INSTRUCTION MANUAL

TYPE 130 L-C METER

Tektronix, Inc.

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Tektronix International A.G.

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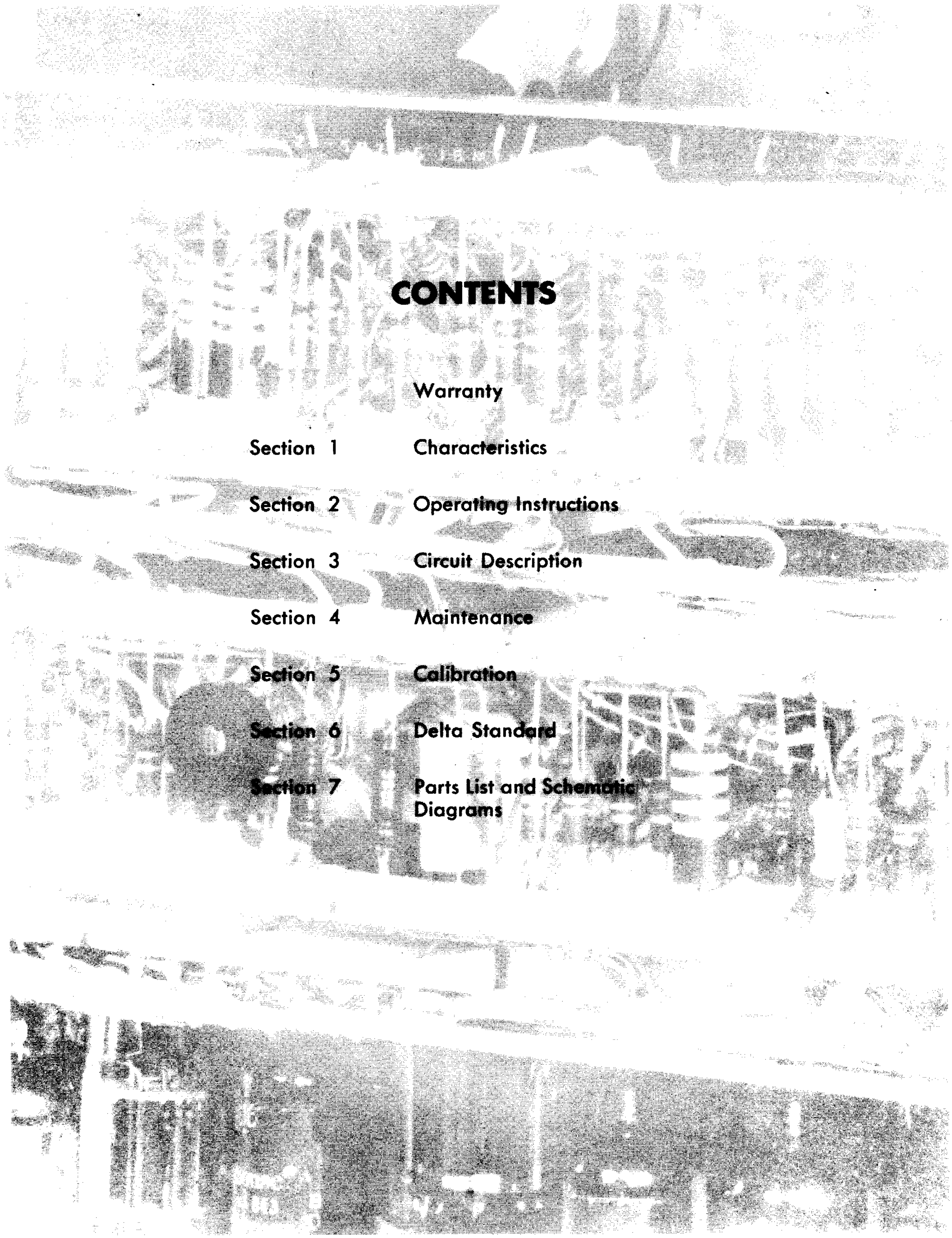
WARRANTY

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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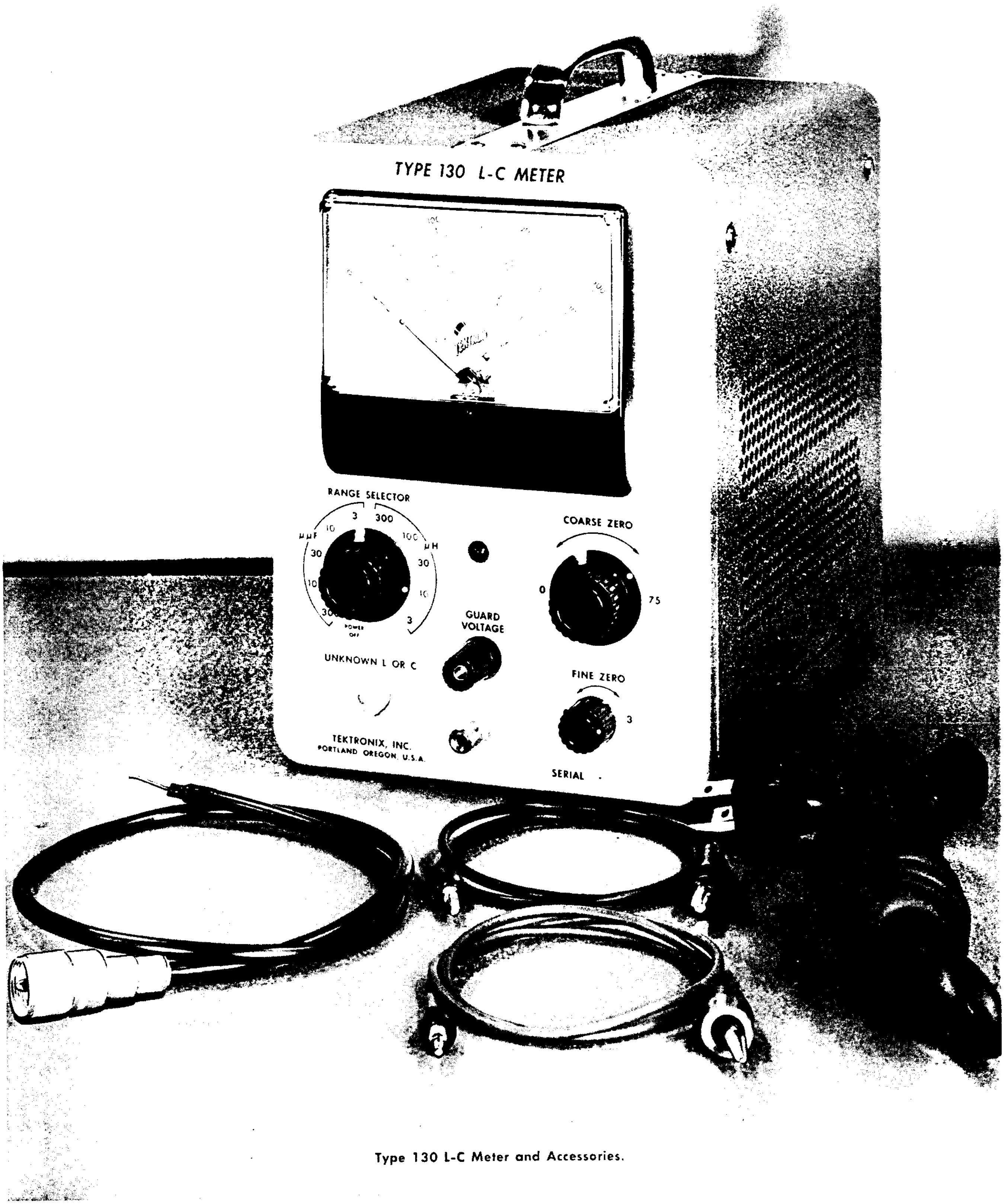
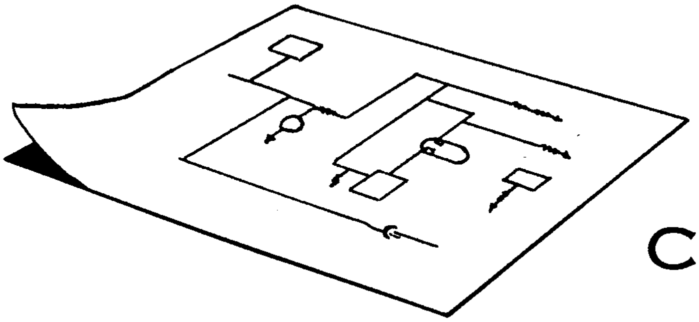


Type 130 L-C Meter and Accessories.



SECTION 1

CHARACTERISTICS

General

The Tektronix Type 130 L-C Meter indicates inductance and capacitance directly on a calibrated meter, and includes a guard-voltage circuit for separating the stray capacitance of nearby conducting materials. The meter is designed for rapid measurements of small inductances and capacitances where possible errors of the order of 5 per cent are permissible.

This meter directly reads accurate inductance and parallel capacitance. To insure accurate measurements of series capacitance and shunt inductance, a graph is included for interpolating the correct figures from the known meter reading. The accuracy of the graph is decreased somewhat for shunt inductance.

Uses

The Type 130 is particularly useful in circuit development for such uses as measuring components already in place in the circuit, for sorting components, for measuring vacuum-tube direct interelectrode capacitances and so forth.

Method of Operation

The instrument operates by measuring the change in frequency the unknown reactance causes when it is added to an oscillator tank circuit. The amount of change in frequency is measured by a direct-indicating electronic counter that counts the frequency difference between a fixed oscillator and the oscillator affected by the reactance. With zero reactance added, the two oscillators zero beat and the counter reads zero.

Indicator

The electronic counter produces a deflection on a direct-current meter calibrated in capacitance and inductance. A rotary switch makes the meter more sensitive for lower counts and less sensitive for higher counts to provide five ranges of capacitance and five of inductance.

Guard Voltage

Any oscillator current flowing into a capacitance affects the oscillator frequency. But current flowing into a capacitance from the guard-voltage circuit does not, because this circuit is isolated from the frequency-determining part of the oscillator. The guard-voltage circuit can keep stray capacitance from drawing oscillator current by driving the strays at exactly the same instantaneous voltage as the capacitance being measured. Since no oscillator current will then flow from the capacitance being measured into the stray capacitance, the meter reads only the desired capacitance.

Input Connections

A two-foot shielded cable is furnished with the instrument for measuring reactances wherever they are in a circuit. The zero adjustments can set the meter to read zero with or without the 30 $\mu\mu$f cable capacitance so that the meter reads directly.

Electrical Characteristics

Indicating Meter—D'Arsonval, 200-microamp movement.

Meter Ranges—All five scales being at zero. Full-scale readings are 3, 10, 30, 100 and 300 microhenries or micromicrofarads. Minimum scale division, 0.1 microhenry or micromicrofarad.

Accuracy—within 3 per cent of full scale. The reset-ability is excellent. By calibrating with the Type S-30 Delta Standard, the accuracy at full scale will be about 1 per cent.

Voltage Across Unknown—The instrument places an ac voltage across the unknown, 1 volt maximum across a capacitance, $\frac{1}{4}$-volt maximum across an inductance with frequency between 120 and 140 kc.

Permissible Load Resistance—The following loads will not appreciably alter the indication:

Capacitance, 0.1 megohm shunt (minimum resistance)

Inductance, 20 kilohms shunt, 10 ohms series (maximum resistance)

A table included in the instruction manual (in Operating Instructions Section) provides corrections for increased loads.

Guard-Voltage Output Impedance—A cathode follower with internal impedance of 250 ohms can safely drive 200 $\mu\mu$f.

Power Requirements—105 to 125 and 210 to 250 volts, 50 to 60 cycles ac. A voltage regulator keeps the instrument accurate over this voltage range. Power consumption 40 watts at 117 or 234 volts.

Physical Characteristics—Size, 7" wide by 10½" high by 10¾" deep. Weight, 9 lbs. Construction, welded aluminum alloy with blue vinyl finished cabinet and photo-etched anodized aluminum panel.

Accessories

1 P93C probe (010-003)

1 W130R lead (012-015)

1 3-conductor power cord (161-010)

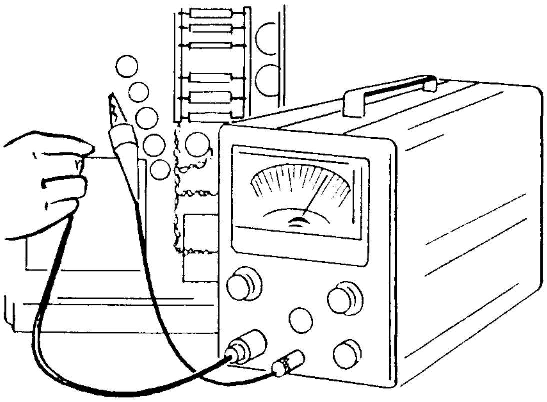
1 3-wire adapter (103-013)

1 W130B lead (012-014)

2 Instruction Manuals

Functions of Controls and Connectors

RANGE SELECTOR	Eleven-position switch turns off ac power in one position and selects five ranges of capacitance and five of inductance in the remaining 10 positions.
COARSE ZERO	Adjustable capacitor sets the variable oscillator to the fixed-oscillator frequency to accommodate inclusion of the probe capacitance or other incidental capacitance.
FINE ZERO	Adjustable capacitor with one-twenty-fifth the range of the above control for accurately setting zero.
UNKNOWN L OR C	UHF coax connector through selector switch to oscillator circuit.
GUARD VOLTAGE	Binding post provides ac voltage through cathode follower equal to oscillator voltage but isolated from frequency-determining portion of oscillator. For removing effects of stray capacitances from measurements.



SECTION 2

OPERATING INSTRUCTIONS

General

No special operating precautions are necessary. The instrument will withstand the usual amount of shock and vibration that a meter movement can take, and any ambient temperature the operator is likely to tolerate.

First-Time Operation

Connect the power cord to a 117-volt 60 cycle source and connect the probe plug to the UNKNOWN uhf connector. Set the RANGE SELECTOR to 100 $\mu\mu$f. The ac power switch energizes the pilot light, which indicates that the instrument is getting power. Connect a ground lead between the TYPE 130 and one end of the capacitance that you want to measure.

Center the FINE ZERO control with the index up, and adjust the COARSE ZERO control so the meter reads zero. Keep the index line above horizontal. Do not be concerned if the meter goes off scale at any time. The maximum possible current through meter movement is safe for any settings of the controls. Let the instrument warm up for a minute or two so that it can become stabilized.

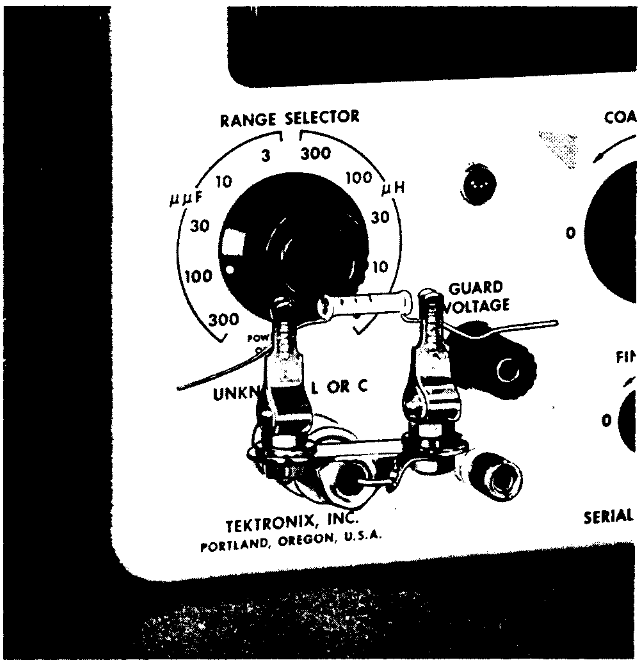


Fig. 2-1. Capacitance measurement using Production Test Fixture.

Capacitance Measurement

First set the meter accurately on zero with the capacitance disconnected. You can connect the capacitance you want to measure either directly at the instrument panel or at the end of the probe. Tektronix Type F30 Production Test Fixture (013-001) is an accessory that can be obtained for measuring inductance and capacitance directly at the instrument panel. It speeds sorting and testing of capacitors and inductors. The probe cable introduces an additional 30 $\mu\mu$f which the COARSE ZERO can easily compensate. Set the COARSE ZERO control with the SELECTOR on 100 or 300 $\mu\mu$f and then switch to 3 or 10 $\mu\mu$f to set the FINE ZERO.

The meter needle will follow the beats below 10 cycles so you will have an accurate zero setting when the needle is at zero and not vibrating.

The percentage accuracy and resolution are better on the upper parts of the scales so you should shift to the next lower range where possible.

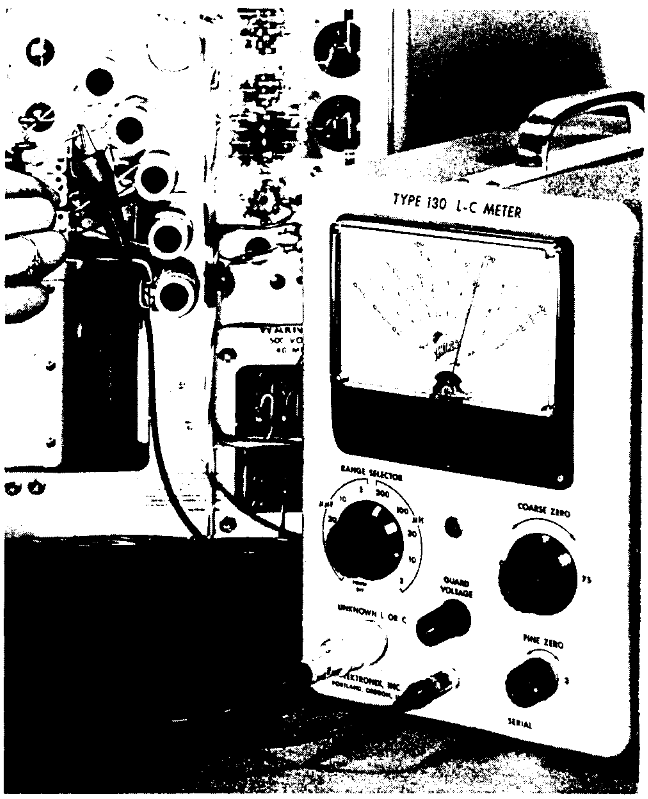


Fig. 2-2. Using the Type 130 L-C Meter to check inductance in a circuit.

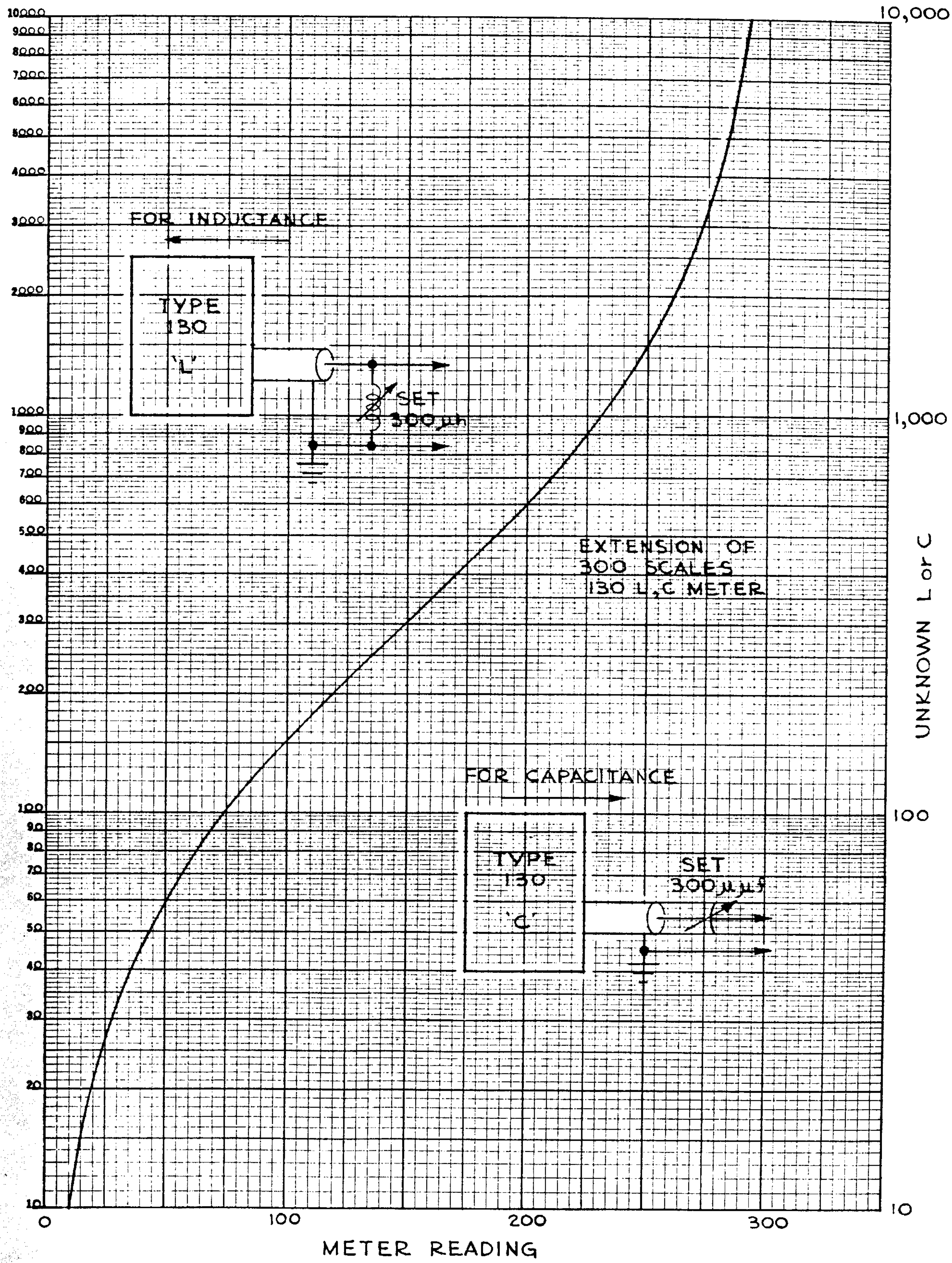


Fig. 2-3. Shunt inductance and series capacitance correction curve.

Inductance Measurements

Set the ZERO controls with the UNKNOWN terminal short circuited and the SELECTOR set to one of the five positions at the right marked μh. Set ZERO by the same adjustment technique you use for capacitance, using the 3-μh setting while setting the FINE ZERO control.

Guard Voltage

The purpose of the guard voltage is for measuring capacitances not isolated from other capacitances, such as vacuum-tube interelectrode capacitance, or the capacitance between switch points on a selector switch, or between terminals on a terminal strip.

The guard voltage drives the capacitance you want to exclude from the measurement, so connect the GUARD VOLTAGE terminal to all elements whose capacitance you want to exclude from the measurements and then make the capacitance measurement as usual. The driving impedance of the guard voltage is about 250 ohms. It can safely drive 200 μμf without appreciably affecting a measurement, or a shunt resistance to 50 kilohms.

For example, to measure the plate-to-grid capacitance of a pentode, ground the grid, connect the plate to the UNKNOWN terminal and connect the cathode, screen, suppressor, and shield to the GUARD VOLTAGE terminal. With this arrangement the cathode, screen, suppressor, and shield will stay at the same instantaneous ac voltage as the plate, and will not contribute to the meter reading.

As another example, consider the output capacitance of the pentode. This measurement should exclude the grid-to-plate capacitance. Connect the grid to the GUARD VOLTAGE circuit and ground the screen, suppressor, cathode and shield. The grid-to-plate capacitance will not be included in the measurement.

Small Reactances

Warm-up drift after a minute or so will not appreciably affect readings on the three highest scales but may be of consequence on the 0.3-μh or μμh scales. Let the Type 130 warm up for 10 or 15 minutes so it will have minimum drift for best accuracy when you use these scales.

For small capacitances or inductances in the order of 0.2 μμf or μh, where you use the 0-3 scales, the needle of the indicator will vibrate (about 62 cps/μμf). The vibrating needle is hard to read accurately, so a better way to measure smaller values is to preset zero reactance at 1.0 on the scale. You then subtract 1.0 from the readings. Be sure to turn the ZERO control clockwise and keep the index mark above horizontal when you advance the meter needle.

Large Reactances

The useful range of the Type 130 can be extended up to essentially 10,000 μμF or 10,000 μH. Accuracy of the range extension is within 15% up to 1500 μμF or 1500 μH.

To extend the capacitance range, simply add an accurate 300 μμf capacitor in series with the unknown. To extend the inductance range, add an accurate 300 μh inductor in parallel with the unknown. Use Fig. 2-3 to obtain the value of the unknown.

An accurate 300 μμf capacitor can be obtained by setting the Type 130 RANGE SELECTOR to 300 μμF, connect a 270 μμf fixed, and a 5 to 25 μμf variable capacitor (in parallel) to the unknown L OR C terminals. Adjust the variable capacitor for full scale reading. Then, place the large unknown in series with the new 300 μμf capacitor and read the meter. Fig. 2-3 will give you the value of the unknown.

An accurate 300 μh inductor can be made using a variable unit adjusted for full scale meter reading with the RANGE SELECTOR switch at 300 μH. Leave the inductor in place, the meter reading at full scale, and connect the unknown inductor across the new 300 μh inductor and read the meter. Fig. 2-3 will give you the value of the unknown.

Suppressed Zero

Comparisons between large capacitors can be made more accurately by setting the zero off scale to the left, and using a lower scale. Actually, the indicator never goes below zero. It rises again on scale as the oscillator goes through zero beat and on above the fixed oscillator. However, when you raise the frequency of the variable oscillator above the fixed oscillator in order to develop frequency difference to make the meter indicate, you operate the oscillator over an uncalibrated range. For this reason you cannot simply read the meter to see how far you have suppressed zero.

To use the suppressed-zero method therefore, you must first accurately determine the size of the capacitance that suppresses the zero, and then add this amount of capacitance to the meter indication you get.

You may use the suppressed zero method to determine the value of small capacitors more accurately than by reading their capacitance directly. For example, if you wish to make a more accurate determination of the value of a 12 μμf capacitor, first measure the value of a 10 μμf capacitor on the 10 μμf range. Make a notation of the exact value indicated. With the capacitor still connected to the instrument, zero the meter reading with the COURSE and FINE ZERO controls. Turn the RANGE SELECTOR to the 3 μμf range. Remove the first capacitor and connect the 12 μμf capacitor to the instrument. Adding this new reading to the notation already made will give you a more accurate reading of the capacitance than could be obtained by measuring it directly.

WARNING: Do not forget to zero the meter after completing the measurement.

Resistance-Loading Corrections

Add these corrections to the readings you get to increase accuracy or when there is more resistance loading than 10 ohms in series with an inductance, or 0.1 megohm shunt resistance. Interpolate between resistance and reactance values, if desired.

If you correct the zero reading in the presence of the loading, add the difference between the listed zero correction and the interpolated correction at the approximate inductance or capacitance you are measuring. Add the correction value when the sign is +, subtract when the sign is —.

Inductance with Series Resistance

Correction, μh

Series Resistance	At 0 μh	At 100 μh	At 300 μh
0 Ω	0.00	0.00	0.00
1 Ω	—0.06	—0.04	.03
2 Ω	—0.12	—.08	.06
4 Ω	—0.18	—.12	.18
6 Ω	—0.19	—.11	.35
8 Ω	—0.15	—.03	.55
10 Ω	—0.06	+.10	.80
15 Ω	+.37	+.60	1.66
20 Ω	+1.11	+1.40	2.80
30 Ω	+3.60	+3.86	6.08
40 Ω	+7.40	+7.90	10.80

Precautions

Reactors much greater than 300 μμf or μh can cause erroneous readings. The counter circuit may be unable to follow the large difference in frequency that results, but still develop dc current that will put the meter on scale. The meter needle will flutter and be unstable and the COARSE ZERO adjustment will give erratic results to warn you to question the reading. Be skeptical of any reading you get if it is at all unstable.

Be sure you raise the frequency of the oscillator when you suppress zero. You can be sure of this if turning ZERO control clockwise sends the needle toward zero, and the white index on the knob is up.

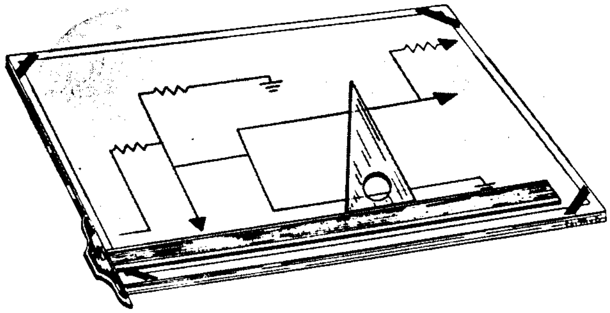
Capacitance with Parallel Resistance

Correction, μμf

Shunt Resistance	At 0 μμf	At 100 μμf	At 300 μμf
4 meg	—.02	—.01	+.01
2 meg	—.04	—.02	+.02
1 meg	—.09	—.04	+.03
.5 meg	—.13	—.08	+.10
300 k	—.18	—.06	+.22
200 k	—.20	—.01	+.39
150 k	—.18	+.08	+.56
100 k	—.08	+.36	+1.14
80 k	+.09	+.60	+1.64
60 k	+.60	+1.45	+2.70
50 k	+1.15	+2.15	+3.68
40 k	+2.20	+3.35	+5.40
30 k	+4.70	+6.05	+9.00

Do not suppress zero for inductance measurements, and do not compensate for large residual inductance with the ZERO adjustment. Additional inductance in the oscillator circuit changes the amount of total capacitance required to cause the meter to read zero, and therefore affects the scale accuracy. If there is unavoidable residual inductance in a measurement, measure the residual and subtract it from the total inductance you measure. Correction of 10 μh of residual inductance by the ZERO controls will cause noticeable error in the inductance reading.

SECTION 3



CIRCUIT DESCRIPTION

Variable Oscillator

V4 is the variable-oscillator tube, with T1, C2, C3, C4 and the unknown the tuned circuit. Feedback from the plate of the pentode section of V4 is coupled to its grid through the triode section, which is connected as a cathode follower. The output signal of the pentode is such as to drive the cathode follower below cutoff except during positive peaks, so that the cathode current consists of pulses. The pulses are fed back to a winding on the oscillator transformer, T1, through C10.

Screen current for the pentode is the cathode current for the cathode follower, filtered by means of R10, C11. This arrangement stabilizes the operating point of the pentode plate, which in turn determines the average current of the cathode follower. For example, if the average plate voltage becomes too high it will raise the cathode-follower grid and cathode voltage, which will raise the pentode screen. The increased pentode plate current returns the pentode plate back down toward its original level.

The phase of the pentode plate voltage can be adjusted by means of C7 so that the feed-back signal will be in phase with the tuned-circuit voltage. When this adjustment is properly made, reduction in Q of the tuned circuit, caused by resistance components in the unknown, will not appreciably affect the oscillator frequency for effective shunt resistance of 100 kilohms or higher. (10 ohms series resistance for inductance.)

When the selector switch is set for inductance measurement and no coil is connected, the grid of the oscillator is held toward positive by R6 and R14, which are connected to the plate supply, so that grid current flows. The resulting low grid-input impedance reduces the voltages coupled in to the grid through stray capacitances on the grid lead, and so reduces any tendency for the circuit to oscillate spuriously. Oscillator input to the mixer, V60, is coupled through buffer V15A.

The selector switch, sections A and B, arranges the oscillator tuned circuit so that the UNKNOWN terminal either shunts the tuned circuit for capacitance measurements, or is in series with the tuned circuit inductance for inductance measurements.

Guard-Voltage Circuit

V110 is a cathode follower whose gain is slightly less than one. The voltage at its grid is increased over the voltage at the UNKNOWN terminal by a small additive winding on T1. The additional voltage is just enough to make up for the slight voltage loss in the cathode follower, so that the GUARD VOLTAGE output voltage is equal to the UNKNOWN terminal voltage. Voltage divider R112, R113, sets the dc grid voltage at about +50 volts so that about 5 ma of cathode current flows. The output impedance with this amount of cathode current is about 250 ohms.

Fixed Oscillator

V30 is the fixed oscillator that can be adjusted to 140 kc by means of the powdered-iron tuning slug in T30. The circuit is similar to the variable oscillator circuit, but without the feedback phase adjustment. V45A is the buffer amplifier.

Buffer Amplifiers

V15A and V45A are the buffer amplifiers that reduce the coupling between the two oscillators. When two oscillators couple to each other, they tend to pull together to a common frequency when their natural frequencies are nearly the same, and actually lock together at the same frequency with enough coupling. The two buffer amplifiers reduce the coupling so that there is no lock-in above about one cycle per second, and the pull-in produces no error above about three cycles per second. Output from the buffers has approximately sawtooth waveform because of the high-resistance plate loads.

Mixer

V60 is the mixer. The purpose of the mixer is to produce an output at the frequency difference between the two oscillators. Higher frequency output components of the mixer are reduced by a low-pass rc filter with C61, C62, C63, and R61, R62. The 120- to 140-kc carrier components are additionally reduced by a bridge-T rejection filter with R64, C64, and C65. The output dc level of the filter is adjustable by means of R68, labeled MULTI ADJ.

Multivibrator

V70 is a multivibrator that generates a square pulse for each cycle of the difference frequency. The square wave is practically symmetrical, regardless of the frequency, when the MULTI. ADJ. control is properly set.

The multivibrator is arranged to shift rapidly from one stable state to a second stable state when the input grid goes past a transition point. For example when the B section of V70 is conducting its plate is down and divider R73, R72 between plate and ground hold the A-section grid below plate-current cutoff. The A-section plate will therefore be positive, and the common cathode voltage will be determined only by current through the B section. If the B-section grid drops, its plate will rise carrying the A-section grid more positive, and the common cathode voltage will drop placing the A-section grid-to-cathode bias nearer to conduction.

When the input grid drops far enough it reaches the transition point and the A section conducts thereby diverting some of the cathode current from the B section. The resulting positive signal at the plate further raises the A-section grid. C73 bypassing R73 improves the ac transmission so that a large positive signal reaches the grid and raises the cathode so high that the B section of V70 is cut off.

The plate of the A section generates a square pulse for each cycle. The positive level of the square pulse is determined by diode-connected V76B at about +150 volts. The bottom of the pulse is determined by cathode follower V76A. The grid voltage of this cathode follower determines the clipping level, and provides a means of adjusting the meter sensitivity at the 300-μh and $\mu\mu$f range. The adjustment is labeled ADJ. 300.

Counter Circuit

The square pulses from the plate of multivibrator V70A are applied to the left-hand end of one of the capacitors, C90, C91, C92, C93 or C94, for example, C90. Clamp diode V15B holds the right-hand end of C90 at about +150 volts during the negative excursion while the multivibrator pulls down the left-hand end to about +100 volts, thus charging C90 to about 50 volts.

During the positive excursion, the multivibrator raises the left-hand end of C90 to about +150 volts and the right-hand end thus goes above +150 volts toward +200 volts. This places the plate of diode V45B above its cathode so that it conducts and discharges C90 into the +150-volt bus through the indicating meter.

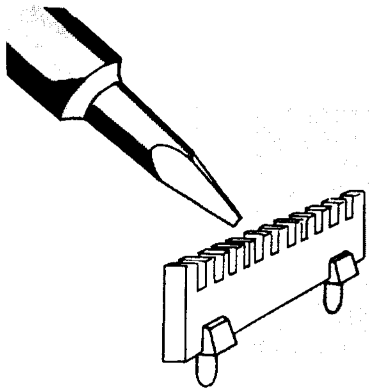
The capacitor always charges completely to the same voltage, so the current it discharges through the meter depends linearly on how many times it discharges per second and on the size of the capacitor. The range-selector switch selects the capacitor sizes in ratios of about 3 to provide ranges of 3, 10, 30, 100, and 300. The largest capacitor is used for the lowest range to increase the quantity of charge per cycle. Resistors R97, R98, R99 and R100 are adjustable shunts across the meter, selected by the range switch to provide individual sensitivity adjustment. The 300 range has no shunt and its sensitivity is adjusted by the negative-peak-clamper grid voltage.

Power Supply

DC power is furnished by a full-wave rectifier and capacitor filter. V403 is a voltage stabilizer that supplies the circuits likely to be affected by line-voltage variations. Heaters of all tubes are biased halfway between ground and +150 volts to reduce the heater-to-cathode voltage of several cathodes that operate at +150 volts.

The transformer primary has two equal 117-volt windings that are normally connected in parallel for 117-volt service. For 234-volt service, they can be connected in series.

The range selector switch opens the input to the primary in the OFF position.



SECTION 4

MAINTENANCE

Replacement of Components

Replacements for all parts in the Type 130 L-C Meter can be purchased directly from Tektronix at current prices. However, since most of the components are standard electronic and radio parts, they can generally be obtained locally in less time than is required to obtain them from the factory. Before purchasing or ordering parts, be sure to consult the parts list to determine the tolerances and ratings required. The parts list gives the values, tolerances, ratings and Tektronix parts number for each component in the instrument.

In addition to the standard components, special parts are manufactured by Tektronix or manufactured by other companies to the Tektronix specifications. These parts and most mechanical parts should be obtained directly from Tektronix or the local Tektronix Field Office, since they are difficult or impossible to obtain from other sources.

Parts Ordering Information

You will find a serial number in the frontispiece of this manual. This is the serial number of the instrument for which this manual was prepared. Be sure the manual number matches the number of the instrument when you order parts.

We make some of the changes in the instrument, the diagrams, parts list and manual to include the latest circuit improvements. The hand-made changes show changes that have been made after the printing of the manual.

Since the production of your instrument, some of the parts may have been superceded by improved components. In such cases, the parts numbers will not be listed in your Parts List. However, if you order a part from Tektronix and it has been superceded by an improved component, the new part will be shipped in place of the part ordered. Your local Tektronix Field Engineering Office has knowledge of these changes and may call you if a change in your purchase order is necessary. Replacement information sometimes accompanies the improved components to aid their installation.

When ordering parts, be sure to include both the description of the part and the 6-digit Tektronix part number found in the Parts List. For example, if the serial number of your Type 130 L-C Meter were 351, a certain capacitor would be ordered as follows: C30, .001 microfarad, fixed, mica, 500 v, 1%, part number 283-526, for Type 130 L-C Meter, Serial Number 351.

Trouble Shooting

If the instrument fails to operate and the pilot light does not light, check the source of ac power and see whether the connecting cord is firmly seated. Then check the 0.8-amp line fuse at the back of the instrument near the power plug. A good way to check the fuse is to replace it with a good one. The ac circuit to the power transformer is completed through the RANGE-SELECTOR switch. Check the switch contracts. To make this check, you will need to remove the case.

Some cases have side panels held in place by small screwhead fasteners. To remove the panels, use a screwdriver to rotate the fasteners approximately two turns counter-clockwise. Then pull the upper portion of the panels outward from the handle. Other cases do not have the side panel fasteners, but the whole case is removed. To remove this case, twist the slotted fastener, at the rear of the case, counter-clockwise and the case will come loose. Disconnect the power plug and you can then slide the instrument forward out of the case. Cases are replaced by reversing the order of their removal.

WARNING: The power supply furnishes 270 volts dc across a 30-μf capacitor, so be careful to avoid contact with it when the instrument is operating.

Troubles are usually caused by tube failure, and you can frequently correct them by simply finding the bad tube and replacing it with a good one. However, sometimes a bad tube burns resistors or overstresses capacitors when it fails, and in these cases you will also have to find the bad components. Sometimes you can find them by visual inspection.

Since troubles are usually caused by tube failure, be sure you investigate this possiblity before adjusting the interior controls. One way to find bad tubes is to replace all the tubes with good ones. If this helps the troubles, try putting the old tubes back, one at a time, until the bad tube is discovered.

Tube failure will often show up in the voltage readings of the power supply. So, another early step to take in looking for trouble is to check the dc voltages. The two supply voltages appear conveniently at the two ends of R403, a ceramic wire-wound resistor mounted behind the power transformer on the same side of the chassis (see Figure 5-3). The outside terminal should measure +150 volts ±5 volts and the terminal nearest to the chassis should read approximately 270 volts, depending on the line voltage. There is no voltage adjustment, and if the voltages are off it is a sign of trouble elsewhere in the circuit. The +150 volt can be checked also at the check point indicated in Figure 5-2.

Total dc current from the rectifier should be about 35 ma, of which 21 ma goes to the circuits connected to the 150-volt bus and the remainder, about 14 ma, goes through the regulator tube, when the ac supply is at 115 volts. Current to other circuits connected to the 270-volt bus is a fraction of a milliampere.

You can check the indicating meter by connecting another milliameter across it. The meter is connected to the +150-volt bus, so be careful not to get a terminal grounded.

The variable oscillator may be checked for operation by connecting an oscilloscope to the GUARD VOLTAGE terminal. The guard voltage will be about half a volt peak-to-peak at 120 to 140 kc. The fixed oscillator can be checked at pin 6 of V45. These points can also be checked with an ac voltmeter capable of reading a fraction of a volt at 140 kc.

This is a fairly complex electronic device and there is no simple way to find troubles. With a good understanding of the circuits you will be able to make a good guess at the source of the trouble from the symptoms. Be sure that any difficulty you are having does not come from the settings of the front-panel controls.

Soldering and Ceramic Strips

Many of the components in your Tektronix instrument are mounted on ceramic terminal strips. The notches in these strips are lined with silver alloy. Repeated use of excessive heat, or use of ordinary tin-lead solder will break down the silver-to-ceramic bond. Occasional use of tin-lead solder will not break the bond if excessive heat is not applied.

If you are responsible for the maintenance of a large number of Tektronix instruments, or if you contemplate frequent parts changes, we recommend that you keep on hand a stock of solder containing about 3% silver. This type of solder is used frequently in printed circuitry and should be readily available from radio-supply houses. If you prefer, you can order the solder directly from Tektronix in one-pound rolls. Order by Tektronix part number 251-514.

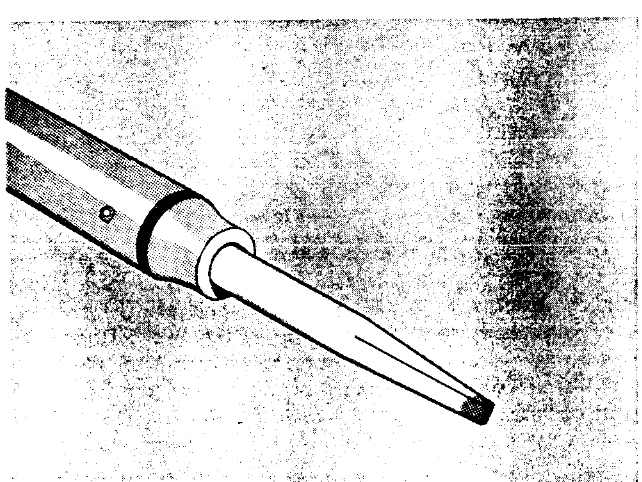


Fig. 4-1. Soldering tip preparation.

Because of the shape of the terminals on the ceramic strips it is advisable to use a wedge-shaped tip on your soldering iron when you are installing or removing parts from the strips. Fig. 4-1 will show you the correct shape for the tip of the soldering iron. Be sure and file smooth all surfaces of the iron which will be tinned. This prevents solder from building up on rough spots where it will quickly oxidize.

When removing or replacing components mounted on the ceramic strips you will find that satisfactory results are obtained if you proceed in the manner outlined below.

1. Use a soldering iron of about 75-watt rating.
2. Prepare the tip of the iron as shown in Fig. 4-1.
3. Tin only the first 1/16 or 1/8 inch of the tip. For solder to ceramic terminal strips tin the iron with solder containing about 3% silver.
4. Apply one corner of the tip to the notch where you wish to solder (see Fig. 4-2).
5. Apply only enough heat to make the solder flow freely.
6. Do not attempt to fill the notch on the strip with solder; instead, apply only enough solder to cover the wires adequately, and to form a slight fillet on the wire as shown in Fig. 4-3.

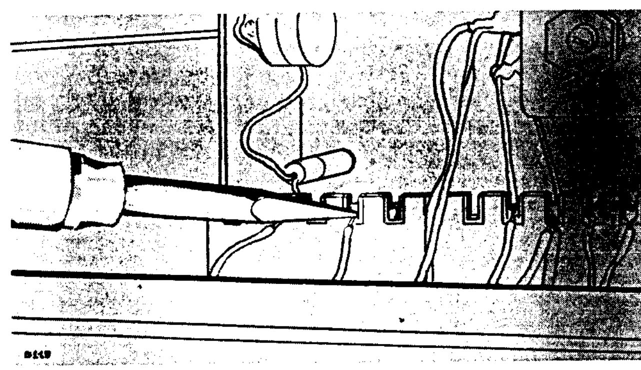


Fig. 4-2. Applying iron tip to strip.

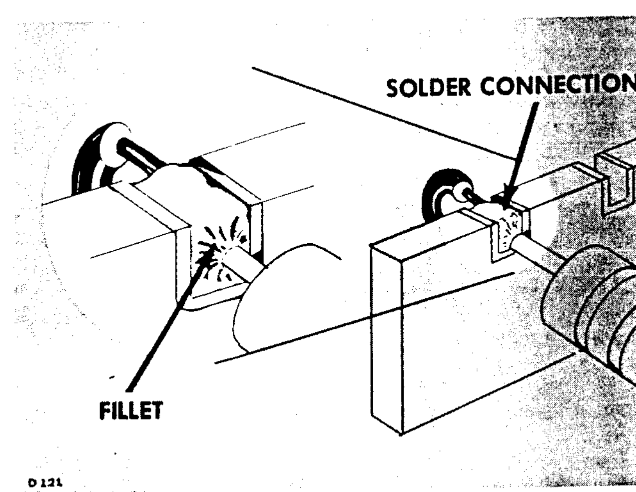


Fig. 4-3. Fillet on wire.

In soldering to metal terminals (for example, pins on a tube socket) a slightly different technique should be employed. Prepare the iron as outlined above, but tin with ordinary tin-lead solder. Apply the iron to the part to be soldered as shown in Fig. 4-4. Use only enough heat to allow the solder to flow freely along the wire so that a slight fillet will be formed as shown in Fig. 4-3.

General Soldering Considerations

When replacing wires in terminal slots clip the ends neatly as close to the solder joint as possible. In clipping the ends of wires take care the end removed does not fly across the room as it is clipped.

Occasionally you will wish to hold a bare wire in place as it is being soldered. A handy device for this purpose is a short length of wooden dowel, with one end shaped as shown in Fig. 4-5. In soldering to terminal pins mounted in plastic rods it is necessary to use some form of "heat sink"

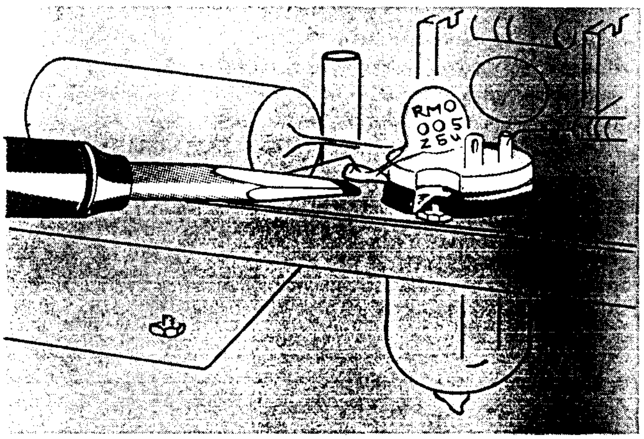


Fig. 4-4. Soldering to metal terminals.

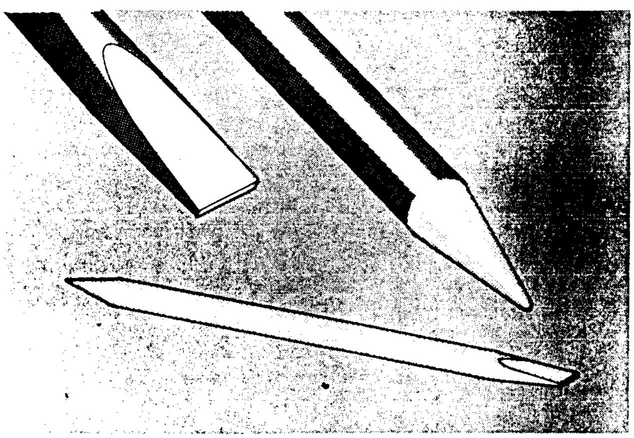


Fig. 4-5. Wooden dowel

to avoid melting the plastic. A pair of long-nosed pliers (see Fig. 4-6) makes a convenient tool for this purpose.

Ceramic Strips

Two distinct types of ceramic strips have been used in Tektronix instruments. The earlier type mounted on the chassis by means of #2-56 bolts and nuts. The later type is mounted with snap-in, plastic fittings. Both styles are shown in Fig. 4-7.

To replace ceramic strips which bolt to the chassis, screw a #2-56 nut onto each mounting bolt, positioning the bolt so that the distance between the bottom of the bolt and the

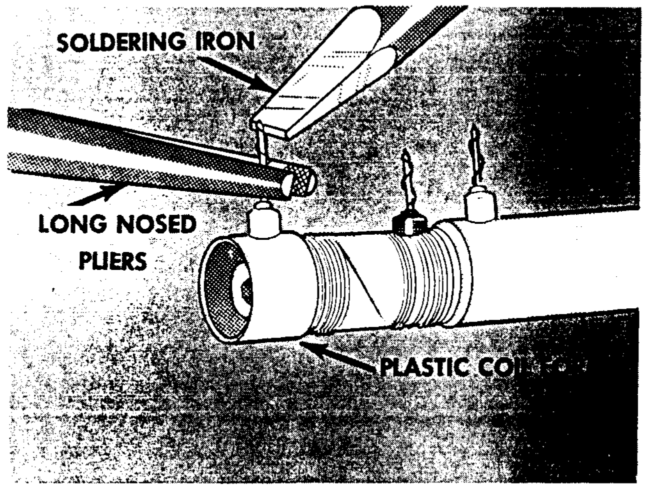


Fig. 4-6. Long-nosed pliers as "heat sink".

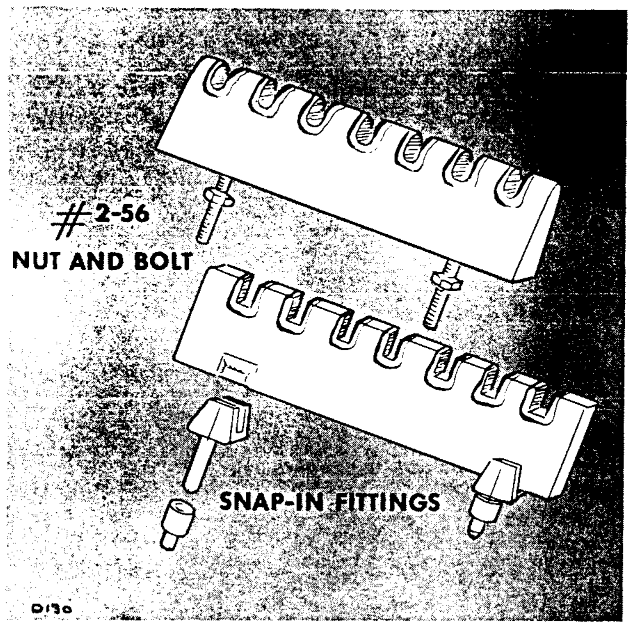
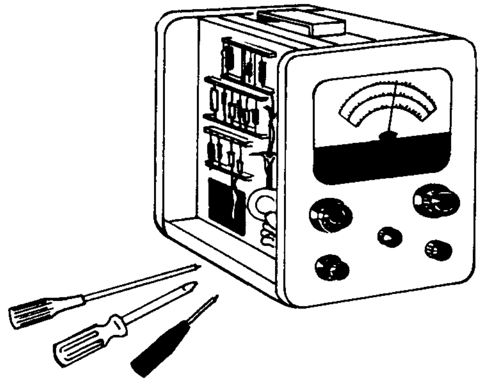


Fig. 4-7. Ceramic strips and fittings.

bottom of the ceramic strip equals the height at which you wish to mount the strip above the chassis. Secure the nuts to the bolts with a drop of red glyptal. Insert the bolts through the holes in the chassis where the original strip was mounted, placing a #2 starwasher between each nut and the chassis. Place a second set of #2 starwashers on the protruding ends of the bolts, and fasten them firmly with another set of #2-56 nuts. Place a drop of red glyptal over each of the second set of nuts after fastening.

To replace ceramic strips which mount with snap-in plastic fittings, first remove the original fittings from the chassis. Assemble the mounting post on the ceramic strip. Insert the nylon collar into the mounting holes in the chassis. Carefully force the mounting posts into the nylon collars. Snip off the portion of the mounting post which protrudes below the nylon collar on the reverse side of the chassis.

Note: Considerable force may be necessary to push the mounting rods into the nylon collars. Be sure that you apply this force to the upper ends of the mounting rods rather than to the ceramic strip.



SECTION 5

CALIBRATION PROCEDURE

Ordinarily you will not need to calibrate this instrument except after tube replacement, and then the calibration required will be less extensive than the calibration procedure which follows. If in doubt as to the effect of an adjustment you wish to make we suggest that you run through the complete calibration procedure.

Equipment Required

The following equipment is necessary for a complete calibration of the Type 130 L-C Meter:

(1.) Tektronix Type S-30 Delta Standards and connectors.

(2.) DC voltmeter.

(3.) Either an accurate frequency meter, such as a Type LM-13 or Type BC-221, an oscilloscope with accurately calibrated sweep rates including 5 and 20 μsec/CM and band pass of at least 500 kc, for example a Tektronix 530 or 540 series.

(4.) Low-Capacitance Recalibration Tools: See Recalibration Tools in the Accessories Section of the Operator's Manual.

Adjustment Procedure

Remove side panels of L-C Meter. Zero adjust meter with screwdriver. Check power supply at check point (see Figure 5-3) for +150 volts ± 5 volts. There is a 21 ma load plus 4 ma shunted through the regulator V402.

1. Fixed-Oscillator Frequency

The fixed oscillator should be set to a frequency of 140 kc $\pm 1/2$ kc by one of the following methods:

(a.) Measure the frequency by comparing a Type BC-221 or a Type LM-13 with the signal from the fixed oscillator as it appears at Pin 6 of V45. Figure 5-3 shows the test point. Frequency adjustment is made with the slug in the top of the inductor T30 (see Figure 5-4).

(b) Connect the scope probe to the FIXED OSCILLATOR CHECK POINT as shown on Fig. 5-3, and set the scope TIME/CM to 5 μsec/CM. Adjust screw in T30 so seven cycles appear on the scope as shown in Fig. 5-2.

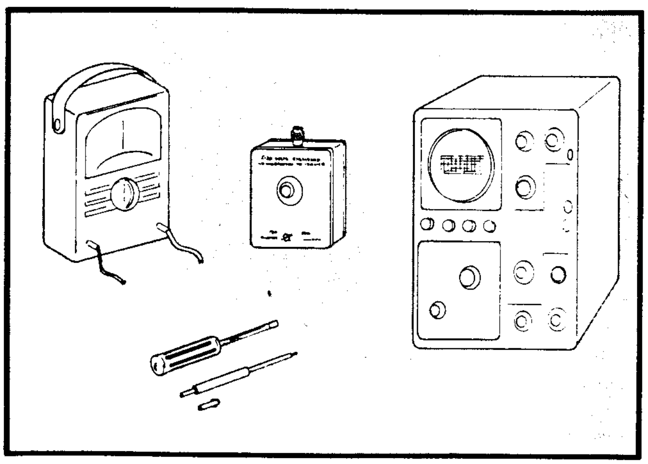


Fig. 5-1. Equipment needed for calibration of Type 130 L-C Meter.

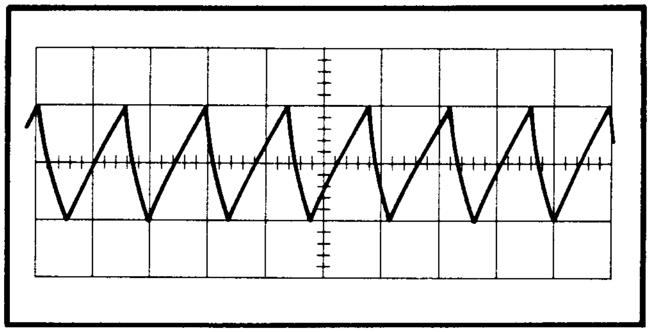


Fig. 5-2

2. Variable-Oscillator Frequency

Set the COARSE ZERO control about 10 degrees above right horizontal, and the FINE ZERO control at full capacitance, index horizontal to the right. Set the internal screwdriver control, C2 (see Figure 5-4), at mid-range, slot vertical. C2 is mounted on the FINE ZERO capacitor.

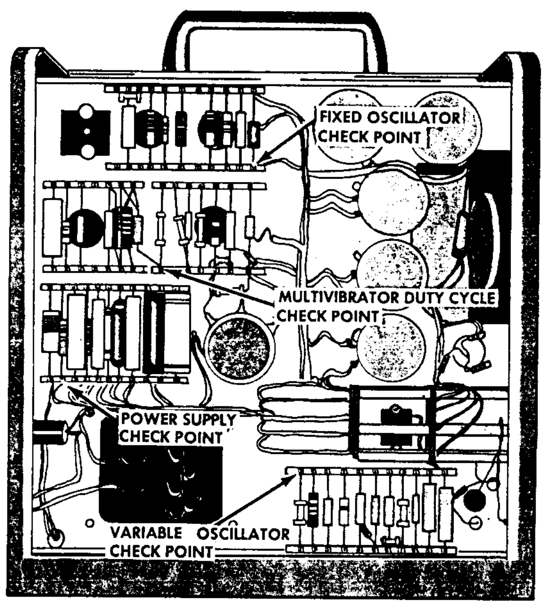


Fig. 5-3 Left side view showing test points.

Set the variable oscillator also to 140 kc by adjusting the tuning slug in T1 (Figure 5-4). The variable-oscillator signal appears at the GUARD VOLTAGE terminal, and the VARIABLE OSCILLATOR CHECK POINT, Fig. 5-3.

3. ADJUST 1 and ADJUST 2

Turn ADJUST 1 until a reading is obtained on the meter. Connect the 10X probe to MULTIVIBRATOR DUTY CYCLE CHECK POINT. Set scope TIME/CM for 20 μsec. Connect the S-30 Delta Standard to the UNKNOWN connector on the 130 and set the RANGE SELECTOR on both units to the 300 μμf range.

4. Multivibrator Duty Cycle, ADJ. 1 R68

Set ADJUST 1 until a symmetrical square wave is seen on the scope. Set the S-30 to 0 μμf and the 130 to the 10 μμf range and adjust COARSE and FINE ZERO on the 130 so the meter reads at 0. For a closer adjustment on the ZERO settings, make final adjustments with the 130 on the 3 μμf range. Now switch both units to the 300 μμf range and set ADJUST 2 so the meter reads full scale. These adjustments are interacting, so should be gone over several times.

5. LC Compensation

Set the S-30 to SHORT/CIRCUIT and the L-C Meter to 3 μh. Now carefully adjust the L-C Meter to zero. Set the S-30 to 300 μh and the L-C Meter to the 300 μh range. Carefully read the amount of error. Leaving all other controls as they are, adjust the tuning slug in T1 so as to increase the error by a factor of three.

Then set the S-30 to 0 μμf, and readjust the L-C Meter ZERO controls. Repeat step 4, which adjusts the 300-μμf range. Recheck the 300 μh reading again. If any error remains, repeat the procedure.

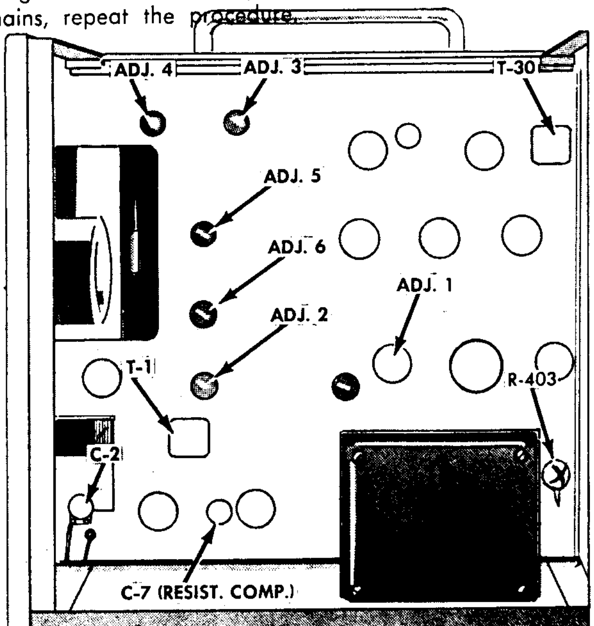


Fig. 5-3. Right side view showing calibration control adjustments.

6. O-3 Range. ADJ. 3 R100

Set the L-C Meter to zero indication with the S-30 at 0 μμf and the L-C Meter on the 3 μμf range, using the coarse and fine controls.

Then set the S-30 to + 3 μμf and set ADJ. 3 pot, so the indicating meter reads full scale.

Now set the S-30 to — 3 μμf and check to see if the meter still reads at full scale. If not, adjust FINE ZERO so meter is at full scale.

Reset the S-30 to + 3 μμf and reset ADJ. 3 if necessary for full scale reading.

This procedure minimizes a small error in zero setting that may occur when the case is off due to lock in of the two oscillators.

7. 0-10 Range, ADJ. 4, R99

Set the S-30 to 10 μμf and the L-C Meter to 10 μμf. Set the ADJ. 4 control so that the indicating meter reads full scale.

8. O-30 Range, ADJ. 5, R98

Set the S-30 to 30 μμf and the L-C Meter to 30 μμf. Set the ADJ. 5 control (see Figure 5-3) so that the indicating meter reads full scale.

9. 0-100 Range, ADJ. 6, R97

Set the S-30 to 100 μμf and L-C Meter to 100 μμf. Set the ADJ. 6 control (see Figure 5-3) so that the indicating meter reads full scale.

With the S-30 at 0 μμf, set the L-C Meter ZERO controls to get S-30 to 1 megohm and adjust the ZERO control so the meter deflection indicates an even scale division. Switch the S-30 to 100 kilohm and see if there is any change in the deflection. If there is a change, adjust the RESIST. COMP. control, (see Figure 5-3), so the deflection is the same as for the 1-megohm position and repeat a time or two.

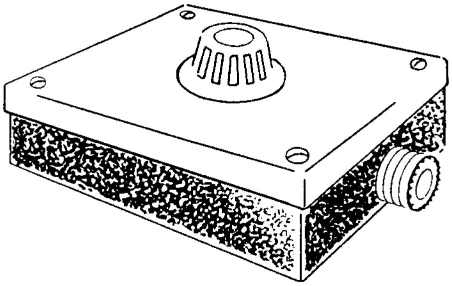
If you cannot find a satisfactory adjustment, try a new tube for V4, or interchange it with V15 or V45, and try the procedure again. Tubes that cannot be compensated by adjusment of C7 will drift in frequency when the line voltage changes.

Remove the S-30 from the L-C Meter. Set the COARSE ZERO and FINE ZEDO controls so they are fully meshed. Check behind the panel to be positive that the meshing is absolutely completed. Set the RANGE SELECTOR to the 10-μμf position and adjust C2, (see Figure 5-3), so the meter reads 7.5. Check whether the meter can be made to read zero with a small rotation to the left of the COARSE ZERO control.

12. CHECK THE ACCURACY OF THE GUARD VOLTAGE.

With no external devices or leads connected to the UNKNOWN connector, set the RANGE SELECTOR to the 3 $\mu\mu$f range. Adjust the ZERO control so the meter reads at mid scale of 1.5 $\mu\mu$f Now touch the center of the UNKNOWN connector with the tip of the finger and note which way the meter deflects. Next, hold a 100 $\mu\mu$f, $\pm 5\%$ capacitor in a pair of plastic tongs or other insulator, so as to avoid body capacity effects, touching one lead to the center of the UNKNOWN connector, and the other lead to the GUARD VOLTAGE terminal. If the meter deflects in the same direction as when touched with the finger, GUARD VOLTAGE is low. The deflection should be less than ½ $\mu\mu$f. If out of tolerance, try changing V110. If this does not correct it, change R112 to 2.7 or 3.3 meg. to bring it in. If meter deflects in the opposite direction as when touched with the finger, the guard voltage is high, however, the meter deflection tolerance on the high side is + 1 $\mu\mu$f.

NOTES



SECTION 6

DELTA STANDARD

Fig. 6-1. The S-30 Delta Standards.

The S-30 Delta Standards provides a means for calibrating the Type 130 L-C Meter. The accuracy of the S-30 is ±1% or better in all ranges.

The S-30 provides seven calibrated capacitance ranges, two precision resistors, and one standard inductance of 300 μh at 140 kc.

Equipment Required for Calibration of Delta Standards

A commerical impedance bridge with tolerances of ± one quarter of one per cent for capacitance, and one per cent for inductance.

Inductance Standardizer, to be constructed from the following specifications in the circuit diagram preceding all sections on the S-30 Delta Standards. The value of the capacitor and resistor must be within 2% of those shown. Figure 6-2 is a pictorial representation of the completed Inductance Standardizer.

Operation

Only the stray capacitance of the connector and switch assembly is in the circuit in the —3 μμfd position. The actual capacitance of these strays is approximately 10 to 20 μμfd. No effort is made to standardize this value. As the switch is rotated, capacitors are switched into the circuit to provide a change (or "Delta") of capacitance as indicated. In the 0 μμfd position, an additional 3 μμfd has been added in addition to the strays.

NOTE

Later models of the Type S-30 have the capacitance ranges marked in picofarads. Since one picofarad equals one micromicrofarad the actual value of capacitance selected remains unchanged.

Calibration of Capacitance Ranges

Calibration of the capacitance ranges is possible with most commercial bridges. The procedure is to measure the capacitance of the S-30 in the —3 μμfd position, then switch to the 0 μμfd position and determine if the "Delta" change is 3 μμfd ±1%. Adjustment of C-2 will be necessary if not within tolerance. Continue to switch to each range and measure the capacitance, adjusting the trimmer as indicated in Table I to give the correct "Delta" changes.

TABLE I

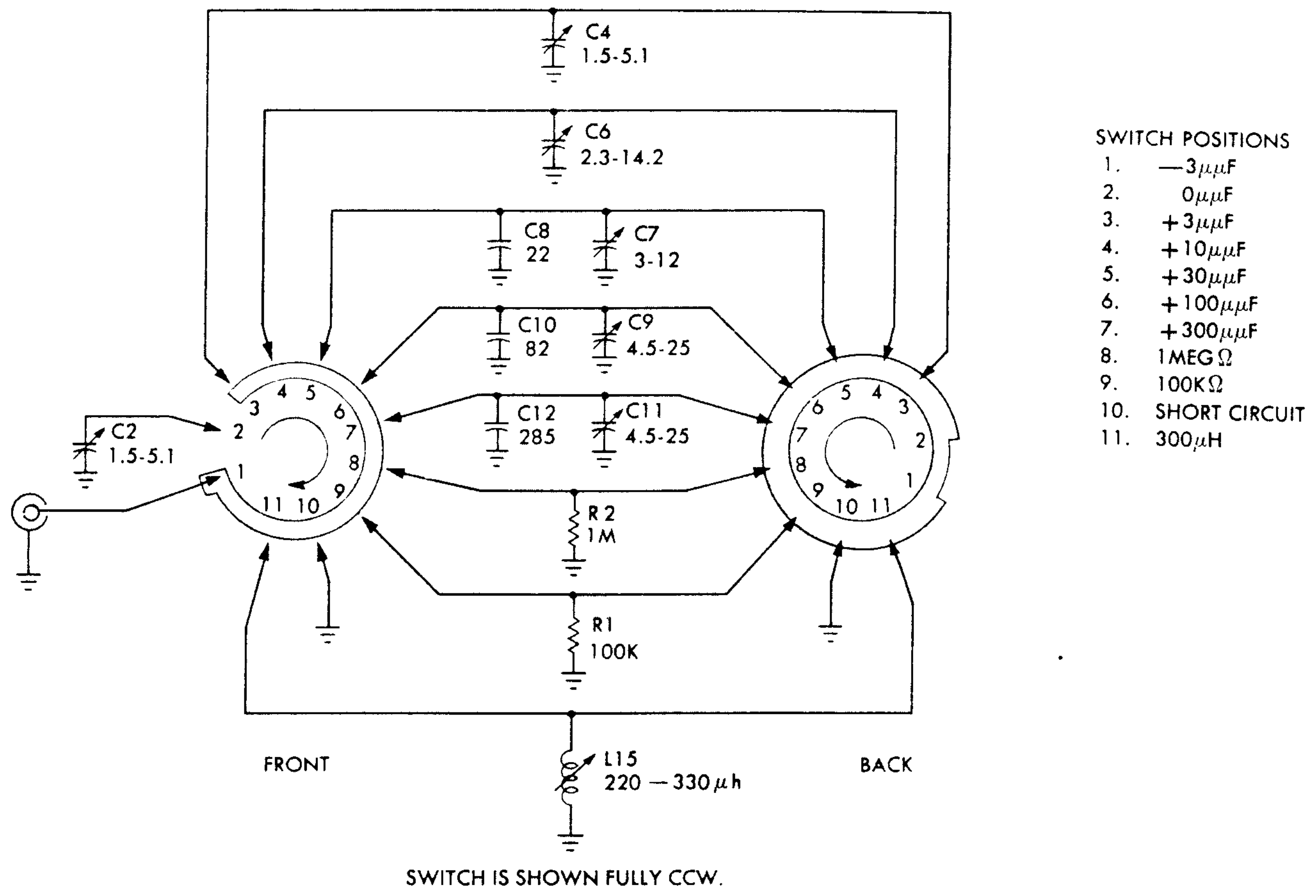
Switch Position	Typical Value	Adjustment
—3 μμfd	13 μμfd	None
0 μμfd	16 μμfd	C-2
+3 μμfd	19 μμfd	C-4
+10 μμfd	26 μμfd	C-6
+30 μμfd	46 μμfd	C-7
+100 μμfd	116 μμfd	C-9
+300 μμfd	316 μμfd	C-11

Calibration of Resistance Ranges

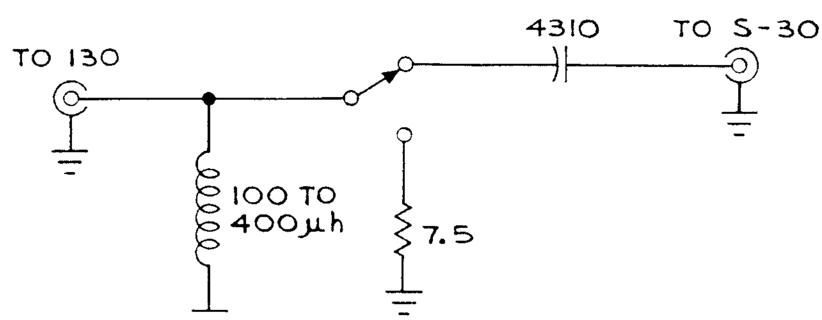
Two precision resistors of identical manufacture are used to standardize the resistance compensation. These can be checked for resistance value with any reliable bridge. If either resistor is out of tolerance, it is advisable to change both to maintain the balance of capacity, unless a resistor of similar manufacture is available.

Calibration of Inductance Ranges

Standardization of the 300 μh inductance is somewhat complicated since its value cannot be read directly with a "Bridge" type device. This is due to the fact that the circuit has stray capacitance in parallel with the inductance which will give false indications on a bridge due to the



TYPE S-30 DELTA STANDARD



INDUCTANCE STANDARDIZER

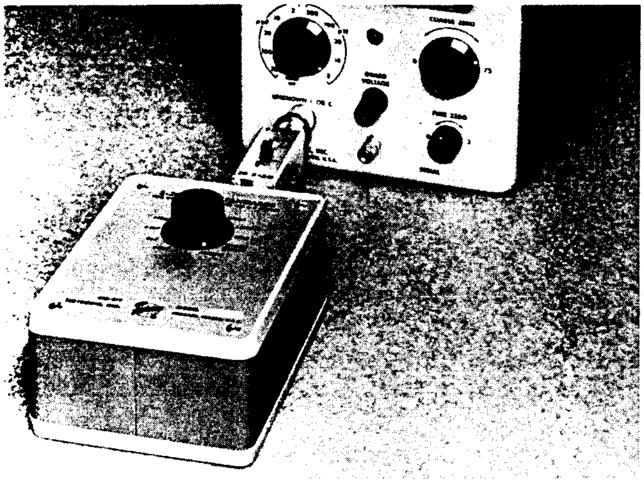


Fig. 6-2. The Type S-30 and the Type 130 L-C Meter connected with the Inductance Standardizer.

change in admittance caused by the stray capacitance. With the circuitry used in the Type 130 L-C Meter, only the inductance in the circuit materially affects the oscillator frequency.

To calibrate the 300 μh range of the Type S-30, construction of the Inductance Standardizer shown on the facing page is suggested. The value of the capacitor and resistor must be within 2% of those shown.

Connect the Type S-30, the Inductance Standardizer, and the Type 130 as shown in Fig. 6-2. Place the switch of the Type 130 in the 300 μh position. Depress the switch on the inductance standardizer. With the COARSE and FINE ZERO controls bring the meter reading of the Type 130 to 0. With the switch depressed, the 100-400 μh coil is parallel resonant with the internal capacity of the 130 LC meter, and the 7.5 Ω resistor replaces the DC resistance of the 300 μh coil in the 130.

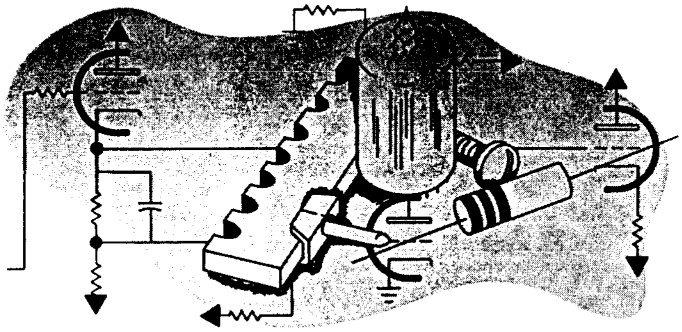
Release the shorting switch on the Inductance Standardizer and adjust L15 until the Type 130 meter reading is brought back to 0.

The 4310 $\mu\mu$f Capacitor in the Inductance Standard is series resonant with the 300 μh coil in the type 130 at 140 KC, and the 130 sees only the 7.5 Ω resistnce of the coil.

After completing the adjustment, lock the slug of L15 in place.

Replace the outer case of the Type S-30.

NOTES



SECTION 7

PARTS LIST AND SCHEMATICS

ABBREVIATIONS

Cer.	Ceramic	n	Nano or 10^{-9}
Comp.	Composition	Ω	ohm
EMC	Electrolytic, metal cased	p	Pico or 10^{-12}
f	Farad	PTB	Paper, "Bathtub"
G	Giga, or 10^{9}	PMC	Paper, metal cased
GMV	Guaranteed minmum value	Poly.	Polystyrene
h	Henry	Prec.	Precision
K or k	Kilohms or kilo (10^{3})	PT	Paper Tubular
M/Cer.	Mica or Ceramic	T	Terra or 10^{12}
M or meg	Megohms or mega (10^{6})	v	Working volts DC
μ	Micro. or 10^{-6}	Var.	Variable
$\mu\mu$	Micromicro or 10^{-12}	w	Watt
m	milli or 10^{-3}	WW	Wire-wound

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number.

000X Part removed after this serial number.

*000-000 Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

Use 000-000 Part number indicated is direct replacement.

HOW TO ORDER PARTS

Replacement parts are available from or through your local Tektronix Field Office.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Field Office will contact you concerning any change in part number.

PARTS LIST

*000-000 Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

Capacitors

							Part Number Tektronix
C1		.1 μf	PT	Fixed	400 v	20%	285-526
C2		5-25 μμf	Cer.	Var.	500 v		281-011
C3		1-4 μμf	Air	Var.			281-015
C4		5-80 μμf	Air	Var.			281-016
C5		.001 μf	Mica	Fixed	500 v	1%	283-526
C6		470 μμf	Cer.	Fixed	500 v	20%	281-525
C7	101-5108	5-25 μμf	Cer.	Var.			281-011
	5109-up	8-50 μμf	Cer.	Var.			281-013
C9		.01 μf	PT	Fixed	400 v	20%	285-510
C10		22 μμf	Cer.	Fixed	500 v	10%	281-511
C11		.001 μf	Cer.	Fixed	500 v	GMV	283-000
C15		22 μμf	Cer.	Fixed	500 v	20%	281-510
C17		100 μμf	Cer.	Fixed	350 v	20%	281-523
C18		.005 μf	Cer.	Fixed	500 v	GMV	283-001
C30		.001 μf	Mica	Fixed	500 v	1%	283-526
C31		470 μμf	Cer.	Fixed	500 v	20%	281-525
C33		.01 μf	PT	Fixed	400 v	20%	285-510
C35		.001 μf	Cer.	Fixed	500 v	GMV	283-000
C36		22 μμf	Cer.	Fixed	500 v	10%	281-511
C45		22 μμf	Cer.	Fixed	500 v	20%	281-510
C47		100 μμf	Cer.	Fixed	350 v	20%	281-523
C48		.005 μf	Cer.	Fixed	500 v	GMV	283-001
C60		.02 μf	Cer.	Fixed	150 v	GMV	283-004
C61		150 μμf	Cer.	Fixed	500 v	20%	281-524
C62		100 μμf	Cer.	Fixed	350 v	20%	281-523
C63		470 μμf	Cer.	Fixed	500 v	20%	281-525
C64		47 μμf	Cer.	Fixed	500 v	10%	281-519
C65		47 μμf	Cer.	Fixed	500 v	10%	281-519
C73		4.7 μμf	Cer.	Fixed	500 v	±0.1 μμf	281-501
C90		250 μμf	Mica	Fixed	500 v	5%	283-543
C91		.0015 μf	PT	Fixed	400 v	20%	285-504
C92		.0047 μf	PT	Fixed	400 v	20%	285-506
C93		.015 μf	PT	Fixed	400 v	20%	285-512
C94		.047 μf	PT	Fixed	400 v	20%	285-519
C97	X259-up	470 μμf	Cer.	Fixed	500 v	20%	281-525
C99	X6040-up	5 μf	EMT	Fixed	6 v		290-125
C100	X6040-up	25 μf	EMT	Fixed	6 v		290-124
C110		.022 μf	PT	Fixed	400 v	20%	285-515
C112		.001 μf	Cer.	Fixed	500 v	GMV	283-000
C401		2X15 μf	EMC	Fixed	350 v	—20+50%	290-034
C402		6.25 μf	EMC	Fixed	300 v	—20+50%	290-000
C403		.022 μf	PT	Fixed	400 v	20%	285-515

Fuses

			Tektronix Part Number
Fuse		0.8 amp 3 AG Slo-Blo for 117 v operation	159-018
Fuse		0.4 amp 3 AG Slo-Blo for 234 v operation	159-031

Meters

Meter	101-5167	4700 Ω	050-013
	5168-up	0-200 μa	149-010

Resistors

R1		10 meg	½ w	Fixed	Comp.	10%	302-106
R6		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R7		100 k	½ w	Fixed	Comp.	10%	302-104
R8		1 meg	½ w	Fixed	Comp.	10%	302-105
R9		56 k	½ w	Fixed	Comp.	10%	302-563
R10		470 k	½ w	Fixed	Comp.	10%	302-474
R14		10 meg	½ w	Fixed	Comp.	10%	302-106
R15		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R16		47 Ω	½ w	Fixed	Comp.	10%	302-470
R17		1 meg	½ w	Fixed	Comp.	10%	302-105
R18		1 meg	½ w	Fixed	Comp.	10%	302-105
R19		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R31		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R32		100 k	½ w	Fixed	Comp.	10%	302-104
R33		56 k	½ w	Fixed	Comp.	10%	302-563
R35		470 k	½ w	Fixed	Comp.	10%	302-474
R45		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R46		47 Ω	½ w	Fixed	Comp.	10%	302-470
R47		1 meg	½ w	Fixed	Comp.	10%	302-105
R48		1 meg	½ w	Fixed	Comp.	10%	302-105
R49		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R60		47 k	½ w	Fixed	Comp.	10%	302-473
R61		22 k	½ w	Fixed	Comp.	5%	301-223
R62		22 k	½ w	Fixed	Comp.	5%	301-223
R64		11 k	½ w	Fixed	Comp.	5%	301-113
R67		100 k	½ w	Fixed	Comp.	10%	302-104
R68		50 k	2 w	Var.	Comp.	20%	311-023
R69	X435-up	10 k	½ w	Fixed	Comp.	10%	302-103
R70		6.8 k	½ w	Fixed	Comp.	10%	302-682
R71		5.6 k	1 w	Fixed	Comp.	5%	303-562
R72		180 k	½ w	Fixed	Comp.	5%	301-184
R73		470 k	½ w	Fixed	Comp.	5%	301-474
R74		15 k	1 w	Fixed	Comp.	10%	304-153
R75		330 k	½ w	Fixed	Comp.	10%	302-334
R76		47 Ω	½ w	Fixed	Comp.	10%	302-470
R77		4.7 meg	½ w	Fixed	Comp.	10%	302-475
R78		100 k	2 w	Var.	Comp.	20%	311-026
R79		82 k	½ w	Fixed	Comp.	10%	302-823
R80		47 Ω	½ w	Fixed	Comp.	10%	302-470
R81		47 Ω	½ w	Fixed	Comp.	10%	302-470

Resistors *(continued)*

								Tektronix Part Number
R95		33 k	2 w	Fixed	Comp.	10%		306-333
R96		470 Ω	½ w	Fixed	Comp.	10%		302-471
R97		10 k	2 w	Var.	WW	20%		311-015
R98		10 k	2 w	Var.	WW	20%		311-015
R99		10 k	2 w	Var.	WW	20%		311-015
R100		10 k	2 w	Var.	WW	20%		311-015
R110		1 meg	½ w	Fixed	Comp.	10%		302-105
R111		10 k	½ w	Fixed	Comp.	10%		302-103
R112		2.2 meg	½ w	Fixed	Comp.	10%		302-225
R113		4.7 meg	½ w	Fixed	Comp.	10%		302-475
R116		47 Ω	½ w	Fixed	Comp.	10%		302-470
R401		100 k	½ w	Fixed	Comp.	10%		302-104
R402		100 k	½ w	Fixed	Comp.	10%		302-104
R403	101-753	3.5 k	20 w	Fixed	WW	5%		308-032
R403	754-up	3 k	10 w	Fixed	WW	5%		308-020
R405		1.5 Ω	1 w	Fixed	WW	10%		308-058

Switches

SW1	3 wafer, 11 position, rotary RANGE SELECTOR	*260-072

Transformers

T1	Oscillator Transformer	120-053
T30	Oscillator Transformer	120-053
T400	Plate and Heater Supply T130 PA 1 Primary: 117-234 vac, 60 cycles Secondary: 240-0-240 vac at 40 ma 6.5 vac at 4 amp	*120-038

Vacuum Tubes

V4	6U8	154-033
V15	6U8	154-033
V30	6U8	154-033
V45	6U8	154-033
V60	6BE6	154-025
V70	6U8	154-033
V76	6DJ8	Use 154-187
V110	6BH6	154-026
V400	6X4	154-035
V403	OA2	154-001

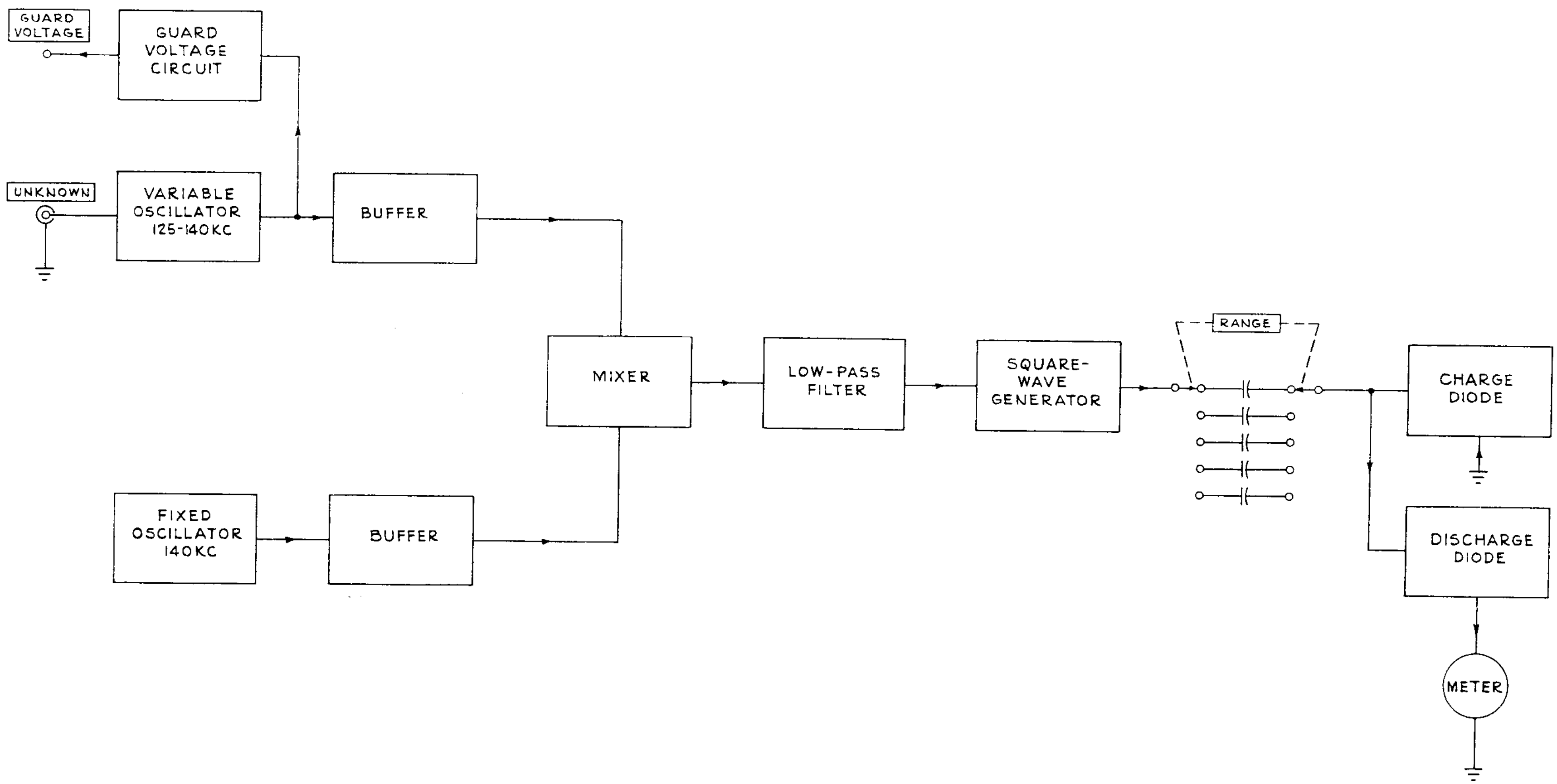
Type 130
Mechanical Parts List

	Tektronix Part Number
BAR, $^3/_{16} \times ^1/_2 \times 1$	381-084
BAR, EXTRUDED $8^7/_{16}$ LG., BLUE VINYL FINISH	381-159
BRACKET, TRANSFORMER MTG SN X7580-up	406-872
BUSHING, NYLON, FOR 5-WAY BINDING POST	358-036
CABINET SN 101-5000X	437-021
CABLE, HARNESS, 130	179-051
CAP, FUSE, 3AG, RAW	200-015
CHASSIS SN 101-5000	441-074
CHASSIS SN 5001-up	441-153
CONNECTOR, CHASSIS MT. COAX 83-IRTY	131-012
CONNECTOR, CHASSIS MT. 2 WIRE SN 101-5496	131-010
CONNECTOR, CHASSIS MT. 3 WIRE SN 5497-up	131-102
EYELET, TAPERED BARREL	210-601
GROMMET, RUBBER, $^1/_4$	348-002
GROMMET, RUBBER, $^5/_{16}$	348-003
HANDLE, DRAWER SN X5001-up	367-007
HOLDER, FUSE 3AG	352 -010
KNOB, SMALL BLACK, $^1/_4$ INSERT HOLE	366-033
KNOB, LARGE BLACK, $^1/_4$ HOLE PART WAY	366-042
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, INT. #8	210-008
LOCKWASHER, INT. #10	210-010
LOCKWASHER, INT. $^3/_8 \times ^{11}/_{16}$	210-013
LUG, SOLDER, SE4	210-201
LUG, SOLDER, SE6	210-202
LUG, SOLDER, SE10, LONG	210-206
LUG, SOLDER, POT, PLAIN, $^3/_8$	210-207
NUT, HEX 2-56 x $^3/_{16}$	210-405
NUT, HEX 4-40 x $^3/_{16}$	210-406
NUT, HEX 6-32 x $^1/_4$	210-407
NUT, HEX $^3/_8$-32 x $^1/_2$	210-413
NUT, HEX 10-32 x $^3/_8$ x $^1/_8$ THICK	210-445
NUT, KEPS 6-32 x $^5/_{16}$	210-457

	Tektronix Part Number
NUT, HEX, ALUM. 6-32 x 5/16, 5-10 W RES. MTG.	210-478
NUT, KEPS STEEL 10-32 x 3/8	220-410
PANEL, FRONT SN 101-5000	333-023
PANEL, FRONT SN 5001-5167	333-334
PANEL, FRONT SN 5168-up	333-427
PLATE, FRAME TOP SN 101-5000X	387-534
PLATE, FRAME BOTTOM SN 101-5000X	387-533
PLATE, SUBPANEL, BACK SN X5001-up	386-603
PLATE, SUBPANEL, FRONT SN 101-5000	386-354
PLATE, SUBPANEL, FRONT SN 5000-5167	386-604
PLATE, SUBPANEL, FRONT SN 5168-up	386-763
PLATE, CABINET SIDE BLUE WRINKLE SN 5001-6213	386-539
PLATE, CABINET SIDE BLUE VINYL SN 6214-up	387-027
PLATE, CABINET BOTTOM BLUE WRINKLE SN 5001-6213	386-538
PLATE, CABINET BOTTOM BLUE VINYL SN 6214-up	387-028
PLATE, REAR OVERLAY BLUE WRINKLE SN 5001-6213	386-643
PLATE, REAR OVERLAY BLUE VINYL SN6214-up	387-035
POST, BINDING (ASS'Y OF 355-503 & 200-072)	129-020
POST, BINDING 5-WAY STEM & CAP ASS'Y	129-036
RING, SECURING, POLYETHEYLENE, 1/2 ID x 9/16 OD x 1/2 HI	354-068
SCREW, 2-56 x 7/8 RHS	211-003
SCREW, 4-40 x 1/4 BHS	211-008
SCREW, 4-40 x 1/4 FHS	211-023
SCREW, 4-40 x 5/16 PAN HS W/LOCKWASHER	211-033
SCREW, 6-32 x 5/16 BHS	211-507
SCREW, 6-32 x 5/16 PHS W/LOCKWASHER	211-534
SCREW, 6-32 x 3/8 TRUSS HS, PHILLIPS SLOT	211-537
SCREW, 6-32 x 5/16 FHS 100°, PHILLIPS SLOT	211-538
SCREW, 6-32 x 5/16 THS	211-542
SCREW, 6-32 x 1 1/2 RHS, PHILLIPS	211-553
SCREW, 8-32 x 5/16 BHS	212-004
SCREW, 8-32 x 3 3/4 HHS	212-077
SCREW, THREAD FORMING, #4 x 1/4 PHS	213-088
SOCKET, STM7G	136-008
SOCKET, STM9G	136-015
SOCKET, LIGHT, W/#14 LIGHT RED JEWEL ASS'Y SN 5168-up	136-047
SPACER, NYLON, 3/8 FOR CERAMIC STRIP SN 5690-up	361-009
STRIP, CERAMIC 3/4 x 7 NOTCHES, CLIP MTD. SN 101-5689	124-014
STRIP, CERAMIC 3/4 x 7 NOTCHES SN 5690-up	124-089
STRIP, CERAMIC 3/4 x 11 NOTCHES, CLIP MTD. SN 101-5689	124-016

Mechanical Parts List *(continued)*

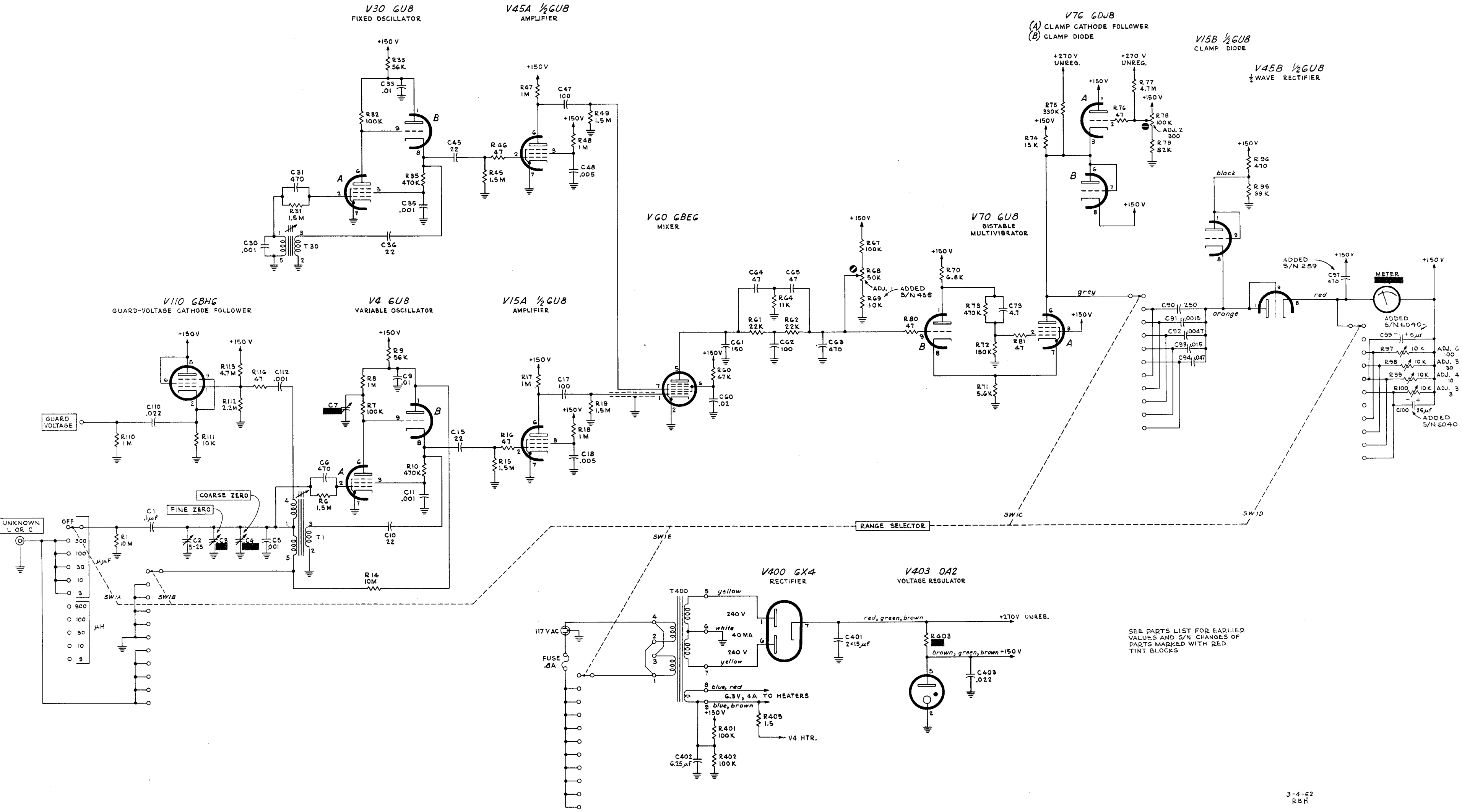
	Tektronix Part Number
STRIP, CERAMIC $^3/_4$ x 11 NOTCHES SN 5690-up	124-091
TAG, VOLTAGE RATING 117 V	334-649
WASHER, STEEL 5S x $^9/_{32}$	201-801
WASHER, STEEL 6L x $^3/_8$	210-803
WASHER, STEEL .390 ID x $^9/_{16}$ OD	210-840
WASHER, RUBBER, FOR FUSE HOLDER	210-873



TYPE 130 L-C METER

BLOCK DIAGRAM

AA1



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

3-4-62
RBH

TYPE 130 L,C METER