitivity of the oscilloscope. Attenuation by the probe permits observation and measurement of signal voltages in excess of those that can be accepted by the preamplifier alone.

The Type P6003 or P6945 Probe supplied with the Type 945 Oscilloscope is a 10X probe, and may be used with the Type ML Preamplifier. The input impedance of this probe is 10 Megohms shunted by 10 picofarads. Maximum voltage which may be applied to the probe is 600 volts dc-plus-peak-ac. Exceeding this limit may result in damage to the components inside the probe. If the displayed waveform contains high-frequency portions, it is generally necessary to clip the probe ground lead to the chassis of the equipment being checked.

Before using a probe, check its adjustment. An adjustable capacitor in the body of the probe is used to compensate for differences between input capacitances of various oscilloscopes. To insure the accuracy of pulse and waveform measurements, the probe adjustment should be checked when changing scopes and occasionally when used with any oscilloscope.

Probe Compensation

To adjust the compensation of the P6003 or P6945 Probe, first turn on the Type 945/Type ML combination and allow adequate warm-up time. Connect the probe cable to the INPUT connector of the Type ML Preamplifier. Set the oscilloscope and Type ML controls as in First-Time Operation and set the AMPLITUDE CALIBRATOR for 1 VOLT. Touch the probe tip to the CALIBRATOR OUT connector and adjust the STABILITY and TRIGGERING LEVEL controls of the MAIN SWEEP for a stable display of the waveform. Loosen the flanged locking ring of the probe, then hold the knurled base and rotate the barrel of the probe for compensation. Adjust for a square-wave display having a flat top, with no overshoot nor undershoot (rolloff). When compensation is correct, carefully tighten the locking ring without disturbing the probe adjustment.

VOLTAGE MEASUREMENTS

The Type 945/Type ML combination can be used to make accurate voltage measurements of a displayed waveform, as described in the following paragraphs. To eliminate error due to thickness of the trace, make all measurements from the same part of the trace--the top, center or bottom. If the center of the trace is used for one reading, it should be used for all subsequent readings.

Measuring Peak-to-Peak Voltages

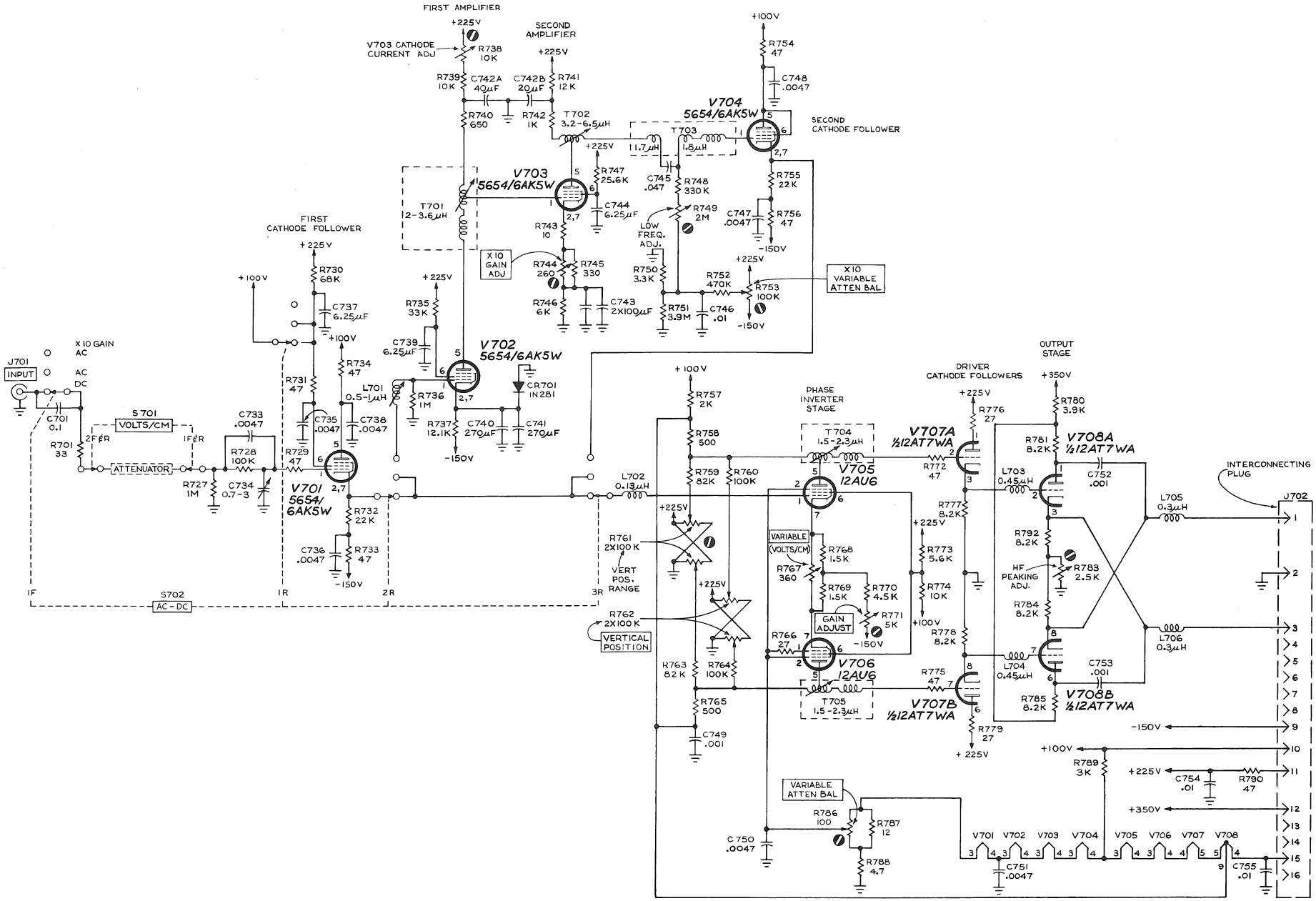
To measure the peak-to-peak voltage of a signal, first connect the probe or coaxial cable to the INPUT connector of the Type ML Preamplifier, with a termination if necessary, and to the signal source. Adjust the controls of the oscilloscope and the preamplifier to obtain a stable display of the signal waveform on the crt screen. Use as large an amplitude as possible without exceeding the size of the graticule. Be sure the VARIABLE control is in CALIBRATED position.

Using the graticule markings, determine the vertical difference in centimeters (major graticule divisions) between the maximum and minimum peaks of the waveform. To obtain the voltage at the INPUT connector, multiply the graticule measurement by the setting of the VOLTS/CM switch. (Use the black numbers for AC or DC, and the white numbers for X10 GAIN AC). If an attenuator or attenuator probe is used, multiply the INPUT voltage by the attenuation factor to obtain the peak-to-peak voltage of the signal.

Measuring Peak-to-Reference Voltages

It is often desired to measure the voltage of a waveform with respect to some reference voltage, usually ground. Connect the probe or coaxial cable to the INPUT connector, with a termination if necessary. Adjust the controls of the oscilloscope and the preamplifier for a free-running trace, with the X10 GAIN-AC-DC switch at DC and the VARIABLE control in CALIBRATED position. Touch the tip of the input cable to the reference voltage (ground), and adjust the VERTICAL POSITION control to set the trace at some convenient reference position on the graticule. Without changing any controls of the instruments, remove the input cable from the reference voltage (ground) and connect it to the voltage signal to be measured. Adjust the oscilloscope triggering controls for a stable display. If the amplitude of the signal is inconveniently large or small, reset the VOLTS/CM switch for a more suitable value and repeat the above procedure.

Determine the vertical distance on the oscilloscope graticule between the waveform peak and the original trace position. Recheck the reference level. The INPUT voltage is equal to the graticule measurement multiplied by the setting of the VOLTS/CM switch. If an attenuator or attenuator probe is used, multiply the INPUT voltage by the attenuation factor to obtain the peak-to-reference voltage.



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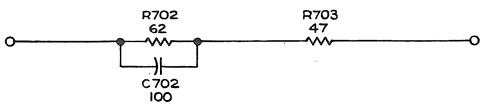
TYPE ML PREAMPLIFIER

.05V/CM (X1)



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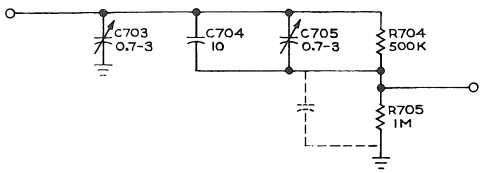

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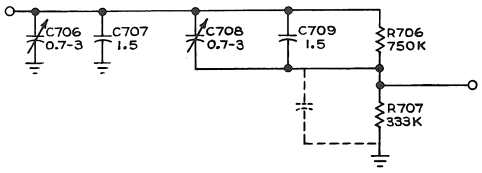

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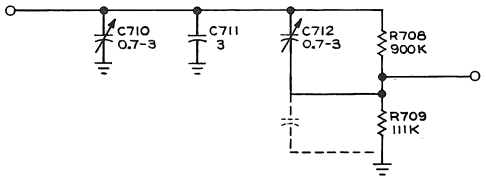

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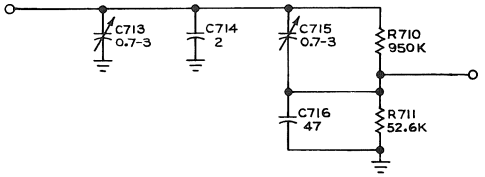

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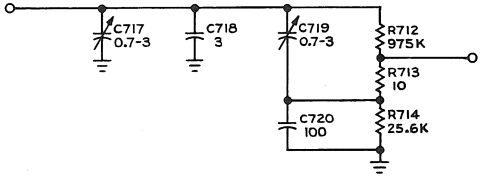

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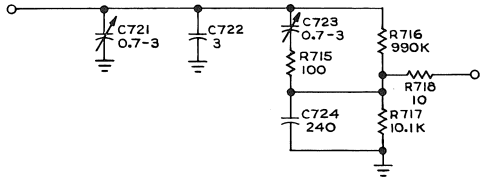

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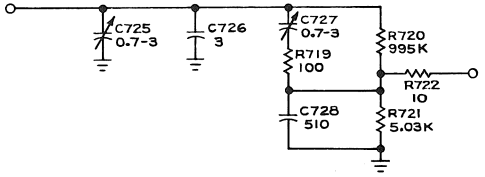

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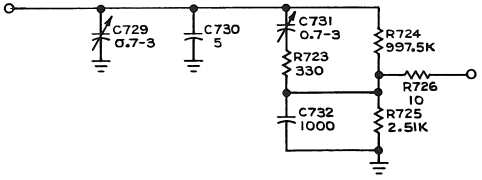

TYPE ML UNIT

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ATTENUATORS

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