INSTRUMENT REFERENCE BOOK
for the Tektronix types

time-mark generators

For all serial numbers

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## 14 Time-Mark Intervals

Two per decade from $1 \mu \mathrm{sec}$ to 5 sec , available separately or in combinations as a timing comb.

## Three Sine-Wave Frequencies

$5 \mathrm{mc}, 10 \mathrm{mc}$, and 50 mc .

## Six Trigger-Rate Frequencies

$1,10,100$ cycles, $1,10,100 \mathrm{kc}$.

## Accuracy Within $0.001 \%$

Stability of 3 parts per million over a 24 -hour period.

The Type 180A Time-Mark Generator is a high-quality source of time markers, sine waves and trigger impulses. Fourteen time markers, 3 sine-wave frequencies and 6 trigger-rate frequencies provide instrument versatility for a large number of applications in the laboratory or on the production line. With its frequency accuracy of $.001 \%$ and stability of 3 ppm , the Type 180A is an ideal calibrating source for oscilloscope sweeps, oscillators, and counters. It can also be used as a time-measuring instrument and as a trigger-rate generator. Markers can be presented separately or mixed into a timing-comb combination.

## CHARACTERISTICS

Time Markers-Time markers occur at intervals of $1,5,10,50,100,500 \mu \mathrm{sec}, 1,5,10,50,100,500 \mathrm{milli}-$ $\mathrm{sec}, 1 \mathrm{sec}$ and 5 sec . Markers are available separately and simultaneously through banana jacks, or mixed into a timing combination through a push-button arrangement and available at a coaxial connector.


Sine Waves-Push-button switches connect the sinewave frequencies of $5 \mathrm{mc}, 10 \mathrm{mc}$ or 50 mc to the output connector. Output is 3 volts minimum across 50 ohms.

Trigger-Rate Generator-Trigger-rate frequencies of $1,10,100$ cycles, 1,10 , and 100 kc are derived from the dividing multivibrators. Output is through a frontpanel coaxial connector.

Timing comb formed by a combination of 100,500 $\mu \mathrm{sec}, 1$, and 5 msec markers. Sweep time/cm, 1 msec.


Stabillity-All outputs are derived from a 1-mc crystal-controlled oscillator with a frequency tolerance of about $0.001 \%$. The $1-\mathrm{mc}$ crystal is mounted in a temperature-stabilized oven and a trimmer capacitor provides a means of adjusting the crystal frequency to zero beat with W.W.V. Stability is within 3 parts per million over a 24 -hour period.

Regulated Power Supply-Electronica!ly-regulated dc supplies insure stable operation over line-voltage and load variations between 105 and 125 v or 210 and $250 \mathrm{v}, 50-60$ cycles.

Power Requirement- 105 v to 125 v or 210 v to $250 \mathrm{v}, 50$ to 60 cps , typically 240 watts at 117 v .

Mechanical Specificattions-Dimensions are $133 / 4$ " high by $10^{\prime \prime}$ wide by $16 \frac{5}{8}$ " deep. Net weight is $301 / 4$ pounds. Shipping weight is 42 pounds, approx.

TYPE 180A TIME-MARK GENERATOR
Each instrument includes: 2-93- $\Omega$ output cable, BNC, $1012-0075$ -
00); 1-clip-lead adapter, BNC, (013-0076-00); 1-3-conductor power cord (161-0010-00); 1-3 to 2 -wire adapter (103-0013-00); 2 -instruction manual (070-0074-00).

## FREQUENCY DOUBLER

This accessory is useful for timing the sweep on Type 580-Series Oscilloscopes. It doubles the 50-Mc output of the Type 180A to 100 Mc .

Order Part Number 015-0056-00 (BNC connector) . .
\$29.50
Order Part Number 015-0013-00 (UHF connector) . .
\$29.50

## RACK MOUNT ADAPTER

A cradle mount to adapt the Type 180A Time-Mark Generator for rack mounting is available. It consists of a cradle to support the instrument in any standard 19" relay rack and a mask to fit around the regular instrument panel. Tektronix blue vinyl finish. Rack height requirements $153 / 4^{\prime \prime}$.

Order Part Number 040-0277-00 \$45
U.S. Sales Prices f.o.b. Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

| Nominal Voltage, Impedance and Risetime Values |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Marker Out Terminall |  |  | Jacks |  |
|  | Open Circuit Volifage | limpedance for Half=Voltage | Risetime * | Open Circuit Voltage | llmpedance for Half=Voltage |
| Markers | 3 volt minimum | $390 \Omega$ or less | $0.07 \mu \mathrm{sec}$ at $1 \mu \mathrm{sec}$ to $1.7 \mu \mathrm{sec}$ at 5 seconds | 25 v minimum <br> Using a P6006 probe | $390 \Omega$ at $1 \mu \mathrm{sec}$ to $900 \Omega$ at 5 seconds |
| Trigger Pulses | 6 volt minimum | $56 \Omega$ or less | $0.08 \mu \mathrm{sec}$ at 100 kc to $0.30 \mu \mathrm{sec}$ at 1 cps |  |  |
| Sine <br> Waves | 3 volt minimum across 50 -ohms |  |  |  |  |
| * With MARKER OUT and TRIGGER OUT terminated in $93 \Omega$ |  |  |  |  |  |

## E Cacturat <br> DESCRIPTION

The Tektronix Type 180 Time-Mark Generator is a portable precision laboratory instrument designed to provide accurate time markers which can be displayed on a cathode-ray oscilloscope for calibrating sweep speeds and for comparison time measurements.

Outputs Available
Microsecond markers at intervals of 1,5 , $10,50,100$, and 500 microseconds.

Millisecond markers at intervals of $1,5,10$, 50,100 , and 500 microseconds.

A one-second interval marker.
Sine waves of $5 \mathrm{mc}, 10 \mathrm{mc}$, and 50 mc .

Triggering pulses at rates of $1 \mathrm{cps}, 10 \mathrm{cps}$, and $100 \mathrm{cps}, 1 \mathrm{kc}$ and 100 kc .

The markers are available, individually, at pin jacks on the front panel, or from the SIGNAL OUTPUT connector. Each individual toggle switch connects the marker signals to a common bus, so that any or all of the markers are available from the output at the same time. The SIGNAL OUTPUT connector is controlled by the four-position, black SIGNAL SELECTOR switch, which selects the MARKER bus, or any of the three sine waves of $5 \mathrm{mc}, 10 \mathrm{mc}$, or 50 mc . These sine waves are also available from the three SINE WAVE OUTPUT connectors. In addition to these waveforms, six pulse triggers of $1 \mathrm{cps}, 10 \mathrm{cps}, 100 \mathrm{cps}, 1 \mathrm{kc}, 10 \mathrm{kc}$, and 100 kc are available at the black TRIGGER OUTPUT connector.

Nominal Voltage, Impedance, and Risetime Values

|  | At Signal Output |  |  | At Pin Jacks |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| MARKER | $\begin{aligned} & \text { OPEN- } \\ & \text { CIRCUIT } \\ & \text { VOLTAGE } \end{aligned}$ | IMPEDANCE | RISETIME | OPENCIRCUIT VOLTAGE | IMPEDANCE |
| $1 \mu \mathrm{sec}$ | 1 V | 300 ohms | $0.04 \mu \mathrm{sec}$ | 20 v | 400 ohms |
| $5 \mu \mathrm{sec}$ to $50 \mu \mathrm{sec}$ | 1 v | 600 ohms | $0.08 \mu \mathrm{sec}$ | 20 v | 400 ohms |
| $100 \mu \mathrm{sec}$ to 1 sec | 3 v | 600 ohms | $0.3 \mu \mathrm{sec}$ | 30 v | 600 ohms |
| TRIGGER PULSES |  |  |  |  |  |
| 1, 10, 100 cycles |  |  |  |  |  |
| $1,10 \mathrm{kc}$ | 7 v | 200 ohms | $0.2 \mu \mathrm{sec}$ |  |  |
| 100 kc | 2 v | 200 ohms | $0.2 \mu \mathrm{sec}$ |  |  |
| SINE WAVES |  |  |  |  |  |
| 5, 10, 50 mc | $31 / 2 \mathrm{v}$ | 52 ohms |  |  |  |

Crystal Frequency

The controlling crystal oscillator has a frequency tolerance of .03 per cent. The short time stability is about . 005 per cent per hour. For uses requiring better stability, Tektronix manufactures the Type 180-S1 with a tempera-ture-controlled crystal, and an adjustable trimmer that permits the frequency to be standardized. Consult your nearest Tektronix representative or the factory at Portland, Oregon for details.

Output Impedance
Output impedance at the TRIGGER OUTPUT CONNECTOR is 200 ohms. Marker output impedances are between 300 ohms and 600 ohms , and impedances of the sine-wave outputs are about 30 ohms.

## Power Requirements

105 volts to 125 volts or 210 volts to 250 volts, ac, 50 to 60 cycles, 260 watts at 117 volts. (3.2 amp. thermal-delay fuse.) NOTE: F401 should be changed from 3.2 amp . to 1.6 amp . for 234 -volt operation.

## Instruction Manual- <br> 

 Charecteristics Addendum
## General

The Tektronix Type 180A Time-Mark Generator is a portable laboratory instrument designed to provide accurate time marks, trigger pulses, and sine-wave outputs. The Type 180A may be used in any application where accurate measurement of short time intervals is necessary.

## Output Characteristics

Microsecond markers at intervals of $1,5,10,50,100$ and 500 microseconds.

Millisecond markers at intervals of $1,5,10,50,100$ and 500 milliseconds.

One-second and five-second interval markers. Sine-waves

## CHARACTERISTICS

## SECTION 1

of $5 \mathrm{mc}, 10 \mathrm{mc}$, and 50 mc . Trigger pulses at rates of 1 cps , 10 cps , and $100 \mathrm{cps}, 1 \mathrm{kc}, 10 \mathrm{kc}$ and 100 kc .

The markers are available individually at banana jacks on the front panel and at a front panel connector labeled MARKER OUT. The individual push-button switches connect the markers to a common bus, so that any or all of the markers can be made available simultaneously at the output. Push-button switches are also provided to connect any one of the three sine-wave outputs to the MARKER OUT connector. Only one sine-wave can be used at a time.

Trigger pulses are available at the TRIGGER OUT connector on the front panel of the Type 180A. The trigger pulses are also selected by the operation of a push-button switch.

TABLE 1-1
For Type 180A, S/N 5479 and up
NOMINAL VOLTAGE, IMPEDANCE, AND RISETIME VALUES

|  | Open Circuit Voltage | Impedance (at half-voltage) | *Risetime | Open Circuit Voltage | Impedance |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Markers | 3 volt minimum | $390 \Omega$ or less | varies from 0.07 $\mu \mathrm{sec}$ at $1 \mu \mathrm{sec}$ to $1.7 \mu \mathrm{sec}$ at 5 seconds | 25 volts minimum using 10X probe | $390 \Omega$ at $1 \mu \mathrm{sec}$ to $680 \Omega$ at 5 seconds |
| Trigger Pulses | 6 volt minimum <br> 8 volt maximum | $56 \Omega$ or less | $0.08 \mu \mathrm{sec}$ at 10 $\mu \mathrm{sec}$ to $0.30 \mu \mathrm{sec}$ at 1 sec |  |  |
| Sine Waves | 3 volt minimum peak-to-peak across 50 -ohms |  |  |  |  |

TABLE 1-1 S/N 5001-5478
NOMINAL VOLTAGE, IMPEDANCE AND RISETIME VALUES



## CHARACTERISTICS

## General

The Tektronix Type 180A Time-Mark Generator is a portable laboratory instrument designed to provide accurate time marks, trigger pulses, and sine-wave outputs. The Type 180A may be used in any application where accurate measurement of short time intervals is necessary.

## Output Characteristics

Microsecond markers at intervals of $1,5,10,50,100$ and 500 microseconds.

Millisecond markers at intervals of $1,5,10,50,100$ and 500 milliseconds.

One-second and five-second interval markers. Sine-waves
of $5 \mathrm{mc}, 10 \mathrm{mc}$, and 50 mc . Trigger pulses at rates of 1 cps , 10 cps , and $100 \mathrm{cps}, 1 \mathrm{kc}, 10 \mathrm{kc}$ and 100 kc .
The markers are available individually at banana jacks on the front panel and at a front panel connector labeled MARKER OUT. The individual push-button switches connect the markers to a common bus, so that any or all of the markers can be made available simultaneously at the output. Push-button switches are also provided to connect any one of the three sine-wave outputs to the MARKER OUT connector. Only one sine-wave can be used at a time.

Trigger pulses are available at the TRIGGER OUT connector on the front panel of the Type 180A. The trigger pulses are also selected by the operation of a push-button switch.

TABLE 1-1
For Type 180A, S/N 5479 and up
NOMINAL VOLTAGE, IMPEDANCE, AND RISETIME VALUES

|  | Open Circuit Voltage | Impedance (at half-voltage) | *Risetime | Open Circuit Voltage | Impedance |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Markers | 3 volt minimum | $390 \Omega$ or less | varies from 0.07 $\mu \mathrm{sec}$ at $1 \mu \mathrm{sec}$ to $1.7 \mu \mathrm{sec}$ at 5 seconds | 25 volts minimum using 10X probe | $390 \Omega$ at $1 \mu \mathrm{sec}$ to $680 \Omega$ at 5 seconds |
| Trigger Pulses | 6 volt minimum <br> 8 volt maximum | $56 \Omega$ or less | $0.08 \mu \mathrm{sec}$ at 10 $\mu \mathrm{sec}$ to $0.30 \mu \mathrm{sec}$ at 1 sec |  |  |
| Sine Waves | 3 volt minimum peak-to-peak across 50 -ohms |  |  |  |  |

*With marker out and frigger out terminated in 93 ohms.
TABLE 1-1 S/N 5001-5478
NOMINAL VOLTAGE, IMPEDANCE AND RISETIME VALUES

|  | Open Circuit Voltage using 10X Probe | Impedance (at half voltage) | *Risetime | Open Circuit Voltage using 10X Probe | Impedance |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Time Markers | 1.5 V Min. | $390 \Omega$ or less | varies from 0.07 $\mu \mathrm{sec}$ at $1 \mu \mathrm{sec}$ to $1.7 \mu \mathrm{sec}$ at 5 sec | 8 V Min. | $390 \Omega$ at $1 \mu \mathrm{sec}$ to $680 \Omega$ at 5 sec . |
| Trigger Pulses | 2.0 V Min. | $56 \Omega$ or less | $0.08 \mu \mathrm{sec}$ at 10 $\mu \mathrm{sec}$ to $0.3 \mu \mathrm{sec}$ at 1 sec . |  |  |
| Sine Waves Using $50 \Omega$ Terminator | $\begin{aligned} & 5 \& 10 \mathrm{MC}-2.5 \mathrm{~V} \\ & 50 \mathrm{MC}-1.5 \mathrm{~V} \end{aligned}$ |  |  |  |  |

## Characteristics - Type 180A

## Other Characteristics

Crystal Oscillator
Frequency-1 $\mathrm{mc} \pm 10 \mathrm{cps}$. May be accurately set for 1 mc . Stability-within 3 parts per million in 24 hours.

## Power Requirements

117 or 234 V Nominal Line Voltage
50 to $60 \mathrm{cps}, 240$ watts.

## Mechanical Specifications

Ventilation-filtered, forced air.

Finish-Anodized panel. Blue vinyl, perforated cabinet. Dimensions- $131 / 2^{\prime \prime}$ high, $93 / 4^{\prime \prime}$ wide, $17^{\prime \prime}$ depth.
Weight-31 pounds.

## Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

## CATALOG

The 158-006 (180-S1) and 158-007 (180A or 181
Mod 110) crystal-and-oven combinations are replaceable as assemblies only; the individual components are not stocked individually for sale to customers. We purchase the crystal-and-oven combination as a calibrated assembly, tested by the vendor to operate within our specs in the specific oscillator circuit (180 or 180A/181) in which the unit is to be used. We do not require of the vendor that his crystals and ovens be freely interchangeable and still meet performance specs; even if we did, no vendor could promise that any crystal he ships will be $100 \%$ compatible with all ovens his competitors may have shipped over a period of ten years or so. The only interface point at which we can offer some assurance of interchangeabil-
ity is at the octal socket for the assembly.
A customer may, if he wishes, replace a crystal-and-oven assembly with a crystal intended for operation at instrument-ambient temperature thus effectively converting his 180 -S1 back to a 180, or a 181 Mod 110 back to a standard 181. For this purpose, use a Type Zl crystal, 158002.

Particularly to be avoided, however, is any attempt to put an instrument-ambient type crystal such as the 158-014 from the 3B2 (spec tolerance .01\%) INTO AN OVEN. Even if the oven were disconnected, the instrument accuracy would probably be less than for the less expensive 158-002 crystal by itself.

# MODIFIED PRODUCTS 

Product
Mod

| 180 | 119 F |
| :--- | :--- |
|  |  |
| 180 A | 101 |
| 180 A | 101 G |
| 180 A | 127 A |
| 180 A | 153 A |
| 180 A | 161 C |
| 180 A | 209 H |
| 180 A | 222 A |
| 180 A | 237 D |

Description

Banana jacks changed to BNC
$50-400 \mathrm{~Hz}$ operation, DC fan.
60 or 400 Hz Standard fan motor with Tek chopper. Provision for external 1 MHz clock (coax at rear). Panel rackmount.
Special export transformer 100-200 V design center. Special hardware on rear.
Blackout.
New Pane1. Change 10us markers to $25 \mu \mathrm{~s}$.

## RACKMOUNTS

180A. CRADLE MOUNT 040-193
Kit 040-193 has been replaced by 040-277. The following information is furnishedfor history purposes.

Each cradle-mount consists of a cradle (or shelf) to support the instrument in any standard $19^{\prime \prime}$ relay rack, and a $1 / 8^{\prime \prime}$ aluminum rack panel cut out as a mask to fit over the regular instrument panel. The only instrument modification required is addition of a small keeper bracket at the rear. By removing the mask, the oscilloscope (or power supply unit) may be quickly removed for portable use.

Indicator unit masks are $17-1 / 2 \times 19^{\prime \prime}$, nominal dimensions. All masks are finished in Tek blue wrinkle unless another finish is specified on special order.

Masks and cradles mount independently, and use standard EIA (formerly "RETMA") notching. The cradle unit is mounted from the rear to allow flushmounting of the mask.

The drawings show mounting information for the cradle mount and EIA rack detail.
TEKTRONIX CRADLE MOUNT - I SOMETRIC


i. Panel heights are multiples of 1-3/4"less $1 / 32^{\prime \prime}$ for clearances.
2. Both top and bottom edges of a properly mounted panel will, neglecting clearances, always fall half way between a pair of holes spaced $1 / 2^{\prime \prime}$ apart on the rack.
3. It is seldom necessary to cut all the possible mounting-screw slots in a panel, but it can be done.
4. Any panel laid out to fit the rack will also fit if the panel is turned end-for-end or back-forfront.

Standard panels are $19^{\prime \prime}$ wide and multiples of 1-3/4" high. Panel mounting holes start with the first one at $1 / 4^{\prime \prime}$ from top or bottom edge of panel, the second $1-1 / 4^{\prime \prime}$ from the first, the third $1 / 2^{\prime \prime}$ from the second, the fourth $1-1 / 4^{\prime \prime}$ from the third and the distances between holes from there on alternate between $1 / 2^{\prime \prime}$ and $1-1 / 4^{\prime \prime}$ in a panel higher than two or three rack units ( $1-3 / 4^{\prime \prime}$ ), it is common practice to drill only sufficient holes to provide a secure mounting. All panel holes are centered $3 / 8^{\prime \prime}$ from the outer edge, $18-1 / 4^{\prime \prime}$ between centers. The holes are $1 / 4^{\prime \prime}$ slotted out to the edges.

Some new Tektronix instruments, such as the Types 567 and 661, use an improved bottom rail, designed to strengthen the instrument and reduce instrument damage, particularly to the power chassis, during handling and shipping.

To accommodate instruments with the new bottom rails, it will be necessary to modify the cradle mount used for rackmounting cabinet-style instruments (IRS 5281). Since the modified cradle mount will also accept instruments with the old bottom rails, production of the older cradle mounts has been discontinued. Kit 040-277 (for 190A/190B) will replace 040-193.

If necessary, the old cradle mount may be modified to accept instruments with the new bottom rails. The instructions and parts list are given below.

Parts Required:

| Quantity | Description | Tek No. |
| :---: | :--- | :--- |
| 4 ea. | Screw, $8-32 \times 3 / 8 \mathrm{BHS}$ | $212-023$ |
| 1 ea. | Bar, stiffening, $1 / 4 \times$ <br> $5 / 8 \times 16-5 / 8$ | $381-198$ |
| 2 ea. | Bar (guide rail), alum. <br> angle, 18 in. | $381-202$ |
| 2 ea. | Plate (slide), bakelite, <br> $1-1 / 8 \times 1 / 8 "$ | $387-636$ |

## Installation Instructions

1. Remove the spacer rail fastened to the cradle between the two guide rails.
2. Replace the channel-tye guide rails and slides with the new guide rails and slides. Mount the new rails in the same holes, with the lip on the outside.
3. Remove the five pem nuts mounted in a row along the front edge of the cradle.
4. Drill four No. 19 (or $11 / 64^{\prime \prime}$ ) holes at points A, B, C, and D, as shown in Fig. 2.
5. Fasten the stiffening bar to the bottom front edge of the cradle, with an $8-32 \times 3 / 8$ BHS screw in each of the four holes drilled in Step 4.
6. This completes the modification.


Fig. 2. Top View of Cradle


## CRADLE MOUNT

For the following Tektronix instruments:
Types 180A, 190A, 190B, 515, 515A and 516 All serial numbers

## DESCRIPTION

This modification enables the above Tektronix instruments to be rackmounted in a standard 19 in . relay rack. A vertical front panel space of $15-3 / 4 \mathrm{in}$. is required.

Future instruments with the same front panel dimensions may also be used with this kit, providing they have bottom rails similar to those on the above listed instruments. This kit directly replaces 040-193.

(®)


Publication:
Instructions for 040-277
April 1964
Supersedes:
January 1963
(C) 1964, Tektronix, Inc. All Rights Reserved.

| Quantity | Description | Part Number |
| :---: | :---: | :---: |
| $1 \mathrm{ea}$. | Assembly, cradle mount, oscilloscope, including: | 426-208 |
|  | 2 ea. Screw, 4 - $40 \times 3 / 8$ FHS | (211-025) |
|  | 4 ea. Screw, $8-32 \times 3 / 8$ BHS | (212-023) |
|  | 1 ea . Bar, stiffening, $1 / 4 \times 5 / 8 \times 16-5 / 8$ | (381-198) |
|  | 2 ea . Bar, mounting, $1 / 4 \times 1 / 2 \times 8-1 / 8$ | (381-211) |
| 1 ea . | Stop, instrument | 105-013 |
| 2 ea. | Lockwasher, int \#8 | 210-008 |
| 2 ea. | Nut, hex, $8-32 \times 5 / 16$ | 210-409 |
| 2 ea. | Washer, flat, $8 \mathrm{~S} \times 3 / 8$ | 210-804 |
| 8 ea. | Washer, cup, \#10 | 210-833 |
| 2 ea. | Washer, spacer, $3 / 16$ ID x $3 / 8 \mathrm{OD} \times 0.091$ | 210-852 |
| 6 ea. | Screw, 4-40 x 3/8 FHS | 211-025 |
| 2 ea. | Screw, $8-32 \times 5 / 16$ BHS | 212-004 |
| 8 ea. | Screw, $8-32 \times 1 / 2$ BHS | 212-008 |
| 8 ea. | Screw, 10-32 x $1 / 2$ OHS | 212-512 |
| 1 ea . | Panel, front, mask for rackmounting | 333-493 |
| 2 ea. | Bar (guide rail), aluminum, angle, 18 in . | 381-202 |
| 2 ea. | Plate (slide), bakelite, $1-1 / 8 \times 18 \mathrm{in}$. | 387-636 |
| 1 ea. | Bracket, hold-down | 406-424 |

## INSTRUCTIONS

( ) 1. Mount the two guide rails and bakelite slides (from kit) on the cradle assembly, with the rail lip on the outside (Fig.1A). Use the threaded holes in the cradle, spaced according to the lengths listed for the kits in Fig.1B. Mount the rails with the $4-40 \times 3 / 8$ FHS screws from the kit.
( ) 2. Fasten each side of the cradle assembly to the front flange of the relay rack, with three $8-32 \times 1 / 2$ BHS screws from the kit (see Figs. 2 and 6). Each mounting bar is fastened to the cradle by a single 4-40 screw, allowing it to beadjusted for slight variations in rack width.

NOTE: To install the cradle assembly in channeltype racks, it will be necessary to tilt the assembly sideways, while bending one side inward.
( ) 3. Remove the voltage tag on the rear right hand side of the instrument.
( ) 4. Relocate the voltage tag on the middle left hand side of the instrument, use a \#43 drill (see Fig. 3).
( ) 5. Mount the hold-down bracket (from kit) on the rear panel of the instrument, as near to the vertical center line as possible (see Fig. 3).
() a. Drill and tap the two holes in the rear panel shown in Fig. 3. Use a \#29 drill and an 8-32 tap.
CAUTION: BE CAREFUL NOT TO DRILL INTO COMPONENTS MOUNTED BEHIND THE REAR SUB-PANEL.
( ) b. Mount the hold-down bracket, using two $8-32 \times 1 / 2$ BHS screws from the kit.
( ) c. If the instrument will be subject to excessive vibration, the $8-32$ nuts '(from kit) should be added.
( ) 6. Place the instrument on the cradle guide rails and slide it into place.
( ) 7. Temporarily mount the mask (from kit) on the front of the relay rack, over the instrument front panel, and hold it in place with three or four of the 10-32 x $1 / 2$ OHS screws from the kit.

(A)
(B)

FIG. 1


FIG. 2


FIG. 3
( ) 8. Position the instrument so that the stainless steel ring touches the mask all the way around the instrument (see Fig. 4).
( ) 9. Place the instrument stop (from kit) on the cradle so that it meshes with the hold-down bracket on the instrument (see Fig. 5). If necessary, the holddown bracket may be adjusted up or down.
( ) Mark the exact location of the stop on the cradle.
( ) 10. Remove the mask and the instrument.
( ) 11. Place the instrument stop in the location marked in step 7. Select two of the tapped
holes in the stop, and mark and drill $11 / 64 \mathrm{in}$. holes in the cradle at these points.
( ) 12. Mount the stop, using the $8-32 \times 5 / 16$ BHS screws, flat washers and lockwashers from the kit (see Fig. 5).
( ) 13. Replace the instrument. Make sure the hold-down bracket and instrument stop come together properly.
( ). 14. Replace the mask, using the $10-32 \times 1 / 2$ OHS screws, the \#10 cup washers, and the two spacer washers from the kit (see Fig. 6).

THIS COMPLETES THE INSTALLATION.

JT:1s


FIG. 4


FIG. 5


## COMPATIBILITY

## 180A FREQUENCY DOUBLER -- UHF OR BNC?

FEN 5-8-64

The Long Form Catalog shows as an optional accessory for the 180A, a Frequency Doubler -- Part No. 015-013. We are now shipping 180A's with BNC connectors, and the Frequency Doubler listed has

UHF connectors. If customers want one with BNC connectors they will be available in about a month -- watch the PAL for price and availability. Part number will be 015-056 for the new BNC type.

The 015-013 frequency doubler unit -- used for obtaining 100 mc from the 50 mc output of the 180A (S/N 5479-up) -- is intended to be mounted on the 180 A , not at the end of a cable. The confusion arises from the fact that the marking on the case of some of these units implied that the
female UHF connector was the input and the male connector the output.

The marking is now turned around to avoid the erroneous implication.

The implication in the 7-24-64 FEN that the 100 mc frequency doubler accessory for the 180A was suitable only for 180A's from S/N 5479-up is incorrect. Operation is satisfactory with all serial numbers, though the output is limited to
about 1 v p-p (unterminated cable into 580/82 shows 600 mv ) 180A's S/N 5000-5478 which had only about half the present 50 mc sinewave output amplitude.

## COMPETITION

## HICKOK COMPETITION

Call report: James Jacobs, 10-24-63

The local Hickok representative had called on Bob last week and left a brochure on the 1805A, which chey are selling commercially. The price of the scope and their plug-in line is listed below:

| 1805 A | (545A) | $\$ 1,340$ | 1827 | (G) | $\$ 180$ |
| :--- | :--- | ---: | ---: | ---: | ---: |
| 1822 | (B) | 130 | 1831 | (K) | 126 |
| 1823 A | (CA) | 220 | 1832 | (L) | 178 |
| 1824 | (D) | 150 | 1836 | (P) | 84 |
| 1825 | (E) | 178 |  |  |  |

Bob also said that their version of the 180A is a model 1817, which sells for $\$ 558$. Since he had no use for the brochure, he was kind enough to pass it along to me.

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## PERFORMANCE

$75^{\circ} \mathrm{C} \pm 1^{\circ}$ 。

## 180A--SINEWAVE OUTPUT AMPLITUDE

Instruments below SN 5479 just barely make 1.5 v ptp output into $52 \Omega$ as advertised in the 1958 catalog. They won't make the 3 vptp advertised in catalogs 1959 and up.

Instruments after sn 5479 were modified and output will be approx 15 v at $50 \mathrm{mc}, 12 \mathrm{v}$ at 10 mc and 6 v at 5 mc 。

## 180A-MIARKER OUTPUTT RISETIME

The 180A won't make the marker output specs in the 1959 catalog (. $05 \mu \mathrm{sec}$ at $1 \mu \mathrm{sec}$ varying to $1 \mu \mathrm{sec}$ at 5 sec ). Later catalogs are revised to more accur-
ate specs $(.07 \mu \mathrm{sec}$ at $1 \mu \mathrm{sec}$ varying to $1.7 \mu \mathrm{sec}$ at 5 sec ).

## 180A--MARKER OUTPUT IMPEDANCE

FEN 9-29-61

A recent shakedown of 180A specifications and performance in IMSE reveals that there is an interpretation problem in the "Impedance" specification. The source impedance from the connectors and jacks can be measured by loading down the output with a pot, adjusting the load until the no-load output voltage is halved, and then measuring the pot resistance.

By this method, the output impedance of the 1 sec and 5 sec markers at the banana jacks looks like 750-850 ohms in most instruments, as against a catalog spec of 680 ohms. However, a load of 680
ohms will still provide a $15-16 \mathrm{v}$ output, well over half of the nominal 25 v output. The open circuit output at the 1 sec and 5 sec jacks runs $38-42$ volts. Therefore, so far as load impedances are concerned the 180A will provide specified voltage or more into the indicated impedances in all cases. The next issue of the catalog will be revised to eliminate the conflict.

The IMSE measurements confirmed that current 180A production instruments meet or exceed all other published specs, with no problems.

Tolerance: $1 \mathrm{mc}, \pm .001 \%$ (catalogs 18 and before specify $.03 \%$; this has been improved).

Range: The crystal trimmer capacitor in these units provides a range of adjustment of approximately 50 cycles from one end to the other. Somewhere within this 50 cycle range, the crystal frequency must zero beat with WWV. The crystal supplier was given the specification that each crystal shall pass through zero beat with WWV at least 10 cycles from either end of the 50 cycle adjustment range. In order to
provide properly for normal production tolerances of the oscillator circuit components, we consider crystals acceptable if they tune through zero beat with WWV at least 3 cycles from either end of the 50 cycle adjustment range.

If a crystal does not fall within this 3 cycle adjustment tolerance, return the crystal and oven unopened to Beaverton. State the conditions under which you reject each crystal.

# OPERATING INSTRUCTIONS 

## General Information

The Type 180 Time Mark Generator operates efficiently and accurately, indoors and outdoors, when adequately protected from moisture. Should the Type 180 become exposed to dampness, it is advisable to leave it in a warm room until thoroughly dry before reoperating.

> CAUTION: ALWAYS KEEP THE INSTRUMENT WELL-VENTILATED. DURING OPERATION, THE BACK, TOP ANDSIDES MUST BE CLEAR. OTHERWISE, EXCESSIVE INTERIOR DAMAGE MAY RESULT.

If the Type 180 is used continuously for similar applications with the same setting of the switches, it is advisable to check, periodically, all settings of the switches, not only for clean contacts, but also for accurate measurements.

Although the components are well supported and the adjustable components are stable enough to permit the Type 180 to be transported easily, do not handle the instrument roughly nor subject it to shock or excessive vibration.

Signal Output Connection
There are sixteen signal sources that are independent of any switching. The thirteen pin jacks labeled 500, 100, 50 MICROSEC, etc., provide marker pulses of the corresponding repetition rate. Sine waves of 5,10 , and 50 mc are available at the three SINE-WAVEOUTPUT connectors.

The connector labeled SIGNAL OUTPUT is controlled by the SIGNAL SELECTOR switch and the thirteen toggle switches that select the marker pulses. The SIGNAL SELECTOR switch in the MARKER position will allow the application of any one marker pulse or any combination of marker pulses to the SIGNAL OUTPUT connector by closing the appropriate toggle switch. The remaining three positions of the SIGNAL SELECTOR switch connect one of the three available sine-wave outputs to the SIGNAL OUTPUT connector.

The TRIGGER OUTPUT connector provides trigger-pulse output as selected by the TRIGGER RATE SELECTOR switch.


## General

The Type 180A may be operated in any normal indoor location, or in the open if protected from moisture. If the instrument has been exposed to dampness, it should be left in a warm room until thoroughly dry before being placed in operation. Operation of the controls also helps to keep the contact surfaces of the switches free from an accumulation of dirt and tarnish.

## Cooling

A fan maintains safe operating temperature in the Type 180A Time Mark Generator by circulating air through a filter and over the components. Therefore, the instrument must be placed so that the air intake is not blocked. The air filter must be kept clean to permit adequate air circulation. If the interior temperature should rise too high, for some reason, a thermal cutout switch will disconnect the power and keep it disconnected until the temperature drops to a safe value.

For proper air circulation, the bottom and side panels must be in place. Be sure the bottom panel is installed according to directions.

## Power Requirements

A metal plate is attached to the back of your instrument showing the input voltage for which the instrument was originally wired. The regulated power supplies in the Type 180A will operate with line voltages from 105 to 125 volts at 117 nominal line volts, or from 210 to 250 volts at 234 nominal line volts. Proportionate line voltage variations apply when other nominal line voltage primary connections are made. For maximum dependability and long life the voltage should be near the center of this range. Fig. 2-1 shows the connections for the various line voltages.

Voltages outside of these limifs, or poor line-voltage waveforms, may cause hum or jitter on the trace and may cause unstable operation. Be sure to check for proper line voltage if indications such as these are present.


Fig. 2-1 Transformer Primary connections for various line voltages.

## Operating Instructions - Type 180A



Fig. 2-2 Primary connections for crystal-oven transformer, T702. The lower drawing indicates the position of the terminal strips.

## Fan Connections

The fan is connected across a portion of the primary of the power transformer and the connections need not be disturbed when changing input line voltages.

## Crystal Oven Transformer Connections

The crystal oven transformer has two primary windings which are connected in series for 220 to 248 volt operation as shown in Fig. 2-2.

## Signal Output Connections

The time mark signals are connected to the MARKER OUT connector by pushbutton switches. A banana jack is mounted below each switch to provide an additional output connector for each range. The signal appearing at the banana jack is not affected by the operation of the pushbutton for that range.
Keep in mind the type of service for which the time marks are intended when making connections to the MARKER OUT connector.

Table 1-1 in the Characteristics section of this manual shows the output voltages and risetimes available. Type P93

Coaxial Cables are furnished with the Type 180A. If you desire to get the optimum risetime from your instrument you should use a $93 \Omega$ Terminating Resistor at the MARKER OUT connector.

To disconnect a time marker from the MARKER OUT connector, it is necessary to operate the CANCEL pushbutton switch. This will disconnect all of the time markers. Then, you may reconnect the desired time markers to the MARKER OUT connector by operating the appropriate pushbuttons.

Sine-wave outputs of 5, 10 and 50 megacycles are available at the MARKER OUT connector, and are selected by pushbutton switches at the top of the front panel. Each time you operate one of the sine-wave pushbutton switches, it will cancel all of the output signals previously selected and will over-ride any time mark pushbuttons that may be depressed.

Triggering pulses are available separately from a connector on the front panel labeled TRIGGER OUT. Here, too, the output signals are selected by the operation of a pushbutton switch. However, pushing the switch for one range will automatically cancel the range previously selected, and, therefore, only one range of trigger pulses is available at one time.

## Block Diagram

The basic timing element of the Type 180 Time-Mark Generator is a one-megacycle Pierce type of crystal oscillator. Three onemegacycle output circuits lead from the oscillator. The first, through shaper and amplifier circuits, provides one-microsecond marker pips. The second provides a triggering voltage for a five-microsecond divider circuit and the subsequent chain of eleven cascaded dividers. The third circuit supplies one-megacycle input to the first of a series of three frequency multipliers which multiply their input frequencies by a factor of five times, two times and five times respectively to provide sine-wave outputs of five megacycles, ten megacycles and fifty megacycles. The SIGNAL OUTPUT switch selects sine-wave output from the three multipliers in three of its four positions, and in the fourth position selects a bus on which any of the marker outputs may be connected through individual toggle switches. The trigger amplifier with V501 shapes and limits amplitude of the TRIGGER OUTPUT pulses, and presents them at low output impedance at the front panel.

Oscillator (Serial Numbers 101 through 138)
The crystal-oscillator stage consists of V201 which is connected as a triode. No trimmer capacitor is provided for adjusting the frequency. One-megacycle output to drive the divider stages is developed across resistors R203 and R204 in the plate circuit. The multiplier stages are driven by the output developed across a tuned circuit formed by C204 and L201 (connected in parallel) in the screen circuit of V201.
(Serial Numbers 139 through 293)
The crystal oscillator stage consists of V201 which is connected as a tetrode. Output is developed across R203, the plate load resistor. C200,
connected across the crystal, is a variable capacitor provided for adjusting the output frequency of the oscillator.
(Serial Numbers 294 and up)
The crystal-oscillator uses the triode section of V250 in an untuned oscillator fircuit. No trimmer capacitor is provided in standard models to adjust the frequency. In S1 models C250 is connected across the crystal to provide adjustment of the output frequency.

## One-Microsecond Marker

One-microsecond marker pips are developed by differentiating in the plate circuit of V207A through L205. The grid of V207A is prevented from going negative by diode V206B and the plate of V207A bottoms. The differentiated plate pulse is differentiated again through C239 and R226 and R228. The grid of V207B is held below cutoff by voltage divider R228 and R227 connected between ground and the -135 -volt bus, so that only the positive peaks of the differentiated pulse are reproduced at the cathode of V207B.

## 5 Megacycle Multiplier

The multipliers operate with grid leak bias. V202 is a quintupler. Input to the grid at one megacycle is taken from the anode of the crystal oscillator. A double-tuned transformer tuned to five megacycles couples the five-megacycle signal into the grid of V203, a doubler. Five-megacycle output is taken from a low-impedance coil inductively coupled to this transformer.

## 10 Megacycle Multiplier

The plate of V203 feeds a second doubletuned transformer tuned to ten megacycles which feeds a ten-megacycle signal to the grid of V204, a quintupler. Ten-megacycle output is taken
from a low-impedance coil inductively coupled to the ten-megacycle transformer.

## 50 Megacycle Multiplier

The plate load of V204 is a third doubletuned transformer, tuned to fifty megacycles. Output at fifty megacycles is taken from a lowimpedance coil inductively coupled to this transformer.

## One-Microsecond Trigger Signal

V205A is a cathode follower whose grid is connected to the plate of the buffer through coupling capacitor C203. Diode V206A prevents the cathode of the following disconnect diode, V301A, from rising above +225 volts.

## High-Frequency Divider

The five-microsecond divider is a monostable multivibrator whose recovery time is between four and five microseconds. After being tripped by one pulse of the one-megacycle repetitionrate pulse chain, it is unaffected by the next succeeding four pulses, but is tripped by the fifth pulse. One-megacycle input is provided through V205A, a cathode follower shown on the oscillator and multiplier diagram. L207, an adjustable inductor in the cathode circuit of V205A, permits the phase of the synchronizing voltage to be adjusted so that the markers from the succeeding lower-frequency dividers can be made to coincide with the one-microsecond marker pips.

In the quiescent state, V302B is kept conducting by the positive return of the grid through R310 to +225 volts, the plate is at low voltage, and the grid of V302A is held below plate-current cutoff by the negative voltage from potentiometer R303 connected between ground and - 135 volts. Upon receipt of a negative pulse from V205 through C304, the grid of V302B is driven below plate-current cutoff and the plate jumps positive toward +225 volts, but is clamped at +140 volts by V301B. V303B is a cathode follower whose grid is connected to V302B plate, and whose cathode couples the positive step through C302 to the grid of V302A. This positive step at V302A grid pulls the plate down and holds it there as long as the grid of V303B is clamped against +140 volts. Diode V301B disconnects the divider circuits from the one-megacycle source during the period the plate is down. Since V301A con-
ducts only during negative pulses, its cathode, which is capacitively coupled to the trigger source, rises positive as the coupling capacitor charges. Diode V206A limits the positive voltage to which this capacitor can charge to a maximum of +225 volts.

The negative pulse at the plate of V302A is the triggering waveform for the next divider. It also depresses the grid of V302B farther negative. After being driven negative this grid starts to rise toward +225 volts as fast as V304 can discharge. The time constant of C304, R310 is chosen so that the time required for V302B grid to reach plate-current conduction is between four and five microseconds. As soon as plate-current conduction occurs in V302B, the plate drops and a negative step is transmitted through cathode-follower V303B to the grid of V302A and V302A plate rises. When the plate rises near the cathode voltage of diode V301A, the one-megacycle pulse source is again connected to the divider circuit, and the first one of these pulses drives the divider back through the sequence again.

Diode V301B limits the positive excursion of the grid of V303B so as to reduce the effects of tube aging or tube replacement on the circuit timing. Cathode-follower, V303B, speeds the transition by reducing the loading on the plate of V302B. A cathode follower for this function is used only in the three highest repetition-rate dividers. The step voltage from V303B cathode is differentiated in C309 and applied at low impedance from the cathode to a front-panel pinjack connector and to a signal-selector switch. Voltage divider R314, R315, connected between -135 volts and ground, holds the grid of V303A below cathode-current cutoff so that only the positive pulses appear at the cathode.

The ten-microsecond divider operates in a manner similar to the five-microsecond divider. Pulses spaced five microseconds apart, at the plate of V302A of the five-microsecond divider, are applied to the grid of cathodefollower V304 through coupling-capacitor C314. Cathode output from V304 is applied through C315 and disconnect diode V305A to the grid of V306B. The cathode of diode V305A is limited to +225 volts by means of a crystal diode so that coupling capacitor C314 can not charge above this level. The remainder of the circuit is similar to the circuit of the five-microsecond divider, except for the component values.

The time constant of R332, C320 is such that it takes more than five microseconds but less than ten microseconds for V306B to become conducting, and every second pulse from the fivemicrosecond divider is rejected while the intervening pulses are accepted. Thus a division by two results.

Triggering voltage for the 50 -microsecond divider is suplied by the plate of V306A, the nega-tive-going multivibrator of the 10 -microsecond divider, at the junction of R321 and R322. C318 bypasses R322 for high frequencies. When V306A plate first drops, the triggering pulse starts toward plate voltage, but C318 rapidly charges to the voltage across R322 and then continues at this level until V306A is cut off again. The amount of overshoot is negligible. The capacitance to ground of the disconnect diode, V308A, increases the steepness of the start of the pulse. The remainder of the dividers have a similar speedup capacitor around a portion of the plateload resistor of the negative-going multivibrator to improve the risetime of the triggering pulse, except the last divider in the chain. Only the 5- 10 - and 50 -microsecond dividers use a cathode follower to couple the negative-going multivibrator grid to the positive-going multivibrator plate.

Individual marker output from each of the dividers, except the 1 -microsecond and 5-microsecond dividers is connected through a coaxial cable lead to a pin jack and to a toggle switch mounted on the front panel. The 1 -microsecond and 5 -microsecond markers are connected to their respective pin jacks and switches by unshielded insulated leads to reduce capacitance to ground.

The toggle switches are all connected to a common lead running to one position of the SIGNAL SELECTOR switch so that any one or more of the dividers may be connected to a front-panel UHF connector labeled SIGNAL OUTPUT, through the SIGNAL SELECTOR switch. The resistors in the switch leads isolate the individual divider circuits from each other when two or more are connected to the same bus. The small capacitors around the six highest frequency isolating resistors improve the risetime.

The TRIGGER RATE SELECTOR switch selects any one of the six divider outputs and connects it to the trigger output amplifier, V501,
a cascaded cathode follower pair. The A-section cathode is coupled through C511 to B-section grid, which is biased below cutoff at about -25 volts by voltage divider R525, R526, connected between -135 volts and ground. Only the peaks of the input pulses therefore appear at the B-section cathode. The positive excursion of the B-section grid is limited to a volt or so above ground so the total TRIGGER OUTPUT level from the trigger amplifier output cathode is in the neighborhood of ten volts, peak-to-peak.

## Power Supply

The power supply operates on 60 -cycle, $120-$ volt or 240 -volt ac power. T401 has two primary windings that can be connected in parallel for 120 -volt operation, or in series for 240 -volt operation. The secondary consists of two highvoltage windings, one centertapped, and four filament heater windings. One heater winding supplies the oscillator, multiplier and divider circuits and the other three supply the tubes in the regulated power supply.

The basic voltage reference element is a type 5651 voltage regulator tube. The negative 135volt supply is regulated by comparing the voltage of this tube to the voltage on voltage divider R407, R409, R410 connected between ground and the regulated negative 135 -volt bus, through comparator tube V403. The difference voltage is amplified in V403 and applied to the control grid of V402, a series-regulator tube in the ground lead of the rectifier, V401. C401 is a filter capacitor and R406 is a bleeder resistor to discharge C401. A center-tapped winding supplies the high voltage to V401, a full-wave rectifier. R409 permits the voltage to be adjusted accurately to -135 volts. C402 improves the ac regulation by increasing the ac gain around the regulator loop.

High voltage for the +140 -volt and +225 -volt supplies is supplied from a bridge rectifier with C440 and C441 for filter capacitors and R440 as a bleeder resistor. The +140 -volt supply is regulated by comparing to ground potential in comparator tube V421, the voltage on a voltage divider, R426, R427 connected between the regulated +140 -volt bus and -135 volts. The difference voltage is amplified in V421 and applied to the control grid of series-regulator tube, V420 connected in series with the high voltage and the +140 -volt bus. C420 improves the ac regulation
by increasing the ac gain around the regulator loop.

The +225 -volt supply is regulated by comparing to ground potential, the voltage near ground potential on a voltage divider connected between the regulated +225 -volt bus and regulated -135 volts, in a common-cathode comparator circuit with V442. The grid of A-section of V422 is connected to ground. The cathode of B-section of this tube follows its grid very closely, and since the cathodes of both sections are tied together, the A-section cathode also follows the B-section
grid, and the A-section plate amplifies any change in B-section grid voltage in the same polarity. R448 is the plate load resistor for V442A. R446 and R447 are a voltage divider between plate voltage of V442A and -135 volts. This divider places the dc voltage of the grid of V441 near ground. The ac voltage at the plate of V442A is connected directly to the grid of V441 through C442 so that V441 amplifies any change of plate voltage. The amplified error signal is applied by the plate of V441 to the grids of series-regulator tube V440 which is connected in series with the high-voltage source and the regulated +225 -volt bus.


## DESCRIPTION

In the $1-\mu \mathrm{sec}$ Amp and CF stage, the signal is amplified for coupling to the front-panel $1-\mu \mathrm{sec}$ banana jack and push-button switch. The output from this stage is also connected to the input of the 5 -mc Multiplier.

In the 5-mc Multiplier, the $1-\mu \mathrm{sec}$ time markers drive an rf amplifier tuned to 5 megacycles. The resulting $5-\mathrm{mc}$ sinewave output is coupled to the input of the $10-\mathrm{mc}$ Multiplier, which in turn, drives the $50-\mathrm{mc}$ Multiplier. The $10-\mathrm{mc}$ and $50-\mathrm{mc}$ Multipliers, like the $5-\mathrm{mc}$ Multiplier, are rf amplifiers tuned to the desired output frequency. The sine-wave outputs from all three multipliers are connected to the associated pushbuttons. The pushbuttons are mechanically linked so that only one of the sine-wave signals can be selected at a time. The signal so selected is connected through the pushbutton switches to the MARKER OUT coaxial connector.

## Block Diagram

In the Type 180A, time-marker and sine-wave outputs are derived from a one-megacycle oscillator. The time-marker signals are available individually at banana-jack connectors or in combination at a coaxial connector. The sine-wave signals are available individually at the coaxial connector. In addition, a triggering signal is available at another coaxial connector. The manner in which the circuits are functionally arranged to achieve these ends is shown in Figure 3-1.

The oscillator is an electron-coupled, crystal-controlled oscillator. Its output signal is coupled to the $1-\mu \mathrm{sec}$ Amplifier and Cathode Follower and to the Isolating CF. To insure long-term stability, the crystal is housed in a temperature-controlled oven.

The oscillator signal connected to the Isolating CF drives the $5-\mu \mathrm{sec}$ Divider. In this circuit, one output pulse is produced for every five input pulses. Since the input signal consists of 1 -microsecond pulses, one output pulse will occur every 5 microseconds. The $5-\mu \mathrm{sec}$ markers are coupled to the pushbutton switches and banana jacks for external use, and are also connected to the input of the 10 -microsecond divider. The $10-\mu \mathrm{sec}$ divider produces one output pulse for every two input pulses. Hence with $5-\mu \mathrm{sec}$ markers at the input, the output markers will be spaced 10 -microseconds apart.

All of the other dividers are similar to the $5-\mu$ sec or $10-$ $\mu$ sec divider. They produce one output pulse for every five or every two input pulses. In this manner, the original 1 -microsecond time-marker signal is accurately "counted down" to as low as 5 seconds.

The output signals from all of the dividers are connected to an associated banana jack and pushbutton. The pushbuttons are mechanically linked so that any number may be depressed at one time. A cancel button (not shown in Fig. 3-1) is provided to mechanically release all of the depressed buttons.

The signals at the $10-\mu \mathrm{sec}, 100-\mu \mathrm{sec}, 1-\mathrm{msec}, 10-\mathrm{msec}$, $100-\mathrm{msec}$, and 1 -sec banana jacks are also connected to the TRIGGER RATE pushbuttons. Here, any one of the signals may be selected for connection to the TRIGGER OUT connector. The signals are coupled to the coaxial connector through two cathode-followers.

## OSCILLATOR AND AMPLIFIER

## Oscillator

Circuit details for the oscillator appear on the OSCIL.LATOR AND MULTIPLIER schematic diagram. The oscillator, V100B, operates as a conventional electron-coupled, crystalcontrolled oscillator. The crystal is contained in a tempera-ture-controlled oven. A front-panel lamp, B101, is connected in parallel with the heating element to indicate operation of the thermostat. A variable capacitor, Cl 05 , is connected in parallel with the crystal to permit slight adjustments of the crystal resonant frequency.

The output waveform at the plate of $\mathrm{V100B}$ is capacitively coupled to the grid of the $1-\mu \mathrm{sec}$ Amplifier, V104B, and direct coupled to the Isolating Cathode Follower, V100A. The rc network, R103-C103, increases the risetime of the pulse at the grid of V104A (in comparison to the pulse at the grid of V 100 A ) to insure the coincidence of the 1 . and $5-\mu \mathrm{sec}$ markers.

## 1- $\mu$ sec Amplifier

The $1-\mu \mathrm{sec}$ Amplifier is a conventional voltage amplifier with high-frequency peaking in the plate circuit. The gain of the stage is about 2.5 . The inductor, L107, serves to improve the risetime of the output waveform.

## 1- $\mu \mathrm{sec}$ Output CF

The $1-\mu \mathrm{sec}$ Output CF, V104A, is biased below cutoff through divider R114-R115. This insures that only the fastrising positive pulses reach the output. The network consisting
of C116 and R116 differentiates the rectangular pulses from the plate of V104B, causing sharp, positive-going pulses to appear at the grid of V104A. These pulses appear at the cathode of V104A as $1-\mu \mathrm{sec}$ time markers. From here, they are coupled to the output switching circuits and to the 5 -mc Multiplier.

## SINE-WAVE MULTIPLIERS

## 5-Mc Multiplier

The 5 -mc Multiplier, V124, is a conventional grid-leak biased, Class-C amplifier, plate-tuned to 5 megacycles. The exciting $1-\mu \mathrm{sec}$ ( 1 -megacycle) pulses cause the plate tank circuit to resonate at 5 megacycles. The $5-\mathrm{mc}$ sine-wave is link-coupled from the output tank circuit and fed to the output switch. Plate voltage for the stage is also controlled by the output switch. The switching arrangement is such that V124 will operate only when the 5 -, 10 - or $50-\mathrm{mc}$ pushbutton is actuated.

## 10-MC Multiplier

V134 acts as a frequency doubler. The primary and secondary of the rf transformer in the plate circuit of V134 are both tuned to 10 mc . The $10-\mathrm{mc}$ output signal is link-coupled to the output switch, and plate voltage for the stage is also coupled through the output switch. The switching arrangement is such that the stage operates only when the $10-$ or $50-\mathrm{mc}$ pushbutton is selected.

## 50-MC Multiplier

The $50-\mathrm{Mc}$ Multiplier, V144, operates as a frequency quintupler. The primary and secondary of the transformer in its plate circuit are tuned to 50 mc . The plate voltage of this stage is turned on only when the $50-\mathrm{mc}$ pushbutton is depressed.

## TIME-MARKER DIVIDERS

## Basic Multivibrator

There are 13 frequency dividers in the Type 180A, producing thirteen of the fourteen output time markers. (The fourteenth time marker is the original time marker derived from the one-megacycle oscillator output.) The operation of all thirteen dividers is essentially the same. In general, a divider consists of a bistable multivibrator, with diode coupling for triggering pulses, and two cathode-follower output stages. The operation of the $5-\mu \mathrm{sec}$ multivibrator is described below. The circuit notation of Figure 3-2 is used for simplification.

In the quiescent state, V 2 is held in conduction by the grid-clamping action of V 4 and V 1 is blocked out of conduction by the fixed grid bias. The plates of V 1 and V 3 rest at about +225 volts. The cathode of $V 3$ is normally at about +225 volts in the absence of a triggering pulse.

The multivibrator is triggered into its unstable state by a negative-going 50 -volt pulse at the cathode of V3. The pulse drives the cathode more negative than the plate, per-


Fig. 3-2 Basic 5- $\mu \mathrm{sec}$. multivibrator. Circuit numbers have been changed for simplification
mitting the tube to conduct. As the tube conducts, the pulse is coupled to the grid of V 2 through capacitor Cl . The negative pulse breaks the clamping action of V 4 , driving the grid of V2 negative and causing V2 cathode current to decrease. The decreasing cathode current through R3 causes the cathode voltage of V 1 to drop also. As the cathode voltage of V 1 approaches the fixed bias voltage, V1 starts to conduct, causing a further decrease in the voltage at the plate. This negative-going voltage is coupled to the grid of V 2 through Cl , reinforcing the switching action.
The plate voltage of V 1 drops to approximately 175 volts. With the plate of V3 at 175 volts and the cathode at 225 volts, subsequent trigger pulses cannot reach the grid of V 2 . As the charge on Cl equalizes, the grid voltage of V2 becomes more positive until the clamping action of V4 is restored and V2 begins to conduct. As V2 goes into conduction, the resulting rise in cathode voltage causes V 1 to cut off. As the plate voltage of V 1 rises, Cl is charged through R2. In the absence of trigger pulses, this would mark the return of the multivibrator to its stable state. The values of R1, R2 and C1 have been selected to provide a lapsed time of approximately 5 microseconds from the time of triggering to the return to the stable state.
As the multivibrator returns to its stable state, the plate of V3 becomes more positive than the cathode, permitting the next trigger pulse to be coupled to the grid of V2.

## Isolating CF

The 1-megacycle waveform at the plate of the oscillator, V100B, is coupled to the $5-\mu \mathrm{sec}$ Divider through cathode
follower V100A. The function of the cathode follower is to isolate the loading effects of the multivibrator triggering circuit from the oscillator.

## $5 \mu$ sec Divider

The operation of the $5 \mu \mathrm{sec}$ Multivibrator is described in previous paragraphs. Referring to the OSCILLATOR and MULTIPLIER diagram, the $5-\mu \mathrm{sec}$ adjustment ( R 168 ) determines the charging rate of Cl 67 , and hence the elapsed time for one cycle of operation. LR171 in the plate circuit of V165B improves the high-frequency response of the circuit and thereby the leading edge of the output waveform.
The waveform at the plate of V165A is coupled to the $10-\mu$ sec Divider through the Isolating CF, V173B. The purpose of this cathode follower is to prevent signals generated in the $10-\mu$ sec Divider from being coupled back into the $5-\mu \mathrm{sec}$ divider.
The output waveform at the plate of V 165 B is differentiated by Cl 77 and R177, and then coupled to the pushbutton circuits through the OUTPUT CF. Notice that the grid of V173A is biased at -17 volts. Operating the stage in this manner insures that only the fast-rising parts of the multivibrator waveform are coupled to the output.

## $10 \mu \mathrm{sec}$ Divider

The circuit configuration and operation of the $10-\mu \mathrm{sec}$ Divider is essentially the same as the $5-\mu \mathrm{sec}$ Divider with one exception. Instead of producing one output pulse for every five input pulses, the $10-\mu \mathrm{sec}$ Divider produces one
output pulse for every two input pulses. This is brought about by the proper selection of circuit time constants.

## Other Dividers

All of the dividers in the Type 180A perform in the same manner as the $5-\mu \mathrm{sec}$ or $10-\mu \mathrm{sec}$ divider. In each divider, time constants have been selected to provide the appropriate duty cycle. Notice that the last divider, the 5 -sec Divider, does not have an Isolating CF. This, of course, is because there is no need for a $5-\mu \mathrm{sec}$ triggering pulse.

## EXTERNAL TRIGGERING

## Switching

The manner in which all of the dividers and multiplier output signals are connected to the output terminals is shown on the TRIGGER CF \& SWITCHING diagram. Notice that all of the divider Output CFs are connected directly to the banana jacks. Switch connections to the MARKER OUT connector are made through an isolating resistor.

To provide an external triggering signal, switching connections are made directly to the $10-\mu \mathrm{sec}, 100-\mu \mathrm{sec}, 1-\mathrm{ms}$, $100-\mathrm{ms}$ or 1 -second banana jacks. These signals are selected by a pushbutton switch in which only one button may be locked in the depressed position. The selected signal is fed to the input of the first TRIGGER CF, and is available at the TRIGGER OUT terminal.

## Trigger CFs

The output signal from the first cathode follower is capacity coupled to the grid of the second CF. The de level of a time-marker signal coupled in this fashion is a function of the signal repetition rate. To avoid wide excursions in the output-signal dc level, a grid-clamping diode is included in the grid circuit of V553B.

Under no-signal conditions, the diode and its associated voltage divider, R560-R561, maintain the grid voltage at approximately -8 volts. Upon the arrival of a positive-going time-marker pulse, the diode ceases to conduct, permitting the grid, and hence the cathode, to follow the signal excursion. At the completion of the pulse, the diode again clamps the grid at about - 8 volts. This is true regardless of the pulse repetition rate.

With the grid of V553B always clamped at about -8 volts between pulses, the output pulses at the TRIGGER OUT connector will always start at about 6.5 volts. Their amplitude will depend upon the amplitude of the input signal at the grid of V553A.

## POWER SUPPLY

## Transformers

Plate and filament power for the tubes in the Type 180A is furnished by a single power transformer, T701. The primary has two equal tapped windings; these may be connected in parallel for 105 - to 125 -volt operation, or in series for 210 - to 250 -volt operation. Silicon rectifiers are employed for the three separate full-wave, bridgetype, power supplies. The three supplies furnish regulated
dc voltages of -150 volts, +225 volts and +350 volts. In addition, -8 volts bias is taken from the -150 volt supply through a voltage divider, and -17 volts bias is taken from the cathode of V433.

A separate transformer, T702, is provided to supply 6.3 volts for the crystal-oven heater. Notice that the primary connections bypass the power switch. This arrangement insures constant crystal-oven temperature even though the power switch may be turned off.
A thermal cut-out is provided in the primary of T701 to open the circuit should the Type 180A internal temperature rise too high. The device is set to open at 137 -degrees Fahrenheit. If the cut-out opens, the crystal-oven will operate but the fan and other circuits will not operate. Then, when the internal temperature drops below 137-degrees, the cutout will close, restoring power to the other circuits.

## - 150 Volt Supply

Reference voltage for the -150 -volt supply is established by a gas diode Voltage-Reference Tube V749. This tube, which has a constant voltage drop, establishes a fixed potential of about - 84 volts at the grid of V744B, one-half of a Difference Amplifier. The grid potential for the other half of the Difference Amplifier V744A, is obtained from a voltage divider consisting of R742, R743, and R744. R743, the - 150 Adj. control, determines the percentage of total voltage that appears at the grid of V744A and thus determines the total voltage across the divider. When this control is properly adjusted, the output voltage is exactly -150 volts.

Should the loading on the supply tend to change the output voltage, the potential at the grid of V744A will change in proportion, and an error voltage will exist between the two grids of the Difference Amplifier. The error signal is amplified by $V 744 \mathrm{~B}$, whose plate is dc-coupled to the grids of the Series Tubes V757 and V767. The error voltage appearing at the grids of the Series Tubes will change the voltage drop across the tubes and hence change the voltage at the plates of the fubes. This change in voltage at the plates of the Series Tubes, which will be in a direction to compensate for the change in the output voltage, is coupled through the rectifiers and C741 to the output and thus returns the output voltage back to its established value of -150 volts. C744 improves the ac gain of the feedback loop, and thus increases the response of the circuit to sudden changes in output voltage.

## $\mathbf{+ 2 2 5 - V o l t}$ Supply

The -150 -volt supply serves as a reference for the +225 volt supply. The voltage divider R736-R737 establishes a voltage of essentially zero at the grid of the Amplifier V724. (The actual voltage at this grid will be equal to the bias voltage required by the tube.) If the loading should tend to change the output voltage, an error voltage will appear at the grid of the Amplifier. The error voltage will be amplified and will appear at the grid of the Series Tube V707A. The cathode of V707A will follow the grid, and thus the output voltage will be returned to its established value of +225 volts. C736 improves the response of the regulator circuit to sudden changes in output voltage.

A small sample of the unregulated-bus ripple will appear at the screen of V724 through R724. This ripple signal appearing at the screen (which acts as an injector grid) will produce a ripple component at the grid of V707A which will be opposite in polarity to the ripple appearing at the plate of V707A. This tends to cancel the ripple at the cathode of V707A, and hence reduces the ripple on the +225 -volt bus. This same circuit also improves the regulation of the circuit in the presence of line-voltage variation.

## +350-Volt Supply

The +350 -volt supply functions in the same manner as the +225 -volt supply. Rectified voltage from terminals 9 and 16 of the power transformer is added to the voltage supplying the +225 -volt regulator to supply power for the +350 -volt regulator.

## Bias-Voltage Supply

The two bias supply voltages are drawn from separate sources. The -17 -volt supply is drawn from the cathode of

V433B. C770, connected between the -17 -volt supply and ground aids in filtering the output of the supply.

The -8 volts supply is drawn from the R774-R776 divider which is connected across the output of the -150 volt supply.

## Color Coding

The power supply circuits can be checked at any point in the instrument by following the color coding of the wires. This coding follows the standard RMA system. Negative voltages from the supply are carried in wires with a black base color while white wires are used for positive voltages. For example, -150 is found on black with a brown and a green tracer stripe while +225 will be found on white with two red tracers. (The last figure is not indicated). The +350 volts will be found on white with an orange and a green tracer.

The bias voltages do not follow the coding system, however. The -8 volt bias will be found on white with a black tracer, and -17 volts will be found on white with grey tracer.

## NOTES

## TECHNIQUES

Question: What is a good method to tune a Type 130 L-C Meter?

Answer: Small-Instrument Department suggests use of $180-\mathrm{S} 1$ to trigger sweep of test scope. Set scope to $5 \mu \mathrm{sec}$ per cm , tune 130 for a stable display of 7 cycles per 10 cm .

## DESIGN

Modifying $180^{\prime} \mathrm{s}$ for a $.1 \mu \mathrm{sec}$ marker output isn't feasible without new design and addition of a block-
ing oscillator. We suggest you use the 10 mc sine waves instead.

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## MODIFICATION SUMMARY

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Effective Prod s/n 139

## DESCRIP TION:

Provides an access hole in the instrument cabinet for adjusting the Oscillator Frequency. A cabinet tag was riveted to the cabinet calling out the adjustment hole. The printing on the tag states 'OSC. FREQ. ADJ.' See M7674.

Parts Removed:
Parts Added:
Tag, cabinet
Rivet, alum
unknown
(2) unknown

OSCILLATOR CIRCUIT COMPONENTS
CHANGED TO IMP ROVE ADJ RANGE
INFORMATION ONLY
M431
Effective Prod s/n 139

## DESCRIPTION:

Improves the adjustment range of the oscillator circuit by changing from inductance tuned to capacity tuned to allow convenient setting of pulse time intervals.

Parts Removed:
Parts Added:
C201 $0.01 \mu \mathrm{f} 400 \mathrm{v}$ unknown C 200 3-12 pf unknown
C202 $0.001 \mu \mathrm{f}$ unknown
C204 270 pf unknown
L201 CV733 114-024
R202 $\quad 470 \Omega 1 / 2$ w $10 \% \quad 302-471$
R204 $4.7 \mathrm{k} \mathrm{1/2}$ w 10\% $302-472$
C201 47 pf
unknown

NOTE: See before and after schematics on following page.
(continued)


Effective Prod s/n 142
DESCRIPTION:
Improves the adjustment range of the 1 second FREQUENCY DIVIDER potentiometer R381H by changing the value of R 380 H .

Parts Removed:
R380H
2.7 M 1/2 w 10\% 302-275

Parts Added:
R380H $\quad 2.2$ M $1 / 2 \mathrm{w} 10 \%$
302-225

POWER CHASSIS, BACKPLATE, AND HARDWARE CHANGED TO PERMIT PROPER FIT IN CABINET

Effective Prod s/n 144
DESCRIPTION:
Permits a proper cabinet fit by making the Power Chassis and back plate more narrow.
Also replaces various hardware items to accommodate the chassis change.
Permits a proper cabinet fit by making the Power Chassis and back plate m
Also replaces various hardware items to accommodate the chassis change.
Parts Removed:
$\begin{array}{llll}\text { Screw, } 6-32 \times 1 / 4 & \text { FHB } & \text { (2) } & \text { unknown } \\ \text { Screw, } 8-32 \times 1 / 2 & \text { FHB } & \text { (2) } & \text { unknown } \\ \text { Lug, solder no. } 8 & & & 210-205\end{array}$

Parts Added:
Screw, 6-32 $\times 1 / 4 \mathrm{FHB}$ unknown Screw, $8-32 \times 3 / 8 \mathrm{BHB}$ unknown
Lug, solder no. 6

210-202
Screw, 6 -32 x $1 / 4$

Effective Prod s/n 164
DESCRIPTION:
Improves the appearance of the selenium rectifier assembly by changing the mounting brackets to the type used on the Type 524 oscilloscope. The solder lugs were also changed from a type $S$ to a type $Q$.

Parts Removed:
Bracket, rect
406-066
unknown
Parts Added:

Lug, solder S
Bracket, rect
406-084
Lug, solder Q
unknown

100KHZ TRIGGER CIRCUIT CHANGED TO IMP ROVE PERFORMANCE AND

See SQB
M438 SIMPLIFY ADJUSTMENT

Effective Prod SN 164
Usable in field instruments SN 101-163

## DESCRIPTION:

Improves performance and simplifies the adjustment of the 100 KHz trigger circuit by making changes in the trigger circuit. See Field Modification kit 040-0002-00 and M444.

Parts Removed:

| C324 | $8 \mathrm{pf} \mathrm{GP} \mathrm{1A}$ | unknown | C324 | 15pf GP 1A | $281-509$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| L205,L206 | CV733 | $114-024$ | L205 | CF184 | $108-028$ |
| R206 | $39 \mathrm{k} \mathrm{1/2w10} \mathrm{\%}$ | $302-392$ | R378A-F | $100 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | $302-104$ |
| R378A-F | $120 \mathrm{k} 1 / 2 \mathrm{w} \mathrm{10} \mathrm{\%}$ | $302-124$ | R526 | $56 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | $302-563$ |

HF DIVIDER CIRCUIT COMPONENTS
CHANGED TO IMPROVE PERFORMANCE
Effective Prod s/n 164

Usable in field instruments s/n 101-163

DESCRIP TION:
Improves the performance of the HF dividers by changing circuit components and adding a phasing adjustment for the $5 \mu \mathrm{sec}$ marker. See Field Modification kit 040-0002-00 and M438.

Parts Removed:

| R219 | $560 \Omega 1 \mathrm{w} \pm 10 \%$ | unknown | R219 | $2.7 \mathrm{k} 1 \mathrm{w} \pm 10 \%$ | 304-272 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| R228 | $12 \mathrm{k} 1 / 2 \mathrm{w} \pm 10 \%$ | unknown | R228 | $2.7 \mathrm{k} 1 / 2 \mathrm{w} \pm 10 \%$ | 302-272 |
| R223 | $1 \mathrm{k} 1 \mathrm{w} \pm 10 \%$ | unknown | R206 | $3.9 \mathrm{k} 1 \mathrm{w} \pm 10 \%$ | 304-392 |
| R206 | $407 \mathrm{k} 1 / 2 \mathrm{w} \pm 10 \%$ | unknown | C212 | $0.001 \mu \mathrm{f} 500 \mathrm{v}$ | 283-000 |
| C238 | $0.01 \mu \mathrm{f}$ discap | unknown | C213 | 270 pf 500 v | 283-517 |
| C206 | $6.25 \mu \mathrm{f} 300 \mathrm{WVDC}$ | unknown | L207 | 73-100 $\mu \mathrm{h}$ var | 114-039 |
| L206 | CF114 | unknown | V205 | 12 AT 7 | 154-039 |
| V205 | $12 \mathrm{AU7}$ | unknown | R321,R340 | $3.3 \mathrm{k} 1 \mathrm{w} \pm 10 \%$ | 304-332 |
| R308 | $8.2 \mathrm{k} 2 \mathrm{w} \pm 10 \%$ | unknown | C309,C324 | 15 pf | 281-509 |
| R321 | $8.2 \mathrm{k} \mathrm{l} \mathrm{w} \pm 10 \%$ | unknown | C318 | 100 pf | 281-523 |
| R335 | $8.2 \mathrm{k} 2 \mathrm{w} \pm 10 \%$ | unknown | C319,C323 | 8 pf | 281-503 |
| R340 | $8.2 \mathrm{k} 1 \mathrm{w} \pm 10 \%$ | unknown | C326 | 22 pf | 281-511 |

C309 8 pf cer unknown C318 27 pf cer unknown C324 8 pf cer unknown C326 12 pf cer unknown

Parts Required for Field Installation:
Field Modification kit 040-0002-00
INSTALLATION INSTRUCTIONS:
Refer to kit instructions.
$50 \mu$ SEC DIVIDER CAPACITOR CHANGED TO INCREASE SYNC

See SQB
M462 AMPLITUDE OUTPUT

Effective Prod s/n 164
Usable in field instruments s/n 101-163

## DESCRIPTION:

Increases the output amplitude of the $50 \mu \mathrm{sec}$ divider by changing the value of C325
Parts Removed:
Parts Added:
$\begin{array}{llllll}\text { C325 } & 47 \mathrm{pf} & \text { unknown } & \text { C325 } & 100 \mathrm{pf} & \text { 281-536 }\end{array}$
Parts Required for Field Installation:
See 'Parts Added'.
INSTALLATION INSTRUCTIONS:
Replace C325 between ceramic strip turret and pin 1 of V309, a 100 pf ceramic capacitor.
-135 V POWER SUPPLY DECOUPLING
CAPACITOR CHANGED TO REDUCE
INFORMATION ONLY
M449 RIPPLE AND INCREASE VOLTAGE RATING

Effective Prod s/n 175
DESCRIPTION:
Decreases the ripple of the -135 V power supply by changing the value of the decoupling capacitor. The voltage rating of C350 was increased to provide proper voltage rating.

Parts Removed:
Parts Added:
$\begin{array}{llllll}\text { C350 } & 100 \mu \mathrm{f} 25 \mathrm{v} & \text { unknown } & \mathrm{C} 350 & 20 \mu \mathrm{f} & 150 \mathrm{v}\end{array} \quad \begin{aligned} & \text { 290-008 } \\ & \end{aligned}$

## DESCRIP TION:

Reduces $5 \mathrm{MHz}, 10 \mathrm{MHz}$ and 50 MHz jitter by changing components in the 100 ms frequency divider to provide better isolation between 100 ms and 500 ms dividers which reduces pulling.

Parts Removed:
C343F $\quad 100 \mathrm{pf}$ unknown
R375F $\quad 8.2 \mathrm{k} 1 \mathrm{w} \mathrm{10} \mathrm{\%} \mathrm{304-822}$
304-123

Parts Added:

R375F $\quad 3.9 \mathrm{k} 1$ w 10\% 304-392
R376F $15 \mathrm{k} 1 \mathrm{w} 10 \%$

10 MHZ FREQUENCY MULTIPLIER

Effective Prod s/n 268
DESCRIPTION:
Improves the adjustment range of the 10 MHz frequency multiplier by adding C224 in parallel with C225.

Parts Removed:

Parts Added:
C224 4.7 pf
281-501

FREQUENCY DIVIDER COMPONENTS CHANGED TO REDUCE ADJUSTMENT INFORMATION ONLY

M508-3
RANGE PROBLEMS
Effective Prod s/n 268
DESCRIPTION:
Reduces adjustment range problems in the low frequency dividers by tightening R379A-H and R378A-H resistor tolerances.

Also, C345 and C347 +225 V decoupling capacitors were removed from the plate circuits of V321A and V322A respectively.

| Parts Removed: |  | Parts Added: |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| R375A-H $\quad 100 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | $302-104$ | R375A-H <br> R376A-H | $100 \mathrm{k} 1 / 2 \mathrm{w} 5 \%$ | $303-104$ |  |
| R376A-H |  |  |  |  |  |
| C345 | $6.25 \mu \mathrm{f} 300 \mathrm{v}$ | unknown |  |  |  |
| C347 $6.25 \mu \mathrm{f} 300 \mathrm{v}$ |  | unknown |  |  |  |
| Clamp, CL-16 | (2) unknown |  |  |  |  |
| Bolt, spade | (2) unknown |  |  |  |  |
| Screw, 6-32 x 1/4 BHB | (2) unknown |  |  |  |  |
| Nut, 6-32 hex | (4) unknown |  |  |  |  |
| Lockwasher |  | unknown |  |  |  |

$10 \mu$ SEC FREQUENCY DIVIDER
RESISTOR VALUE CHANGED TO
INFORMATION ONLY
M512
INCREASE OUTPUT AMPLITUDE
Effective Prod s/n 268

## DESCRIPTION:

Increases the output amplitude of the $10 \mu \mathrm{sec}$ Frequency Divider by increasing the value of the output amplifier V306B plate load resistor.

| Parts Removed: | Parts Added: |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| R336 | $10 \mathrm{k} \mathrm{2} \mathrm{w} 10 \%$ | $306-103$ | R336 | $12 \mathrm{k} \mathrm{2} \mathrm{w} 10 \%$ | $306-123$ |

Effective date 5-18-53

## DESCRIPTION:

Improves the stability of the crystal oscillator by adding 16 ventillating louvers to the left cabinet side.

1 MHz OSCILLATOR REDESIGNED TO
IMPROVE CRYSTAL STARTING AND
INFORMATION ONLY
M553
INCREASE CRYSTAL FREQ ADJ RANGE
Effective Prod s/n 299

## DESCRIPTION:

Increases the adjustment range of the 1 MHz crystal oscillator and insures that the crystal oscillator will start by redesigning the oscillator circuit. This involved removing crystal oscillator V201 (6AU6) and replacing it with a 6U8, V250, which provided a buffer amplifier between the oscillator and the 5 MC multiplier amplifier.
The $5 \mu \mathrm{sec}$ plate load resistor R301 was also changed.

Parts Removed:

| V201 | 6AU6 |
| :--- | :--- |
| R203 | $33 \mathrm{k} 1 \mathrm{w} \mathrm{10} \mathrm{\%}$ |
| R201 | $100 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ |
| C200 | $3-12 \mathrm{pf} \mathrm{NPO}$ |
| C201 | $47 \mathrm{pf} \mathrm{GP} \mathrm{1A} \mathrm{20} \mathrm{\%}$ |
| R301 | $12 \mathrm{k} 1 \mathrm{w} \mathrm{10} \mathrm{\%}$ |
| Socket, | 7 -pin, STM7G |

Parts Added:

| unknown | V250 | 6U8 | unknown |
| :---: | :---: | :---: | :---: |
| unknown | R250 | $100 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | unknown |
| unknown | R251 | 447 k 1/2 w $10 \%$ | unknown |
| unknown | R252 | $68 \mathrm{k} \mathrm{1/2} \mathrm{w} 10 \%$ | unknown |
| unknown | R253 | $1 \mathrm{M} 1 / 2 \mathrm{w} 10 \%$ | unknown |
| unknown | R254 | $680 \Omega 1 / 2 \mathrm{w} 10 \%$ | unknown |
| unknown | R255 | $18 \mathrm{k} 1 \mathrm{w} 10 \%$ | unknown |
|  | R256 | $10 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | unknown |
|  | R257 | $47 \Omega 1 / 2 \mathrm{w} 10 \%$ | unknown |
|  | C250 | 7-45 pf | unknown |
|  | C251 | $47 \mathrm{pf} \mathrm{GP1A}$ | unknown |
|  | C252 | 1 k discap | unknown |
|  | C253 | $12 \mathrm{pf} \mathrm{GP} \mathrm{1A}$ | unknown |
|  | C254 | 10 k pf discap | unknown |
|  | C255 | 1 kpf discap | unknown |
|  | R301 | $5.6 \mathrm{klw} 10 \%$ | unknown |
|  | Socket | in, STM9G | unknown |
|  | Solder | SE4 | unknown |
|  | Ceram | rret, single | unknown |
|  | Tubing | mflex \#20 (2 in.) | unknown |

Refer to before and after schematics on following page.
continued



POWER SUPPLY SELENIUM RECTIFIER MOUNTING STUD BOLT CHANGED TO

INFORMATION ONLY
M585

## PREVENT THREAD STRIPPING

Effective date 9-3-53

## DESCRIPTION:

Prevents stripping the selenium rectifier stud bold threads by changing from an aluminum bolt to a brass bolt.

Parts Removed:
Rod, alum $3 / 16 \times 7-7 / 8$
(2) unknown
Rod, brass $3 / 16 \times 7-7 / 8$
(2) unknown

Parts Added:

50 MHZ MULTIPLIER CAP ACITOR ADDED TO IMP ROVE TUNING RANGE

Effective Prod s/n 333
DESCRIPTION:
Improves the 50 MHz multiplier adjustment tuning range by adding C 231 in parallel with C230.

Parts Removed:

## Parts Added:

C231 2.2 pf 500 v unknown

FUSE AND FUSE HOLDER CHANGED TO 3AG TYPE TO IMP ROVE AVAILABILITY

Effective Prod s/n 362
DESCRIPTION:
Improves the availability of the fuse and fuse holder by standardizing on the 3AG type fuse and fuse holder. The fuse holder mounting hole was changed from a $5 / 8^{\prime \prime}$ dia hole to a $1 / 2^{\prime \prime}$ dia "D" hole.

Parts Removed:
Fuse, 4AG unknown Holder, fuse HCM

Parts Added:
Fuse, 3AG
Holder, fuse HKM-H
unknown
unknown

Effective Prod s/n 373

## DESCRIPTION:

Improves the adjustment range of the High Frequency Divider adjustment potentiometers by changing the potentiometer values from 100 k to 50 k and adding limiting resistors in series with the potentiometers.

Parts Removed:
R303,R325, R342,R362


Parts Added:
R303,R325,
R342,R362
50 k pot unknown
R306,R327,
R348,R363
3

INFORMATION ONLY
M636
-135 V POWER SUPPLY RESISTOR CHANGED
TO IMP ROVE ADJUSTMENT RANGE
Effective Prod s/n 379

## DESCRIPTION:

Improves the adjustment range of the -135 v power supply adjustment of R 409 by changing the value of voltage divider resistor R407.

Parts Removed:
R407 $22 \mathrm{k} \mathrm{1/2w10} \mathrm{\%} \mathrm{302-223}$

Parts Added:
R407 27 k 1/2 w $10 \%$
302-273

Effective Prod s/n 409

## DESCRIPTION:

Provides consistent color coding for all +140 V wires in the Power, Div. A and Div. B cables by replacing $182^{\prime \prime}$ of white-yellow-green-brown wire with the same length of white-brown-green-brown wire.

Parts Removed:
Wire, \#22 sol w-y-gn-bn
175-522
Parts Added:
Wire, \#22 sol w-bn-gn-bn
175-522

FAN RING THICKNESS DECREASED
TO ALLOW EASIER WELDING
INFORMATION ONLY
M450
Effective Prod s/n 450
DESCRIPTION:
Makes the fan ring easier to weld by decreasing the thickness of the aluminum material from $0.081^{\prime \prime}$ to $0.064^{\prime \prime}$.

Parts Removed:
Aluminum $1-1 / 8 \times 18-1 / 4 \times .081$ unknown

## Parts Added:

Aluminum $1-1 / 8 \times 18-1 / 4 \times .064$ unknown

INFORMATION ONLY
M651

FUSEHOLDER CAPS MARKED WITH CURRENT RATING

Effective Prod s/n not given
DESCRIPTION:
To indicate the proper size fuse to be used in the instrument, the current rating of the fuse is silk-screened on the fuseholder cap.

Effective Prod s/n 469

## DESCRIPTION:

Prevents the instrument cabinet from wearing away caused by the power supply chassis rubbing against the cabinet. This was accomplished by bending the power supply chassis flanges inward to provide support for the weight of the instrument.

Effective Prod s/n not given
DESCRIPTION:
To place the instrument serial number in a more convenient location, the serial number is moved from the bottom of the front panel to just beneath the instrument type. Also, the instrument title is laid out so that "special" numbers may be added when necessary.
+140 V POWER SUPPLY RESISTOR
INFORMATION ONLY
M752 ITS DISSIP ATION RATING

Effective Prod s/n 483
DESCRIPTION:
Prevents damage to the +140 V Power Supply resistor R422, caused by exceeding its power dissipation rating, by replacing it with a 1 watt resistor.

This mod is superseded by M1196.
Parts Removed:
$\begin{array}{llllll}\text { R422 } & 120 \mathrm{k} 1 / 2 \mathrm{~W} 10 \% & 302-124 & \text { R422 } & 120 \mathrm{k} 1 \mathrm{~W} 10 \% & 304-124\end{array}$

Effective Prod s/n 535

## DESCRIPTION:

Provides a Crystal Oscillator frequency accuracy of $0.03 \%$ by changing C 250 from a variable ceramic to a fixed mica capacitor.

NOTE: Special model 180-S1 will be made with temperature-stabilized precision crystal. The cabinet tag, which was removed will be used on 180-S1 instruments only.

See M439.
Parts Removed:
Parts Added:
C250 7-45 pf 500v unknown C250 22 pf 500 v unknown
Tag, "OSC. FREQ. ADJ" unknown
Rivet, alum $1 / 16 \times 5 / 32 \quad 210-604$

SUB-PANEL SWITCH INDEX HOLE
RELOCATED TO ACCEPT
INFORMATION ONLY
M745
INSTALLATION OF SWITCH
Effective Prod s/n 545
DESCRIPTION:
Relocates a sub-panel switch index hole to accommodate the installation of a new OAK switch, SWR1-6D.
L.F. DIVIDER RESISTOR CHANGED TO INCREASE 50 MSEC THROUGH 1 SEC

INFORMATION ONLY
M809
AMPLITUDE OUTPUT
Effective Prod s/n 591
DESCRIP TION:
Increases the output amplitude of the $50 \mathrm{msec}, 100 \mathrm{msec}, 0.5 \mathrm{sec}$ and 1 sec timing pulses by increasing the value of R390.

Parts Removed:
$\begin{array}{llllll}\text { R390 } 22 \mathrm{k} 1 / 2 \mathrm{w} 10 \% & 302-223 & \text { R390 } 27 \mathrm{k} 1 / 2 \mathrm{w} 10 \% & 302-273\end{array}$

Effective Prod s/n 592
DESCRIPTION:
Makes it easier to service the Divider and Multiplier chassis by installing 8-32 pem nuts to the inside of the rear flange of the divider " B " chassis.

Parts Removed:
Nut, hex $8-32 \times 5 / 16$
(2) 210-409

Lockwasher, \#8 int
(2) 210-008

Parts Added:
Nut, pem 8-32
210-404

INFORMATION ONLY
M771

FAN MOTOR WIRED DIRECTLY TO
117 V LINE TO PREVENT POSSIBLE
INSTRUMENT DAMAGE
Effective Prod s/n 599

## DESCRIPTION:

Prevents any possible damage to the instrument caused by the fan motor becoming accidentally disconnected from the 117 V line by eliminating the two prong interconnecting fan motor plug. The fan motor leads will now be connected directly to Power Transformer terminals no. 1 and no.3.
This mod also initiated the following minor changes:

1. Changed SP $12-12$ to $3 / 8^{\prime \prime}$ hex aluminum.
2. Added a solder lug to the rectifier bracket to properly ground the transformer.
3. Changed four hole sizes in power supply chassis to $3 / 16^{\prime \prime}$ and installed $6-32$ pem nuts in two.

Parts Removed:

| Socket, SCB-2, 2-pin |  | $136-004$ |
| :--- | ---: | ---: |
| Screw, 4-40 x 1/4 BHB | (2) | $211-008$ |
| Lockwasher, int \#4 | (2) | $210-004$ |
| Nut, hex, 4-40 x 3/16 | (2) | $210-406$ |
| Plug, PWB-2, 2-pin |  | $134-001$ |
| Lug, solder SE\#10 long | $210-206$ |  |
| Rod, alum, round 24ST4 (2-1/2') $251-084$ |  |  |
| Wire, solid \#18 | $\left(15-1 / 2^{\prime \prime}\right)$ | unknown |
| Lockwasher, int\#6 |  | $210-006$ |

Parts Added:
Nut, captive CL 6-32 (2) 210-403
Screw, 6-32 x $3 / 8$ FHB (2) 211-509
Lug, solder SE\#6 210-202
Lockwasher, int \#10 210-010
Bar, alum, hex 24ST4 (2-1/2") unknown

CERAMIC POST AND TURRET STUD REPLACED WITH SPRING PIN

INFORMATION ONLY
M787
FOR ECONOMY
Effective Prod s/n not given
DESCRIPTION:
To save labor costs, the solid ceramic post and ceramic turret stud is replaced with a spring pin stud.

Parts Removed:
Parts Added:
Stud, 6-32 x 1/2
(16) 355-001

Pin, spring, sel-10k
166-058

HIGH FREQ MULTIPLIER CHASSIS SOLDER LUG ADDED TO ELIMINATE

INFORMATION ONLY
M793 THE NECESSITY OF ENLARGING HOLES

Effective Prod s/n not given

## DESCRIPTION:

Eliminates the necessity of enlarging banana lug $1 / 4^{\prime \prime}$ holes to $5 / 16^{\prime \prime}$ by adding a $5 / 16^{\prime \prime}$ solder lug under the nut on the coax connector.

Parts Removed:
Parts Added:
Lug, banana (3) 210-214 Lug, solder 5/16" (3) 210-217
+225 V POWER SUPPLY RESISTOR
ADDED TO P ROTECT V440 AGAINST CIRCUIT OVERLOADS

Effective Prod s/n 606
See SQB
M1006

DESCRIPTION:
Provides protection for the +225 V power supply shunt regulator tube V440. This was accomplished by adding a $10 \Omega 1 / 2 \mathrm{w} 10 \%$ resistor in the plate circuit of V440 to function as a fuse.

Parts Removed: Parts Added:

$$
\text { R439 } 10 \Omega 1 / 2 \mathrm{w} 10 \% \quad 302-100
$$

Parts Required for Field Installation:
See 'Parts Added'.
INSTALLATION INSTRUCTIONS:
a) Move C442 on terminal board BB16R to connect between pin 1, V403 and ground.
b) Move R443 from between solder lug and pin 2, V440 to solder lug and terminal board BB16R.
c) Add R439 between terminal board. Refer to drawings on following page.
continued


M1006

$5 \mu$ SEC, $10 \mu$ SEC AND $50 \mu$ SEC

Effective Prod s/n 638
Usable in field instruments SN 101-637
w/exceptions 260-293 may be modified if a 6U8 oscillator tube is present.

## DESCRIPTION:

Increases stability of the $5 \mu \mathrm{sec}, 10 \mu \mathrm{sec}$ and $50 \mu \mathrm{sec}$ dividers by:

1. Increasing the amount of RF drive for the $5 \mu \mathrm{sec}$ divider
2. Deleting the use of a stability control in a multivibrator-divider to set the time width divider ratio
3. Changing to $1 \%$ resistors in grid voltage-divider networks and plate loads
4. Deleting the phasing control.

See Field Modification kit 040-0006-00.
Parts Removed:

| R305,R323, <br> R343 | $100 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | $302-104$ |
| :--- | :--- | :--- |
| R304, R324, |  |  |
| R344 k $1 / 2 \mathrm{w} 10 \%$ | $302-563$ |  |
| R351 |  |  |
| V309 k $2 \mathrm{w} 10 \%$ | $306-103$ |  |
|  | 12 AU7 | $154-041$ |

Parts Added:

| R204 | 4.7 M 1/2 w $10 \%$ | 302-475 |
| :---: | :---: | :---: |
| $\begin{aligned} & \text { R305,R323, } \\ & \text { R343 } \end{aligned}$ | $82 \mathrm{k} \mathrm{1/2} \mathrm{w} 1 \%$ | 309-043 |
| $\begin{aligned} & \text { R304, R324, } \\ & \text { R344 } \end{aligned}$ | $60 \mathrm{k} 1 / 2 \mathrm{w} 1 \%$ | 309-041 |
| R351 | 12k 2 w 10\% | 306-123 |
| C328 | 22 pf NPOA cer | 281-511 |
| V309 | $12 \mathrm{AT7}$ | 154-039 |

Parts Required for Field Installation:
Field Modification kit 040-0006-00
INSTALLATION INSTRUCTIONS:
Refer to kit instructions.

## ACCURACY

Effective Prod s/n 723

## DESCRIPTION:

Provides a more accurate power supply voltage in the -135 V and +225 V power supplies by replacing composition type comparator-amplifier voltage divider resistors with precision components.

| Parts Removed: |  |  | Parts Added: |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| R407 | $27 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | 302-273 | R407 | 18k 1/2 w $1 \%$ | 309-036 |
| R410 | $47 \mathrm{k} 1 / 2 \mathrm{w} \mathrm{10} \mathrm{\%}$ | 302-473 | R410 | $34.5 \mathrm{k} 1 / 2 \mathrm{w} \mathrm{1} \mathrm{\%}$ | 309-038 |
| R411,R454 | $1.5 \mathrm{M} 1 / 2 \mathrm{w} 10 \%$ | 302-155 | R411,R454 | 100k 1/2 w 10\% | 302-104 |
| R449 | 220 k 1/2 w $10 \%$ | 302-224 | R451 | $333 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | 309-053 |
| R451 | 470k 1/2 w 10\% | 302-474 | R453 | $200 \mathrm{k} 1 / 2 \mathrm{w} 1 \%$ | 309-051 |

R452 100 k 2 wPSD 311-026

R453 270 k 1/2 w 10\% $302-274$

See SQB
M1138
$100 \mu$ SEC HF DIVIDER RESISTOR VALUE CHANGED TO PREVENT TRIGGER PULL

Effective Prod s/n 883
Usable in field instruments s/n 101-882

## DESCRIPTION:

Prevents trigger pull in the $100 \mu \mathrm{sec} \mathrm{HF}$ Divider by increasing the value of R367 to 1.2 meg .
Parts Removed:
R367
1 M $1 / 2$ w $10 \%$
302-105
Parts Added:
R367 1.2M 1/2w 5\%
301-125
Parts Required for Field Installation:
See 'Parts Added'.
INSTALLATION INSTRUCTIONS:
Replace R367 located between pin 7, V312 and ceramic turret notch with a $1.2 \mathrm{meg} 1 / 2 \mathrm{w}$ $5 \%$ resistor.

1 MH.z CRYSTAL OVEN CHANGED TO INSURE FREQUENCY STABILITY

Effective Prod s/n 890 (180-S1 only)
DESCRIPTION:
Insures that the crystal oven will meet Tektronix specifications by changing from a Type JKO-2 to a JKO-9 crystal oven.

Parts Removed:
Oven, crystal JKO-2/H-17 crystal 158-005

Parts Added:
Oven, crystal JKO-9/H-17 crystal 158-006

CERAMIC TURRETS CHANGED TO
CERAMIC STRIPS TO ENHANCE
INSTRUMENT APPEARANCE
INFORMATION ONLY
M1196
AND WIRING EASE
Effective Prod s/n 951

## DESCRIPTION:

Provides a neater appearance over old circuitry and improves ease of wiring by changing from turret type to standard type ceramic strips.

This mod also added many new components and made extensive circuit changes. The 'Parts Removed" listing was lost and only a few parts are listed under Parts Removed. See M1 233

Parts Removed:
Rod, alum, $3 / 8 \times 3 / 4$ (2)
Cover, capacitor
Cover, capacitor
T401 transformer, power
C421 $\quad 125 \mu \mathrm{~F} 350 \mathrm{~V}$
Switch, SPST
Motor
Cabinet
$385-065$
$200-065$
$200-060$
$120-073$
$290-052$
$260-134$
$147-001$
$437-008$

Parts Added:

| R439 | /2W | 302-100 |
| :---: | :---: | :---: |
|  |  |  |
|  |  |  |
|  |  |  |
| R423 | $18 \mathrm{k} 1 / 2 \mathrm{~W}$ | 302-1 |
| R445 | $22 \mathrm{k} 1 / 2 \mathrm{~W}$ | 302-223 |
| R405, R424 | $33 \mathrm{k} 1 / 2 \mathrm{~W}$ | 302-333 |
| R450 | 270 k 1/2W | 302-274 |
| R443 | 470 k 1/2W | 302-474 |
| R448 | $560 \mathrm{k} \mathrm{1/2W}$ | 302-5 |
| R411, R454,) |  |  |
| R425, R403,) | )- $1 \mathrm{M} 1 / 2 \mathrm{~W}$ | 302-1 |
| R 421 l ) |  |  |
| R446, R447 | 2.2M1/2W $10 \%$ | 302-225 |
| R444 | 56 k 1W 10\% | 304-563 |
| R422 | 120 k 2W 10\% | 306-124 |
| R406, R440 | 220 k 1W 10\% | 304-224 |
| R407 | $18 \mathrm{k} 1 / 2 \mathrm{~W} \quad 1 \%$ | 309-036 |
| R410 3 | 34.5 k 1/2W 1\% | 309-038 |
| R453 | $200 \mathrm{k} 1 / 2 \mathrm{~W} 1 \%$ | 309-051 |
| R451 | $333 \mathrm{k} 1 / 2 \mathrm{~W}$ 1\% | 309-053 |
| R427 | $1 \mathrm{Ml} / 2 \mathrm{~W} \quad 1 \%$ | 309-014 |
| R426 | $1.11 \mathrm{Ml} / 2 \mathrm{~W} 1 \%$ | 09-015 |
| C402, C403, ) 0 ) $01 \mu \mathrm{~F} 400 \mathrm{~V}$ 285-5 |  |  |
| C444 | $0.1 \mu \mathrm{~F} 600 \mathrm{~V}$ | 285-527 |
| Fuse Post | 3AG | 352-002 |
| R385A-H | 4.7 k 1/2W 10\% | 302-472 |
| R387, R389 | $10 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-103 |
| R390 | $27 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-273 |
| R388 | $33 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-333 |
| R384A | $68 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-683 |
| R378A-H, ) | $100 \mathrm{k} 1 / 2 \mathrm{~W} 5 \%$ | 301-104 |
| R384B | $180 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-184 |
| R384C | 330 k 1/2W 10\% | 302-334 |
| R380A | $560 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-564 |
| R380B, D, E | 820 k 1/2W 10\% | 302-824 |
| R384D | 680 k 1/2W 10\% | 302-684 |

Continued.

Parts Removed:

## Continued.

Parts Added (con'd):

| R380F | $1 \mathrm{M} 1 / 2 \mathrm{~W} 10 \%$ | 302-105 |
| :---: | :---: | :---: |
| R380G | $1.2 \mathrm{M} 1 / 2 \mathrm{~W} 10 \%$ | 302-125 |
| R380C | $1.8 \mathrm{Ml} / 2 \mathrm{~W} 10 \%$ | 302-185 |
| R380H, ) | 2.2M1/2W | 302-225 |
| R384E ) | 2.2M1/2W | 302-225 |
| R384F | $3.3 \mathrm{M} 1 / 2 \mathrm{~W}$ | 302-335 |
| R384G | $5.6 \mathrm{M} 1 / 2 \mathrm{~W}$ | 302-565 |
| R384H | $6.8 \mathrm{M1} / 2 \mathrm{~W}$ | 302-685 |
| R375F | 3.9 k 1 W | 304-392 |
| R382A-G, ) |  |  |
| R375A-E, )- | 8.2 k 1W | 304-822 |
| R375G-H) |  |  |
| R376A-E, ) | 12 k 1W | 304-123 |
| R376G-H ) | 12 k 1W |  |
| R376F | 15 k 1W | 304-153 |
| R382H | 8.2 k 2W | 306-822 |
| R383A-H | 10 k 2W | 306-103 |
| C342A-B | 47 pF 500 V | 281-518 |
| C342C | 46 pF 500 V | 281-521 |
| C342D | 82 pF 500 V | 281-522 |
| $\begin{aligned} & \text { C342E, ) } \\ & \text { C343A-G) } \end{aligned}$ | 100 pF 350 V | 281-523 |
| C340D | $0.01 \mu \mathrm{~F} 400 \mathrm{~V}$ | 285-510 |
| C340C | $0.0047 \mu \mathrm{~F} 400 \mathrm{~V}$ | 285-506 |
| C340A-B | $0.001 \mu \mathrm{~F} 600 \mathrm{~V}$ | 285-501 |
| C340E-H | $0.1 \mu \mathrm{~F} 400 \mathrm{~V}$ | 285-526 |
| C342F | $220 \mathrm{pF} 500 \mathrm{~V} 10 \%$ | 285-536 |
| C342G-H | 470 pF 500V 20\% | 281-525 |
| C346, C348 | $0.01 \mu \mathrm{~F}$ | 283-002 |
| L207 | 73-100 $\mu \mathrm{H}$ | 114-039 |
| R303Q, R325 | ,) -50 k 2 W | 311-023 |
| $\begin{aligned} & \text { R342, R362 } \\ & \text { R455 } \end{aligned}$ | $\begin{aligned} & \text { s.j0k } \\ & 1.5 \mathrm{k} \quad 25 \mathrm{~W} \end{aligned}$ | 308-040 |
| R428 | $3 \mathrm{k} 25 \mathrm{~W} 5 \%$ | 308-042 |
| C404 | 150 x 250 V | 290-047 |
| C401 | 2 x 40450 V | 290-042 |
| C443, C440, | 40450 V | 290-043 |
| C441 |  |  |
| R409 | 10 k pot | 311-015 |
| R381 A-H | 1 M 2 WPSD pot | 311-039 |
| C349, C350 | $20 \mu \mathrm{~F} 150 \mathrm{~V}$ | 290-008 |
| C228, C230 | $1.5-7 \mathrm{pF}$ | 281-005 |
| C220, C225 | 3-12 pF | 281-007 |
| C209, C216 | 7-45 pF | 281-012 |
| R521, R522 | $27 \Omega 1 / 2 \mathrm{~W} 10 \%$ | 302-270 |
| R257 | $47 \Omega 1 / 2 \mathrm{~W} 10 \%$ | 302-470 |
| R520 | $56 \Omega 1 / 2 \mathrm{~W} 10 \%$ | 302-560 |
| R524 | $560 \Omega 1 / 2 \mathrm{~W} 10 \%$ | 302-561 |
| R254 | $680 \Omega 1 / 2 \mathrm{~W} 10 \%$ | 302-681 |

Parts Removed:
Parts Added (con'd):

| R228 | $2.7 \mathrm{k} \mathrm{1/2W} \mathrm{10} \mathrm{\%}$ | 302-272 |
| :---: | :---: | :---: |
| R316, R320,) |  |  |
| R329, R346, )-4.7k 1/2W 10\% 302-472 |  |  |
| R371, R229, ) | . k 1/2W $10 \%$ | 302-472 |
| R251 ) |  |  |
| R256 | $10 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-103 |
| R355 | $12 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-123 |
| R315 | $27 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-273 |
| R306, R327,) | $33 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-333 |
| R209, R211,) |  |  |
| R216 ) | 47 k 1/2W 10\% | 302-473 |
| R326, R328,) |  |  |
| R347, R356,) | 56 k 1/2W 10\% | 302-563 |
| R226, R526) |  |  |
| R525 | $8.2 \mathrm{k} \mathrm{1/2W} 10 \%$ | 302-822 |
| R307, R370,) | 68 k 1/2W 10\% | 302-683 |
| R250, R360 | $100 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-104 |
| R314 | 180k 1/2W 10\% | 302-184 |
| R210, R215 | $220 \mathrm{k} 1 / 2 \mathrm{~W} 10 \%$ | 302-224 |
| R332 | 270 k 1/2W 10\% | 302-274 |
| R310 | 390 k 1/2W 10\% | 302-394 |
| R208, R218 | 470 k 1/2W 10\% | 302-474 |
| $\begin{aligned} & \text { R319, R205,) } \\ & \text { R253 } \end{aligned}$ | $1 \mathrm{M} 1 / 2 \mathrm{~W} 10 \%$ | 302-105 |
| R367 | 1.2M1/2W 5\% | 301-125 |
| R350 | $2.2 \mathrm{Ml} / 2 \mathrm{~W} 10 \%$ | 302-225 |
| $\begin{aligned} & \text { R304, R324,) } \\ & \text { R344 } \end{aligned}$ | $60 \mathrm{k} 1 / 2 \mathrm{~W} \quad 1 \%$ | 309-041 |
| R343 | 1/2W 1\% | 309-043 |
|  | 1/2W |  |
| R204 | 4.7 M 1/2W 10\% | 302-475 |
| R523 | $1 \mathrm{k} \quad 1 \mathrm{~W} 10 \%$ | 304-102 |
| R219 | 2.7 k 1W 10\% | 304-272 |
| R321, R340 | 3.3 k 1W 10\% | 304-332 |
| R301 | 5.6 k 1W 10\% | 304-562 |
| R302, R358,) | . 2 k 1W 10\% | 304-822 |
| R222 | $10 \mathrm{k} \quad 1 \mathrm{~W} 10 \%$ | 304-103 |
| R322, R341,) | 12 k 1W 10\% | 304-123 |
| R359R255 |  |  |
|  | 18 k 1W 10\% | 304-183 |
| R206 | 3.9 k 1W 10\% | 304-392 |
| R309, R369 | 10 k 2W 10\% | 306-103 |
| R336, R351 | 12 k 2W 10\% | 306-123 |
| C231 | 2.2 pF 500 V | 281-500 |

Continued.

M1196
(con'd)
Parts Removed:
Parts Added (con'd):


Continued.

Parts Removed:
Parts Added (con'd):

| V302 12AT7 aged | 12AT7 aged | 157-010 |
| :---: | :---: | :---: |
| V206, V301,) |  |  |
| V305, V308,) |  |  |
| V311, V323,) |  |  |
| V327, V332,)-6AL5 |  | 154-016 |
| V337, V342,) |  |  |
| V347, V352,) |  |  |
| V357 ) |  |  |
| V303, V307,) |  |  |
| V310, V312,) |  |  |
| V501, V321,) |  |  |
| V325, V330,)-12AU7 | $12 \mathrm{AU7}$ | 154-041 |
| V335, V340,) |  |  |
| V345, V350,) |  |  |
| V355 ) |  |  |
| V304,V313,) |  |  |
| V322, V326,) |  |  |
| V331,V336,)-6C4 | 6 C 4 | 154-029 |
| V341, V346,) |  |  |
| V351, V356) |  |  |
| V250 6U8 | 6U8 | 154-033 |
| V401 6X4 | 6X4 | 154-035 |
| V402 6AS5 | 6AS5 | 154-018 |
| V420 6AQ5 | 6AQ5 | 154-017 |
| V404 5651 | 5651 | 154-052 |
| V440 6AS7 | 6AS7 | 154-020 |
| V442 12AX7 | $12 \mathrm{AX7}$ | 154-043 |
| Lug, pot solder | der (6) | 210-207 |
| Nut, pot, 3/8-32 x 1/2 | -32 x 1/2 (20) | 210-413 |
| Washer, pot, $3 / 8 \times 9 / 16$ | $3 / 8 \times 9 / 16$ (14) | 210-840 |
| Jack, socket tip, black nylon (13)136-037 |  |  |
| Post, binding | (2) | 129-020 |
| Blade, fan |  | 369-001 |
| Knob, | (2) | 366-007 |
| Lockwasher, int, 3/8x $1 / 2$ (19) |  | 210-012 |
| Light, pilot, red assembly | red assembly | 136-025 |
| Lockwasher, int \#10 | int \#10 (6) | 210-010 |
| Nut, hex, 10-32 x 5/16 | -32 x 5/16 (10) | 210-410 |
| Switch, SPST |  | 260-134 |
| Strip, ceramic 11-notch | ic 11-notch (26) | 124-016 |
| Strip, ceramic 7-notch | ic 7-notch (10) | 124-014 |
| Chassis, Power |  | 441-118 |
| Spacer, alum., 10-4 | ., 10-4 | 166-084 |
| Screw, 6-32 5/16 BHB | $5 / 16$ BHB (23) | 211-507 |
| Nut, 6-32 1/4 | 4 (39) | 210-407 |
| Screw, 6-32 5/16 FHB | 5/16 FHB (4) | 211-508 |
| Grommet, 3/8 | /8 (3) | 348-004 |
| Grommet, 5/8 |  | 348-012 |
| Washer, $3 / 8 \times 1 / 2$ | x 1/2 | 210-806 |

Continued.

Parts Removed:
Parts Added (con'd):

| Lug, SE6 solder |  | 210-202 |
| :---: | :---: | :---: |
| Screw, 8-32 x 2-1/4 RHB | ( 4) | 212-014 |
| Nut, 8-32 x 5/16 | (19) | 210-409 |
| Lug, \#10SE solder |  | 210-206 |
| Washer, brass 8s | ( 6) | 210-804 |
| Washer, 25 W cent. | ( 4) | 210-809 |
| Plate, rectifier | (32) | 386-002 |
| Lug | ( 4) | 210-212 |
| Washer, alum. 0.032 x $1 / 4$ ID x $15 / 32$ OD | ( 4) | 210-820 |
| Washer, alum. 0.046 x $1 / 4$ ID x $1 / 2 \mathrm{OD}$ | (92) | 210-821 |
| Washer, bakelite, 0.046x $1 / 4$ ID x $1 / 2$ OD |  | 210-819 |
| Washer, steel end, 0.032 x $3 / 16 \mathrm{ID} \times 7 / 16 \mathrm{OD}$ | 4) | 210-822 |

Tube, insulating $2-7 / 8 \mathrm{x}$
$1-13 / 32$ (2) 166-021

Stud, $10-32 \times 4-1 / 16 \quad$ ( 2) $355-007$
Bracket, alum. $1-1 / 2 \times \quad$ (2) $406-128$
$4-1 / 2 \times 5 / 8$
Chassis, left divider 441-110
Grommet, 1/4 (2) 348-002
Nut, $3 / 8 \times 1 / 2 \quad$ ( 8) 210-422
Bolt, spade, $6-32 \times 3 / 8$ ( 2) 214-012
Washer, plain \#10 int. ( 4) 210-805
Cable, Power 179-076
Clips, $1 / 2$ cable ( 2) 343-006
Screw, 6-32 3/8 BHS ( 3) 211-510
Strip, ceramic 4-notch 124-012
Chassis, divider right 441-111
Shield, multiplier (2) 337-119
Socket, tube 7-pin (33) 136-008
Socket, tube 9 -pin (20) 136-015
Socket, tube 8-pin (2) 136-011
Post, ceramic (3) 129-009
Post, ceramic (13) 129-017
Grommet, $5 / 16 \quad$ (13) 348-003
Screw, 4-40 x $1 / 4$ BHB (106) 211-008
Nut, $4-40 \times 3 / 16 \quad$ (106) 210-406
Lockwasher, \#4 int. (106) 210-004
Lockwasher, \#6 int. (36) 210-006
Lug, solder, SE\#4 (16) 210-201
Nut, $2-56 \times 3 / 16 \quad$ (90) 210-405
Lockwasher, \#2 ext. (172) 210-002
Washer, \#6L plain (9) 210-803
Lockwasher, \#8 int. (13) 210-008
Connector, motor base 131-010
Bracket, alum. 406-041
Switch, SPST (13) 260-134
Continued.

Parts Removed:
Parts Added (con 'd):

| Plate, alum. |  | 386-313 |
| :---: | :---: | :---: |
| Rod, alum. | ( 4) | 385-010 |
| Bar, support |  | 381-055 |
| Panel, front |  | 333-178 |
| Bracket, fan |  | 406-192 |
| Ring, fan |  | 354-008 |
| Plate, frame |  | 387-550 |
| Plate, subpanel |  | 386-436 |
| Connector, chassis | ( 5) | 131-012 |
| Screw, 8-32 x $3 / 8$ FHS | (12) | 212-024 |
| Screw, 4-40 x 3/16 BHB | (20) | 211-007 |
| Screw, $6-32 \times 1 / 4 \mathrm{FHB}$ | (2) | 211-506 |
| Screw, 6-32 x 1/2 FHB | (2) | 211-512 |
| Screw, $8-32 \times 3 / 4 \mathrm{FHB}$ | (2) | 212-011 |
| Screw, $8-32 \times 3 / 8 \mathrm{BHB}$ | ( 6) | 212-023 |
| Screw, 6-32 x 3/8 FHB | (2) | 211-509 |
| Nut, knurled | (13) | 210-418 |

NOTE: The following separate S1 Parts Added and Removed listing concerns only instruments which have a crystal oven for controlled temperature.

Cable, P93
Adapter, A-100 clip lead Fuse, 3 amp FB 3 AG Cabinet
Fuse, $1 / 4 \mathrm{amp} 8$ AG
(2) 012-003

| 012-003 | Holder, fuse 8 AG |
| :--- | :--- |
| $013-003$ | Screw, $6-32 \times 1 / 2 \mathrm{BHB}$ |

352-003
$159-015$ Screw, 6-32 $\times 1 / 2$ BHB $211-511$
159-015 Lockwasher, \#6 int. (3) 210-006
437-034 Nut, 6-32 x 1/4 hex brass (3) 210-407
159-020 Washer, centering 20W (2) 210-808
T180 AA1
120-052
Panel, front
333-177
Screw, $6-32 \times 5 / 16$ BHB (2) 211-507
Light, pilot, assembly 136-025
Jewel, green 378-513
Lamp, \#47
150-001
Crystal 1000 kc Peterson 158-002
Crystal oven JK09 158-006
$5 \mu \mathrm{SEC}, 10 \mu \mathrm{SEC}$ AND $50 \mu$ SEC DIVIDER
RESISTORS ADDED TO ELIMINATE
INFORMATION ONLY

## PARASITIC OSCILLATIONS

## Effective Prod s/n 951

## DESCRIP TION:

Eliminates parasitic oscillations in the $5 \mu \mathrm{sec}, 10 \mu \mathrm{sec}$ and $50 \mu \mathrm{sec}$ Dividers by adding $100 \Omega$ parasitic grid resistors to V302A-B, V306A-B, and V310A-B.

NOTE: This modification was found necessary after the installation of M1196, which installed ceramic terminal strips. However, parasitic resistors may be installed to older instruments exhibiting instability of the $50 \mu \mathrm{sec}$ divider.

Parts Removed:
Parts Added:
R308,R311,
R318,R333, $100 \Omega$ 1/2 w 10\% 302-101
R349,R352

Effective Prod s/n 1022
DESCRIPTION:
Prevents the failure of Line Fuse F401 during overload or "turn-off, turn-on" conditions by changing F401 to a Slo-Blo type fuse.
NOTE: A 3 amp "Slo-Blo" fuse (159-005) was used until the 3.2 amp "Slo-Blo" fuse became available.

Parts Removed:
Parts Added:
F401 3 amp "Fast Blo" $\quad 159-015 \quad$ F401 3.2 amp "Slo Blo",117v ac 159-026
F401 1.6 amp "Slo Blo" 159-003
$5 \mu$ SEC AND $50 \mu$ SEC COMPONENTS CHANGED TO MAINTAIN CIRCUIT STABILITY

Effective Prod s/n 1258
See SQB
M1373

Usable in field instruments s/n 101-1257
w/exceptions s/n 1128,1175,1191,1238-53,1255-56

## DESCRIPTION:

Maintains the $5 \mu \mathrm{sec}$ and $50 \mu \mathrm{sec}$ divider circuit stability by changing the values of C328, R309 and R351, which increases the $5 \mu \mathrm{sec}$ and $50 \mu \mathrm{sec}$ output.

NOTE: This modification permits a higher tube yield for V302 and V309.
Parts Removed:

| C328 | $22 \mathrm{pf} \mathrm{500v}$ | $281-511$ | C328 | 12 pf 500 v | $281-505$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| R309 | $10 \mathrm{k} 2 \mathrm{w} \mathrm{10} \mathrm{\%}$ | $306-103$ | R309 | $12 \mathrm{k} 2 \mathrm{w} 10 \%$ | $306-123$ |
| R351 | $12 \mathrm{k} 2 \mathrm{w} \mathrm{10} \mathrm{\%}$ | $306-123$ | R351 | $15 \mathrm{k} \mathrm{2w} \mathrm{10} \mathrm{\%}$ | $306-153$ |

Parts Required for Field Installation:
See 'Parts Added'.
INSTALLATION INSTRUCTIONS:
a) Replace C328 mounted in parallel with C327 which is located between pin 7, V309 and pin 1, V309.
b) Replace R351 between pin 6, V309 and ceramic turret notch.
c) Replace R309 between pin 6, V302 and ceramic turret notch.

Effective Prod s/n 1532

## DESCRIPTION:

Reduces 60 Hz ripple (by 7 mv ) in the +225 V DC Power Supply by changing ground points established for pin 9 and 2 of V442.

Formerly, pin 2 of V442 was jumpered to pin 9 which was in turn grounded to the V442 socket ground lug adjacent to pin 9. In the modified version, pin 2 of V442 will be grounded at the V442 socket ground lug adjacent to pin 1. Pin 9 of V442 will be grounded at the V441 socket ground lug adjacent to pin 2.

In S-1 models the crystal heater transformer secondary terminal \#6 will be grounded at the V421 socket ground lug adjacent to pin 2, instead of at the V442 socket as was previously done.
$5 \mathrm{MHZ}, 10 \mathrm{MHZ}$ AND 50 MHZ SWITCH WIRE

Effective Prod s/n 1545

## DESCRIPTION:

Eliminates intermittent output distortion and amplitude attenuation caused by the removal of a bare wire strap which connects the shield sections of the sine wave output coaxial cables common at the Signal Selector switch. Removal of the wire permits a measure of frequency interaction in the form of cross-modulation with a resultant loss in output signal fidelity.

Effective Prod s/n 1783
Usable in field instruments s/n 101-1782
w/exceptions s/n $1608,1614,1688,1690,1697,1700,1708,1713,1715,1720,1744,1752$, 1759,1778,1781

## DESCRIPTION:

Centers the adjustment range of the 5 msec adj potentiometer R 381 C by changing the value of its series resistor R380C.

Parts Removed: Parts Added:
$\begin{array}{llllll}\mathrm{R} 380 \mathrm{C} & 1.8 \mathrm{M} \mathrm{1} & 2 \mathrm{w} 10 \% & 302-185 & \text { R380C } & 1.5 \mathrm{M} 1 / 2 \mathrm{w} 10 \% \\ 302-155\end{array}$
Parts Required for Field Installation:
See 'Parts Added'.

INSTALLATION INSTRUCTIONS:
Replace R380C located between pin 7, V330 and ceramic turret notch.

GERMANIUM DIODE REPLACED BY SUPERIOR T12G

INFORMATION ONLY
M1669

Effective Prod date 2-19-58

DESCRIPTION:
Germanium diode T12G replaces the 1N34A now used. The T12G has higher inverse resistance, higher forward conductance and shorter forward and inverse-pulse recovery time.

NOTE: The diode part number remains the same.

Parts Removed:
D300,D500 Germanium 1N34A 158-001

Parts Added:
D300,D500 Germanium T12G 158-001

Effective Prod date approx Dec. 1957

## DESCRIPTION:

Since silver-bearing solder is now available on the market, remove the solder sample and mounting hardware from all instruments. Also change the silk-screened text to the following:
NOTE: It is desirable that only silver-bearing solder be used on the ceramic terminals and for tinning the iron. Ordinary tin-lead solder may be used, but repeated use will break the solder-to-ceramic bond. See your instruction manual.

Parts Removed:
Parts Added:
Screw, 6-32 x 1/4 FH
(2) 211-506

Nut, 6-32
(2) 210-407

Lockwasher, int \#6 (2) 210-005
Washer, centering (2) 210-809
Wire, solder, silver-bearing 251-514 or (approx 15 in.$)$ 251-515

BE:fb

## MODIFICATION SUMMARY


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Effective Prod date 6-1-58

## DESCRIPTION:

Centralab Manufacturing Co. has reduced the voltage rating of their 'Hi-Kap' 0.01 and $0.02 \mu \mathrm{f}$ ceramic capacitors from 250 to 150 volts.
Investigation has shown that the 150 volt rating is adequate in all present instrument usage. Future instrument instruction manuals and Tek parts book releases will assign the 150 volt rating to the capacitors under discussion. No part number changes will be effected.

Parts Removed:
C112 $0.01 \mu \mathrm{f} \cdot 250 \mathrm{v} \quad 283-003$

POWER TRANSFORMER MADE
AVAILABLE FOR MULTITAP
PRIMARY INPUT VOLTAGES
Effective Prod s/n 5025

## DESCRIPTION:

Provides a new power transformer having multitap primary windings for export usage. The transformer was designed to operate from power mains supplying $50-60 \mathrm{~Hz}$ and primary input voltages of $110 \mathrm{v}, 117 \mathrm{v}, 124 \mathrm{v}, 220 \mathrm{v}, 234 \mathrm{v}$ and 248 volts.
A convenient transformer primary tap diagram was added to the transformer to facilitate the selection of taps for proper input voltages. The export voltage range transformer will be a standard component on all 180A instruments.

Effective Prod SN 5215

| w/exceptions C247 only: | $\begin{aligned} & 5119 \\ & 5121 \end{aligned}$ | $\begin{array}{ll} 5146 & 5 \\ 5167 \end{array}$ | 5173517 | $75 \quad 5177$ | 5187 | 5203 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R387 only: | 5007 | 5050-6 | 61 5094-8 | $8 \quad 5128$ | 5145 | 5184 |
|  | 5009 | 5063-7 | 5100-8 | 85130 | 5149 | 5190-1 |
|  | 5011-4 | 5076 | 5111 | 5137 | 5151-4 | 5195 |
|  | 5036-7 | 5079-8 | 1 5113-5 | 55140 | 5156-65 | 5201 |
|  | 5040 | 5084-90 | - 5117-8 | 85143 | 5182 | 5205 |
|  | 5045-6 | 5092 |  |  |  |  |
| C247 and R387: | 5017 | 5116 | 5141-2 | 5166 | 5176 | 5200 |
|  | 5062 | 5122-4 | 5144 | 5168-70 | 5179 | 5206-7 |
|  | 5099 | 5127 | 5148 | 5172 | 5181 | 5210 |
|  | 5110 | 5129 | 5155 | 5174 | 5196-8 | 5212 |

## DESCRIPTION:

Extends the adjustment range of the 500 msec and $100 \mu \mathrm{sec}$ marker potentiometers by decreasing the values of C247 and R387 respectively.

Parts Removed:

| C247 | 82 pF 500 V | $283-534$ | C247 | 56 pF 500 V | $283-503$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| R387 | $15 \mathrm{M} 1 \mathrm{~W} 2 \%$ | $310-061$ | R387 | $11.66 \mathrm{M} \mathrm{1W} \mathrm{1} \mathrm{\%}$ | $310-108$ |

+350V POWER SUPPLY RESISTORS
CHANGED TO INCREASE DC
OUTPUT VOLTAGE
INFORMATION ONLY
M1918
Effective Prod SN 5232
DESCRIPTION:
The +350 V Power Supply output voltage has been +340 V . The output voltage was increased to +350 V by changing the values of voltage divider resistors R712 and R713.

Parts Removed:

| R712 | $780 \mathrm{k} 1 / 2 \mathrm{~W} \mathrm{1} \mathrm{\%}$ | $309-011$ | R712 | $236 \mathrm{k} 1 \mathrm{~W} 1 \%$ | $308-083$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| R713 | $333 \mathrm{k} 1 / 2 \mathrm{~W} \mathrm{1} \mathrm{\%}$ | $309-053$ | R713 | $100 \mathrm{k} 1 / 2 \mathrm{~W} 1 \%$ | $308-084$ |

CABINET BOTTOM FASTENERS
ELIMINATED TO RPOVIDE PERMANENT
INFORMATION ONLY
M1913
INSTALLATION OF CABINET BOTTOM
Effective Prod s/n 5241

DESCRIPTION:
Eliminates the cabinet fasteners on all cabinet bottom plates on small instruments with vertical mounting chassis and parts accessible from sides.

| Parts Removed: | Parts Added: |  |  |
| :--- | :--- | :--- | ---: |
| Plate, bottom | $386-711$ | Plate, bottom |  |
|  |  | Screw, $6-32 \times 5 / 16$ BHS | (4) $211-507$ |
|  |  | Nut, pem $6-32$ | (4) $210-403$ |

## SELENIUM RECTIFIERS STAMPED

WITH PART NUMBERS
INFORMATION ONLY
M1932

Effective Prod $\mathrm{s} / \mathrm{n}$ not given
DESCRIP TION:
To provide quick identification of Tek-made selenium rectifiers, the part number will be stamped on the end plate.

DIVIDER CHASSIS SUPPORT METHOD
INFORMATION ONLY
M2009
CHANGED TO MEET TEK STANDARDS
Effective Prod s/n 5316

## DESCRIPTION:

Allows Tektronix standards to be met by changing the divider chassis support method.
Parts Removed:
Bracket, upper hinge
Bracket, chassis stop
Bracket, bar support
Screw, $3 / 8 \times 8-32$ FHS
(2) 212-040

Screw, $3 / 8 \times 6-32$ BHS
(2) 211-510

Nut, keps, 8-32 x 11/32
Bolt, captive
Ring, securing
(2) 210-458

214-008
354-048
Parts Added:
Bracket, upper hinge
406-310
Bracket, chassis stop
(2) 406-307

Bracket, bar support
406-308
Screw, $5 / 16$ x 6-32 FHS
(3) 211-538

Nut, keps, 6-32 x 5/16
210-457
Latch fastener $1 / 2 \times 8-32$
(2) 213-033

Latch stop
(2) 105-007

Nut, latch
(2) 210-447

Washer, nylon $1 / 2 \times 5 / 32 \quad 210-847$

Effective Prod s/n 5479

## DESCRIPTION:

Provides an increase in the output amplitudes of the sinewave and pulse generators by making extensive circuit changes in the Oscillator and Multiplier, HF Dividers, IF Dividers, LF Dividers, Trigger CF and Switching, and -10 Volt Power Supply. This mod initiated the use of V433B, which is already in the instrument.
$\begin{array}{lll}\text { L107,LR171, } & 600 \mu \mathrm{~h} \text { on } 3.3 \mathrm{k} & 108-068 \\ \text { LR211,LR231 } & \text { l w resistor } & \end{array}$
R108 $\quad 5.6 \mathrm{k} \quad 1 / 2 \mathrm{w} \quad 10 \% \quad 302-562$
R115 $220 \mathrm{k} 1 / 2 \mathrm{w} 5 \% \quad 301-224$
$\begin{array}{llll}\text { R116 } 6.8 \mathrm{k} & 1 / 2 \mathrm{w} & 10 \% & 302-683\end{array}$
R118,R178,
R218,R238,
R258,R278,
R298,R318, $220 \Omega 1 / 2 \mathrm{w}$ 10\% 302-221
R338,R358,
R378,R398,
R418,R438

| R126,R136 | 47 k | $1 / 2 \mathrm{w}$ | $10 \%$ | $302-473$ |
| :--- | :--- | :--- | :--- | :--- |
| R155 | 33 k | 1 w | $10 \%$ | $304-333$ |
| R205 | 18 k | 2 w | $5 \%$ | $305-183$ |
| R207 | 1.5 M | $1 / 2 \mathrm{w}$ | $1 \%$ | $309-017$ |
| R221 | 12 k | 1 w | $5 \%$ | $303-123$ |
| R222 | 15 k | 1 w | $5 \%$ | $303-153$ |
| R225 | 27 k | 2 w | $5 \%$ | $305-273$ |
| R245, R770 | $39 \mathrm{k} \quad 2 \mathrm{w}$ | $5 \%$ | $305-393$ |  |
| R247 | 3 M | $1 / 2 \mathrm{w}$ | $1 \%$ | $309-026$ |
| R251 | 18 k | $1 / 2 \mathrm{w}$ | $10 \%$ | $302-183$ |
| R271 | 33 k | $1 / 2 \mathrm{w}$ | $10 \%$ | $302-333$ |
| R367 | 15 M | 1 w | $2 \%$ | $310-061$ |
| R561 | 68 k | $1 / 2 \mathrm{w}$ | $10 \%$ | $302-683$ |
| R772 | 270 k | $1 / 2 \mathrm{w}$ | $10 \%$ | $302-274$ |

$\begin{array}{lllll}\text { R } 391, R 411, ~ & 56 \mathrm{k} & 1 / 2 \mathrm{w} & 10 \% & 302-563\end{array}$
C116 8pf 281-503
C122,C277
C237
C257
C297
C317 330 pf 281-546
C337,C357 470 pf 281-525
C377,C397,C417,C437 1000pf 281-536
C560 0.001 discap 283-000

| L107,L177 | 1.1 MH | 108-065 |
| :---: | :---: | :---: |
| R116 $300 \mu \mathrm{~h}$ on 10k |  | 108-156 |
| LR211,LR231, |  |  |
| R108 | $3.3 \mathrm{k} 1 / 2 \mathrm{w} \mathrm{10} \mathrm{\%}$ | 302-332 |
| R115 | 100k 1/2w 5\% | 301-104 |
| R116 | $10 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | 302-103 |
| R118 | $1 \mathrm{k} \quad 1 / 2 \mathrm{w} \quad 10 \%$ | 302-102 |
| R126,R136 | $220 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | 302-224 |
| R155 | 27 k 2 w 10\% | 306-273 |
| R178,R218, |  |  |
| R238,R258, |  |  |
| R278,R298, | 2.7 k 1/2 w 10\% | 302-272 |
| R358,R378, |  |  |
| R398,R418,R438 |  |  |
| R205 | $15 \mathrm{k} 2 \mathrm{w} 5 \%$ | 305-153 |
| R207 | $1 \mathrm{M} 1 / 2 \mathrm{w} 1 \%$ | 309-014 |
| R221 | $8.2 \mathrm{k} 1 \mathrm{w} 5 \%$ | 303-822 |
| R222 | 10k 1 w $5 \%$ | 303-103 |
| R225 | 22k 2 w 5\% | 305-223 |
| R245 | $27 \mathrm{k} 2 \mathrm{w} 5 \%$ | 305-273 |
| R247 | $2 \mathrm{M} 1 / 2 \mathrm{w} 1 \%$ | 309-023 |
| R251 | $22 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | 302-223 |
| R271 | $27 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | 302-273 |
| R367 | 13M1w $2 \%$ | 310-069 |
| R391 | $39 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | 302-393 |
| R411,R431 | $47 \mathrm{k} 1 / 2 \mathrm{w} 10 \%$ | 302-473 |
| R561 | $150 \mathrm{k} 1 / 2 \mathrm{w} \mathrm{10} \mathrm{\%}$ | 302-154 |
| R780 | $39 \mathrm{k} 1 / 2 \mathrm{w} 5 \%$ | 301-393 |
| R781 | 200k 1/2 w $5 \%$ | 301-204 |
| R782 | $100 \Omega 1 / 2 \mathrm{w} 10 \%$ | 302-100 |
| R784 | $15 \mathrm{k} 2 \mathrm{w} \mathrm{10} \mathrm{\%}$ | 306-153 |
| C116 | 3-12 pf var | 281-009 |
| C122,C237 | 47 pf | 281-518 |
| C257 | 68 pf | 281-549 |
| C277 | 150 pf | 281-524 |
| C297 | 470 pf | 281-525 |
| C317,C337,C356,C357 1000pf |  | 281-536 |
| C377, C397, |  | 283-001 |
| C417,C437 | 0.005 discap | 283-001 |
| C560 | 0.1 discap | 283-008 |

TRIGGER CHASSIS MOVED TO POWER
CHASSIS TO PROVIDE EASIER ACCESS
INFORMATION ONLY
M1972-2
TO INSIDE OF INSTRUMENT
Effective Prod s/n 5479

## DESCRIPTION:

Provides easier access to the inside of the instrument by moving the Trigger chassis from the lower hinge bracket to the Power chassis. This change in turn allows the hinged divider chassis to be opened wider to provide greater access to the inside of the instrument.

Parts Removed:
Bracket, lower hinge
Bracket, upper hinge
Divider cable
Ceramic strip, 7 slot
Grommet, 5/8in.
Screw, 6-32 x 5/16 FHS
(4) $211-538$

CRYSTAL-OVEN CAP ACITOR ADDED
TO PERMIT USAGE OF CRYSTALS FROM OTHER SUPPLIERS

Parts Added:

| Bracket, hinge | (2) |
| :--- | ---: |
| $406-411$ |  |
| Divider cable | $179-280$ |
| Grommet $1 / 4$ in. | $348-002$ |
| Clamp, 5/16 in, cable | $343-004$ |
| Screw, 6-32 x 3/8 FHS | (3) |
| $211-509$ |  |
| Screw, 6-32 x 5/8 FHS | $211-522$ |
| Washer, 6-32 steel | $210-803$ |
| Nut, 6-32 keps steel | $210-457$ |
| Screw, 6-32 x 3/8 BHS | $211-510$ |

INFORMATIȮN ONLY
M2095

Effective Prod s/n 5499

## DESCRIPTION:

Permits usage of crystals from other suppliers by adding a $0.01 \mu \mathrm{f} 500 \mathrm{v}$ ceramic discap between crystal-oven socket terminal no. 7 and ground.

Parts Removed:
Parts Added:

$$
\text { C100 } \quad 0.01 \mu \mathrm{f} 500 \mathrm{v} \quad 283-002
$$

Effective Prod s/n 5542

## DESCRIPTION:

Eliminates tube selection and brings the 5 msec I。F. Divider within proper adjustment range by changing the value of R307.

| Parts |  |  | Part |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| R307 | $5 \mathrm{M} \mathrm{1/2w} 1 \%$ | 309-087 | R307 | $4 \mathrm{M} 1 / 2 \mathrm{w} 1 \%$ | 309-093 |

## MOTOR BASE CONNECTOR

CHANGED TO 3-WIRE TYPE
INFORMATION ONLY
M1912
Effective Prod s/n 5552
DESCRIPTION:
The 2 -wire motor base connector is changed to a 3 -wire connector.

Parts Removed:
Connector, 2 -wire
Cord, power 2-wire
Screw, 6-32×3/8 truss

131-010
161-001
(2) 213-041

Parts Added:
Connector, 3-wire (Tek) 131-102
Screw, $6-32 \times 3 / 8$ truss (2) 211-537
Nut, keps $6-32 \times 5 / 16$
(2) 210-457

Cord, power 3-wire Adapter, 3 to 2 wire

161-010 103-013

Effective Prod s/n 5552
DESCRIPTION:
To eliminate a shock hazard at the transformer primary when the power switch is turned off, the 'hot' wire (connected to brass screw of motor base connector) is color-coded and run directly to the power switch.

POWER SUPPLY CABLE CHANGED
SO THAT ALL SWITCHING TAKES
INFORMATION ONLY
M2015
PLACE IN 'HOT' SIDE OF LINE
Effective Prod s/n 5564

## DESCRIPTION:

The thermal cutout is in the neutral leg. All switching should be done in the 'hot' leg.
Modify cable so that the fuse, power switch, and thermal cutout are all in the 'hot' side of the line and no switching or fusing takes place in the neutral side. The cable color-code is standardized at the same time. Wire fuse so that with the fuse removed the outer ring is 'cold'. (Inner ring connected to motor base, outer ring to switch).

POWER TRANSFORMER +225 V
WINDING INCREASED BY $4 \%$ TO
See SQB
M2104
INSURE REGULATION AT LOW LINE
Effective Prod s/n 5599
Usable in field instruments s/n 5001-5589

## DESCRIPTION:

Insures that the +225 v DC Power Supply will regulate at low line by increasing the secondary output voltage of the Power Transformer. This was accomplished by increasing the number of turns between terminals no. 14 and no. 15 by $4 \%$.

NOTE: Parts Replacement kit 050-0004-00 is available to facilitate the replacement of T701.

Parts Removed:
T701 Power transformer 120-102

Parts Added:
T701 Power transformer 120-119
R738 2k 10w WW 308-017
Screw, 6-32 x 1-1/2 RHS 211-553
Lockwasher, int no. 6
Base, resistor 6-32
Screw, 6-32 x 3/8 BHS

210-006
210-478
211-510

Parts Required for Field Installation:
See 'Parts Added'.
INSTALLATION INSTRUCTIONS:
Refer to kit instructions.

Effective Prod s/n 5780

## DESCRIPTION:

Screw-mounted ceramic strips are replaced by less expensive, easier-to-install clip-mounted strips.

Parts Removed:

| Strip, cer, 11-notch | (26) 124-016 |  | Strip, cer, 11-notch | (26) $124-091$ |
| :--- | ---: | :--- | ---: | ---: | ---: |
| Strip, cer, 9-notch | (2) $124-066$ | Strip, cer, 9-notch | (2) $124-090$ |  |
| Strip, cer, 7-notch | (2) $124-014$ | Strip, cer, 7-notch | (2) $124-089$ |  |
| Strip, cer, 2-notch | $124-030$ | Strip, cer, 2-notch |  | $124-086$ |
| Connecting post, cer | (12) $129-017$ | Strip, cer, 1-notch | (15) $124-100$ |  |
| Ceramic connecting | (3) $129-007$ | Spacer, nylon, molded | (72) | $361-007$ |
| Nut, hex, steel | (76) $210-405$ | Spacer, nylon, molded | (4) $361-007$ |  |
| Washer, steel, \#2 flat | (76) $210-850$ | Screw, 5-32 x 3/16 Pan HS (3) $213-044$ |  |  |

Lockwasher, steel, ext \#2 (76) 210-002

5 MHZ ADJUSTMENT CAP ACITOR CHANGED TO CENTER ADJUSTMENT RANGE

INFORMATION ONLY
M2253
Effective Prod s/n 5826

## DESCRIPTION:

Centers the adjustment range of the 5 MHz adjustment by changing the value of C 129 from 12 pf to 22 pf.

Parts Removed:
C127 12pf 500v 281-508 C127 22 pf 500v $\quad 281-511$

## I.F. DIVIDER CAPACITOR AND HF DIVIDER

RESISTOR VALUES CHANGED TO INCREASE
PULSE AMPLITUDE AND EXTEND ADJ
RANGE
INFORMATION ONLY
M2343

Effective Prod s/n 6020

## DESCRIPTION:

Increases the pulse amplitude of the $500 \mu \mathrm{sec}$ markers, thereby eliminating tube selection, by changing the value of R271.
Also improves the adjustment range of the 1 millisecond markers by changing the value of C287.

Parts Removed:
C287 390 pf $\pm 5 \% 500 \mathrm{v}$

R271 27 k 1/2w 10\%

283-545
302-273

Parts Added:
C287 250 pf $\pm 5 \% 500 \mathrm{v}$
283-543
C271 33 k $1 / 2$ w $10 \%$

DIVIDER CHASSIS MOUNTING METHOD
CHANGED TO ELIMINATE CHASSIS,
INFORMATION ONLY
M2333 TOUCHING COMPONENTS

Effective Prod s/n 6180
w/exception s/n 6187

## DESCRIPTION:

Eliminates physical interference between the divider chassis and other components by moving the divider chassis.

Parts Removed:
Bracket, chassis stop
Screw, 6-32 x $3 / 8$ BHS
Washer, no. 6 flat
Clamp, cable 5/16 in.

Parts Added:
Bracket, chassis stop 406-511
Screw, $6-32 \times 3 / 8$ BHS (2) 211-504
Washer, no. 6 flat
Clamp, cable 5/16in.
(2) 210-803

343-004
211-503

Effective date 8-7-59
DESCRIPTION:
The T12G germanium diode is placed in the semiconductor category in the part number book. Also, the Hughes Products type HD2607 diode is set up as an alternate for the Transitron T12G.

Parts Removed:
Parts Added:
B101 germanium T12G
158-001
B101 T12G (or equal)
152-008

NYLON POSTS REPLACED AND
STANDARDIZED TO REDUCE COST
INFORMATION ONLY
M2397 AND ELIMINATE EXTRA POSTS

Effective Prod s/n not given

## DESCRIPTION:

Nylon posts produced from $1 / 4 \mathrm{in}$. nylon rod are replaced with molded Delrin posts. The new posts are standardized to save time and expense and to facilitate manufacture and installation.

Parts Removed:
Post, nylon 385-055
Post, nylon
385-076

Parts Added:
Post, Delrin
385-137
Post, Delrin

385-138
${ }^{*}$ Du Pont registered trademark.

Effective Prod SN 6386
Usable in field instruments SN 5001-6385
w/exceptions: 6380-1

## DESCRIPTION:

Improves the performance and reliability of the Power Supply by replacing selenium rectifiers SR701, SR721, and SR742 with silicon diodes V702A-D, V722A-D, and V742A-D. Also adds resistors R701, R720, and R741 to compensate for the lower forward voltage drop across the new silicon diodes.
Moves the thermal cutout $1-1 / 2 \mathrm{in}$. below the present position. See M3426.
Parts Removed:

| SR701, SR741 |  | 106-005 | V702A-D) | Tek silicon diodes | 152-011 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| SR721A, B |  | 106-049 | V722A-D)- Tek sil |  |  |
| R738 2k 10W | WW | 308-017 | V742A-D) |  |  |
| Lockwashers \#10 ext | (4) | 210-009 | R701,R720) _ | $10 \Omega 1 / 2 \mathrm{~W} 10 \%$ | 302-100 |
| Nuts, 10-32 x 5/16 | (4) | 210-41 | R741 ) ${ }^{-10 \Omega 1}$ |  |  |
| Flatwashers, 10s | (4) | 210-805 | R738 2.5 k | 2.5 k 10W WW | 308-018 |
| Grommet, 1/2in. |  | 348-005 | Power chassis |  | 441-307 |
| Power chassis |  | 441-178 | Strip, cer, 4-notch | (2) | 124-088 |
| Cable, power \#1 |  | 179-183 | Strip, cer, 7-notch | (4) | 124-089 |
| Cable, 110V |  | 179-216 | Spacers, ceramount | (12) | 361-009 |
|  |  |  | Cable, power \#1 |  | 179-400 |
|  |  |  | Cable, 110V |  | 179-401 |

Parts Required for Field Installation:
Field Modification Kit 040-0214-00
INSTALLATION INSTRUCTIONS:
Refer to kit instructions.

Effective Prod s/n 6618
DESCRIPTION:
To obtain a tougher, easier to clean finish and to reduce cost, change the material used for cabinet sides, bottoms, overlays, etc. to textured aluminum (Reynold's pebble grain, 5005, H154). Change the paint from blue wrinkle to blue vinyl of approximately the same color. Paint filter housings, top rails, bottom rails and dot fasteners with blue vinyl also.

Parts Removed:

| Cabinet side | (2) |
| :--- | ---: |
| Cabinet bottom | $386-717$ |
| Rear overlay | $386-822$ |
| Bar, alum ext top | $381-092$ |
| Housing, air filter | $380-009$ |
| Angle frame, alum ext bottom(2) | $122-044$ |

Parts Added:

| Cabinet side | (2) | $387-036$ |
| :--- | ---: | ---: |
| Cabinet bottom | $387-037$ |  |
| Rear overlay | $387-038$ |  |
| Bar, alum ext top | $381-161$ |  |
| Housing, air filter | $380-016$ |  |
| Angle frame, alum ext bottom (2) | $122-062$ |  |

Effective Prod s/n 7011
DESCRIPTION:
Daven wire-wound resistors 308-083 and 308-084 are replaced with Corning Glass Works tin oxide resistors 310-124 and 309-334. The new resistors cost less and have high stability and low noise characteristics.

Parts Removed: Parts Added:
$\begin{array}{lllllll}\text { R712 } 236 \mathrm{k} & 1 \mathrm{w} \text { WW } & 308-083 & \text { R712 } & 237 \mathrm{k} & 1 \mathrm{w} \text { prec } & 310-124\end{array}$
$\begin{array}{llllll}\text { R413 } 100 \mathrm{k} 1 / 2 \mathrm{w} \text { WW } \quad 308-084 \quad \text { R713 } 100 \mathrm{k} 1 / 2 \mathrm{w} \text { prec } & 309-334\end{array}$

1 MHZ OSCILLATOR CAPACITOR REPLACED TO PREVENT FAILURE

See SQB
M3327

## CAUSED BY EXCESSIVE VOLTAGE

Effective Prod s/n 7130
Usable in field instruments s/n 5001-7129

## DESCRIPTION:

Prevents the failure of a 1 MHz oscillator capacitor C 112 by replacing it with a capacitor of increased voltage rating.

Parts Removed:
Parts Added:
$\begin{array}{llllll}\text { C112 } & 0.01 \mu \mathrm{f} 150 \mathrm{v} & 283-003 & \mathrm{C} 112 \quad 0.01 \mu \mathrm{f} 500 \mathrm{v} & 283-002\end{array}$
Parts Required for Field Installation:
See 'Parts Added'.
INSTALLATION INSTRUCTIONS:
Replace C112 located between pin 7, V104 and ground with a $0.01 \mu \mathrm{f} 500 \mathrm{v}$ capacitor.

POWER SUPPLY SILICON DIODES REPLACED WITH MORE RELIABLE HERMETICALLY SEALED SILICON

INFORMATION ONLY

## DIODES

Effective Prod s/n 7190

## DESCRIPTION:

To provide a more reliable hermetically sealed diode, replace silicon diode 1 N 2070 with silicon diode 1 N 2862 , or equal. The larger diameter of the new top hat diode requires alternate diodes to be dressed down between the strips. Also, V702A,B,C,D layout is changed to improve strapping arrangement. See M2608.

This mod is incorporated in Modification kit 040-214.
NOTE: A field Modification kit 040-213 is available for Type 180 instruments s/n 101-5000.

Parts Removed:
V702A-D
V722A-D 1N2070
V742A-D

Parts Added:
D702A-D
152-011
D722A-D 1N2862 (or equal) 152-047
D742A-D
+225V POWER SUPPLY RESISTOR
WATTAGE RATING CHANGED TO
See SQB
M3669 ELIMINATE FAILURE

Usable in field instruments s/n 6387-7502

## DESCRIPTION:

Eliminates a possible +225 v Power Supply resistor failure caused by an inadequate resistor wattage rating, by replacing R720 with a higher wattage rated resistor.

Parts Removed:
R720 $\quad 10 \Omega 1 / 2 \mathrm{w} 10 \% \quad 302-100$

Parts Added:
R720 $10 \Omega 1 \mathrm{w} 10 \% \quad 304-100$
Parts Required for Field Installation:
See 'Parts Added'.
INSTALLATION INSTRUCTIONS:
Replace R720 located between ceramic strips above the thermal cut-out and unit TK701 with a $10 \Omega 1$ w $10 \%$ resistor.

Effective Prod s/n 8241

## DESCRIPTION:

Eliminates the possibility of the Divider Gate from falling out of the hinged bracket by adding two truarc retaining rings and no. 14 flat washers. This also required an 0.030 in . wide x 0.011 in . deep groove to be added 0.035 in . from each end on swivel post. No. 14 flat washers and retaining rings were added on the outside of the hinge brackets, respectively.

Parts Removed: Parts Added:

| Washer, no. 14 flat | (2) | $210-905$ |
| :--- | :--- | :--- |
| Ring, retaining, truarc | (2) | $354-177$ |

OSCILLATOR AND MULTIPLIER 6DK6
TUBES REPLACED BY 8136 TUBES
INFORMATION ONLY
M5307
TO STANDARDIZE
Effective Prod s/n 8310

## DESCRIPTION:

Standardizes the usage of similar tube types and simplifies replacement of 6DK6 tubes by replacing them with 8136 tubes. Also changes chassis markings from '6DK6' to '8136/6DK6'.

Parts Removed:
V124,V134,V144 6DK6 154-149

Parts Added:
V124,V134,V144 8136
154-367

CHASSIS HARDWARE ADDED TO PROVIDE
TRANSFORMER SUPPORT, MORE R738 CLEARANCE AND ALLOW DIVIDER GATE

INFORMATION ONLY
M5946 TO OPEN FREELY

Effective Prod s/n 8854

## DESCRIPTION:

Provides proper support for the Power Transformer, more clearance between resistor R738 and cabinet side and allows the Divider Gate to swing open freely by adding various necessary hardware items.

Parts Removed:

Parts Added:

| Lockwasher, \#6 ext | (4) | $210-005$ |
| :--- | ---: | ---: |
| Screw, $6-32 \times 3 / 8 \mathrm{BHS}$ | (4) | $211-510$ |
| Grommet, rubber $1 / 4 \mathrm{in}$. | $348-002$ |  |
| Bracket, trans mtg | $406-871$ |  |
| Wire, \#22 sol w-i-r-bn $\left(2-1 / 2^{\prime \prime}\right)$ | $175-522$ |  |
| Wire, \#22 sol gy-r-bn | $175-544$ |  |

(4) 210-005

Screw, $6-32 \times 3 / 8$ BHS (4) $211-510$
Grommet, rubber $1 / 4 \mathrm{in}$. 348-002
Bracket, trans mtg 406-871
Wire, \#22 sol w-i-r-bn (2-1/2") 175-522
Wire, \#22 sol gy-r-bn 175-544

Effective Prod s/n 9410
DESCRIPTION:
The UHF connectors are replaced with BNC connectors, to match the military and manufacturing trend toward the BNC type. The BNC type has a constant $50 \Omega$ impedance and a lower input capacitance. It also requires less front panel space.

Parts Removed:
Parts Added:
Connector, UHF female
Adapter, clip lead UHF
Cable, P93, UHF
$\begin{array}{ll}\text { (2) } & 131-081 \\ & 013-003 \\ \text { (2) } 012-003\end{array}$
Connector, BNC female
(2) 131-126

Adapter, clip lead BNC
013-076
(2) 012-003

Cable, $93 \Omega$, BNC
(2) 012-075

HANDLE REPLACED
INFORMATION ONLY
M6692
Effective Prod s/n 9773
DESCRIPTION:
Replace the black leather carrying handle (367-001) with a superior, more economical blue rubber handle (367-037).

Parts Removed:
Bar, top support, assy
381-161
Parts Added:

Bar, top support, assy
381-232

ELECTROLYTIC CAPACITOR ASSEMBLIES REPL ACED WITH EQUIVALENT CAPACITOR, FLANGE, BASE, OR COVER TO ELIMINATE

Effective Prod SN not given

## DESCRIPTION:

All electrolytic capacitor assemblies were replaced with their equivalent raw capacitor, metal or fiber flange, plastic cover, and Delrin base (when required) to eliminate unnecessary part numbers and to facilitate replacement of electrolytic capacitors by customers. For replacement of capacitor assemblies, Customer Service will supply raw capacitors with both metal and fiber flanges and plastic covers when required.

Parts Removed:

| C701 | $2 \times 20 \mu \mathrm{~F} 450 \mathrm{~V}$ | $290-036$ | C701, C715 | $2 \times 20 \mu \mathrm{~F} 450 \mathrm{~V}$ | $290-010$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| C715 | $2 \times 20 \mu \mathrm{~F} 450 \mathrm{~V}$ | $290-037$ | C721 | $2 \times 40 \mu \mathrm{~F} 450 \mathrm{~V}$ | $290-013$ |
| C721 | $2 \times 40 \mu \mathrm{~F} 450 \mathrm{~V}$ | $290-043$ | C741 | $125 \mu \mathrm{~F} 350 \mathrm{~V}$ | $290-016$ |
| C741 | $125 \mu \mathrm{~F} 350 \mathrm{~V}$ | $290-044$ | C763 | $3 \times 10 \mu \mathrm{~F} 350 \mathrm{~V}$ | $290-004$ |
| C763 | $3 \times 10 \mu \mathrm{~F} 350 \mathrm{~V}$ | $290-083$ | Flange |  | $386-252$ |
|  |  |  | Flange | $386-253$ |  |
|  |  |  | Flange | $386-254$ |  |
|  |  |  | Flange | $386-255$ |  |
|  |  | Cover |  | $200-256$ |  |
|  |  |  | Cover |  | $200-257$ |
|  |  |  | Cover |  | $200-258$ |

+350V POWER SUPPLY RESISTORS

## REPLACED TO ELIMINATE

INFORMATION ONLY
M8979
DUPLICATION OF PARTS
Effective Prod s/n 10480

## DESCRIPTION:

To eliminate duplicate parts, 309-334 resistors are replaced with 323-385 metal film resistors.

Parts Removed:
R713
100 k $1 / 2$ w $1 \%$
309-334
Parts Added:
R713 $100 \mathrm{k} \mathrm{1/2w1} \mathrm{\%}$
323-385

JB:bt

## MOD|ETCATLON KNTT

## TRIGGER, MARKER AND H.F. DIVIDER IMPROVEMENTS

For Tektronix Type 180 Time-Mark Generators Serial numbers 101-163

This modification simplifies adjustments. stabilizes the high frequency dividers, inpproves the 100 kc trigger, and provides for $5 \mu$ set merken phasing.

Publication:
Instructions for 040-002
January 1964
Supersedes:
April 1955
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Quantity
1 ea. Coil, fixed, LR-4 in $4.7 \mathrm{k}, 1 \mathrm{w}$
1 ea. Coil, variable, CVA733
1 ea. . Tube, vacuum, 12AT7
2 ea. Washer, flat, \#6S
2 ea. Capacitor, cer,
2 ea. Capacitor, cer,
1 ea. Capacitor, cer,
1 ea. Capacitor, cer,
1 ea. Capacitor, cer,
1 ea. Capacitor, Mica,
6 ea. Resistor, comp,
1 ea. Resistor, comp,
1 ea. Resistor, comp,
1 ea. Resistor, comp,
2 ea. Resistor, comp,
1 ea. Resistor, comp,
12 in. Tubing, plastic, \#20 black 36 in. Wire, \#20 solid,
36 in. Wire, solder, silver-bearing

Description
$180 \mu \mathrm{~h}$ 73-100 $\mu \mathrm{h}$
8 pf
8 pf
15 pf
22 pf

## 100 pf

## $0.001 \mu \mathrm{f}$

270pf
100k
2.7 k

56k
2.7 k
3.3 k
3.9 k

## INSTRUCTIONS

IMPORTANT: When soldering to the ceramic scips use the silver-bearing solder supplied whehishit.
A. TO MODIFY HF DIVIDER AND DREGEA

Part Number

108-028
114-039
154-039
210-802
281-503
281-509
281-511
281-523
283-000
283-517
301-104
302-272
302-563
304-272
304-332
304-392
(162-504)
(176-004).

CIRCUITS:
 at pin 1 of Vso Replace with 100 par ceramictapeciton surpled in kit.
()
2. Remove R440 82, $w$ resister from terminal 2 of 300 tarret. Rylace with $3.3 \mathrm{k}, 1 \mathrm{w}$ refistor, supplied in kit.
() 3. Remove R352, $8.2 \mathrm{k}, 2 \mathrm{w}$ resistor, from terminal 4 of V309 turret. Replace with \#20 bare wire from the kit.
( ) 4. Remove $\mathrm{R} 308,8.2 \mathrm{k}, 2 \mathrm{w}$ resistor, from
terminal 4 of V302 turret. Replace with \#20 bare wire from the kit.
() 5. Remove R321, 8.2 k , 1 w resistor, from
( ) terminal 2 of V306 turret. Replace with $3.3 \mathrm{k}, 1 \mathrm{w}$ resistor, supplied in kit.
( ) 6. Remove R335, 8.2 k , 2 w resistor, from
( ) 6. Remove R335, $8.2 \mathrm{k}, 2 \mathrm{w}$ resistor, from
terminal 4 of V 306 turret. Replace with \#20 bare wire from the kit.
( ) 7. Remove C309, 8 pf ceramic capacitor, from pin 2 to pin 7 of V303. Replace with 15 pf ceramic capacitor, supplied in kit.
. (
(\%) 9. Remove C326, 12pf ceramic capacitor, from pin 2 to pin 8 of V310. Replace with 22 pf ceramic capacitor, supplied in kit.
() 10. Install C319, 8pf ceramic capacitor, supplied in kit, across R323 at pin 2 of V 306.
() 11. Install C323, 8 pf ceramic capacitor, supplied in kit, across R343at pin 2 of V309.
() 12. Remove R526, $39 \mathrm{k}, 1 / 2 \mathrm{w}$ resistor, at pin 2 of V501. Replace with $56 \mathrm{k}, 1 / 2 \mathrm{w}$ $10 \%$. resistor, supplied in kit.
( ) 13. Remove R378A, B, C, D, E, F (120k, $1 / 2 \mathrm{w} 10 \%$ resistors) located at pins 2 of V321, V325, V330, V335, V340 and V345 respectively. Replace with $100 \mathrm{k}, 1 / 2 \mathrm{w}$ $5 \%$ resistors., supplied in kit.
B. TO ADD L207. PHASING CONTROL (L207):
( ) 1. Remove V205, a 12 AU 7.
( ) 2. Remove L205, CV733 located near pin 7 of V205.
( ) 3. Remove $\mathrm{R} 223,1 \mathrm{k}, 1 \mathrm{w}$ resistor, at pin 1 of V207.

## INSTRUCTIONS (Con'd)

( ) 4. Remove L206, CV733 located on top of. chassis near V205. Save for re-use.
( ) 5. Install L205, LR - 4 coil, supplied in kit, from pin 1 of V207 to terminal 1 of turret V207. Run a piece of $\# 20$ bare wire, sleeved with temflex (fro mit) from terminal \#1 to terminal \#5 of V207 turret.
( ) 6. Remove rubber grommet near pin 3 of V206. Mount L207, CVA733 coil (from kit) in this hole, using mounting screw and lockwasher from LR-4 coil (step 5) and two \#6 flat washers supplied in kit, with coil on wiring side of chassis and the coil lugs pointing toward V206.
( ) 7. Remove R219, 560 , 1 w from pin 8 of V205 to pin 5 of V207 (ground). Replace with $2.7 \mathrm{k}, 1 \mathrm{w} 10 \%$ resistor supplied in kit.
( ) 8. Solder \#20 bare wire (from kit) from ground lug of V206 socket Le omer lug of L207.
( ) 9. Solder C213, 270 pf mica depatitor, supplied in kit, across 1 gs o $20 \%$
( )
( ) 11. Remove R228, $12 \mathrm{k}, 1 / 2 \mathrm{w}$ resistor, on turret above pin 4 of V207. Replace with $2.7 \mathrm{k}, 1 / 2 \mathrm{w} 10 \%$ resistor, supplied in kit.
() 12. Remove R206, $4.7 \mathrm{k}, 1 / 2 \mathrm{w}$ resistor at pins 3 and 5 of V205.
( ) 13. Remove C238, $0.01 \mu \mathrm{f}$ discap at pin 6 of V205.
( ) 14. Remove strap from pin 6 to pin 1 of V205

Instal $206,3.9 \mathrm{k}, 1 \mathrm{w} 10 \%$ resistor, supplied in kit, from pin 1 to pin 6 of

Install C212, $0.001 \mu \mathrm{f} 500 \mathrm{v}$ discap from PIn 1 of V205 to ground lug of V205.
( 17. Remove C206, $6.25 \mu \mathrm{f}$ electrolytic caponear $L 207$ at pin 1 of V205. Insert the 12AT7 tube, supplied in kit, in the V205 socket.

## THIS COMPLETES THE INSTALLATION

( ) Check wiring for accuracy.
( ) Fasten the insert pages in your Instruction Manual.

# TRIGGER, MARKER AND H.F.DIVIDER IMPROVEMENTS 

Type 180-s s/n 101-163

## GENERAL INFORMATION

This modification simplifies adjustment, stabiltzes the high frequency dividers, improves the 100 kc trigger, and provides for $5 \mu \mathrm{sec}$ marker phasing.

## RECALIBRATION

1. ADJUSTMENT OF PHASNG CONTROL (L207) With the 1 microsecond and 5 microsecond switches on, adjust L207 so that the 1 mlcro second and 5 microsecond pulses coincide.

ELECTRICAL PARTS UST
Values fixed unless marked variable. Only new parts listed.


Washer, steel, $6 \mathrm{~S} \times 5 / 16 \times 0.028$

[^0]
## 20 <br> FIELD MODIFICATION KIT

## TEKTRONIX TYPE 180 TIMR MAR GENERATOR MODIFICATION

Mod 180-553 Serials 101-138
To increase range of crystal frequency adjustment, and impore crysoni starting.
REMOVE: V201, 6AU6
L201, Near V201 cennedyiop to ping 6201 OR
C201, 10k PTM capacitor pin 7 or V201 chassis
C204, $270 \mu \mu \mathrm{f}$ nicacanacipaross L 21
C200, 3-12mprymer atross crystol socket
R203, 33k hwemp. resistor pin EO V201
C202, discan (either 1 k or 5 k ) aqfonction of R203 33k to R204 4.7k to chassis



A. Remove crystal to prevent damage.
B. Enlarge V201 socket hole to $3 / 4^{\prime \prime}$ diameter using a Pioneer or Greenlee chassis punch or equivalent.
C. Using the V250 turret assembly as a template, mark and drill two mounting holes, using a \#30 drill, parallel to the long side of the chassis.
D. Install the \#4 solder lug at V202 socket mounting screw near crystal socket.
E. Mount the turret assembly with pin 4 of V250 pointing toward V205 socket. Use the old screws from V201 socket.
F. Solder the two White-Blue-Brown filament wires coming from the wiring harness to terminal 4 of V250 socket.
G. Solder R205, 1m 1/2w resistor, from pin 2 of V205 to ground lug of V250 socket.
H. Place C203, $47 \mu \mu$ f ceramic capacitor, from pin 2 of V205 to pin 6 of V250. DO NOT SOLDER.

1. Remove $47 \mu \mu \mathrm{f}$ ceramic capacitor from pin 7 of V205. Replace with $\mathrm{C} 235,47 \mu \mu \mathrm{f}$ ceramic capacitor, (supplied in kit). Slide Temflex sleeve 1 " long over one lead and solder to pin 7 of - V205. Place other end in terminal of turret assembly above pin 5 of V250.
J. Insert and solder \#20 strapping wire in pin 6 of V250. Place dher end in terminal of turret assembly above pin 5 of V250.
K. Remove $100 \mu \mu$ ceramic capacitor from pin 1 of VR08 and nce ithrom terminal 5 of turret assembly to terminal 0 of the turret assembly, ocqed ybve 250 socket guide.
L. Install R257, $47 \mathrm{ohm} 1 / 2 \mathrm{w}$ resistor, (supples in N ) (rompin 1 of V202 to terminal 0 of turret assembly.
M. Solder a plece of \#20 strapping wire rom the dcystav pocket cornection (nearest V205) to pin 1 of V250.
N. Solder one end of \#20 strapping wire to the other crystar connection. Place $11 / 4^{\prime \prime}$ piece of sleeving over it and solder to gin of 250
O. Bend lugs of $7-45 \mu \mu$ f eram trimmer (c250) do ${ }^{\circ}$ and solder the lug at the mounting Hole end of trimmer to the crystal socket lug nearest V205.
P. Solder other lug oftrimmerto the 4 sofprivg at V202 mounting screw.
Q. Solder \#20-strapping wire from pin (f) V205 to terminal on turret assembly above pin 3 of V250.
R. Remove R301. 22 Tw from $\operatorname{sen}^{1} 1$ of V302 turret located on high frequency divider chassis and replace wivh a $5.6 \mathrm{k} 1 \mathrm{w} \%$ resistor.
The oscillator circuit should now be adjusted, by means of C250, according to the procedure as outlined in the Maintenance and Adjustment Section in the Instruction Manual.

The enclosed schematic should be pasted in the manual to correct the circuit.
A picture of the finished modification is shown on page 3.

Page 2 of 3

TEKTRONIX TYPE 180 TIME MARK GENERATOR ILLUSTRATION OF COMPLETED MODIFICATION

Mod 180-553
Serials 101-138



## FIELD MODIFICATION KIT



Mod 180-553 Serials 139-164, approx.
To increase range of crystal frequency adjustment, and improye crystal starting.
REMOVE: V201, 6AU6
R203, 33 k 1 w comp. resiston 10 ated at pin 5 er V 201

C200, 3-12 $\mu \mathrm{ff}$ ceramic cimmer capacitgr locate 0 across crystal socket conn.
C201, $47 \mu \mathrm{f}$ ceramiø fixed capacitor located a@oss R201
C235, $47 \mu \mu \mathrm{f}$ ceramic ©ined Capaser located pin 6 of V201 to pin 7 of V205

ADD:


$$
\begin{aligned}
& 154-033 \\
& 123-004 \\
& 302-470 \\
& 304-562 \\
& 281-518 \\
& 281-012 \\
& 210-201 \\
& 162-004 \\
& 176-004 \\
& 251-514
\end{aligned}
$$

A. Remove crystal to prevent damage.
B. Enlarge V201 socket hole to $3 / 4$ " diameter using a Pioneer or Greenlee chassis punch or equivalent.
C. Using the V250 turret assembly as a template, mark and drill two mounting holes, using a \#30 drill, parallel to the long side of the chassis.
D. Install the \#4 solder lug at V202 socket mounting screw near crystal socket.
E. Mount the turret assembly with pin 4 of V250 pointing toward V205 socket. Use the old screws from V201 socket.
F. Solder the two White-Blue-Brown filament wires coming from the wiring harness to terminal 4 of V250 socket.
G. Solder R205, 1 meg $1 / 2$ w resistor from pin 2 of V205 to pin 4 of V205 or ground lug of V250 socket.
H. Place C203, $47 \mu \mu$ f ceramic capacitor, from pin 2 of V205 to pin 6 of V250. DO NOT SOLDER.
I. Remove $47 \mu \mu \mathrm{f}$ ceramic capacitor from pin 7 of V205. Replace with $\mathrm{C} 235,47 \mu \mu \mathrm{f}$ ceramic capacitor, (supplied in kit). Slide Temflex sleeve 1" long over one lead and solder to pin 7 of V205. Place other end in terminal of turret assembly above pin 5 of V250.
J. Insert and solder \#20 strapping wire in pin 6 of V250. Place other end in terminal of turret assembly above pin 5 of V250.
K. Remove $100 \mu \mathrm{f}$ ceramic capacitor from pin 1 of V202 and place it from terminal 5 of turret assembly to terminal 0 of the turret assembly, located above V250 socket guide.
L. Install R257, 47 ohm $1 / 2 \mathrm{w}$ resistor, (supplied in kit) from pin of 020 to terminal 0 of turret assembly.
M. Solder the White-Brown-Red wire from the crystal socket tory to in of 250 .
N. Solder one end of \#20 strapping wire to the other orybal eomegtion. Place 11/4" piece of sleeving over it and solder to pin 9 of V250.
O. Bend lugs of $7-45 \mu \mu \mathrm{f}$ ceramic trimmer (C250) downward and away arom base of trimmer and solder the lug at the mounting hole end of the trimer og the crygstl socket lug nearest V205.
P. Solder other lug of trimmer to the soder fugat k202 moyning screw.
Q. Solder \#20 strapping wire frompin of 220 to lerminga on turret assembly above pin 3 of V 250 .
R. Remove R301, 12k 1 w frgman 1 env 32 thrret logated on high frequency divider chassis and replace with a $5.6 \mathrm{k} \mathrm{1w}$ (omesiston)
The oscillator circuit sheułd nembo aqjusted, imeans of C250, according to the procedure as outlined in the Maintenance And Adjedtion in \&he Instruction Manual.
The enclosed gehematic shourd pe pastegetn the manual to correct the circuit.
A picture of the fristee hodification is shown on page 3.


TEKTRONIX TYPE 180 TIME MARK GENERATOR
LLLUSTRATION OF COMPLETED MODIFICATION Mod 180-553


## FIELD MODIFICATION KIT

## TEKTRONIX TYPE 180 TIME MARK ENERATOR MODIFICATION

Mod 180-553 Serials approx. 165-293
Except nos. 174, 192, 220, 253 264,266 to 270 inc., $270,273,224,276$ to 292 inc., 294 to 839 inc.

To increase range of crystal frequency adrumment, and ympove crestal starting.
REMOVE: V201, 6AU6
R203, 33 k 1 w comp cesistor located at pide 8 of V205
R201, 100k 1/2uCCmip. resistor locatedfat pin 1 of V201 to gnd.
C200, 3-12 10 cemanictrimper capapitor located across crystal socket conn.

C235. 47 Au . ceranic fised capapfor located from pin 6 of V201 to pin 7 of V205 1 SMMG 7 vin tojue socket
ADD:

$p^{p}$
250, turen assembly $123-0044$
RAST, 7 ahin $1 / 2 w$ comp. resistor $302-470$

1. 501 . 6 k 1 w 10 Comp. resistor $304-562$

Q250. $7-45 \mu \mu \mathrm{f}_{\mathrm{c}}$ eramic trimmer capacitor $281-012$
10 solder lug 210-201
\#20 Temflex sleeving /62-004
12" \#20 Strapping wire 176.004
2' Silver bearing solder 251.514
A. Remove crystal to prevent damage.
B. Enlarge V201 socket hole to $3 / 4$ " diameter using a Pioneer or Greenlee chassis punch or equivalent.
C. Using the V250 turret assembly as a template, mark and drill two mounting holes, using a \#30 drill, parallel to the long side of the chassis.
D. Install the \#4 solder lug at V202 socket mounting screw near crystal socket.
E. Mount the turret assembly with pin 4 of V250 pointing toward V205 socket. Use the old screws from V201 socket.
$F$ : Solder the two White-Blue-Brown filament wires coming from the wiring harness to terminal 4 of V250 socket.
G. Solder strap from terminal 2 of V205 turret (above pin 2 of V205) to pin 6 of V250.
H. Solder strap from terminal 1 of V205 turret to terminal 6 of V250 turret.
I. Remove $100 \mu \mu \mathrm{f}$ ceramic capacitor from pin 1 of V202 and place it from terminal 2 of V205 turret to terminal 0 of V250. Terminal 0 is located above V250 socket guide.
J. Install R257, 47 ohm $1 / 2 \mathrm{w}$ resistor, (supplied in kit) from pin 1 of V202 to terminal 0 of turret assembly.
K. Solder the White-Brown-Red wire from the crystal socket lug to pin 1 of V250.
L. Solder one end of \#20 strapping wire to the other crystal connection. place $11 / 4$ " piece of sleeving over it and solder to pin 9 of V250.
M. Bend lugs of 7-45 $\mu \mu \mathrm{f}$ ceramic trimmer (C250) downara ane then base of trimmer and solder the lug at the mounting hole end of the trimmerto the grytat socket lug nearest V205.
N. Solder other lug of trimmerto the \#4 solder lug $2 \times 22$ mounting screw.
O. Solder \#20 strapping wire from pin 6 of vaon toterininan piturret fasembly above pin 3 of V250.
P. Remove R301, 12k 1 w from pin 1 fisho2 turret located on hesh frequency divider chassis and replace with a $5.6 \mathrm{k} 1 \mathrm{w} 10 \%$ resiser.

The oscillator circuit should now be adjusted, means of cron, according to the procedure as outlined in the Maintenance and Adixstheent Sectign in the Enstruction Manual.
The enclosed schematic should be pasted int manuefo correct the circuit.
A picture of the finished maficanion is fhown qnapage 3.


TEKTRONIX TYPE 180 TIME MARK GENERATOR
ILLUSTRATION OF COMPLETED MODIFICATION Mod 180-553


Modification No. 180-1046
Serial Numbere: 294*-637

Time Mark Generator Type 180
(Oscillator \& HF Dividerg)

KIT K180-1046

## INTRODUCTION:

The following modificatione and new procedure for adusting the firgt three dividere of the Type 180 Time Marker Generator will solve a large percentage of the periodic "instability" problems encountered ia the ifeld.

Instability of the 5 microsecond, 10 micromecond, and 50 microsecond dividers appearg to have been caured by combinations of these factore:

1) Amount of radio Prequency drive (measured in peak-to-peak volts) for the 5 microsecond divider;
2) Use of stability control in a multivibrator-divider to set the time width (divider ratio) of that multivibrator;
3) Variations of:

Vacuum tube plate current;
$10 \%$ resistors used in grid voltage-divider networks;
$10 \%$ resistors used as plate loads;
4) Adjustment of phasing control;

An effort bas been made to keep the amount of change to bare minimum so that a field modification can be carried out.

EQUIPMENT SUGGESTED:

1) KIT K180-1046 supplied by TEKTRONIX, INC:
2) Vacuum Tube Voltmeter, dc, with isolating probe of 1 megohm or more:
3) Oscilloscope: Tektronix Type 315D, 513D, 514D, 524D, 531, or 535, equipped with a 10X probe.

* Check all $\mathrm{S} / \mathrm{N}$ 's from 260 through 293. If a 608 oscillator tube is present, this modification sheet will apply.

180-1046 November 20, 1954
(Revised 1/10/56)

| QUANTITY | DESCRIPTION | SYMBOL | TEK PART NUMBER |
| :---: | :---: | :---: | :---: |
| 1 each | Resistor, $4.7 \mathrm{meg} \mathrm{1/2} \mathrm{~W} 10 \%$ comp | R204 | 302475 |
| 3 each | Resistor, $82 \mathrm{k} 1 / 2 \mathrm{~W}$ precision $1 \%$ | $\begin{aligned} & \text { R305 } \\ & \text { R323 } \\ & \text { R343 } \end{aligned}$ | 309043 |
| 3 each | Resistor, 60 k l/2 W precision 1\% | $\begin{aligned} & \text { R304 } \\ & \text { R324 } \\ & \text { R344 } \end{aligned}$ | 309041 |
| 1 each | Resistor, 12 k 2 W composition $10 \%$ | R351 | 306123 |
| 1 each | Capacitor, . 01 discap 500 v | C301 | 283002 |
| 1 each | Capacitor, 22 pf 500 v ceramic | C328 | 281510 |
| 1 each | Capacitor, 4.7 pf 500 v ceramic | C302 | 281501 |
| 2 each | Capacitor, 8.0 pf 500 v ceramic | $\begin{aligned} & \mathrm{C} 319 \\ & \text { C323 } \end{aligned}$ | 281503 |
| 1 each | Tube, 12AT7 | V309 | 154039 |
| 12 inches | Wire, tinned copper \#20, plastic in 0-151 (Black-brown-green-brown) | ulated, | color-coded |

### 1.0 MC HIGH FREQUENCY DRIVE

## PART I

( ) 1. Remove V301 from it's socket;
( ) 2. Connect 10X probe of scope to V301A pin 5;
( ) 3. With Type 180 turned on, adjust scope controls to provide suitable display of the 1.0 mc slue wave to which the probe is connected;
( ) 4. Adjust L207 slug for maximum 1.0 mc signal amplitude as displayed on scope; measure peak-to-peak ampitude of the sine wave using the scope calibrator; amplitude should be approximately 50-85 volts;
( ) 5. Install a new resistor, R204, $4.7 \mathrm{meg} 1 / 2 \mathrm{w} 10 \%$ comp., between V205A pin 2 and the top of the turret mounted on V205A socket (use a blank pin of the turret); run a wire from -135 volt bus entering the HF chassis to the end of R204 just mounted on turret; installation of R204 serves to bias the grid of the cathode follower and reduces the sine wave output amplitude at the cathode of V205A.

Preset timing capacitor c304 (7-45 pf trimmer) to $1 / 2$ capacity (slot will be crosswise);

With a clip lead, short V205 pin 3 to ground; a convenient place to connect the clip lead is between ground and the top texminal of inductor L207; (shorting out the radio frequency drive to the 5 microsecond divider permits finding the "free-running" bias voltage of that divider).

With a vacuum tube voltmeter or a direct-coupled scope, measure the grid bias voltage at V302 pin 2; slowly turn the stability potentiometer R303--a screwdriver adjustment--until the VIVM reads about -7 volts dc; continue to slowly reduce the grid bias until the VTVM meter needle "jumps" to a much lower voltage ( -1 to -3 volts); the "jump" indicates that the multivibrator bas just begun to "free-run".

After finding the bias voltage at which the multivibrator just begins to "free-run", back off on the pot and set the grid bias about 2 or 3 volts greater than the "free-run" voltage point -o i.e., if the multi begins to free-run at -6 volts dc, set the bias to -8 or -9 volts dc.

Install V301 (removed in step 1); Remove shorting jumper from V205 pin 3;

Measure the peak-to-peak rf amplitude at V301A pin 5; should be approжimately 35 volts $\pm 5$ volts WITH THE 5 MICROSECOND DIVIDER OPERATING; is more than $\pm 5$ volts difference is found, try another $10 \%$ RMA value for R204; possíbly 3.9 megs or 5.6 megs will have to be used.
( ) 6. Carefully verify that clamp diode v206A is clamping against +225 volts by use of the scope (direct-coupled) or a meter; evidence of poor clamping will show up as "touchy" locking of the 5 microsecond divider, V302, or failure of the 1.0 mc drive to keep the 5 microsecond divider counting.
( ) 7. Turn R342 (50 microsecond adjust pot) full clockwise.

## PART II

5 MICROSECOND DIVIDER
( ) 1. C301, . 01 discap capacitor, wired across outer lugs of potentiometer R303, should be removed and reinstalled to bypass the arm of the potentiometer and the lower end of R3O4 to ground;
( ) 2. Remove combination of R305-C302, $100 \mathrm{k} 1 / 2 \mathrm{w}$ comp $10 \%$ in parallel with 4.7 pf 500 v ceramic;

Install a new combination R305-C302, $82 \mathrm{k} 1 / 2 \mathrm{w}$ prec $1 \%$ in parallel with 4.7 pf 500 v ceramic;
( ) 3. Remove R304, 56 k l/2 w comp $10 \%$ resistor;
Install new R304, $60 \mathrm{k} 1 / 2 \mathrm{w}$ prec $1 \%$ resistor;
( ) 4. Verify that plate load resistor R309 is 10 k 2 w comp $10 \%$;
( ) 5. With a clip lead, short V205 pin 3 to ground; convenient place to connect the clip lead is between ground and the top terminal of inductor L207; (shorting out the radio frequency drive to the 5 microsecond divider permits adjustment of the 5 microsecond multivibrator stability pot);

Preset timing capacitor c304 ( $7-45 \mathrm{pf}$ trimmer) to $1 / 2$ capacity (slot will be crosswise);
( ) 6. With a vacuum tube voltmeter, measure the grid bias voltage at V302 pin 2; slowly turn the stability potentiometer R303-- a screwdriver adjustment -until the VTVM reads about -7 volts dc; continue to slowly reduce the grid bias until the VTVM meter needle "Jumps" to much lower voltage ( -1 to -3 volts); the "jump" indicates that the multivibrator has just begun to "free-run"; check to see that the bias voltage at which the multivibrator just breaks into the free-running condition is between -5 and -6.5 volts dc bias; if not, change V302;
( ) 7. After checking the free-running bias voltage, set the grid bias to -9 volts dc with the potentiometer R303; SCREWDRIVER ADJUST POTENTIOMETER R3O3 SHOULD NOT BE TOUCHED AGAIN UNLESS TUBES ARE CHANGED -- ALL TIMING ADJUSTMENTS FOR THE DIVIDER ARE MADE BY ADJUSTING C304, THE TIMING CAPACITOR);
( ) 8, Measure plate voltage at V302B pin 6; if voltage measures more than +115 v dc, change tubes in socket V302 until a satisfactory tube is found; REPEAT STEPS 6 AND 7 EACH TIME TUBE IS CHANGED:
( ) 9. Remove the clip lead used to short out the RF drive;
( ) 10. Make a low capacity probe by attaching a 4.7 mmfd ceramic capacitor to the end of regular 10X acope probe; connect the low capacity probe to V303A pin 8 (cathode);
( ) 10. Make low capacity probe by attaching a 4.7 mmid ceramic capacitor to the end of a regular 10X scope probe; connect the low capacity probe to V303A pin 8 (catbode);

Obtain a display on the scope by setting the sweep time to 1.0 microsecond/cm -- (a sweep time setting which will produce two complete cycles of the 5 microsecond multivibrator waveform PROVIDED the multivibrator is dividing by five times); with an insulated screwdriver, adjust the timing capacitor, C304, (7-45 mmfd trimmer) so that the multivibrator divides by five and produces just a trace of the fourth "pip" as shown on the sketch below:

( ) 11. Now take a look at the "stacking" of the 1 microsecond and 5 microsecond "pips" by connecting a scope to the "SIGNAL OUTPUT" of the Type 180; throw 1 microsecond and 5 microsecond switches on 180;

Adjust the "stacking" of the 5 microsecond "pip" on top of the 1 microsecond "pip" by turning the slug of $\mathbb{L} 207$ (PHASING CONTROL); after finding the point of best stacking, turn the slug $3 / 4$ of a turn CLOCKWISE and set up on the lock-nut;
( ) 12. Return to the scope display used in step 10 and again check the wave shape of the 5 microsecond divider by noting that a slight amount of the fourth 1.0 microsecond "pip" is visible during the recovery portion of the 5 microsecond multivibrator waveform; adjust C304 if needed;

PART III
10 MICROSECOND DIVIDER
( ) 1. Remove combination R323-C319, $100 \mathrm{k} 1 / 2 \mathrm{w}$ comp $10 \%$ resistor in parallel with an 8 pf 500 v ceramic;

Install a new combination R323-C319, $82 \mathrm{k} 1 / 2$ w prec $1 \%$ in parallel with an 8 pf 500 v ceramic;
( ) 2. Remove R324, 56 k l/2 w comp $10 \%$ resistor;
Install a new R324, $60 \mathrm{k} 1 / 2 \mathrm{w}$ prec $1 \%$ resistor:
( ) 3. Verify that the plate load resistor R336 is 12 k 2 w comp $10 \%$;
( ) 4. Short out the RF drive (see Part II);
Preset C320 to $1 / 2$ capacity;
( ) 5. As in Part II, step 6, find the negative bias voltage at which the 10 microsecond multivibrator just begins to free run; this voltage should be between -4 to -8 volts, adjust the bias to -10 volts dc;
( ) 6. Check plate voltage at V306 B pin 6; if the tube plate voltage is more than +115 volts dc, replace the tube; if replaced, repeat step 4 and 5;
( ) 7. Apply drive;
( ) 8. As in Part II step 10, make observations with a scope at V307 pin 8 to determine proper setting of the timing capacitor; just a trace of the intervening "pip" should be permitted to appear on the recovery portion of the 10 microsecond multivibrator waveform show in the sketch below:


PART IV
50 MICROSECOND DIVIDER
( ) 1. Remove combination R343-C323, $100 \mathrm{k} 1 / 2 \mathrm{w}$ comp $10 \%$ resistor in parallel with an 8 pf 500 volt ceramic capacitor;

Install a new combination $\mathrm{R} 343-C 323,82 \mathrm{k} 1 / 2 \mathrm{w}$ prec $1 \%$ resistor in parallel with an 8 pf 500 volt ceramic capacitor;
( ) 2. Remove R344, $56 \mathrm{k} 1 / 2 \mathrm{w}$ comp $10 \%$ resistor;
Install a new R344, $60 \mathrm{k} 1 / 2 \mathrm{w}$ prec $1 \%$ resistor;
( ) 3. Install a new capacitor, C328, 22 pf 500 v ceramic, in parallel with the timing capacitor C 327 ; preset C 327 to $1 / 2$ capacity;
( ) 4. Remove V309, 12AUT;
Install a new tube, V309, 12AT7:
( ) 5. Remove R351, 10 k 2 w comp $10 \%$ resistor:
Install a new R351, 12 k 2 w comp 10\% resistor;
( ) 6. Short out the RF drive as in Part II step 5;
( ) 7. As in Part II, step 6, find the negative bias voltage at which the 50 microsecond multivibrator just begins to free run; this voltage should be between -6 to -8 volts; adjust the bias to -10 volts;
( ) 8. Check plate voltage at $V 309 B$ pin 6 ; if the plate voltage is more than +115 volts dc, replace the tube; if replaced, repeat steps 6 and 7;
( ) 9. Apply drive;
( ) 10. As in Part II step 10, make observations with a scope at V310 pin 8 to determine proper setting of the timing capacitor; just a trace of the fourth "pip" should be permitted to appear on the recovery portion of the 50 microsecond multivibrator weveform.

## MODIFICATTON

## SILICON RECTIFIER

For Tektronix Type 180
Time-Mark Generator
Serial numbers 101-5000

## DESCRIPTION

This modification replaces the selenium rectifier SR401 (106-0002-00) with silicon rectifiers which offer more reliability and longer life.

A series resistor is added to compensate for the lower voltage loss through the new silicon rectifier which replaces the selenium stack.

Publication:
Instructions for 040-0213-00
September 1967
Supersedes:
September 1965
(C) 1964, Tektronix, Inc.

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## PARTS LIST

| Quantity | Part Number |
| :---: | :---: |
| (l ea) |  |
| 2 ea | 124-0088-00 |
| \#\# 4 ea | 152-0040-00 |
| 1 ea | 210-0228-00 |
| 1 ea | 210-0462-00 |
| 1 ea | 210-0809-00 |
| 1 ea | 212-0004-00 |
| 1 ea | 212-0022-00 |
| 1 ea | 308-0035-00 |
| 4 ea | 361-0007-00 |
| 1 ea | 406-0519-00 |
| 1 ea |  |
| 1 ea | 210-0409-00 |
| 1 ea | 214-0210-00 |

Description
Assembly, silicon rectifier, consisting of:
Strip, cer, $3 / 4 \times 4$ notch, clip-mounted Diode, silicon, 500 mA 600 PIV
Lug, solder \#8
Nut, resistor, mounting, 8-32
Washer, centering
Screw, 8-32 $\times 5 / 16$ PHS, Phillips
Screw, 8-32 $\times 1-1 / 2$ RHS
Resistor, WW, $125 \Omega 25 \mathrm{~W} 5 \%$
Spacer, nylon molded, 0.063
Bracket, silicon rectifier mounting
Wire, \#22 solid, bare 4 in .
Nut, hex, 8-32 $\times 5 / 16$
$\begin{array}{ll}1 \mathrm{ea} & 210-0409-00 \\ 1 \mathrm{ea} & 214-0210-00\end{array}$


* Located only on instruments below SN 951


## INSTRUCTIONS

IMPORTANT: When soldering to the ceramic strips, use the silver-bearing solder supplied with this kit.
( ) 1. Unsolder all wires connected to the selenium rectifier, SR401.
( ) 2. Remove the old rectifier and bracket. SAVE SCREWS AND NUTS FOR RE-USE.
( ) 3. FOR INSTRUMENTS ABOVE SN 950 ONLY:
Remove the $125 \Omega 25 \mathrm{~W}$ resistor from the new silicon rectifier assembly.
( ) Secure the ground lug previously held by the resistor with the 8-32 nut from the kit.
( ) 4. Mount the new silicon rectifier bracket, using two of the holes (the two nearest the power transformer) vacated by the seleniums. Use two of the screws and nuts removed in step 2.
( ) 5. Solder the three wires, unsoldered in step 1, to the silicon rectifier bracket as shown in the drawing.
NOTE: Some of the early instruments will have the wires color-coded, as shown in parenthesis (see drawing).

## THIS COMPLETES THE INSTALLATION.

( ) Turn the instrument on and check the power supply for proper operation.
NOTE: If adjustments are made to the power supply, it will be necessary to check the calibration of the instrument.
( ) Refer to the Instruction Manual for the recalibration procedure.
( ) Insert the Manual Parts List and schematic in your Instruction Manual.

JT:Is


# SILICON RECTIFIER 

Type 180-SN 101-5000
Installed in Type 180 SN $\qquad$ Date $\qquad$

## GENERAL INFORMATION

This modification replaces the selenium rectifier SR401 (106-0002-00) with silicon rectifiers which offer more reliability and longer life.
A series resistor is added to compensate for the lower voltage loss through the new silicon rectifier which replaces the selenium stack.

ELECTRICAL PARTS LIST
DIODES
Ckt. No.
Part Number
Description
\#\# D401A, B, C, D 152-0040-00
Silicon 500 mA 600 PIV
RESISTORS
R438* $\quad 308-0035-00 \quad 125 \Omega \quad 25 \mathrm{~W}$

* Located only on instruments below SN 951

MECHANICAL PARTS LIST

| $406-0519-00$ | Bracket, silicon rectifier mounting |
| :--- | :--- |
| $210-0228-00$ | Lug, solder \#8 |
| $210-0409-00$ | Nut, hex, $8-32 \times 5 / 16$ |
| $210-0462-00$ | Nut, resistor mounting, 8-32 |
| $212-0004-00$ | Screw, $8-32 \times 5 / 16$ PHS |
| $212-0022-00$ | Screw, $8-32 \times 1-1 / 2$ RHS |
| $361-0007-00$ | Spacer, nylon molded, 0.063 |
| $124-0088-00$ | Strip, ceramic, $3 / 4 \times 4$ notch, clip-mounted |
| $210-0809-00$ | Washer, centering |

SCHEMATICS



## SILICON RECTIFIER

For Tektronix Type 180A Time-Mark Generators
 Serial numbers 5001-6385*

## DESCRIPTION

This modification replaces selenium rectifiers SR701 and SR741 (106-0005-00) and SR721A, B (106-0049-00) with silicon rectifiers, offering more reliability and longer life.
*Serial numbers 6380 and 6381 were factorymodified.

Publication:
Instructions for 040-0214-00
December 1965
Supersedes:
August 1965
(C) 1965, Tektronix, Inc.

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## PARTS LIST

Quantity
Description
Part Number
1 ea. Assembly, silicon rectifier, consisting of:

| 2 ea. | Strip, cer., $3 / 4 \times 4$ notches, clip-mounted |  | $124-0088-00$ |  |
| ---: | :--- | :--- | :--- | :--- |
| 2 ea. | Strip, cer., $3 / 4 \times 9$ notches, clip-mounted |  | $124-0090-00$ |  |
| 12 ea. | Diode, silicon, $500-750 \mathrm{ma}$ | 400 PIV |  | $152-0066-00$ |
| 3 ea. | Screw, $6-32 \times 1 / 4 \mathrm{PHS}$, Phillips |  |  | $211-0504-00$ |
| 2 ea. | Resistor, comp, $10 \Omega$ | $1 / 2 \mathrm{w}$ | $10 \%$ | $302-0100-00$ |
| 1 ea. | Resistor, comp, $10 \Omega$ | 1 w | $10 \%$ | $304-0100-00$ |
| 8 ea. | Spacer, nylon molded, 0.063 |  |  | $361-0007-00$ |
| 3 ea. Rod, alum. hex, $1 / 4 \times 7 / 16$ |  | $385-0080-00$ |  |  |
| 1 ea. | Bracket, silicon rectifier mounting |  | $406-0516-00$ |  |

1 ea. Assembly, resistor, consisting of:
1 ea. Nut, resistor mounting 210-0478-00
1 ea. Eyelet
1 ea. Screw, 6-32 x 1-1/2 RHS, Phillips
210-0601-00
1 ea. Resistor, WW, $2.5 \mathrm{k} \quad 10$
$5 \%$
211-0553-00
, $6-32 \times 1 / 4$ PHS Phillips
211-0504-00
3 ea. Screw, $6-32 \times 1 / 4$ PHS, Phillips
1 ea.
Screw, $6-32 \times 5 / 16$ PHS, Phillips
1 ea. Spool, w/3 ft. silver-bearing solder
1 ea. Wire, \#22 solid, 6 in. bare
211-0507-00
214-0210-00
1 ea. Tag, MODIFIED INSTRUMENT, gummed back

NOTE: When soldering to the ceramic strips, use the silver-bearing solder supplied with this kit.
( ) 1. Unsolder all wires from selenium rectifiers SR701, SR721A, SR721B, and SR741.
( ) 2. Remove the selenium stacks from the instrument.
( ) 3. Mount the new silicon rectifier assembly, with the $6-32 \times 1 / 4$ PHS screws from the kit. Use the 3 lower holes vacated by the selenium stacks (see Fig. 1).
( ) 4. Solder the wires to the ceramic strips, as shown in Fig. 1.
NOTE: The lacing on the cable should be removed down to grommet.


Fig. 1

## INSTRUCTIONS (con'd)

( ) 5. Serial numbers 5599-6385 --
Replace R738 ( 2 k WW resistor) with a 2.5 k resistor from the kit. Wire as shown in Fig. 2.
( ) 6. Serial numbers 5001-5988 --
( ) Drill a $5 / 32$ in. (\#23) hole midway between tube sockets V707 and V757.
( ) Mount the 2.5 k resistor (from kit), using the $6-32 \times 5 / 16$ PHS screw from the kit.
( ) Wire the resistor as shown in Fig. 2, using bare wire from the kit.
THIS COMPLETES THE INSTALLATION.
( ) Turn the instrument on and check the power supply for proper voltages.
NOTE: If adjustments are made to the power supply, it will be necessary to check the calibration of the rest of the instrument.
( ) Fasten the Manual Insert pages in your Instruction Manual.
( ) Moisten the MODIFIED INSTRUMENT tag (from kit) and place it on the Power Supply schematic in your Manual.

CH:ceb


Fig. 2

INSTRUCTIONS (con'd)


Fig. 3
Diodes drawn as located on bracket.

## SILICON RECTIFIER

Type 180A -- s/n 5001-6385
Installed in Type 180A s/n $\qquad$ Date $\qquad$

## GENERAL INFORMATION

This modification replaces selenium rectifiers SR701 and SR741 (106-0005-00) and SR721A, B (106-0049-00) with silicon rectifiers, offering more reliability and longer life.

The information on these pages supersedes the information in your Manual.

## Electrical parts list

Values fixed unless marked variable.
Ckt. No. Part Number

DIODES

| D702A,B,C,D | $152-0066-00$ | Silicon $500-750 \mathrm{ma}$ | 400 PIV |
| :--- | :--- | :--- | :--- |
| D722A,B,C,D | $152-0066-00$ | Silicon $500-750 \mathrm{ma}$ | 400 PIV |
| D742A,B,C,D | $152-0066-00$ | Silicon $500-750 \mathrm{ma}$ | 400 PIV |

RECTIFIERS

| SR701 | Delete |
| :--- | :--- |
| SR721A,B | Delete |
| SR741 | Delete |


| R701 | $302-0100-00$ | $10 \Omega$ | $1 / 2 \mathrm{w}$ | comp | $10 \%$ |
| :--- | ---: | :---: | ---: | :--- | ---: |
| R720 | $304-0100-00$ | $10 \Omega$ | 1 w | comp | $10 \%$ |
| R738 | $308-0018-00$ | 2.5 k | 10 w | WW | $5 \%$ |
| R741 | $302-0100-00$ | $10 \Omega$ | $1 / 2 \mathrm{w}$ | comp | $10 \%$ |



POWER SUPPLY
Partial Diagram

## FIELD MODIFICATION KIT

## CRYSTAL OVEN

For Tektronix Type 180 Time-Mark Generators Serial numbers 101-950* inclusive

This modification installs a temperature zeamilized dxstal oven. $\mathrm{T}^{\text {Frequency - stability }}$


It is not recommended that this fat be installed unlges the instrument has a 6U8 oscillator tube (V250). Th the Mastrumert haspa gaU6 oscillator tube (V201) instead, it may be reslaced ith 648 by \&hstalling the Crystal oscillator Tube Conversion rod ne 040-286.

KIT LIST:
Quantity
1


Part Number

1 ea. Assembly, crystal oven light, consisting of:
1 ea. Socket, jewel light, Drake 136-025
1 ea. Bulb, incandescent, 鲑7 150-001
1 ea. Jewel, pilot light, green Drake
1 ea. Transformer, oven heater, T180-11
378-513

1 ea.
1 ea. Assembly, crystal oven, H17 crystal in JK09 oven 158-006
1 ea. Fuse, $1 / 4$ amp, fast-blo, 8AG
159-020
5 ea. Lockwasher, int. 非6
210-006
5 ea. Nut, hex, $6-32 \times 1 / 4$
4 ea. Screw, $6-32 \times 5 / 16$ BHS
1 ea. Screw, 6-32 x 1/2 BHS
210-407

1 ea. Capacitor, cer $7-45$
variable

KIT LIST: (continued)
Quantity
Description
Part Number
1 ea. Grommet, rubber, $3 / 8$ in.
348-004
1 ea. Holder, fuse, 8AG 352-003
2 ea. Spacer, nylon molded, . 313 361-009
2 ea. Tag, "MODIFIED INSTRUMENT", gurmed back
1 ea. Tubing, plastic, 非20 black, 2 in.
(162-504)
1 ea. Wire, \#20 solid, 16in. yellow-brown-green-brown
1 ea . Wire, \#20 solid, 10in. yellow-brown-brown-brown
1 ea. Wire, \#20 solid, 32in. white-blue-red
1 ea. Wire, \#20 soldi, 28in. white-blue-green
1 ea. Wire, \#22 solid, 4in. white-blue
1 ea. Wire, \#20 solid, 10in. bare
l ea. Spool, solder $\mathrm{w} / 13 \mathrm{ft}$. silver-bearing sadar

(175-507)
(175-507)
(175-510)
(175-510)
(175-522)
(176-044)
214-210 INSTRUCTIONS:

IMPORTANT: When soldering to the emanic strips, use the silver-bearing oodar gupp red with git $^{\text {tis }} \mathrm{kit}$.
( ) 1. Locate the 1 MC crysta ar the Hise $E$ equenc 0 Multiplier chassis.
() 2. Unsolder and discerd he trinmer or fixge capacitor (if any)
soldered to the cxytal sotket
( ) 3. Unsolder and remone the wres conoecting the crystal socket to v250.


HIGH FREQUENCY MULTIPLIER CHASSIS

$V 250$


XTAL SOCKET MTNG. HOLES
FIG. 1
( ) 5. Locate the vacant area on the High Frequency Multiplier chassis just above the V 250 tube socket. The inspection stamp is usually centered in this space.
( ) 6. Temporarily hold the octal socket (from kit) over the center of the space located in Step 5 (see Fig. 1). Mark and drill a $3 / 8$ in. pilot hole at the center of the socket.

## INSTRUCIIONS: (continued)

() 7. Punch $1-1 / 8$ in. hole, using a chaseis punch.
() 8. Set the octal socket in place and orlent ft a shown in fig. 1. Mark and dell1 two 5/32in. (\#23) mounting holes.
() 9. Pasten the asembly in place wheh the $6-32 \mathrm{~s} 5 / 16$ BHS screws, $\% 6$ lockwashere and $6-32$ nuts frow the kit.
() 10. Tura the instrument upside down Locate and drill six holes. (designated "in through "Fi) in the power chassis (see Fig. 2).
NOTE: On Instrument below s/a 150, the first mow of tube sockets may be located neser to the inone pancl chan on most instruments. Check cereruis betose drilling holes "B" \& "C", the eranstorman mountig Folse (Step 13), and holes "D" ""昆", cgraik gerep moupting holes (Step 14), to see that tha gonodrent hil have sufisio cient room. If nor, drin quendoser to front panel.


RIG. 2
() 11. Cut an $11 / 16 \mathrm{in}$. hole for the crystal oven light assembly through the front panel, sub-panel and power chassis. Locate this hole as shown in Fig. 3, (for all but very early instruments).

NoTE 1: On very early instrumente, it will be necessary to locate the crystal oven 1 ight $2-1 / 2 \mathrm{in}$. to the left of the AC Bower light, which is mounted in the center of the front panel. Por these instruments, the instructions that follow will differ only in the location of the crystal oven light.
NOTE 2: Because of the thickness and tensile strength of the front mb-panel, do not attempt to punch this hole. Drill a maller hole and rean it out to sime with tapered reamer. Check the diameter of the hole by inserting the pilot light socket from the kit.

*     *         * 

September 9, 1960


（）13．Mount the oven heater transfomer（土n⿰亻 ${ }^{2}$ ）on the top side of the

 Dress the transformer med thiough conmetanstalled in Step 12.
（ ）14．Turn the instrument inside down Insertothe two nylon spacers （from kit）in botes＂Dil \＆＂R＂ha cage fully press the $7-s$ lot cera－ mic strip（Erpmoitl 10 na che spaces（see CSA on Fig．4）．
（ ）15．Mount the fusehonet（fer kit）Wer the hole＂F＂，using the 6－32x $1 / 2$ BHS crem（insexted from the fuseholder side），赦 lockwasher and 6－32 maty yon Pit．Pogifion the fuseholder parallel to the front pane．$C$ p $p^{p^{2}}$
（）16．Month the grystal oveqpight assembly（from kit）in the hole cut in the fiontppanel（Stge 11）．
（） $1 \lambda$ On the 1 ing Frequithcy Multiplier chassis，solder the length of white－ bhus wire（frggikit）between pin 1 of V250 and pin 6 of the octal staker．
（ ）18．Solder a length of bare wire（from kit）between pin 9 of V250 and pin 4 of the octal socket．Place length of plastic tubing（from kit）over the wire．
（）19．Solder the length of white－blue－green wire（from kit）to pin 7 of the octal socket．
（）20．Solder the length of white－blue－red wire（from kit）to pin 1 of the octal socket．
（）21．Dress the two wires（installed in Steps 19 and 20）along the top of the High Frequency Multiplier chassis toward the front panel， then down along the cable and through the gromet in the power chassis．
（revised 3－22－66）

## INSTRUCTIONS: (continued)

() 22. Bend down the lugs of 6250 ( $7-45$ pf variable ceramic capacitor, from kit) and solder the capacicor between pin 3 and pin 6 of the octal socket.

RKTIR TO FIG. 4 WHILE PRRPORMIKG STRPS 23 THROUGK 29.


FIG. 4

*     *         * 


## INSTRUCTIONS: (continued)

( ) 23. Solder short length of bare wire (from kit) between notch 1 (CSA-1) and notch 2 (CSA-2) of the ceramic strip.
() Similarly, solder a bare wire between CSA-3 and CSA-4.

NOTR: If the instrument is to be used on 234 v line, do not install the bare wires in the above step. Instead, connect single bare wire between CSA-2 and CSA-3.
() 24. Solder the length of yellowobrowabrownobrown mern kit) between CSA-4 and the unswitched side df the primans of the power transformer, T401.

NOTE: The unswitched side of armey is the side (normally terminal th maica meanures 117 y AC ( 234 v AC) to the yngt us ef fuseholde F401, on the rear pane1, regerdigs of whetoer the POWER ON switch is an OER. (sne "hot"stug is the one wired directly to the RC Plug. 9
() 25. Solder the yel 10 whowngrgenobrowg Pire (fromkit) to the "hot" lug of fuseholdar ruts
( ) Dress the fellow browngreensown wire over to the side of the chaspris. fong tine alde togithe front cornex, and over to the fuseholdernseatied ta step ${ }^{\circ}$.
( ) selder tranre to ghe fuseholder.
( ) 25 nress whitememen and white-blue-red wires (dressed through gromer in Step 21) along the front of the chassis.
( ) Solder the white-blue-red wire to the crystal oven light socket.
( ) Solder the white-blue-green wire to CSA-5.
( ) 27. Solder a leagth of bare wire (from kit) between CSA-1 and the unused end of the fuseholder.
( ) 28. Solder a leagth of bare wire (from kit) between CSA-6 and the nearest tube socket ground lug.
( ) 29. Solder leads from the oven heater transformer (T402) to CSA, as showr in Fig. 4.

*     *         * 

September 9, 1960

INSTRUCTIONS: (continued)
() 30. Place the $1 / 4 \mathrm{amp}$. fuse (from kit) in the fuseholder.
( ) 31. Install the crystal oven assembly (from kit) in the crystal oven socket. THIS COMPLETES THE INSTALLATION.
( ) Check wiring for accuracy.
( ) Connect the instrument to the line. The crystal oven light should cycle on and off and should operate whether the POWER ON switch is ON Or QFR.
( ) Adjust C250, as explained in the Calibration Procedre on the Ignual Insert Page.
( ) Insert the Manual pages in your Instruction Manal
( ) Moisten and apply the MODIFIED INSTRUMENT tagst the eppropriate circuit


# CRISTAL OVEM MODIFICATION 

040-252
Type 180 -a $101-950$ inclusive

## GENERAL INPORMATION:

This modification installs a temperature-stabilized ciystal oven. Frequency-stability characteristics will be impored to three part per million over a 24 hour period.

OPERETING INSTRUCTIONS:
The crystal oven operates whether the fa rower switch is in the ON or the OFF position, 1 ng he he fnstrumenoris connected
 it is recommended thos the ingt umate not bydisconnected from the line.

Adjustment on cryth Oechlator drequency: \%

1. N10w the cryta oven to derate for 20 or 30 minutes beLore menge chic justngit.
2 dormect the tragger ontput of the 180 to the Trigger Input (ftheteftoscillgtcope. Set the 180 Trigger Rate Seleccos 10 K. Sg the oscilloscope triggering for + ExT.
opanest a 1 MOfor any multiple of 10 RC ) signal of known
hcturecy tetthe Vertical signal Input connector of the osc110scope. 5 This signal mey be, for example:
a) $1 \mu \mathrm{sec}$ markers from a calibrated Tektronix Type 180 or 180.
b) The carrier of a strong local broadcast station. (Construct a tuned circuit to tune to the frequency of the station).
2. Adjust the Triggering controls on the oscilloscope until the signal is observed to drift slowly (or not at all) across the face of the CRT. (It may be necessary to adjust C250 for a stable display).

CALIBRATION PROCBDURE: (coa ${ }^{\circ} \mathrm{d}$ )
5. Adjust C250 for an equal drift rate on either side of zero. (When C250 is adjusted properly, the signal will drift in one direction when the oven comes on and in the opposite direction when it goes off. The drift rates ghould be the same).

* Another method may be used if a receruer pas axallable which can be tuned to one of the frequencles dranamited by WWV or WWVH. Connect a wire to the output connedegs of the 180 and place this wire close to tre tepma connector of the receiver. Set the 180 for $1 \mu \mathrm{sec}$ merters or a of 10 MG sine wave. with proper coupling betreen be swo signals, @ beat tone my be heard on the feceiver. Adjust c25gixor zero beat. (The beat signal may bendreplayed on ma oscildgoscope by taking the signal off the frefor the inceiver).


# CRYSTML OVEA MODIRICATION 

040-252
Type 180 - /a $101-950$ inciusive



040-252
1/11/63

## MODOEIGATION KKIT

## CRYSTAL OVEN

For Tektronix Type 180 Time-Mark Generators Serial numbers 951-5000*

## DESCRIPTION

This modification adds a temperature-stabilize crystal oven which will improve the frequency stability to within 3 parts per million over a 24 hour period.
 Oven Mod Kit 040-252.

Publication:
Instructions for 040-285
October 1963
Supersedes:
June 1962

1 ea. Assembly, Crystal oven light, consisting of:

| 1 ea. | Socket, jewel light, Drake | $136-025$ |
| :--- | :--- | :--- |
| 1 ea. | Bulb, incandescent, no.47 | $150-001$ |
| 1 ea. | Jewel, pilot light, green Drake | $378-513$ |

4 ea. Tie, Nylon Cable, blue
006-531
1 ea. Transformer, oven heater, T180-AA1
1 ea. Assembly, crystal oven, H17 crystal in JK09 oven
1 ea . Fuse, $1 / 4 \mathrm{amp}$, fast-blo, 8AG
120-052
158-006
1 ea. Lug, solder, SE6
3 ea. Nut, Keps, 6-32 x 5/16
2 ea. Screw, 6-32 x 5/16 BHS
1 ea. Screw, 6-32 x 1/2 BHS
1 ea. Capacitor, cer, $7-45 \mathrm{pf} 500 \mathrm{v}$
1 ea. Capacitor, cer, $\quad 0.01 \mu \mathrm{f} \quad 500 \mathrm{v}$
1 ea. Holder, fuse, 8AG
2 ea. Tag, MODIFIED INSTRUMENT, gummed back
1 ea. Tubing, plastic, no. 13 black,
1 ea. Wire, no. 22 solid, 22 in .
1 ea. Wire, no. 20 solid, 8 in .
1 ea . Wire, solder, silver-bearing,

2 in.
2 in.

## INSTRUCTIONS

IMPORTANT: When soldering to the ceramic strips, use the silver-bearing solder supplied with this kit.
( ) 1. Remove the 1 mc crystal from the 8 -pin crystal socket.
( ) 2. Solder a $0.01 \mu$ fdiscap (from kit) between pin 7 and the ground lug of the crystal socket (see Fig. 1).
( ) 3. Replace C25 (a 22 pftubular ceramic capacitor) with a $7-45 \mathrm{pf}$ variable ceramic capacitor (from kit) connected between CSC-16 and CSC-19 (see Fig. 1).
( ) 4. Install the crystal oven assembly (from kit) in the crystal socket.
( ) 5. Turn the instrument upside down and locate the $3 / 4 \mathrm{in}$. hole through the front flange of the power chassis and the front sub-panel.
( ) Centering on this hole, carefully drill and ream an $11 / 16$ in. hole in the frontpanel.
(CAUTION: This hole should be no larger than 11/16in.).

NOTE: If a vailate, an $1 / 16 \mathrm{in}$. punchmay be used, but be carefal pot tomar fhefront panel around the hole.

Fig. 1


Fig. 3
() 6. Locate the two holes in the power chassis approximately $3 / 4 \mathrm{in}$. behind the 7 -notch ceramic strip near the POWER ON switch.
( ) Place the oven heater transformer (from kit) on the top side of the chassis with the leads dressed through the grommet. Secure it with the two $6-32 \times 5 / 16$ BHS screws and Keps nuts from the kit. Mount a no. 6 ground lug under the nut nearest the grommet (see Fig. 2).
7. Mount a fuseholder (from kit) in front of CSA (see Fig. 2) using the existing hole in the chassis. Use the $6-32 \times 1 / 2$ BHS screw (inserted from the fuseholder side) and 6-32 Keps nut from the kit.
( )
8. Mount the crystal oven light assembly (from kit) in the hole cut in the front panel (step 5). Orient the assembly as shown in Fig. 2.
()
9. Solder a length of bare wire (from kit) between CSA-7 and the crystalovenligh (see Fig. 2).
( )
10. Solder a length of bare wiyf bermeen CSA-5 and one end of the fusenomer pe Fig. 2).
NOTE: If the instrument has one yellow bronn-indbrown and one bare wire conpected to CSA $A$ esin Fig. 2), skip step 11 and (proeeed with step 12.
( ) 11. Unsolder the yo how-hrown-ret-browpp and bare y/Tres con CSAB and resoldal them to CSA 1.
NOTE: It may be necessary toplice the yllow-brown-red-brown wire (s) length ossimilarly color-coded wire and plastic tubing from the kit.
() 12. Solder the yellow-brown-red-brown wire (from kit) to the outer ring of fuse F401, mounted on the rear sub-panel.
() Dress this wire along the wiring cable toward the front of the chassis; use the cable ties from the kit.
() 13. Solder the yellow-brown-red-brown wire (installed above) to the remaining end of the fuseholder installed in step 7.
( ) 14. FOR 117 V OPERATION ONLY Solder a short length of bare wire (from kit) between CSA-2 and CSA-3 (see Fig. 3).
( ) Solder a bare wire between CSA-4 and CSA-5 (see Fig. 3).
( ) 15. FOR 234 YPPERATION ONLY Soldey shot length of bare wire (from kif) betmeen GSA-3 and CSA-4 (see thansfoymer, T402, to the ground lug (see Solyer the reqiaining transformer wires IOCSA, ashown in Fig. 3.

Place the $1 / 4 \mathrm{amp}$ fuse (from kit) in the fu@

SHIS COMPLETES THE INSTALLATION
(8) Check wiring for accuracy.
( ) Connect the instrument to the line. The oven light should cycle on and off, and should operate whether the AC power switch is ON or OFF.
() Adjust C250, as explained in the Recalibration procedure on the Manual insert page.
() Insert the Manual page in your Instruction Manual.
( ) Moisten the backs of the MODIFIEDINSTRUMENT tags (from kit) and place them on the Manual schematic pages affected by this modification.

JB:cc

## CRYSTAL OVEN

Type $180-$ - $\mathrm{s} / \mathrm{n} 951-5000$

## GENERAL INFORMATION

This modification converts a Tektronix Type 180 to a Type $180-$ S1, by adding a temperature-stabilized crystal oven. Frequency stability will be improved to 3 parts per million over a 24 -hour period.

## OPERATING INSTRUCTIONS

The crystal oven operates whether the AC Power switch is in the ON or the OFF position, as long as the instrument is connected to the AC line. Therefore, for maximum stability of operation, it is recommended that the instrument not be disconnected from the line.

Step 3 (contd)
a) $1 \mu \mathrm{sec}$ markers from a calibrated Tetronix Type 180 or 180A.
b) The carrier of a strong local broadcast station. (Construct a tuned circuit to tune to the frequency of the station.)
4. Adjust the Triggering controls on the oscilloscope until the signal is observed to drift slowly (or not atari) across the face of the CRT. (It may benecespakytoadjust C 250 for a stable display).
5. Adjust Curse for an equal drift rate on either side of zero. When C250 is adjusted properly, tho sigma win drift in one direction when the oren comes on and in the opposite direction when 1 gees off. Thedrift rates should be the same

* Andurer mofiod may be used if a receiver is available which can be tuned to one of the froquencies $Q_{\text {transmitted by WWV or WWVH. Con- }}$ nett \& wire to the Output connector of the 180 andelace this wire close to the antenna conActor of the receiver. Set the 180 for $1 \mu \mathrm{sec}$ markers or a 5 or 10 mc sine wave. With proper coupling between the two signals, a beat tone may be heard on the receiver. Adjust C250 for zero beat. (The beat signal may be displayed on an oscilloscope by taking the signal off the AVC of the receiver).



## LAMPS

Ckt. No. B250

T402
SCHEMATICS


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180A DIVIDER

$$
610-220
$$



## MAINTENANCE NOTES

50 MC RIDING 1 AND $5 \mu \mathrm{SEC}$ MARKERS

On some of the early production models of the 180 Time Mark Generator, it may be found that excessive 50 mc signal appears on the one and the five $\mu \mathrm{sec}$ time markers. This may be due to the bypass capacitors $\mathrm{C}-211, \mathrm{C}-222$ and $\mathrm{C}-229$ not being grounded. In some cases, it seems that these capacitors were connected between the frequency adjusting trimmers instead of being connected between the B+ end of the coil and ground. To ground these
capacitors, install a soldering lug under one of the trimmer capacitor screws and then unsolder the bypass capacitor from the right hand trimmer and ground this lead to the soldering lug just installed. This will remove about $95 \%$ of the fifty mc signal from the one and five $\mu \mathrm{sec}$ markers and improve the output of the fifty mc signal. This must be done on the five, ten and fifty mc multipliers.

## BOOSTING OPEN-CIRCUIT TRIGGER PULSE VOLTAGE

FQD 5-57

How can open-circuit trigger pulse voltage of the Type 180 Time-Mark Generator be raised to meet specifications of 9 v ?

If the instrument is properly calibrated, the selection of 1 N 34 A crystal in trigger output cathode will probably do the trick. The output will increase with the crystal removed, but the risetime of the trigger pulse suffers.

## PHASING CONTROL PROBLEMS

FQD 4-58

The Phasing Control L207 may not have enough inherent friction to keep it from shifting. A standard

No. $3-48 \times 3 / 16^{\prime \prime}$ nut should be placed on the slug and tightened after proper coil adjustment.

## 180-S1 OUTPUT NOISE

FEN 10-14-60

Occasionally when the crystal oven heater is off, there is excessive noise on the scope trace which disappears when the heater is on. This may be due to use of a Midland oven instead of a James

Knight. The internal circuitry of the Midland differs capacitively from the James Knight. If you have a Midlánd oven, install a . $01 \mu \mathrm{f}$ capacitor between pin 7 and ground.

## UNWIRED TURRETS -- OLD MOD KITS

FEN 3-17-61
Apparently we have been shipping Field Mod kits 040-003/004/005 for the past three years with unwired turrets; strange that no one noticed it! If you
have any of these kits kicking around, please return them to Customer Service for exchange or credit.

WATER SOLUBLE CHASSIS LACQUER
FEI-165, 4-28-61
SN 5975-6890
Silk-screening on aluminum parts of this sn range may be damaged if washed. Clean only with compressed air and dry brush.

About 60 low serial-numbered 180A's were shipped with V553 silk-screened for a type 5965 tube instead of a type 5659 tube.

## SHORTING HAZARD

On SN's below 6180, components on the right side chassis can be grounded out by pushing on the cabinet. Serial numbers 6180 up were modified to re-

## CANCEL BAR BINDING

If the cancel button binds, use a little lubricant on the metal-to-metal contact portion.

Or, better yet, replace the binder-head screw (212-010) holding the cancel bar with an 8-32 X 5/8" truss-head screw (212-072).

A lot of the trouble has been caused by the binderhead screw--with its concave shoulder--bowing the 210-804 washer over the 358-049 brass bushing and down against the cancel bar. The truss-head screw has a flat undersurface.
duce this hazard; the swinging chassis is mounted on the inside surface of the hinge post, and the rear bracket is moved in by a corresponding amount.

When replacing the screw, make sure that if the washer has been bowed, it's reinstalled with the bowing toward the screw head instead of toward the cancel bar.


## PREVENTIVE MAINTENANCE

## Air Filter

Care must be taken to assure free ventilation of the Type 180A inasmuch as some of the components are operated at dissipation levels such that excessive interior temperatures will result without adequate air circulation. To assure free passage of air the instrument must be placed so the air intake is not blocked, and the filter must be kept clean. Moreover, the side panels and bottom cover must be in place for proper air circulation; do not remove the covers except during maintenance.

A washable "E-Z KLEEN" filter is used at the air intake port of the instrument. Under normal operating conditions the filter should be inspected, and cleaned if necessary, every three to four months. More frequent inspection is required when the operating conditions are more severe.

Th following cleaning instructions are issued by the filter manufacturer:

1. If grease or dirt load is light, remove filter from installation and rap gently on hard surface to remove loose dirt. Flush remaining dirt or grease out of filter with a stream of hot water or steam; flush from clean side.
2. If load is too heavy for treatment described in (1), prepare mild soap or detergent solution in pan or sink deep enough to cover filter when laid flat. Agitate filter up and down in solution until grease or dirt is loosened and floated off.
3. Rinse filter and let dry.
4. Dip or spray filter with fresh Filter Coat or HandiCoater. These products are available from the local representative of the Research Products Corporation, and from most air-conditioner suppliers.

## Recalibration

The type 180A is a stable instrument and will provide many hours of trouble-free operation. To insure the reliability of measurements obtained on the Type 180A we suggest that its calibration be checked after each 500 hours of operation, or at least every six months if used intermittently. A check of the calibration also provides a means for checking the operation of each circuit. Minor operational deficiencies that are not apparent in normal use are often detected during a calibration check.

## MAINTENANCE

## Visual Inspection

You should visually inspect the entire instrument every few months for possible circuit defects. These defects may include such things as loose or broken connections, damaged binding posts, improperly seated tubes, scorched wires or resistors, missing tube shields, or broken terminal strips. For most visual troubles the remedy is apparent; however particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent, defects in the circuit. It is essential that you determine the cause of overheating before replacing heat-damaged parts in order to prevent further damage.

## Fan Motor

The fan motor bearings are permanently lubricated and need not be oiled. The fan blade should be cleaned each time the filter is cleaned.

## Soldering and Ceramic Strips

Many of the components in your Tektronix instruments are mounted on ceramic terminal strips. The notches in these strips are lined with a 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.


Fig. 4-1. Soldering iron tip properly shaped and tinned.

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.

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 to 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 $1 / 16$ to $1 / 8$ inch of the tip. For soldering to ceramic terminal strips tin the iron with solder containing about $3 \%$ silver.


Fig. 4-2. Correct method of applying heat in soldering to a ceramic strip.
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 solcier 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.

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.


Fig. 4-3. A slight fillet of solder is formed around the wire when heat is applied correctly.

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


Fig. 4-4. Soldering to a terminal. Note the slight fillet of solderexaggerated for clarity-formed around the wire.

## 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 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 star washer between each nut and the chassis. Place a second set of \#2 flat washers 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 tightening.


Fig. 4-5. A soldering aid constructed from a $1 / 4$ inch wooden dowel.

## Mounting Later Ceramic Strips

To replace 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 post 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 that area of the ceramic strip above the mounting rods.

## Cleaning Ceramic Strips

After soldering is completed on ceramic strips, all rosin and other residue should be removed, using Trichloroethylene, Fotocol or other residue-free solvent, applied with a swab or brush.

## REPLACEMENT PARTS

## Standard Parts

Replacement components can be obtained from Tektronix at current net prices. However, since most of the


Fig. 4-6. Soldering to a terminal mounted in plastic.. Note The use of the long-nosed pliers between the iron and the coil form to absorb the heat.
components are standard electronic and radio parts, they can generally be obtained locally in less time than required to obtain them from the factory. Before ordering or purchasing parts, be sure to consult the parts list to determine the tolerances required.

## Tekłronix-Manufactured Parłs

Tektronix manufactures almost all of the mechanical parts, and some of the electronic components, used in your instrument. When ordering mechanical parts, be sure to describe the part completely to prevent delays in filling your order.

The Tektronix-manufactured electronic components are so noted in the parts list. These components, as well as the mechanical parts, must be obtained from the factory or from the local Tektronix Field Engineering Office.

Replacement information notes sometimes accompany the improved component to aid in its installation.

Each part in your instrument has a 6 -digit Tektronix part number. This number, together with a description of the part, will be found in the parts list. When ordering parts, be sure to include both the description of the part and the part number. For example, a certain resistor should be ordered as follows: R110; $220 \mathrm{~K}, 1 / 2 \mathrm{~W}$, Fixed, Comp., $10 \%$, part number 304-224, for a Type 180A Time-Mark Generator, Serial Number -. When parts are ordered in this manner we are able to fill your order promptly, and delays that might result from transposed numbers in the part number are avoided.

## NOTE

Always include the instrument TYPE and SERIAL NUMBER in any correspondence concerning your instrument.

## TROUBLESHOOTING AND CIRCUIT ISOLATION

## General Information

The following sections contain information necessary for troubleshooting in the Type 180A. Although the Type 180A


Fig. 4-7. Two types of ceramic strip mountings.
is a complex instrument it can conveniently be divided into basic sections. This division is shown on the Block Diagram of the instrument. The sections that follow describe a method of isolating the trouble to a basic circuit, and then locating the trouble within the basic circuit.

## Power Supply

Before attempting to locate a particular trouble in any circuit the power supply should be checked. Proper operation of every circuit within the Type 180A is dependent upon the proper operation of the regulated power supply. Failure of the power supply to regulate properly may appear as an apparent trouble at some other point in the instrument.

If your Type 180A appears to be completely inoperative, make sure that it is properly connected to a source of power. If the pilot lamp on the front panel, and the fan at the rear of the instrument, do not come on when the power switch is turned on, check the source of power, the power cord connection, and the fuse.

If the power supply is receiving the power line voltage correctly, the outputs of the various supplies should be checked next. The power supply outputs can be checked at the points shown in Fig. 5-2. If an improper voltage reading is found, the first thing to suspect is the tubes. Replace all the tubes in the suspected circuit with new tubes. If this cures the trouble, replace the old tubes, one at a time, until the defective tube is found.

If replacing the tubes does not cure the trouble, check the components through which the tube draws current. Shorted tubes sometimes draw enough current to overload
plate-load resistors and cathode resistors. Frequently, a visual inspection of the circuit will reveal burned or discolored parts.

## Circuit Isolation

Before attempting to isolate a trouble in either the oscillator or divider circuits, check the operation of the power supply as described in the preceding section. Removal of V162 from its socket, isolates the oscillator and multiplier stages from the divider stages. After removing V162 from its socket use an oscilloscope to check the output at the 1-microsecond banana jack. If one megacycle output is available at the front panel you may assume that the oscillator stage is operating correctly.

## Oscillator

If one megacycle output is not available at the front panel, the oscilloscope should be used to trace back through the amplifier stage, V104A, to the crystal oscillator, V100B. If the oscillator waveform appears at the plate of V100B, it should also appear at the cathode of V100A. If you find that the oscillator waveform appears at the cathode of V100A all the circuits are working properly up to that point.

Failure to discover the oscillator waveform at any point indicates trouble in the preceding circuitry. Replacement of tubes should be tried first. If tube replacement does not cure the trouble, the schematic diagram of the circuit should be used as a guide to troubleshooting with a voltmeter.

## Dividers

If operation of the oscillator and amplifier is found to be satisfactory, replace V162, and proceed to check the divider stages until you have found the last working stage. The procedure given in Step 3 of the Calibration Procedure can be used to check the operation of the divider stages. Remove the Input Diode which couples the output of the defective stage to the following stages and see if normal operation of the defective stage is resumed. If it is, the trouble is probably due to loading by the following stages, and the trouble should be looked for there.

Replace all the tubes in the defective circuit. If this cures the trouble replace the old tubes, one at a time, until the defective tube is found.

If the trouble does not appear to be due to tubes, use the test oscilloscope to check for triggering signal to the multivibrator. If this is correct, check the output of the multivibrator at the plate of the output triode. If output is present here, check the grid of the cathode follower output stage. If the output signal is found at the grid, proceed to check the cathode. If a loss of signal is noted at the cathode, and if you have tried several tubes with no improvement, the signal path through the switch to the MARKER OUT connector should be checked.

If no output is found at the plate of the multivibrator, and if the signal pulse is being provided correctly, measure the plate voltages at both plates of the multivibrator. The
voltage at the left-hand plate should be equal to the supply voltage $(+225$ volts). The voltage at the right-hand plate should be down by a considerable amount, possibly as low as +100 volts.

If the plate voltage proves to be correct, measure bias voltage being applied to the grid of the left-hand triode of the multivibrator. This voltage should be between five and seven volts negative.

If these measures fail to locate the trouble in the circuit, a check of the various circuit components is indicated.

## Frequency Multipliers

Little difficulty beyond that caused by tubes will normally be found with the multipliers. The Calibration Procedure provides the instructions for adjusting the output of three multiplier stages.

## NOTES

## ABBREVIATIONS

| Cer. | ceramic | m | milli or 10 |
| :---: | :---: | :---: | :---: |
| Comp. | composition | $\Omega$ | ohm |
| EMC | electrolytic, metal cased | PMC | paper, metal-cased |
| f | farad | Poly. | polystyrene |
| GMV | guaranteed minimum value | Prec. | precision |
| h | henry | PT | paper tubular |
| k | kilohm or 10 ohms | v | working volts dc |
| meg | megohm or 10 ohms | Var. | variable |
| $\mu$ | micro or 10 | w | watt |
| $\mu \mu$ | micromicro or 10 | WW | wire wound |

## SPRCIAL NOTE AND SYMBOLS

Approximate serial number
X000 Part first added at this serial number
000X. Part removed at this serial number
(Mod. w/) Simple replacement not recommended.
Modify for later instruments and change other listed parts to match.

|  |  | LAMP |
| :---: | :---: | :---: |
| Ckt. | SN Range | Description |
| No. |  | Part No. |
| B401 | X951-up | Type \#47, Incandescent |

## CAPACITORS

| C200 | X139-293X | $3-12 \mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | $281-007$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| C201 | $101-138$ $.01 \mu \mathrm{f}$ | Cer. | Fixed | 400 v |  | $20 \%$ | $283-002$ |
|  | $139-293 \mathrm{X}$ | $47 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | $20 \%$ | $281-518$ |
| C202 | $101-138 \mathrm{X}$ | $.001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | $283-000$ |
| C203 |  | $47 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | $20 \%$ | $281-518$ |
| C204 | $101-138 \mathrm{X}$ | $270 \mu \mu \mathrm{f}$ | Mica | Fixed | 500 v | $10 \%$ | $283-517$ |


| C205 |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-523 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| C206 | 101-163X | $6.25 \mu \mu \mathrm{f}$ | EMT | Fixed | 300 v |  | 290-000 |
| C207 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C208 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C209 |  | 7-45 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-012 |
| C210 |  | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
| C211 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C212 | X164-up | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C213 | X164-up | $270 \mu \mu \mathrm{f}$ | Mica | Fixed | 500 v | 10\% | 283-517 |
| C214 | X638-950X | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C215 |  | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
| C216 |  | 7-45 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-012 |
| C217 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C219 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C220 |  | 3-12 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-007 |
| C221 |  | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
| C222 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C223 | X638-950X | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C224 | X268-up | $4.7 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | +or-1 $\mu \mu \mathrm{f}$ | 281-501 |
| C225 |  | 3-12 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-007 |
| C226 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C227 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C228 |  | 1.5-7 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-005 |
| C229 |  | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v |  | 283-000 |
| C230 |  | 1.5-7 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-005 |
| C231 | X333-up | $2.2 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | +or-. $5 \mu \mu \mathrm{f}$ | 281-500 |
| C235 |  | $47 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-518 |
| C236 |  | . $001 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C237 |  | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-002 |
| 5-2 |  |  | E 180- | TS LIS |  |  |  |


| C238 | 101-163X | $.01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | $283-002$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| C239 |  | $4.7 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | $+\mathrm{or}-1 \mu \mu \mathrm{f}$ | $281-501$ |
| C249 | X951-up | $22 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | $10 \%$ | $281-511$ |
| C250* | X294-534 | $7-45 \mu \mu \mathrm{f}$ | Cer. | Var. | 500 v | $10 \%$ | $281-012$ |
|  | $535-950 \mathrm{X}$ | $22 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | $10 \%$ | $281-511$ |

${ }^{*} \mathrm{C} 250$ is a $7-45 \mu \mu \mathrm{f}$ capacitor in S-1 models only. Standard models have a $22 \mu \mu \mathrm{f}$, fixed capacitor in place of C250.

| C251 | X294-up | $47 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-518 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| C252 | X294-up | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C253 | X294-up | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
| C254 | X294-up | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-002 |
| C255 | X294-up | . $001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-000 |
| C301 |  | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-002 |
| C302 |  | $4.7 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | +or-1 $\mu \mu \mathrm{f}$ | 281-501 |
| C303 |  | . $005 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-001 |
| C304 |  | 7-45 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-012 |
| C309 | 101-163 | $8 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v |  | 281-503 |
|  | 164-up | $15 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-509 |
| C314 |  | $56 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-521 |
| C315 |  | $47 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-518 |
| C316 |  | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-002 |
| C318 | 101-163 | $27 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-512 |
|  | 164-up | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C319 |  | $8 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | +or-1/2 $\mu \mu \mathrm{f}$ | 281-503 |
| C320 |  | 7-45 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-012 |
| C323 |  | $8 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | +or- $1 / 2 \mu \mu \mathrm{f}$ | 281-503 |
| C324 | 101-163 | $8 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | +or-1/2 $\mu \mu \mathrm{f}$ | 281-503 |
|  | 164-up | $12 \mu \mu \mathbf{f}^{\text {' }}$ | Cer. | Fixed | 500 v | 10\% | 281-509 |
| C325 | 101-163 | $47 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-518 |
|  | 164-up | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C326 | 101-163 | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
|  | 164-up | $22 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-511 |


| C327 |  | 7-45 $\mu \mu \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| C328 | X638-1237 | $22 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-511 |
|  | 1238-up | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-505 |
| C330 |  | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-002 |
| C335 |  | $22 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-511 |
| C336 |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C337 |  | 7-45 $\mu \boldsymbol{\mu} \mathrm{f}$ | Cer. | Var. | 500 v |  | 281-012 |
| C338 |  | $27 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-513 |
| C340A |  | . $001 \mu \mathrm{f}$ | PT | Fixed | 600 v | 20\% | 285-501 |
| C340B |  | . $001 \mu \mathrm{f}$ | PT | Fixed | 600 v | 20\% | 285-501 |
| C340C |  | . $0047 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-506 |
| C340D |  | . $01 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-510 |
| C340E |  | . $1 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-526 |
| C340F |  | . $1 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-526 |
| C340G |  | . $1 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-526 |
| C 340 H |  | . $1 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-526 |
| C342A |  | $47 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-518 |
| C342B |  | $47 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-518 |
| C342C |  | $56 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-521 |
| C342D |  | $82 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-528 |
| C342E |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C342F |  | $220 \mu \mu \mathrm{f}$ | Mica | Fixed | 500 v | 10\% | 283-523 |
| C342G |  | $470 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-525 |
| C342H |  | $470 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 20\% | 281-525 |
| C343A |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C343B |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C343C |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C343D |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |


| C343E |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| C343F | 101-268X | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C343G |  | $100 \mu \mu \mathrm{f}$ | Cer. | Fixed | 350 v | 20\% | 281-523 |
| C344 | 101-637X | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-002 |
| C345 | 101-267X | $6.25 \mu \mathrm{f}$ | EMC | Fixed | 300 v | $-20+50 \%$ | 290-025 |
| C346 |  | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-002 |
| C347 | 101-267X | $6.25 \mu \mathrm{f}$ | EMC | Fixed | $300{ }^{\circ} \mathrm{v}$ | $-20+50 \%$ | 290-025 |
| C348 |  | . $01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | 283-002 |
| C349 | 101-950 | $6.25 \mu \mathrm{f}$ | EMC | Fixed | 300 v | -20+50\% | '290-025 |
|  | 951-up | $20 \mu \mathrm{f}$ | EMC | Fixed | 150 v | $-20+50 \%$ | 290-008 |
| C350 | 101-174 | $100 \mu \mathrm{f}$ | Cer. | Fixed | 25 v | EMC | 290-015 |
|  | 175-up | $20 \mu \mathrm{f}$ | Cer. | Fixed | 150 v | EMT | 290-008 |
| C401 |  | $2 \mathrm{x} 40 \mu \mathrm{f}$ | EMC | Fixed | 450 v | $-20+50 \%$ | 290-042 |
| C402 |  | . $01 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-510 |
| C403 |  | . $01 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-510 |
| C404 | 101-950 | $2 \mathrm{x} 40 \mu \mathrm{f}$ | EMC | Fixed | 450 v | -20+50\% | 290-042 |
|  | 951-up | $150 \mu \mathrm{f}$ | EMC | Fixed | 250 v | $-20+50 \%$ | 290-047 |
| C420 |  | . $01 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-510 |
| C421 | 101-950 | $2 \mathrm{x} 40 \mu \mathrm{f}$ | EMC | Fixed | 450 v | -20+50\% | 290-042 |
|  | 951-up | $125 \mu \mathrm{f}$ | EMC | Fixed | 350 v | -20+50\% | 290-052 |
| C440 |  | $2 \mathrm{x} 40 \mu \mathrm{f}$ | EMC | Fixed | 450 v | $-20+50 \%$ | 290-043 |
| C441 |  | $2 \mathrm{x} 40 \mu \mathrm{f}$ | EMC | Fixed | 450 v | $-20+50 \%$ | 290-043 |
| C442 |  | . $01 \mu \mathrm{f}$ | PT | Fixed | 400 v | 20\% | 285-510 |
| C443 |  | $2 \mathrm{x} 40 \mu \mathrm{f}$ | EMC | Fixed | 450 v | $-20+50 \%$ | 290-043 |
| C444 |  | . $1 \mu \mathrm{f}$ | PT | Fixed | 600 v | 20\% | 285-527 |
| C501 |  | $4.7 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | +or-1 $\mu \mu \mathrm{f}$ | 281-501 |
| C502 |  | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
| C 503 |  | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
| C504 |  | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
| C505 |  | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |
| C506 |  | $12 \mu \mu \mathrm{f}$ | Cer. | Fixed | 500 v | 10\% | 281-506 |


| C510 | $.01 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | $283-002$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| C511 | $.001 \mu \mathrm{f}$ | Cer. | Fixed | 500 v | GMV | $283-000$ |
| C520 | $200 \mu \mu \mathrm{f}$ | Mica | Fixed | 500 v | $10 \%$ | $283-512$ |

## CRYSTAL

Crystal
Crystal-Oven
Type Z-1 $1000 \mathrm{kc}+.005 \%$
180-S1

Use 158-006
158-006

## INDUCTORS

| L201 | 101-138X | $73-100 \mu \mathrm{~h}$ | Var. | CV733 | $114-039$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| L202A | $18 \mu \mathrm{~h}$ | Fixed | CF183 | $108-011$ |  |
| L202B | $18 \mu \mathrm{~h}$ | Fixed | CR 183 | $108-011$ |  |
| L203A | $9.2 \mu \mathrm{~h}$ | Fixed | CF922 | $108-023$ |  |
| L203B | $9.2 \mu \mathrm{~h}$ | Fixed | CF922 | $108-023$ |  |
| L204A | $1.1 \mu \mathrm{~h}$ | Fixed | CF112 | $108-003$ |  |
| L204B |  | Fixed | CF112 | $108-003$ |  |
| L205 | $101-163$ | $73-100 \mu \mathrm{~h}$ | Var. | CV733 |  |
|  | $164-$ up | $180 \mu \mathrm{~h}$ | Fixed | CF184 | LR4 |
| L206 | $101-138 \mathrm{X}$ | $73-100 \mu \mathrm{~h}$ | Var. | CV733 | $114-039$ |
| L207 | X164-up | $73-100 \mu \mathrm{~h}$ | Var. | CV733 |  |

RESISTORS

| R201 | $101-138$ <br> $139-293 X$ | 1 meg <br> 100 k | $1 / 2 \mathrm{w}$ <br> $1 / 2 \mathrm{w}$ | Fixed <br> Fixed | Comp. <br> Comp. | $10 \%$ <br> $10 \%$ | $302-105$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| R202 | $101-138 \mathrm{X}$ | $470 \Omega$ | $1 / 2 \mathrm{w}$ | Fixed | Comp. | $10 \%$ | $302-103$ |
| R203 | $101-293 \mathrm{X}$ | 33 k | 1 w | Fixed | Comp. | $10 \%$ | $304-333$ |
| R204 | $101-138 \mathrm{X}$ | 4.7 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | $10 \%$ | $302-472$ |
|  | X638-up | 4.7 meg | $1 / 2 \mathrm{w}$ | Fixed | Comp. | $10 \%$ | $302-475$ |
| R205 |  | 1 meg | $1 / 2 \mathrm{w}$ | Fixed | Comp. | $10 \%$ | $302-105$ |


| R206 | $\begin{aligned} & 101-163 \\ & 164-\mathrm{up} \end{aligned}$ | $\begin{aligned} & 4.7 \mathrm{k} \\ & 3.9 \mathrm{k} \end{aligned}$ | $\begin{aligned} & 1 / 2 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ | Fixed <br> Fixed | Comp. Comp. | $\begin{aligned} & 10 \% \\ & 10 \% \end{aligned}$ | $\begin{aligned} & 302-472 \\ & 304-392 \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R208 |  | 470 k | 1/2 w | Fixed | Comp. | 10\% | 302-474 |
| R209 |  | 47 k | 1/2 w | Fixed | Comp. | 10\% | 302-473 |
| R210 |  | 220 k | 1/2 w | Fixed | Comp. | 10\% | 302-224 |
| R211 |  | 47 k | $1 / 2 \mathrm{w}$ | Fixed ${ }^{\prime}$ | Comp. | 10\% | 302-473 |
| R215 |  | 220 k | 1/2 w | Fixed | Comp. | 10\% | 302-224 |
| R216 |  | 47 k | 1/2 w | Fixed | Comp. | 10\% | 302-473 |
| R218 |  | 470 k | 1/2 w | Fixed | Comp. | 10\% | 302-474 |
| R219 | 101-163 | $560 \Omega$ | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 304-561 |
|  | 164-up | 2.7 k | 1 w | Fixed | Comp. | 10\% | 304-272 |
| R221 |  | 4.7 k | 1 w | Fixed | Comp. | 10\% | See L205 |
| R222 |  | 10 k | 1 w | Fixed | Comp. | 10\% | 304-103 |
| R223 | 101-163X | 1 k | 1 w | Fixed | Comp. | 10\% | 304-102 |
| R226 |  | 56 k | 1/2 w | Fixed | Comp. | 10\% | 302-563 |
| R227 |  | 68 k | 1/2 w | Fixed | Comp. | 10\% | 302-683 |
| R228 | 101-163 | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
|  | 164-up | 2.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-272 |
| R229 |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R250 | X294-up | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
| R251 | X294-up | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R252 | X294-up | 68 k | 1/2 w | Fixed | Comp. | 10\% | 302-683 |
| R253 | X294-up | 1 meg | 1/2 w | Fixed | Comp. | 10\% | 302-105 |
| R254 | X294-up | $680 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-681 |
| R255 | X294-up | 18 k | 1 w | Fixed | Comp. | 10\% | 304-183 |
| R256 | X204-up | 10 k | 1/2 w | Fixed | Comp. | 10\% | 302-103 |
| R256 | X294-up | 10 k | 1/2 w | Fixed | Comp. | 10\% | 302-103 |
| R257 | X294-up | $47 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-470 |
| R301 | 101-293 | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
|  | 294-up | 5.6 k | 1 w | Fixed | Comp. | 10\% | 304-562 |
| R302 |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |


| R303 | 101-372 | 100 k | 2 w | Var. | Comp. | 20\% | 311-026 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 373 - up | 50 k | 2 w | Var. | Comp. | 20\% | 311-023 |
| R304 | 101-637 | 56 k | 1/2 w | Fixed | Comp. | 10\% | 302-563 |
|  | 638-up | 60 k | 1/2 w | Fixed | Prec. | 1\% | 309-041 |
| R305 | 101-637 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 638-up | 82 k | 1/2 w | Fixed | Prec. | 1\% | 309-043 |
| R306 | X373-up | 33 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-333 |
| R307 |  | 68 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-683 |
| R308 | 101-163X | 8.2 k | 2 w | Fixed | Comp. | 10\% | 306-822 |
|  | X951-up | $100 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-101 |
| R309 | 101-1237 | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
|  | 1238 - up | 12 k | 2 w | Fixed | Comp. | 10\% | 306-123 |
| R310 |  | 390 k | 1/2 w | Fixed | Comp. | 10\% | 302-394 |
| R311 | X951-up | $100 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-101 |
| R314 |  | 180 k | 1/2 w | Fixed | Comp. | 10\% | 302-184 |
| R315 |  | 27 k | 1/2 w | Fixed | Comp. | 10\% | 302-273 |
| R316 |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R318 | X951-up | $100 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-101 |
| R319 |  | 1 meg | 1/2 w | Fixed | Comp. | 10\% | 302-105 |
| R320 |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 304-472 |
| R321 | 101-163 | 8.2 k | 1 w | Fixed | Comp. | 10\% | 306-822 |
|  | 164-up | 3.3 k | 1 w | Fixed | Comp. | 10\% | 304-332 |
| R322 |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R323 | 101-637 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-103 |
|  | 638-up | 82 k | 1/2 w | Fixed | Prec. | 1\% | 309-043 |
| R324 | 101-637 | 56 k | 1/2 w | Fixed | Comp. | 10\% | 302-563 |
|  | 638-up | 60 k | 1/2 w | Fixed | Prec. | 1\% | 309-041 |
| R325 | 101-372 | 100 k | 2 w | Var. | Comp. | 20\% | 311-026 |
|  | 373-up | 50 k | 2 w | Var. | Comp. | 20\% | 311-023 |
| R326 |  | 56 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-563 |
| R327 | X373-up | 33 k | 1/2 w | Fixed | Comp. | 10\% | 302-333 |
| R328 |  | 56 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-563 |
| R329 |  | 4.7 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-472 |


| R332 |  | 270 k | 1/2 w | Fixed | Comp. | 10\% | 302-274 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R333 | X951-up | $100 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-101 |
| R335 | 101-163X | 8.2 k | 2 w | Fixed | Comp. | 10\% | 306-822 |
| R336 | 101-267 | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
|  | 268 - up | 12 k | 22w | Fixed | Comp. | 10\% | 306-123 |
| R340 | 101-163 | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
|  | 164-up | 3.3 k | 1 w | Fixed | Comp. | 10\% | 304-332 |
| R341 |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R342 | 101-372 | 100 k | 2 w | Var. | Comp. | 20\% | 311-026 |
|  | 373-up | 50 k | 2 w | Var. | Comp. | 20\% | 311-023 |
| R343 | 101-637 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 638-up | 82 k | 1/2 w | Fixed | Prec. | 1\% | 309-043 |
| R344 | 101-637 | 56 k | 1/2 w | Fixed | Comp. | 10\% | 302-563 |
|  | 638-up | 60 k | 1/2 w | Fixed | Prec. | 1\% | 309-041 |
| R345 |  | 56 k | 1/2 w | Fixed | Comp. | 10\% | 302-563 |
| R346 |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R347 |  | 56 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-563 |
| R348 | X373-up | 33 k | 1/2 w | Fixed | Comp. | 10\% | 302-333 |
| R349 | X951-up | $100 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-101 |
| R350 |  | 2.2 meg | 1/2 w | Fixed | Comp. | 10\% | 302-225 |
| R351 | 101-637 | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
|  | 638-1237 | 12 k | 2 w | Fixed | Comp. | 10\% | 306-123 |
|  | 1238-up | 15 k | 2 w | Fixed | Comp. | 10\% | 306-153 |
| R352 | 101-163X | 8.2 k | 2 w | Fixed | Comp. | 10\% | 306-822 |
|  | X951-up | $100 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-101 |
| R355 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R356 |  | 56 k | 1/2 w | Fixed | Comp. | 10\% | 302-563 |
| R358 |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R359 |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R360 |  | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
| R361 |  | 56 k | 1/2 w | Fixed | Comp. | 10\% | 302-563 |
| R362 | 101-372 | 100 k | 2 w | Var. | Comp. | 20\% | 311-026 |
|  | 373 - up | 50 k | 2 w | Var. | Comp. | 20\% | 311-023 |


| R363 | X373-up | 33 k | 1/2 w | Fixed | Comp. | 10\% | 302-333 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R367 | 101-882 | 1 meg | 1/2 w | Fixed | Comp. | 10\% | Use 301-125 |
|  | 883-up | 1.2 meg | 1/2 w | Fixed | Comp. | 5\% | 301-125 |
| R368 |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R369 |  | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R370 |  | 68 k | 1/2 w | Fixed | Comp. | 10\% | 302-683 |
| R371 |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R375A |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R375B |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R375C |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R375D |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R375E |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R375F | 101-267 | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
|  | 268-up | 3.9 k | 1 w | Fixed | Comp. | 10\% | 304-392 |
| R375G |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R375H |  | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R376A |  | 12 k | 1. w | Fixed | Comp. | 10\% | 304-123 |
| R376B |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R376C |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R376D |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R376E |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R376F | 101-267 | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
|  | 268-up | 15 k | 1 w | Fixed | Comp. | 10\% | 304-153 |
| R376G |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R376H |  | 12 k | 1 w | Fixed | Comp. | 10\% | 304-123 |
| R378A | 101-163 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 164-up | 100 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 5\% | 301-104 |
| R378B | 101-163 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 164-up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R378C | 101-163 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 164-up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |


| R378D | 101-163 | 100 k | $1 / 2$ w | Fixed | Comp. | 10\% | 302-104 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 164-up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R378E | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268 - up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R378F | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268 - up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R378G | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268 - up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R378H | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268 - up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R379A | 101-267 | 100 k | 1/2w | Fixed | Comp. | 10\% | 302-104 |
|  | 268 - up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R379B | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268-up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R379C | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268 - up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R379D | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268 - up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R379E | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268 - up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R379F | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268-up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R379G | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268-up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R379H | 101-267 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 268-up | 100 k | 1/2 w | Fixed | Comp. | 5\% | 301-104 |
| R380A |  | 560 k | 1/2 w | Fixed | Comp. | 10\% | 302-564 |
| R380B |  | 820 k | 1/2 w | Fixed | Comp. | 10\% | 302-824 |
| R380C | 101-1782 | 1.8 meg | 1/2 w | Fixed | Comp. | 10\% | 302-185 |
|  | 1783-up | 1.5 meg | 1/2 w | Fixed | Comp. | 10\% | 302-155 |
| R380D |  | 820 k | 1/2 w | Fixed | Comp. | 10\% | 302-824 |
| R380E |  | 820 k | 1/2 w | Fixed | Comp. | 10\% | 302-824 |
| R380F |  | 1 meg | 1/2 w | Fixed | Comp. | 10\% | 302-105 |
| R380G |  | 1.2 meg | 1/2 w | Fixed | Comp. | 10\% | 302-125 |
| R380H | 101-141 | 2.7 meg | 1/2w | Fixed | Comp. | 10\% | 302-275 |
|  | 142-up | 2.2 meg | 1/2 w | Fixed | Comp. | 10\% | 302-225 |


| R381A | 1 meg | 2 w | Var. | Comp. | 20\% | 311-039 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R381B | 1 meg | 2 w | Var. | Comp. | 20\% | 311-039 |
| R381C | 1 meg | 2 w | Var. | Comp. | 20\% | 311-039 |
| R381D | 1 meg | 2 w | Var. | Comp. | 20\% | 311-039 |
| R381E | 1 meg | 2 w | Var. | Comp. | 20\% | 311-039 |
| R381F | 1 meg | 2 w | Var. | Comp. | 20\% | 311-039 |
| R381G | 1 meg | 2 w | Var. | Comp. | 20\% | 311-039 |
| R381H | 1 meg | 2 w | Var. | Comp. | 20\% | 311-039 |
| R382A | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R382B | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R382C | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R382D | 8.2 k | 1 w | Fịed | Comp. | 10\% | 304-822 |
| R382E | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R382F | 8.2 k | 1. w | Fixed | Comp. | 10\% | 304-822 |
| R382G | 8.2 k | 1 w | Fixed | Comp. | 10\% | 304-822 |
| R382H | 8.2 k | 2 w | Fixed | Comp. | 10\% | 306-822 |
| R383A | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R383B | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R383C | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R383D | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R383E | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R383F | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R383G | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R383H | 10 k | 2 w | Fixed | Comp. | 10\% | 306-103 |
| R384A | 68 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-683 |
| R384B | 180 k | 1/2 w | Fixed | Comp. | 10\% | 302-184 |
| R384C | 330 k | 1/2 w | Fixed | Comp. | 10\% | 302-334 |
| R384D | 680 k | 1/2 w | Fixed | Comp. | 10\% | 302-684 |


| R384E |  | 2.2 meg | $1 / 2{ }^{\text {w }}$ | Fixed | Comp. | 10\% | 302-225 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R384F |  | 3.3 meg | 1/2 w | Fixed | Comp. | 10\% | 302-335 |
| R384G |  | 5.6 meg | 1/2 w | Fixed | Comp. | 10\% | 302-565 |
| R384H |  | 6.8 meg | 1/2 w | Fixed | Comp. | 10\% | 302-685 |
| R385A |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R385B |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R385C |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R385D |  | 4.7 k | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-472 |
| R385E |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R385F |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R385G |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R385H |  | 4.7 k | 1/2 w | Fixed | Comp. | 10\% | 302-472 |
| R387 |  | 10 k | 1/2 w | Fixed | Comp. | 10\% | 302-103 |
| R388 |  | 33 k | 1/2 w | Fixed | Comp. | 10\% | 302-333 |
| R389 |  | 10 k | 1/2 w | Fixed | Comp. | 10\% | 302-103 |
| 'R390 | 101-590 | 22 k | 1/2 w | Fixed | Comp. | 10\% | 302-223 |
|  | 591-up | 27 k | 1/2 w | Fixed | Comp. | 10\% | 302-273 |
| R401 |  | $47 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-470 |
| R403 |  | 1 meg | 1/2 w | Fixed | Comp. | 10\% | 302-105 |
| R404 |  | 1 k | 1/2 w | Fixed | Comp. | 10\% | 302-102 |
| R405 |  | 33 k | 1/2 w | Fixed | Comp. | 10\% | 302-333 |
| R406 |  | 220 k | 1 w | Fixed | Comp. | 10\% | 302-224 |
| R407 | 101-378 | 22 k | 1/2 w | Fixed | Comp. | 10\% | 302-223 |
|  | 379-722 | 27 k | 1/2 w | Fixed | Comp. | 10\% | 302-273 |
|  | 723 -up | 18 k | 1/2 w | Fixed | Prec. | 1\% | 309-036 |
| R409 |  | 10 k | 1/2 w | Var. | WW | 20\% | 311-015 |
| R410 | 101-722 | 47 k | 1/2 w | Fixed | Comp. | 10\% | 302-473 |
|  | 723-up | 34.5 k | 1/2 w | Fixed | Prec. | $1 \%$ | 309-038 |
| R411 | 101-722 | 1.5 meg | 1/2 w | Fixed | Comp. | 10\% | 302-155 |
|  | 723 - up | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-105 |
| R420 |  | $47 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-470 |


| R421 |  | 1 meg | 1/2 w | Fixed | Comp. | 10\% | 302-105 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R422 | 101-482 | 120 k | 1/2 w | Fixed | Comp. | 10\% | 302-124 |
|  | 483 - up | 120 k | 1 w | Fixed | Comp. | 10\% | 304-124 |
| R423 |  | 18 k | 1/2 w | Fixed | Comp. | 10\% | 302-183 |
| R424 |  | 33 k | 1/2 w | Fixed | Comp. | 10\% | 302-333 |
| R425 | 101-950 | 470 k | 1/2 w | Fixed | Comp. | 10\% | 302-474 |
|  | 951-up | 1 meg | 1/2 w | Fixed | Comp. | 10\% | 302-105 |
| R426 |  | 1.11 meg | 1/2 w | Fixed | Prec. | 1\% | 309-115 |
| R427 |  | 1 meg | 1/2 w | Fixed | Prec. | 1\% | 309-014 |
| R428 |  | 3 k | 25 w | Fixed | WW | 5\% | 308-042 |
| R439 | X606-up | $10 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-100 |
| R440 |  | 220 k | 1 w | Fixed | Comp. | 10\% | 304-224 |
| R441 |  | 1 k | 1/2 w | Fixed | Comp. | 10\% | 302-102 |
| R442 |  | 1 k | 1/2 w | Fixed | Comp. | 10\% | 302-102 |
| R443 |  | 470 k | 1/2 w | Fixed | Comp. | 10\% | 302-474 |
| R444 |  | 56 k | 1 w | Fixed | Comp. | 10\% | 304-563 |
| R445 |  | 22 k | 1/2 w | Fixed | Comp. | 10\% | 302-223 |
| R446 |  | 2.2 meg | $1 / 2 \mathrm{w}$ | Fixed | Comp. | 10\% | 302-225 |
| R447 |  | 2.2 meg | 1/2 w | Fixed | Comp. | 10\% | 302-225 |
| R448 |  | 560 k | 1/2 w | Fixed | Comp. | 10\% | 302-564 |
| R449 | 101-722X | 220 k | 1/2 w | Fixed | Comp. | 10\% | 302-224 |
| R450 |  | 270 k | 1/2 w | Fixed | Comp. | 10\% | 302-274 |
| R451 | 101-722 | 470 k | 1/2 w | Fixed | Comp. | 10\% | 302-474 |
|  | 723-up | 333 k | 1/2 w | Fixed | Prec. | 1\% | 309-053 |
| R452 | 101-722X | 100 k | 2 w | Var. | Comp. | 20\% | 311-026 |
| R453 | 101-722 | 270 k | 1/2 w | Fixed | Comp. | 10\% | 302-274 |
|  | 723-up | 200 k | 1/2 w | Fixed | Prec. | 1\% | 309-051 |
| R454 | 101-722 | 1.5 meg | 1/2 w | Fixed | Comp. | 10\% | 302-155 |
|  | 722-950 | 100 k | 1/2 w | Fixed | Comp. | 10\% | 302-104 |
|  | 951-up | 1 meg | 1/2 w | Fixed | Comp. | 10\% | 302-105 |
| R455 |  | 1.5 k | 25 w | Fixed | WW | 5\% | 308-040 |


| R501 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R502 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R503 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R504 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R505 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R506 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R50'7 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R508 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R509 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R510 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R511 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R512 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R513 |  | 12 k | 1/2 w | Fixed | Comp. | 10\% | 302-123 |
| R515 |  | $820 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-821 |
| R520 |  | $56 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-560 |
| R521 |  | $27 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-270 |
| R522 |  | $27 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-270 |
| R523 |  | 1 k | 1 w | Fixed | Comp. | 10\% | 304-102 |
| R524 |  | $560 \Omega$ | 1/2 w | Fixed | Comp. | 10\% | 302-561 |
| R525 |  | 8.2 k | 1/2 w | Fixed | Comp. | 10\% | 302-822 |
| R526 | 101-163 | 39 k | 1/2 w | Fixed | Comp. | 10\% | 302-393 |
|  | 164-up | 56 k | 1/2 w | Fixed | Comp. | 10\% | 302-563 |



| V327 |  | 6AL5 | 154－016 |
| :---: | :---: | :---: | :---: |
| V330 |  | $12 \mathrm{AU7}$ | 154－041 |
| V331 |  | 6C4 | 154－029 |
| V332 |  | 6AL5 | 154－016 |
| V335 |  | 12AU7 | 154－041 |
| V336 |  | 6C4 | 154－029 |
| V337 |  | 6AL5 | 154－016 |
| V340 |  | 12AU7 | 154－041 |
| V341 |  | 6C4 | 154－029 |
| V342 |  | 6AL5 | 154－016 |
| V345 |  | 12AU7 | 154－041 |
| V346 |  | ${ }^{6} \mathrm{C} 4$ | 154－029 |
| V347 |  | 6AL5 | 154－016 |
| V350 |  | 12AU7 | 154－041 |
| V351 |  | 6C4 | 154－029 |
| V352 |  | 6AL5 | 154－016 |
| V355 |  | $12 \mathrm{AU7}$ | 154－041 |
| V356 |  | 6C4 | 154－029 |
| V357 |  | 6AL5 | 154－016 |
| V401 |  | 6X4 | 154－035 |
| V402 | $\begin{aligned} & 101-950 \\ & 951-u p \end{aligned}$ | $\begin{aligned} & \text { 6AQ5 } \\ & \text { 6AS5 } \end{aligned}$ | $\begin{aligned} & 154-017 \\ & 154-018 \end{aligned}$ |
| V403 |  | 6AU6 | 154－022 |
| V404 |  | 5651 | 154－052 |
| V420 |  | 6AQ5 | 154－017 |
| V421 |  | 6AU6 | 154－022 |
| V440 |  | 6AS7 | 154－020 |
| V441 |  | 6AU6 | 154－022 |
| V442 |  | $12 \mathrm{AX7}$ | 154－043 |


| V501 | $12 \mathrm{AU7}$ |  | 154-041 |
| :---: | :---: | :---: | :---: |
| D500 | Germanium Diode | Transitron T12G (preferred) or 1 N 34 A | 158-001 |
| RECTIFIERS |  |  |  |
| SR401 |  | 8 plates per leg | 106-002 |
|  | FUSES |  |  |
| F401 | 101-361 5 amp , | Type 4AG, Slo-Blo for 117-volt operation | 159-009 |
|  | $362-9505 \mathrm{amp}$, | Type 3AG, Slo-Blo for 117-volt operation | 159-006 |
|  | 951 -up 3.2 amp , | Type 3AG, Slo-Blo for 117-volt operation | 159-026 |
|  | 951 -up 1.6 amp , | Type 3AG, Slo-Blo for 234 -volt operation | 159-003 |
| F402 | 951 -up 1/4 amp, | Type 8AG Fast-Blo for 180-S1 only | 159-020 |

SWITCHES


## CERAMIC STRIPS AND MOUNTINGS



## CABINET



## ACCESSORIES





## RIGHT SIDE



| REF． |  | SERI | NO． | ${ }^{\circ}$ | DESCRIPTION |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NO． | PART NO． | EFE． | DISC． | r． |  |  |
| 1. | 441－053 |  |  | 1 | CHASSIS，Divider＂A＂ |  |
| 2. | 385－010 |  |  | 4 | ROD，slum．round， $3 / 8 \times 1-7 / 16 \mathrm{ln}$ ． |  |
|  | 212－040 |  |  | 8 | SCREW， $8-32 \times 3 / 8 \mathrm{in}$ ．FHE $100^{\circ} \mathrm{Phillips}$ |  |
| 3. | 136－015 |  |  | 3 | SOCKET，STM9G |  |
| 4. | 179－042 |  |  | 1 | CABLE，harness，＂Large Mike＂ |  |
| 5. | 387－503 |  |  | 1 | PLATE，alum．front support $5 \times 7-1 / 2 \mathrm{ln}$ ． |  |
| 6. | 441－017 |  |  | 1 | CHASSIS，high frequency multipller |  |
| 7. | 136－011 |  |  | 1 | SOCRET，STM8，ground |  |
| 8. | 406－040 |  |  | 1 | BRACKET，alum． $1-1 / 8 \times 1-15 / 16 \times 1 / 2 \mathrm{in}$ ． |  |
| 9. | 406－039 |  |  | 1 | BRACKET，alum． $1 / 2 \times 2-7 / 32 \mathrm{ln}$ ．meg．fan ring |  |
| 10. | 369－001 |  |  | 1 | FAN，alum． $501 / 2 \mathrm{in}$ ，blade |  |
| 11. | 212－037 |  |  | 2 | SCREW， $8-32 \times 1-3 / 4 \mathrm{in}$ ．Fill HS |  |
|  | 210－809 |  |  | 2 | WASHER，brass，centering |  |
|  | 210－462 |  |  | 2 | NUT，alum． $8032 \times 1 / 2 \mathrm{in}$ ． |  |
| 12. | 179－038 |  |  | 1 | CABLE，harness，power |  |
| 13. | 406－041 |  |  | 1 | BRACKET，alum． $3 \times 3-5 / 16 \times 1-5 / 16 \mathrm{in}$ ． |  |
| 14. | 354－008 |  |  | 1 | RING，fan |  |
| 15. | 386－313 |  |  | 1 | PLATE， $1 / 2 \times 1-1 / 8 \mathrm{in}$ ．spacing |  |
| 16. | 179－039 |  |  | 1 | Cable，harness，Divider＂A＂ |  |
| 17. | 210－413 |  |  | 4 | NUT，3／8－32 $\times 1 / 2 \mathrm{in}$ ． |  |
|  | 210－840 |  |  | 4 | WASHER，steel，9／16 in． |  |
| 18. | 348－002 |  |  | 4 | CROMMET，rubber， $1 / 4 \mathrm{in}$ ． |  |
| 19. | 136－008 |  |  | 10 | SOCKET，STM7G |  |
| 20. | 123－004 |  |  | 7 | TURRET，socket ass＇y |  |
| 21. | 210－201 |  |  | 2 | LuG，solder SE4 |  |
| 22. | 406－038 |  |  | 1. | BRACKET，alum．high frequency multiplier |  |
| 23. | 337－032 |  |  | 2 | SHIELD，coil，alum． $1-1 / 8 \times 1-1 / 2 \times 7 / 16 \mathrm{in}$ ． |  |
|  | 211－011 |  |  | 4 | SCREN， $4-40 \times 5 / 16 \mathrm{in}$ ．BHS |  |
|  | 210－004 |  |  | 4 | LOCKWASHER，int．\＃⿰三丨⿰丨三⿵⿰丿⿺⿻⿻一㇂㇒丶𠃌灬丶 |  |
|  | 210－406 |  |  | 4 | NUT， $4-40 \times 3 / 16$ 1n． |  |
| 24. | 211－033 |  |  | 40 | SCREW，4－40 $\times 5 / 16 \mathrm{in}$ ．Pan HS w／lockwasher |  |
|  | 210－004 |  |  | 40 | LOCKWASHER，int 非 |  |
|  | 210－406 |  |  | 40 | NUT， $4-40 \times 3 / 16 \mathrm{in}$ ． |  |
| 25. | 179－041 |  |  | 1 | CABLE，harness，high frequency multiplier |  |
| 26. | 385－041 |  |  | 1 | ROD，nylon， $5 / 16$ dia．$* 1-1 / 4 \mathrm{in}$ ．w／2 pins |  |
| 27. | 147－001 |  |  | 1 | MOTOR， 1500 RPM，115V， $1 / 4 \mathrm{in}$ ．dia． |  |
| 28. | Pg．B－36 |  |  | 1 | POWER |  |
| 29. | 212－023 |  |  | 2 | SCREW， $8 \times 32 \times 3 / 8 \mathrm{in}$ ．BHS | ， |

## RIGHT SIDE




## LEFT SIDE



## LEFT SIDE

s/n 101-950


## LEFT SIDE



## LEFT SIDE

s/n 951-up


\begin{tabular}{|c|c|c|c|c|}
\hline \& \& \&  \&  \\
\hline \[
\begin{aligned}
\& \text { Ref. } \\
\& \text { No. }
\end{aligned}
\] \& PARt No. \& SERI \& \begin{tabular}{c|c} 
NO. \& \begin{tabular}{c}
0 \\
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r \\
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\hline
\end{tabular} \& DESCRIPTION \\
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17. \& | $386-297$ $136-015$ |
| :--- |
| 392-065 |
| 166-033 |
| 348-004 |
| 441-018 $136-004$ |
| 134-001 |
| $212-011$ $385-065$ |
| 211-507 |
| $210-006$ $210-407$ |
| 348-005 |
| 211003 $210-004$ |
| 210-406 |
| 136-008 $385-016$ |
| 210-204 |
| 211-504 |
| 392-052 |
| 381-019 |
| $179-038$ $212-540$ |
| $210-010$ $210-445$ | \& \& 1

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2
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1 \& | Plate, sub pane 1 |
| :--- |
| SOCKET, STM9G |
| BOARD, terminal, $3 / 32 \times 1-7 / 8 \times 6-1 / 2 \mathrm{in}$. |
| SPACER, $1 / 4 \times 3 / 8 \mathrm{in}$. |
| GROMMET, rubber, $3 / 8$ in. |
| CHASSIS, Power |
| SOCKET, SCB2, 2 prong |
| PLuG, 2 pin, PwB2 |
| SCREN, $8-32 \times 3 / 4 \mathrm{in}$. FHS $100^{\circ}$ |
| SPACER, $3 / 8 \times 1-1 / 16 \mathrm{in}$. |
| SCREW, $6-32 \times 5 / 16 \mathrm{in}$. BHS |
| LOCKWASHER, int $\# \# 6$ |
| NuT, $6-32 \times 1 / 4 \mathrm{in}$. |
| GROMMET, rubber, $1 / 2 \mathrm{in}$. |
| SCREW, $4-40 \times 5 / 16 \mathrm{in}$. Pan HS w/lockws sher |
| LOCKNASHER, int. 非 4 |
| NUT, $4-40 \times 3 / 16 \mathrm{in}$. |
| SOCKET, STM7G |
| ROD, nylon, $5 / 16 \times 1 \mathrm{in}$. |
| LUG, solder, DE6 |
| SCREW, $6-32 \times 1 / 4 \mathrm{in}$. |
| SOCKET, STM8 ground |
| BOARD, terminal, $3 / 32 \times 1-5 / 8 \times 1-7 / 8 \mathrm{in}$. |
| BAR, alum. $3 / 8 \times 1 / 2 \times 9-3 / 8 \mathrm{in}$. |
| CABLE, harness, Power |
| SCREW, $10-32 \times 5-1 / 2 \mathrm{in}$. |
| LOCKWASHER, int. \#10 |
| NUT, $10-32 \times 3 / 8 \mathrm{in}$. | <br>

\hline
\end{tabular}



## PARTS REPLACEMENT KNT

## POWER TRANSPORMER

For Tektronix Type 180A Time Mark Generators

Serial number 5001-5598

## DESCRIPTION

New Power Transformer 120-0119-00 replaces 120-0102-00.

The new transformer and minor circuit changes provide a significant improvement in the voltage regulation of the 225 V supply.

NOTE: If the serial number of your instrument is above those listed, or if this kit has already been installed, disregard the instructions as PN 120-0119-00 is a direct replacement.

(®)

Publication:
Instructions for 050-0004-00
November 1966
Supersedes:
050-004
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## PARTS LIST

Quantity
( 1 ea )
1 ea
1 ea
1 ea
1 ea
1 ea
1 ea
1 ea
1 ea $\quad(176-0004-00)$

Description
Assembly, resistor, consisting of:
Nut, resistor mounting, $6-32 \times 5 / 16 \times 0.194$
Eyelet
Screw, 6-32 $\times 1-1 / 2$ RHS, Phillips Resistor, WW, 2k 10W 5\%

Transformer, power, 180A
Screw, 6-32 $\times 3 / 8$ PHS
Spool, w/3 ft. silver-bearing solder
Wire, " 20 solid, 9 in. bare

## INSTRUCTIONS

IMPORTANT: When soldering to the ceramic strips, use the silver-bearing solder supplied with this kit.
( ) 1. Remove the bottom and both side panels of the instrument cabinet.
( ) 2. Carefully unsolder the wires from the terminals of the power transformer. (Make a sketch of these connectors to use during re-assembly.)

NOTE: To prevent damage to the plastic insulation, use a well-tinned iron and apply heat to the terminals only long enough to release wires.
( ) 3. Release and swing the movable chassis outward on its hinges, exposing the top side of the power transformer (T701).
( ) 4. Remove transformer T701 from the chassis.
NOTE: While removing the transformer retaining nuts, support the transformer with one hand. This prevents it from dropping out of the chassis, causing damage to other components.
( ) 5. Mount the new transformer (T701 from kit) into the instrument.
() 6. Carefully solder the wires (removed in step 2) to the corresponding terminals of the new transformer.
( ) 7. In line with, and centered between V707 and V757, drill a hole 7-1/2 in. from the rear sub-panel. Use a \#27 drill.
( ) 8. Mount the $10 \mathrm{~W} 5 \%$ WW resistor assembly (R738, from kit) onto the underside of the chassis, using the hole drilled in step 7, and the 6-32 $\times 3 / 8$ PHS screw provided. (Mount the resistor with the terminals toward the adjacent terminal strip.)
( ) 9. Locate notch \#11 (counting from the back of instrument) on terminal strip adjacent to T701.

INSTRUCTIONS (cont)
( ) 10. Connect the inner terminal (terminal nearest chassis) of the $10 \mathrm{~W} 5 \%$ WW resistor to the notch located in step 9. Use the "20 bare wire from the kit.
( ) 11. Connect the outer terminal of the 10W $5 \%$ WW resistor to pin 2 of V707. Use the \#20 bare wire from the kit.

## THIS COMPLETES THE INSTALLATION.

( ) Check wiring for accuracy.
( ) For future reference, correct the Instruction Manual Parts List and Schemaric as required.
( ) Refer to the Calibration Procedure of the Instruction Manual and recalibrate your instrument as required.

BE:Is

## 

## SILICON DIODES REPLACE 106-005

For the following Tektronix Instruments:

Type 315D All serial numbers
Type 180A s/n 5001-6385

## DESCRIPTION

152-066 Silicon Diodes replace 106-005 selenium stack which is no longer being manufactured. The silicon diodes offer better reliability and longer life.

If you wish to replace all the selenium stacks at one time, order Modification Kit 040-214, for Type 180A, or $040-220$, for Type 315D.

NOTE: If the serial number of your instrument is above those listed or if this kit has already been installed, disregard the instructions and use $P / N$ 152-066 as a direct replacement.

Publication:
Instructions for 050-226
January 1965

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1 ea.
Assembly, Silicon rectifier, consisting of:
4 ea. Diode, silicon 1N3194
$10 \Omega$
1 ea. Resistor,
1 ea. Bracket, mounting
1 ea. Washer, steel, flat 6L x 3/8 x 0.032
1 ea. Screw, 6-32 x $3 / 8$ BHS
1 ea. Spool, $\mathrm{w} / 3 \mathrm{ft}$. of silver-bearing solder

211-510
152-066
302-100
Special
210-803
211-510
214-210

## INSTRUCTIONS

( ) 1. Remove selenium stack SR741 (180A), SR701 (180A) or SR460 (315D).

FOR TYPE 180A ONLY
( ) 2. Connect wires to silicon rectifier assembly (from kit) as shown in Fig. 1.
( ) Orient assembly as shown in Fig. 2. If replacing SR701, do not connect the bare wire to SR721 until step 3.
( )
3. Mount silicon rectifier assembly in in-
strument using a \#6-32 $\times 3 / 8$ screw and flat washer from the kit. Orient as indicated in Fig. 2 or 3.

( )
Connect bare wire to SR701 as shown in Fig. 2.

## FOR TYPE 315D ONLY

( ) 4. Connect wires to the rectifier assembly as shown in Fig. 4.

## THIS COMPLETES THE INSTALLATION

( ) Make the necessary corrections to the Parts List in your Instruction Manual.

GG:ceb



Fig. 1


180A Power Supply
(Partial Diagram)


Fig. 2


Fig. 3


Fig. 4

## PARTS REPLACEKMENT KIT

## AIR FILTER

For the following Tektronix Instruments:

| \#\# Types | 180A | SN | 5001- |
| :---: | :---: | :---: | :---: |
|  | 316 | SN | 101- up |
|  | 551 Power Supply | SN | 101- 5979 |
| \#\# | and | SN | 100001-100409 |
|  | 555 Power Supply | SN | 101-9989 |
| \#\# | and |  | 100158-100306 |


\#\# Scott foam air filter 378-0031-00 replaces aluminum air filter 378-0015-00, and nylon air filter 378-0015-01 (for Guernsey).

An aluminum filter screen, 378-0763-00 is included to maintain clearance between the fan blade and the filter.

NOTE: If the serial number of your instrument is above those listed, or if this kit has been installed, disregard the instructions as PN 378-0031-00 is a direct replacement.

Publication:
Instructions for 050-0253-01
August 1967
Supersedes:
January 1967
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## PARTS LIST

| Quantity |  | Part Number |
| :---: | :---: | :---: |$\quad$| Description |
| :---: |
| \#\# 2 ea |
| 1 ea |
| 1 ea |

## INSTRUCTIONS

( ) 1. Remove the filter housing and aluminum filter.
( ) 2. Install the filter screen (from kit) under the two left and two right fan ring mounting screws. Align the mesh so that it runs vertically and horizontally. Mount with the curved area of screen away from fan.
NOTE: For Type 180A instruments the two lower screws are the only usable ones. For these instruments, check clearance inside instrument and drill two $7 / 64 \mathrm{in}$. (\#36) holes through the upper part of the screen and secure withetwo 6-32 $\times 5 / 16$ thread-forming screws from the kit.
( ) 3. Place the new air filter (from kit) over the screen and between the mounting screws.
( ) 4. Replace the filter housing.
THIS COMPLETES THE INSTALLATION.
( ) Record the part number of the filter and filter screen in your Instruction Manual.

DF:Is

# SECTION 6 PARTS LIST and DIAGRAMS 

## PARTS ORDERING INFORMATION

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 Tektronix Field Office will contact you concerning any change in part number.

ABBREVIATIONS AND SYMBOLS

| a or amp | amperes | mm | millimeter |
| :---: | :---: | :---: | :---: |
| BHS | binding head steel | meg or M | megohms or mega (10) |
| C | carbon | met. | metal |
| cer | ceramic | $\mu$ | micro, or $10^{-6}$ |
| cm | centimeter | n | nano, or $10^{-9}$ |
| comp | composition | $\Omega$ | ohm |
| cps | cycles per second | OD | outside diameter |
| crt | cathode-ray tube | OHS | oval head steel |
| CSK | counter sunk | p | pico, or $10^{-12}$ |
| dia | diameter | PHS | pan head steel |
| div | division | piv | peak inverse voltage |
| EMC | electrolytic, metal cased | plstc | plastic |
| EMT | electroyltic, metal tubular | PMC | paper, metal cased |
| ext | external | poly | polystyrene |
| f | farad | Prec | precision |
| F \& I | focus and intensity | PT | paper tubular |
| FHS | flat head steel | PTM | paper or plastic, tubular, molded |
| Fil HS | fillister head steel | RHS | round head steel |
| g. or G | giga, or $10^{9}$ | rms | root mean square |
| Ge | germanium | sec | second |
| GMV | guaranteed minimum value | Si | silicon |
| h | henry | S/N | serial number |
| hex | hexagonal | $t$ or T | tera, or $10^{12}$ |
| HHS | ehex head steel | TD | toroid |
| HSS | hex socket steel | THS | truss head steel |
| HV | high voltage | tub. | tubular |
| ID | inside diameter | v or V | volt |
| incd | incandescent | Var | variable |
| int | internal | w | watt |
| k or K | kilohms or kilo ( $10^{3}$ ) | w/ | with |
| kc | kilocycle | w/o | without |
| m | milli, or $10^{-3}$ | WW | wire-wound |
| mc | megacycle |  |  |

## SPECIAL NOTES AND SYMBOLS

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, or reworked or checked components.

Use 000-000
Part number indicated is direct replacement.
Internal screwdriver adjustment.
Front-panel adjustment or connector.


FRONT (Cont'd)







SUB-PANEL (Cont'd)



POWER


POWER (Cont'd)

| $\begin{aligned} & \text { REF. } \\ & \text { NO. } \end{aligned}$ | PART NO. | SERIAL/MODEL NO. |  | $\begin{aligned} & \mathrm{Q} \\ & \mathrm{~T} \\ & \mathrm{Y} . \end{aligned}$ | DESCRIPTION |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | EFF. | DISC. |  |  |
| 13 | $441-178$ <br> $441-307$ <br> $-\cdots-$ <br> --- <br> --- <br> $212-040$ <br> $210-458$ | 5001 <br> 6386 <br> PLUS <br> PLUS | $\begin{aligned} & 6385 \\ & 6380 \\ & 6381 \end{aligned}$ | 1 1 <br> 7 7 | CHASSIS, power CHASSIS, power <br> mounting hardware: (not included w/chassis) SCREW, $8-32 \times 3 / 8$ inch FHS $100^{\circ}$ CSK phillips NUT, keps, $8-32 \times 11 / 32$ inch |
| 14 | $\begin{aligned} & 179-183 \\ & 179-400 \\ & \hdashline \cdots \\ & \hdashline- \end{aligned}$ | 5001 <br> 6386 <br> PLUS <br> PLUS | $\begin{aligned} & 6385 \\ & 6380 \\ & 6381 \end{aligned}$ | $\begin{aligned} & 1 \\ & 1 \end{aligned}$ | CABLE, power \#1 CABLE, power \#1 |
| 15 | $\begin{aligned} & 179-216 \\ & 179-401 \\ & -\cdots \\ & -\cdots \end{aligned}$ | $\begin{aligned} & 5001 \\ & 6386 \\ & \text { PLUS } \\ & \text { PLUS } \end{aligned}$ | $\begin{aligned} & 6385 \\ & 6380 \\ & 6381 \end{aligned}$ | $\begin{aligned} & 1 \\ & 1 \end{aligned}$ | CABLE HARNESS, 110 V CABLE HARNESS, 110 V |
| 16 | $\begin{aligned} & 386-252 \\ & --- \\ & 211-534 \\ & 210-006 \\ & 210-407 \end{aligned}$ |  |  | $\begin{aligned} & 2 \\ & - \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | PLATE, small, fiber mounting hardware for each: (not included w/plate) SCREW, 6-32 $\times 5 / 16$ inch PHS w/lockwasher LOCKWASHER, internal, \#6 NUT, hex, $6-32 \times 1 / 4$ inch |
| 17 | $\begin{aligned} & 386-255 \\ & -- \\ & 211-534 \\ & 210-006 \\ & 210-407 \end{aligned}$ |  |  | $\begin{aligned} & 1 \\ & - \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | PLATE, large, metal mounting hardware: (not included w/plate) SCREW, $6-32 \times 5 / 16$ inch PHS $w /$ lockwasher LOCKWASHER, internal, \#6 NUT, hex, $6-32 \times 1 / 4$ inch |
| 18 | $\left\lvert\, \begin{aligned} & 386-254 \\ & -- \\ & 211-543 \\ & 210-006 \\ & 210-407 \end{aligned}\right.$ |  |  | $\begin{aligned} & 1 \\ & - \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | PLATE, large, fiber mounting hardware: (not included w/plate) SCREW, $6.32 \times 5 / 16$ inch RHS LOCKWASHER, internal, \#6 NUT, hex, $6-32 \times 1 / 4$ inch |
| 19 | $\begin{aligned} & 386-253 \\ & -- \\ & 211-534 \\ & 210-006 \\ & 210-407 \end{aligned}$ |  |  | $\begin{aligned} & 1 \\ & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | PLATE, small, metal mounting hardware: (not included w/plate) SCREW, $6-32 \times 5 / 16$ inch PHS $w /$ lockwasher LOCKWASHER, internal, \#6 NUT, hex, $6-32 \times 1 / 4$ inch |
| $\begin{aligned} & 20 \\ & 21 \end{aligned}$ | $\left\lvert\, \begin{aligned} & 348-012 \\ & 136-015 \\ & \hdashline-7 \\ & 213-044 \end{aligned}\right.$ |  |  | $\begin{aligned} & 2 \\ & 8 \\ & - \\ & 2 \end{aligned}$ | GROMMET, rubber, $5 / 8$ inch SOCKET, STM9G mounting hardware for each: (not included $w /$ socket) SCREW, thread cutting, $5-32 \times 3 / 16$ inch PHS phillips |
| $\begin{aligned} & 22 \\ & 23 \end{aligned}$ | $\left\lvert\, \begin{aligned} & 348-002 \\ & 385-104 \\ & -\overline{213-041} \end{aligned}\right.$ |  |  | 4 <br> 2 <br> - | GROMMET, rubber, $1 / 4$ inch ROD, nylon mounting hardware for each: (not included w/rod) SCREW, thread cutting, $6-32 \times 3 / 8$ inch THS phillips |

POWER (Cont'd)


DIVIDER


DIVIDER

| REF. NO. | PART NO. | SERIAL/MODEL NO. |  | $\begin{aligned} & \mathrm{O} \\ & \mathrm{~T} \\ & \mathrm{Y} \end{aligned}$ | DESCRIPTION |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | EfF. | DISC. |  |  |
| 1 | $\begin{aligned} & 343-007 \\ & \hdashline-7 \\ & 214-012 \\ & 210-407 \\ & 210-006 \end{aligned}$ |  |  | $\begin{aligned} & 1 \\ & -1 \\ & 3 \\ & 2 \end{aligned}$ | CLAMP, cable, $5 / 8$ inch mounting hardware: (not included $\mathrm{w} /$ clamp) BOLT, spade, $6-32 \times 3 / 8$ inch NUT, hex, $6-32 \times 1 / 4$ inch LOCKWASHER, internal, \#6 |
| 2 | $\begin{aligned} & 343-004 \\ & \hdashline- \\ & 210-504 \\ & 210-803 \end{aligned}$ |  |  | $\begin{aligned} & 2 \\ & i \\ & 1 \\ & 1 \end{aligned}$ | CLAMP, cable $5 / 16$ inch (not shown) mounting hardware for each: (not included w/clamp) SCREW, $6-32 \times 1 / 4$ inch BHS <br> WASHER, $6 \mathrm{~L} \times 3 / 8$ inch |
| 3 | $\begin{aligned} & 384-537 \\ & \hdashline 210-821 \\ & 354-177 \end{aligned}$ |  |  | $\begin{aligned} & 1 \\ & 2 \\ & 2 \end{aligned}$ | ROD, swivel, $3 / 8 \times 3 / 8 \times 121 / 4$ inches, tapped $6-32$ mounting hardware: (not included $w / \mathrm{rod}$ ) WASHER, $1 / 4$ ID $\times 1 / 2$ inch OD RING, retaining |
| 4 5 | $\begin{aligned} & 179-185 \\ & 179-280 \\ & 441-175 \\ & \hdashline- \\ & 211-510 \end{aligned}$ | $\begin{array}{l\|l} 5001 \\ 5479 \end{array}$ | 5478 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & - \\ & 3 \end{aligned}$ | CABLE HARNESS, divider CABLE HARNESS, divider CHASSIS, divider mounting hardware: (not included w/chassis) SCREW, $6-32 \times 3 / 8$ inch BHS |
| 6 | 136-008 213-044 |  |  | $\begin{array}{r} 12 \\ 2 \end{array}$ | SOCKET, STM7G mounting hardware for each: (not included $\mathrm{w} /$ socket) SCREW, thread cutting, $5-32 \times 3 / 16$ inch, PHS phillips |
| 7 | 385-138 213-041 |  |  | $\begin{aligned} & 1 \\ & i \end{aligned}$ | ROD, delrin, $5 / 16 \times 19 / 16$ inches mounting hardware: (not included $w / r o d)$ SCREW, thread cutting, $6-32 \times 3 / 8$ inch THS phillips |
| $\begin{aligned} & 8 \\ & 9 \end{aligned}$ | $\begin{gathered} 348-002 \\ \hdashline-\cdots \\ 210-840 \\ 210-413 \end{gathered}$ |  |  | $\begin{array}{r} 1 \\ 12 \\ - \\ 1 \\ 1 \end{array}$ | GROMMET, rubber, $1 / 4$ inch POT mounting hardware for each: (not included w/pot) WASHER, 390 ID $\times 9 / 16$ inch OD NUT, hex, $3 / 8-32 \times 1 / 2$ inch |
| 10 11 | $\begin{gathered} 213-033 \\ 105-007 \\ 214-008 \\ 210-847 \\ 354-048 \\ 210-223 \\ \hdashline-- \\ 213-044 \end{gathered}$ | $\begin{aligned} & 5001 \\ & 5001 \\ & 5316 \\ & 5316 \\ & 5316 \end{aligned}$ | $\begin{aligned} & 5315 \\ & 5315 \end{aligned}$ | $\begin{aligned} & 2 \\ & 2 \\ & 1 \\ & 1 \\ & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ | SCREW, fastening (not shown) <br> STOP <br> BOLT, captive <br> WASHER, nylon <br> RING, securing <br> LUG, solder, $1 / 4$ inch mounting hardware: (not included $w /$ lug) SCREW, thread cutting, $5-32 \times 3 / 16$ inch PHS phillips |
| 12 |  |  |  | $\begin{array}{r} 24 \\ \hline \end{array}$ | SOCKET, STM9G <br> mounting hardware for each: (not included w/socket) SCREW, thread cutting, $5-32 \times 3 / 16$ inch PHS phillips |
| 13 | $\begin{aligned} & 211-510 \\ & 210-803 \\ & 210-407 \end{aligned}$ |  |  | $\begin{aligned} & 1 \\ & - \\ & 2 \\ & 4 \\ & 2 \end{aligned}$ | CAPACITOR <br> mounting hardware: (not included w/capacitor) <br> SCREW, $6-32 \times 3 / 8$ inch BHS <br> WASHER, $6 L \times 3 / 8$ inch <br> NUT, hex, $6-32 \times 1 / 4$ inch |


|  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| REF. NO. | PART NO. | SERIAL/MODEL NO. |  | $\begin{aligned} & \hline \mathbf{Q} \\ & \mathbf{T} \\ & \mathbf{Y} . \end{aligned}$ | DESCRIPTION |  |
|  |  | Eff. | Disc. |  |  |  |
| 1 | $\begin{aligned} & 386-682 \\ & 387-038 \\ & -- \\ & 213-041 \end{aligned}$ | $\begin{aligned} & 5001 \\ & 6618 \end{aligned}$ | 6617 | $\begin{aligned} & 1 \\ & 1 \\ & - \\ & 4 \end{aligned}$ | PLATE, back overlay PLATE, back overlay mounting hardware: (not included w/plate) SCREW, $6-32 \times 3 / 8$ inch THS phillips |  |
| 2 | $\begin{aligned} & 380-009 \\ & 380-016 \\ & -- \\ & 210-402 \\ & 212-031 \\ & 210-458 \end{aligned}$ | $\begin{aligned} & 5001 \\ & 6618 \end{aligned}$ | 6617 | $\begin{aligned} & 1 \\ & 1 \\ & - \\ & 4 \\ & 4 \\ & 4 \end{aligned}$ | HOUSING, air filter HOUSING, air filter mounting hardware: (not included w/housing) NUT, cap, hex, $8-32 \times 5 / 16$ inch SCREW, $8-32 \times 1 \frac{1}{4}$ inches RHS NUT, keps, $8-32 \times{ }^{11 / 32}$ inch |  |
| 3 |  | $\begin{aligned} & 5001 \\ & 5552 \end{aligned}$ | 5551 | $\begin{aligned} & 1 \\ & 1 \\ & - \\ & 1 \\ & 1 \\ & 2 \\ & 2 \end{aligned}$ | CONNECTOR, 2 contact, male CONNECTOR, 3 wire, male connector includes: POST, ground, threaded one end COVER <br> NUT, hex, $4-40 \times 1 / 4$ inch SCREW, $4-40 \times 1 / 2$ inch RHS |  |

REAR (Cont'd)



CABINET



POWER CHASSIS


STRIP DETAIL

| REF. NO. | PART NO. | SERIAL/MODEL NO. |  | $\begin{aligned} & \mathrm{Q} \\ & \mathrm{~T} \\ & \mathrm{Y} . \end{aligned}$ | DESCRIPTION |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | EFF. | DISC. |  |  |
| 1 | $124-016$ <br> --- <br> $210-850$ <br> $210-002$ <br> $210-405$ <br> $124-091$ <br> --9 <br> $355-046$ <br> $-761-009$ | $\begin{aligned} & 5001 \\ & 5001 \\ & 5001 \\ & 5001 \\ & 5780 \\ & 5780 \\ & 5780 \end{aligned}$ | $\begin{aligned} & 5779 \\ & 5779 \\ & 5779 \\ & 5779 \end{aligned}$ | $\begin{array}{r} 18 \\ - \\ 2 \\ 2 \\ 2 \\ 18 \\ \hline 2 \\ \hline 2 \end{array}$ | STRIP, ceramic, $3 / 4$ inch $\times 11$ notches each strip includes: <br> WASHER, \#2 <br> LOCKWASHER, external, \#2 <br> NUT, hex, $2-56 \times 3 / 16$ inch <br> STRIP, ceramic, $3 / 4$ inch $\times 11$ notches each strip includes: <br> STUD, nylon <br> mounting hardware for each: (not included w/strip) SPACER, nylon |
| 2 | $124-016$ --- $210-850$ $210-002$ $210-405$ $214-091$ $--\overline{-}$ $355-046$ $-761-009$ | 5001 5001 5001 5001 5780 5780 5780 | $\begin{aligned} & 5779 \\ & 5779 \\ & 5779 \\ & 5779 \end{aligned}$ | $\begin{array}{r} 10 \\ \hline \\ 2 \\ 2 \\ 2 \\ 10 \\ \hline \\ 2 \\ \hline \\ 2 \end{array}$ | STRIP, ceramic, $3 / 4$ inch $\times 11$ notches each strip includes: <br> WASHER, \#2 <br> LOCKWASHER, external, \#2 <br> NUT, hex, $2-56 \times 3 / 16$ inch <br> STRIP, ceramic, $3 / 4$ inch $\times 11$ notches each strip includes: <br> STUD, nylon <br> mounting hardware for each: (not included w/strip) <br> SPACER, nylon |
| 3 | $\begin{aligned} & 129-017 \\ & 124-100 \\ & -7 \\ & 355-046 \\ & ---\overline{-} \\ & 361-009 \end{aligned}$ | $\begin{aligned} & 5001 \\ & 5780 \\ & 5780 \\ & 5780 \end{aligned}$ | 5779 | $\begin{array}{r} 12 \\ 12 \\ 1 \\ 1 \\ 1 \end{array}$ | POST, connecting, ceramic <br> STRIP, ceramic, $3 / 4$ inch $\times 1$ notch each strip includes: <br> STUD, nylon <br> mounting hardware for each: (not included w/strip) <br> SPACER, nylon |
| 4 | $\begin{array}{\|l\|} 124-089 \\ --7 \\ 355-046 \\ --9 \\ 361-009 \end{array}$ | X6386 <br> X6386 <br> X6386 |  | $\begin{aligned} & 4 \\ & - \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | STRIP, ceramic, $3 / 4$ inch $\times 7$ notches each strip includes: <br> STUD, nylon <br> mounting hardware for each: (not included w/strip) <br> SPACER, nylon |
| 5 | $\begin{aligned} & 124-030 \\ & -7 \\ & 210-850 \\ & 210-002 \\ & 210-405 \\ & 124-086 \\ & \hdashline-- \\ & 355-046 \\ & --- \\ & 361-009 \end{aligned}$ | $\begin{aligned} & 5001 \\ & 5001 \\ & 5001 \\ & 5001 \\ & 5780 \\ & 5780 \\ & 5780 \end{aligned}$ | $\begin{array}{\|l\|l} 5779 \\ 5779 \\ 5779 \\ 5779 \end{array}$ | $\begin{aligned} & 1 \\ & - \\ & 1 \\ & 1 \\ & 1 \\ & 1 \\ & \hline 1 \\ & 1 \\ & 1 \end{aligned}$ | STRIP, ceramic, $3 / 4$ inch $\times 2$ notches strip includes: <br> WASHER, \#2 <br> LOCKWASHER, external, \#2 <br> NUT, hex, $2-56 \times 3 / 16$ inch <br> STRIP, ceramic, $3 / 4$ inch $\times 2$ notches <br> strip includes: <br> STUD, nylon <br> mounting hardware: (not included w/strip) <br> SPACER, nylon |
| 6 | $\begin{aligned} & 124-066 \\ & -70-8 \\ & 210-002 \\ & 210-405 \\ & 124-090 \\ & \hdashline 355-046 \\ & -\overline{-} \\ & 361-007 \end{aligned}$ | $\begin{aligned} & 5001 \\ & 5001 \\ & 5001 \\ & 5001 \\ & 5780 \\ & 5780 \\ & 5780 \end{aligned}$ | $\begin{array}{\|l\|l} 5779 \\ & 5779 \\ 5779 \\ 5779 \end{array}$ | $\begin{aligned} & 2 \\ & - \\ & 2 \\ & 2 \\ & 2 \\ & 2 \\ & \hline \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | STRIP, ceramic, $3 / 4$ inch $\times 9$ notches each strip includes: <br> WASHER, \#2 <br> LOCKWASHER, external, \#2 <br> NUT, hex, $2-56 \times 3 / 16$ inch <br> STRIP, ceramic, $3 / 4$ inch $\times 9$ notches each strip includes: <br> STUD, nylon <br> mounting hardware for each: (not included w/strip) <br> SPACER, nylon |

## ACCESSORIES



## ELECTRICAL PARTS LIST

Values are fixed unless named variable.

|  | Tektronix <br> Part No. |  | Description |
| :--- | :--- | :--- | :--- |
|  |  |  | Bulbs |
|  |  |  |  |
| Ckt. No. |  |  |  |
| B701 | $150-001$ | Incandescent \#47 | Crystal Oven |
| B701 | $150-001$ | Incandescent \#47 Pilot Light |  |
|  | $158-007$ | Crystal Oven Assembly |  |

## Capacitors

Tolerance $\pm 20 \%$ unless otherwise indicated.
Tolerance of all electrolytic capacitors are as follows: (with exceptions)
$3 V-50 V=-10 \%,+250 \%$
$51 \mathrm{~V}-350 \mathrm{~V}=-10 \%,+100 \%$
$351 \mathrm{~V}-450 \mathrm{~V}=-10 \%,+50 \%$

| C100 | 283-002 | . $01 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  | X5499-up |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| C101 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C103 | 281-518 | 47 pf | Cer. |  | 500 v |  |  |
| C104 | 281-501 | 4.7 pf | Cer. |  | 500 v | $\pm 1 \mathrm{pf}$ |  |
| C105 | 281-010 | $4.5-25 \mathrm{pf}$ | Cer. | Var. |  |  |  |
| C110 | 281-518 | 47 pf | Cer. |  | 500 v |  |  |
| C112 | Use 283-002 | . $01 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C114 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C116 | 281-503 | 8 pf | Cer. |  | 500 v | $= \pm .5 \mathrm{pf}$ | 5001-5478 |
|  | 281-009 | 3-12 pf | Cer. | Var. |  |  | 5479-up |
| C120 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C121 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| Cl 22 | 281-509 | 15 pf | Cer. |  | 500 v | 10\% | 5001-5478 |
|  | 281-518 | 47 pf | Cer. |  | 500 v |  | 5479-up |
| C123 | 281-012 | 7-45 pf | Cer. | Var. |  |  |  |
| C124 | 281-508 | 12 pf | Cer. |  | 500 v | $\pm .6 \mathrm{pf}$ |  |
| C126 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C127 | Use 281-511 | 22 pf | Cer. |  | 500 v | 10\% |  |
| C129 | 281-012 | 7-45 pf | Cer. | Var. |  |  |  |
| C130 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C131 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C133 | 281-007 | 3-12 pf | Cer. | Var. |  |  |  |
| C134 | 281-508 | 12 pf | Cer. |  | 500 v | $\pm .6 \mathrm{pf}$ |  |
| C136 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C137 | 281-508 | 12 pf | Cer. |  | 500 v | $\pm .6 \mathrm{pf}$ |  |
| C139 | 281-007 | 3-12 pf | Cer. | Var. |  |  |  |
| C140 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C141 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type |  | 500 v |  |  |
| C143 | 281-007 | 3-12 pf | Cer. | Var. |  |  |  |
| C147 | 281-007 | 3-12 pf | Cer. | Var. |  |  |  |

## Parts List — Type 180A



| Capacirors (continued) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Ckt. No. | Tektronix Part No. | Description |  |  |  | S/N Range |
| C422 | 281-518 | 47 pf | Cer. | 500 v |  |  |
| C427 | 285-553 | $1 \mu \mathrm{f}$ | PMC | 600 v |  |  |
| C437 | 281-536 | 1000 pf | Cer. | 500 v | 10\% | 5001-5478 |
|  | 283-001 | . $005 \mu \mathrm{f}$ | Disc. Type | 500 v |  | 5479-up |
| C503 | 281-501 | 4.7 pf | Cer. | 500 v | $\pm 1 \mathrm{pf}$ |  |
| C505 | 281-506 | 12 pf | Cer. | 500 v | 10\% |  |
| C553 | 281-536 | 1000 pf | Cer. | 500 v | 10\% |  |
| C560 | 283-000 | . $001 \mu \mathrm{f}$ | Disc. Type | 500 v |  | 5001-5478 |
|  | 283-008 | . $1 \mu \mathrm{f}$ | Disc. Type | 500 v |  | 5479-up |
| C701 | Use 290-0010-00 | $2 \times 20 \mu \mathrm{f}$ | EMC | 450 v |  |  |
| C712 | 285-510 | . $01 \mu \mathrm{f}$ | MT | 400 v |  |  |
| C715A,B | Use 290-0010-00 | $2 \times 20 \mu \mathrm{f}$ | EMC | 450 v |  |  |
| C721 | Use 290-0013-00 | $2 \times 40 \mu \mathrm{f}$ | EMC | 450 v |  |  |
| C736 | 285-510 | . $01 \mu \mathrm{f}$ | MT | 400 v |  |  |
| C741 | Use 290-0016-00 | $125 \mu \mathrm{f}$ | EMC | 350 v |  |  |
| C744 | 285-510 | . $01 \mu \mathrm{f}$ | MT | 400 v |  |  |
| C761 | 285-510 | . $01 \mu \mathrm{f}$ | MT | 400 v |  |  |
| C763 | Use 290-0004-00 | $3 \times 10 \mu \mathrm{f}$ | EMC | 350 v |  |  |
| C770 | 290-025 | $6.25 \mu \mathrm{f}$ | EMT | 300 v |  |  |
| C774 | 285-510 | . $01 \mu \mathrm{f}$ | MT | 400 v |  |  |
|  |  | Diodes |  |  |  |  |
| D562 | 152-008 | Germaniu | 2G |  |  |  |
| D702A, B, C, D | *152-047 | Silicon Rep | able by 1N2862 |  |  | X6386-up |
| D722A, B, C, D | *152-047 | Silicon Rep | able by 1N2862 |  |  | X6386-up |
| D742A,B,C,D | *152-047 | Silicon Rep | able by 1N2862 |  |  | X6386-up |

## Fuses

| F701 | $159-026$ | $3.2 \mathrm{amp}, 3 \mathrm{AG}$ Slo-Blo 117 v operation, $50-60$ cycle |
| :--- | :--- | :--- |
| F702 | $159-003$ | $1.6 \mathrm{amp}, 3 \mathrm{AG}$ Slo-Blo 234 v operation, $50-60$ cycle |
|  | $159-028$ | $.25 \mathrm{amp}, 3 \mathrm{AG}$ Fast-Blo 117 v and 234 v operation, $50-60$ cycle |

Inductors

| L101 | $* 108-065$ | $700 \mu \mathrm{~h}$ |  |
| :--- | :--- | :--- | ---: |
| L107 | $* 108-068$ | $600 \mu \mathrm{~h}$ |  |
|  | $* 108-065$ | $700 \mu \mathrm{~h}$ | 5001-5478 |
| LR116 | $* 108-156$ | $300 \mu \mathrm{~h}$ | (on $10 \mathrm{k}, 1 \mathrm{w}$, resistor) |
| L124 | $* 108-011$ | $18 \mu \mathrm{~h}$ |  |
| X5479-up |  |  |  |


| L127 | $* 108-142$ | $16 \mu h$ |
| :--- | :--- | :--- |
| L134 | $* 108-023$ | $9.2 \mu \mathrm{~h}$ |
| L137 | *108-023 | $9.2 \mu \mathrm{~h}$ |
| L144 | *108-003 | $1.1 \mu \mathrm{~h}$ |
| L147 | $* 108-003$ | $1.1 \mu \mathrm{~h}$ |

Inductors (continued)
Ckt. No.

| LR171 | *108-068 | $600 \mu \mathrm{~h}$ |
| :--- | :--- | :--- |
|  | $* 108-155$ | 1 mh |
| L177 | $* 108-065$ | $700 \mu \mathrm{~h}$ |
| LR211 | $* 108-068$ | $600 \mu \mathrm{~h}$ |
|  | $* 108-155$ | 1 mh |
|  |  |  |
| LR231 | $* 108-068$ | $600 \mu \mathrm{~h}$ |
|  | $* 108-155$ | 1 mh |

Tektronix
Part No. Description

| (on $3.3 \mathrm{k}, 1 \mathrm{w}$, resistor) | $5001-5478$ |
| :--- | ---: |
| (on $10 \mathrm{k}, 1 \mathrm{w}$, resistor) | $5479-\mathrm{up}$ |
|  | X5479-up |
| (on $3.3 \mathrm{k}, 1 \mathrm{w}$, resistor) | $5001-5479$ |
| (on $10 \mathrm{k}, 1 \mathrm{w}$, resistor) | $5479-\mathrm{up}$ |
|  |  |
| (on $3.3 \mathrm{k}, 1 \mathrm{w}$, resistor) | $5001-5478$ |
| (on $10 \mathrm{k}, 1 \mathrm{w}$, resistor) | $5479-\mathrm{up}$ |

## Rectifiers $\dagger$

| SR701 | $* 106-005$ | 4 plates $/ \mathrm{leg}$ | $5001-6385 \mathrm{X}$ |
| :--- | :--- | :--- | :--- |
| SR721A,B | $* 106-049$ | 8 plates $/ \mathrm{leg}$ | $5001-6385 \mathrm{X}$ |
| SR741 | $* 106-005$ | 4 plates/leg | $5001-6385 \mathrm{X}$ |

## Resistors

Resistors are fixed, composition, $\pm 10 \%$ unless otherwise indicated.

| R101 | 302-563 | 56 k | 1/2w |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| R102 | 302-182 | 1.8 k | $1 / 2 \mathrm{w}$ |  |  |
| R103 | 302-392 | 3.9 k | $1 / 2 \mathrm{w}$ |  |  |
| R105 | 302-563 | 56 k | 1/2w |  |  |
| R108 | 302-562 | 5.6 k | $1 / 2 \mathrm{w}$ |  | 5001-5478 |
|  | 302-332 | 3.3 k | $1 / 2 \mathrm{w}$ |  | 5479-up |
| R110 | 302-224 | 220 k | 1/2w |  |  |
| R112 | 302-473 | 47 k | $1 / 2 \mathrm{w}$ |  |  |
| R114 | 302-393 | 39 k | $1 / 2 \mathrm{w}$ |  |  |
| R115 | 301-224 | 220 k | $1 / 2 \mathrm{w}$ | 5\% | 5001-5478 |
|  | 301-104 | 100 k | $1 / 2 \mathrm{w}$ | 5\% | 5479-up |
| R116 | 302-682 | 6.8 k | 1/2w |  | 5001-5478 |
|  | 302-103 | 10 k | $1 / 2 w$ |  | 5479-up |
| R117 | 302-101 | $100 \Omega$ | $1 / 2 \mathrm{w}$ |  |  |
| R118 | 302-221 | $220 \Omega$ | $1 / 2 w$ |  | 5001-5478 |
|  | 302-102 | 1 k | 1/2w |  | 5479-up |
| R120 | 302-473 | 47 k | 1/2w |  |  |
| R122 | 302-822 | 8.2 k | $1 / 2 \mathrm{w}$ |  |  |
| R126 | 302-473 | 47 k | 1/2w |  | 5001-5478 |
|  | 302-224 | 220 k | 1/2w |  | 5479-up |
| R128 | 302-220 | $22 \Omega$ | 1/2w |  |  |
| R130 | 302-473 | 47 k | 1/2w |  |  |
| R136 | 302-473 | 47 k | 1/2w |  | 5001-5478 |
|  | 302-224 | 220 k | 1/2w |  | 5479-up |
| R138 | 302-220 | $22 \Omega$ | 1/2w |  |  |
| R140 | 302-473 | 47 k | 1/2w |  |  |

A kit is available to convert from Selenium Rectifiers to Silicon Diodes. Order Mod Kit \#040-214.

Resistors (Cont'd.)

| Ckt. No. | Part No. |  | Descrip |  |  |  | S/N Range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R154 | 302-101 | $100 \Omega$ | $1 / 2 w$ |  |  |  |  |
| R155 | 304-333 | 33 k | 1 w |  |  |  | $\begin{array}{r} 5001-5478 \\ 5479-\mathrm{up} \end{array}$ |
|  | 306-273 | 27 k | 2 w |  |  |  |  |
| R161 | 305-682 | $6.8 k$ | 2 w |  |  | 5\% |  |
| R163 | 302-102 | 1 k | $1 / 2 \mathrm{w}$ |  |  |  |  |
| R164 | 302-101 | $100 \Omega$ | $1 / 2 w$ | Var. | Prec. | $\begin{aligned} & 5 \% \\ & 1 \% \\ & 5 \mu \mathrm{SEC} \end{aligned}$ |  |
| R165 | 305-153 | 15 k | 2 w |  |  |  |  |
| R167 | 309-017 | 1.5 meg | $1 / 2 \mathrm{w}$ |  |  |  |  |
| R168 | $311-039$ | 1 meg | 2 w |  |  |  |  |
| R170 | 302-101 | $100 \Omega$ | $1 / 2 \mathrm{w}$ |  |  |  |  |
| R172 | 302-562 | 5.6 k | $1 / 2 w$ |  |  |  | $\begin{array}{r} \text { 5001-5478 } \\ 5479-u p \end{array}$ |
| R174 | 302-101 | $100 \Omega$ | $1 / 2 w$ |  |  |  |  |
| R175 | 306-333 | 33 k | 2 w |  |  |  |  |
| R177 | 302-183 | 18 k | $1 / 2 \mathrm{w}$ |  |  |  |  |
| R178 | 302-221 | $220 \Omega$ | $1 / 2 w$ |  |  |  |  |
|  | 302-272 | 2.7 k | $1 / 2 w$ |  |  |  |  |
| R181 | 302-181 | $180 \Omega$ | $1 / 2 w$ |  |  |  |  |
| R201 | 305-822 | 8.2 k | 2 w |  |  | 5\% |  |
| R204 | 302-101 | $100 \Omega$ | $1 / 2 w$ |  |  |  |  |
| R205 | 305-183 | 18 k | 2 w |  |  | 5\% | 5001-5478 |
|  | 305-153 | 15 k | 2 w |  |  | 5\% | 5479-up |
| R207 | 309-017 | 1.5 meg 1 meg 5 meg $100 \Omega$ 8.2 k | $\begin{gathered} 1 / 2 w \\ 1 / 2 w \\ 2 w \\ 1 / 2 w \\ 1 / 2 w \end{gathered}$ | Var. | Prec. Prec. | $\begin{aligned} & 1 \% \\ & 1 \% \\ & 10 \mu \mathrm{SEC} \end{aligned}$ | $\begin{array}{r} 5001-5478 \\ 5479-u p \end{array}$ |
|  | 309-014 |  |  |  |  |  |  |
| R208 | 311-044 |  |  |  |  |  |  |
| $\begin{aligned} & \text { R210 } \\ & \text { R211 } \end{aligned}$ | 302-101 |  |  |  |  |  |  |
|  | 302-822 |  |  |  |  |  |  |
| R214 | 302-101 | $100 \Omega$ | $1 / 2 w$ |  |  |  |  |
| R215 | 306-333 | 33 k | 2 w |  |  |  |  |
| R217 | 302-183 | 18 k | $1 / 2 \mathrm{w}$ |  |  |  | 5001-54785479-up |
| R218 | 302-221 | $220 \Omega$ | $1 / 2 \mathrm{w}$ |  |  |  |  |
|  | 302-272 | 2.7 k | $1 / 2 \mathrm{w}$ |  |  |  |  |
| R221 | 303-123 | 12 k | 1 w |  |  | 5\% | 5001-5478 |
|  | 303-822 | 8.2 k | 1 w |  |  | 5\% | 5479-up |
| R222 | 303-153 | 15 k | 1 w |  |  | 5\% | 5479-up |
|  | 303-103 | 10 k | 1 w |  |  | 5\% |  |
| R224 | 302-101 | $100 \Omega$ | $1 / 2 \mathrm{w}$ |  |  |  |  |
| R225 | 305-273 | 27 k | 2 w | Var. | Prec. | $\begin{gathered} 5 \% \\ 5 \% \\ 1 \% \\ 50 \mu \mathrm{SEC} \end{gathered}$ | $\begin{array}{r} \text { 5001-5478 } \\ \text { 5479-up } \end{array}$ |
|  | 305-223 | 22 k | 2 w |  |  |  |  |
| R227 | 309-023 | 2 meg | 1/2w |  |  |  |  |
| R228 | 311-042 | 2 meg | 2 w |  |  |  |  |
| R230 | 302-101 | $100 \Omega$ | $1 / 2 w$ |  |  |  |  |
| R231 | 302-153 | 15 k | 1/2w |  |  |  |  |
| R234 | 302-101 | $100 \Omega$ | 1/2w |  |  |  |  |
| R235 | 306-333 | 33 k | 2 w |  |  |  |  |
| R237 | 302-183 | 18 k | $1 / 2 w$ |  |  |  |  |
| R238 | 302-221 | $220 \Omega$ | $1 / 2 \mathrm{w}$ |  |  |  | 5001-5478 |
|  | 302-272 | 2.7 k | $1 / 2 \mathrm{w}$ |  |  |  | 5479-up |

Resistors (continued)


Resistors (continued)

| Ckt. No. | Part No. |
| :--- | ---: |
| R304 | $302-101$ |
| R305 | $305-473$ |
| R307 | Use $309-093$ |
| R308 | $311-044$ |
| R310 | $302-101$ |
|  |  |
| R311 | $302-393$ |
| R314 | $302-101$ |
| R315 | $304-473$ |
| R317 | $302-223$ |
| R318 | $302-221$ |
|  | $302-272$ |

$100 \Omega$
47 k
4 meg
5 meg
$100 \Omega$

39 k
$100 \Omega$
47 k
22 k
$220 \Omega$
2.7 k

## R321

R322
R324

| R328 | $311-044$ |
| :--- | :--- |
| R330 | $302-101$ |
| R331 | $302-393$ |
| R334 | $302-101$ |
| R335 | $304-473$ |


| R337 | $302-223$ |
| :--- | :--- |
| R338 | $302-221$ |
|  | $302-272$ |
| R341 | $301-183$ |
| R342 | $301-223$ |

$22 k$
$220 \Omega$
$2.7 k$
$18 k$
$22 k$
$302-101$
$305-473$
$309-095$
$311-044$
$302-101$
$100 \Omega$
47 k
10 meg
5 meg
$100 \Omega$

| R351 | $302-393$ |
| :--- | :--- |
| R354 | $302-101$ |
| R355 | $304-473$ |
| R357 | $302-223$ |
| R358 | $302-221$ |
|  | $302-272$ |

$39 k$
$100 \Omega$
$47 k$
$22 k$
$220 \Omega$
$2.7 k$

R361
R362
R364

Resisiors (continued)


Resistors (continued)

Ckt. No.

| R507 | 302-182 | 1.8 k |
| :---: | :---: | :---: |
| R509 | 302-182 | 1.8 k |
| R511 | 302-182 | 1.8 k |
| R513 | 302-182 | 1.8 k |
| R515 | 302-182 | 1.8 k |
| R517 | 302-182 | 1.8 k |
| R519 | 302-182 | 1.8 k |
| R521 | 302-182 | 1.8 k |
| R523 | 302-182 | 1.8 k |
| R525 | 302-182 | 1.8 k |
| R527 | 302-182 | 1.8 k |
| R529 | 302-182 | 1.8 k |
| R530 | 302-101 | $100 \Omega$ |
| R531 | 302-101 | $100 \Omega$ |
| R532 | 302-101 | $100 \Omega$ |
| R550 | 302-224 | 220 k |
| R551 | 302-101 | $100 \Omega$ |
| R553 | 302-471 | $470 \Omega$ |
| R560 | 301-332 | 3.3 k |
| R561 | 302-683 | 68 k |
|  | 302-154 | 150 k |
| R565 | 302-104 | 100 k |
| R567 | 302-101 | $100 \Omega$ |
| R569 | 302-221 | $220 \Omega$ |
| R701 | 302-100 | $10 \Omega$ |
| R703 | 306-154 | 150 k |
| R704 | 302-273 | 27 k |
| R707 | 302-104 | 100 k |
| R708 | 302-185 | 1.8 meg |
| R712 | 309-011 | 780 k |
|  | Use 310-124 | 237 k |


| R713 | $309-053$ | $333 k$ |
| :--- | ---: | :--- |
|  | Use $323-385$ | $100 k$ |
| R720 | Use $304-100$ | $10 \Omega$ |
| R721 | $302-274$ | $270 k$ |
| R722 | $302-563$ | $56 k$ |


| R724 | $302-155$ | 1.5 meg |
| :--- | :--- | :--- |
| R726 | $302-185$ | 1.8 meg |
| R735 | $302-225$ | 2.2 meg |
| R736 | $309-052$ | 220 k |
| R737 | $309-092$ | 143 k |
|  |  |  |
| R738 | $308-017$ | 2 k |
|  | $308-018$ | 2.5 k |
| R741 | $302-100$ | $10 \Omega$ |
| R742 | $309-042$ | 68 k |
| R743 | $311-015$ | 10 k |

Tektronix Part No.

$$
\begin{aligned}
& 302-182 \\
& 302-182 \\
& 302-182 \\
& 302-182 \\
& 302-182
\end{aligned}
$$

$$
1.8 \text { k }
$$

$$
1.8 k
$$

$$
\begin{aligned}
& 1.8 \mathrm{k} \\
& 1.8 \mathrm{k}
\end{aligned}
$$

$$
1.8 \mathrm{k}
$$

$$
1.8 \mathrm{k}
$$

$$
\begin{aligned}
& 1.8 \mathrm{k} \\
& 1.8 \mathrm{k}
\end{aligned}
$$

$$
1.8 \mathrm{k}
$$

$$
3 k
$$

$$
\begin{aligned}
& .0 \mathrm{k} \\
& 1.8 \mathrm{k} \\
& 100 \Omega \\
& 100 \Omega \\
& 100 \Omega
\end{aligned}
$$

$$
220 \mathrm{k}
$$

$$
770 \Omega
$$

$$
3.3 \text { k }
$$

$$
68 \mathrm{k}
$$

$$
\begin{aligned}
& 100 \mathrm{k} \\
& 100 \Omega \\
& 220 \Omega \\
& 10 \Omega \\
& 150 \mathrm{k}
\end{aligned}
$$

$$
\begin{aligned}
& 27 \mathrm{k} \\
& 100 \mathrm{k} \\
& 1.8 \mathrm{mec} \\
& 780 \mathrm{k} \\
& 237 \mathrm{k}
\end{aligned}
$$

$$
\begin{aligned}
& 302-274 \\
& 302-563
\end{aligned}
$$

$$
\begin{aligned}
& 100 \mathrm{k} \\
& 10 \Omega \\
& 270 \mathrm{k} \\
& 56 \mathrm{k}
\end{aligned}
$$ 10 k

Description
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 \mathrm{w}$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
/2w
$1 / 2 \mathrm{w}$
$1 / 2 \mathrm{w}$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$

$$
1 / 2 w
$$

$1 / 2 w$ $1 / 2 w$
$1 / 2 w$ 2 w

$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 w$

$$
1 / 2 w
$$

$1 / 2 w$
$1 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$
$1 / 2 w$

10 w
10 w $1 / 2 \mathrm{w}$ $1 / 2 w$
$2 w$

Resistors (continued)

| Ckt. No. | Tektronix Part No. |  | Description |  |  | S/N Range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R744 | 309-090 | 50 k | 1/2w | Prec. | $1 \%$ |  |
| R746 | 302-105 | 1 meg | $1 / 2 \mathrm{w}$ |  |  |  |
| R750 | 302-183 | 18 k | $1 / 2 \mathrm{w}$ |  |  |  |
| R754 | 302-155 | 1.5 meg | $1 / 2 w$ |  |  |  |
| R758 | 302-102 | 1 k | $1 / 2 \mathrm{w}$ |  |  |  |
| R762 | 302-333 | 33 k | 1/2w |  |  |  |
| R770 | 302-393 | 39 k | $1 / 2 w$ |  |  | 5001-5479x |
| R772 | 302-274 | 270 k | $1 / 2 \mathrm{w}$ |  |  | 5001-5479X |
| R774 | 301-682 | 6.8 k | $1 / 2 \mathrm{w}$ |  | 5\% |  |
| R776 | 301-124 | 120 k | $1 / 2 \mathrm{w}$ |  | 5\% |  |
| R780 | 301-393 | 39 k | 1/2w |  | 5\% | X5479-up |
| R781 | 301-204 | 200 k | $1 / 2 w$ |  | 5\% | X5479-up |
| R782 | 302-101 | $100 \Omega$ | $1 / 2 w$ |  |  | X5479-up |
| R784 | 306-153 | 15 k | 2 w |  |  | X5479-up |

SW510
SW520
SW550
SW701
TK701

T701
T702
*050-004
*120-119
*120-052
L.V. Power
L.V. Power
Crystal Oven Power

Electron Tubes

V100
V104
V124
V134
V144

V162
V165
V173
V202
V205

V213
V222
V225
V233
V242

Unwired
260-191 260-192 260-193
260-134
260-120

Pushbutton, HIGH FREQUENCY
Pushbutton, LOW FREQUENCY
Pushbutton, TRIGGER SELECTOR
Toggle, POWER ON
Thermal Cut-Out $137^{\circ} \mathrm{F}$

## Transformers

$\begin{array}{ll}154-078 & \text { 6AN8 } \\ 154-078 & \text { 6AN8 }\end{array}$
$\begin{array}{ll}154-078 & \text { 6AN8 } \\ 154-367 & \text { 6DK6/8136 }\end{array}$
154-367 6DK6/8136
154-367 6DK6/8136

154-016 6AL5
154-147 5965
154-041 12AU7
154-016 6AL5
154-147 5965

154-041
12AU7
154-016 6AL5
154-147 5965
154-041 12AU7
154-016 6AL5

Electron Tubes (continued)

| Ckt. No. | Tektronix Part No. |  | Description | S/N Range |
| :---: | :---: | :---: | :---: | :---: |
| V245 | 154-147 | 5965 |  |  |
| V253 | 154-041 | $12 \mathrm{AU7}$ |  |  |
| V262 | 154-016 | 6AL5 |  |  |
| V265 | 154-147 | 5965 |  |  |
| V273 | 154-041 | $12 \mathrm{AU7}$ |  |  |
| V282 | 154-016 | 6AL5 |  |  |
| V285 | 154-147 | 5965 |  |  |
| V293 | 154-041 | $12 \mathrm{AU7}$ |  |  |
| V302 | 154-016 | 6AL5 |  |  |
| V305 | 154-147 | 5965 |  |  |
| V313 | 154-041 | $12 \mathrm{AU7}$ |  |  |
| V322 | 154-016 | 6AL5 |  |  |
| V325 | 154-147 | 5965 |  |  |
| V333 | 154-041 | $12 \mathrm{AU7}$ |  |  |
| V342 | 154-016 | 6AL5 |  |  |
| V345 | 154-147 | 5965 |  |  |
| V353 | 154-041 | $12 \mathrm{AU7}$ |  |  |
| V362 | 154-016 | 6AL5 |  |  |
| V365 | 154-147 | 5965 |  |  |
| V373 | 154-041 | 12AU7 |  |  |
| V382 | 154-016 | 6AL5 |  |  |
| V385 | 154-147 | 5965 |  |  |
| V393 | 154-041 | 12AU7 |  |  |
| V402 | 154-016 | 6AL5 |  |  |
| V405 | 154-147 | 5965 |  |  |
| V413 | 154-041 | 12AU7 |  |  |
| V422 | 154-016 | 6AL5 |  |  |
| V425 | 154-147 | 5965 |  |  |
| V433 | 154-041 | 12AU7 |  |  |
| V553 | 154.147 | 5965 |  |  |
| V704 | 154-022 | 6AU6 |  |  |
| V707 | 154-056 | 6080 |  |  |
| V724 | 154-022 | 6AU6 |  |  |
| V744 | 154-078 | 6AN8 |  |  |
| V749 | 154-052 | 5651 |  |  |
| V757 | 154-044 | 12B4 |  |  |
| V76̣ | 154-044 | 12B4 |  |  |

## MISCELLANEOUS CALIBRATION INFORMATION

## CALIBRATING THE CRYSTAL FREQUENCY

FQD 11-57

Use an antenna and a trap tuned to a local AM broadcast station. Plug the signal from the trap into a scope and trigger the scope with the 10 kc trigger from the Type 180-S1. Adjust the trimmer across the crystal until the drift of the pattern on the oscilloscope is about the same in each direction as the crystal oven warms and cools.

This method works because all broadcast stations work on frequencies that are multiples of 10 kc , and are required to maintain a frequency tolerance of $\pm 20$ cycles.

## MAINTENANCE

## Replacement of Components

Tektronix will supply replacement components at current net prices. However, since most of the components are standard electronic and radio parts we suggest you get them from your local dealer if you can. Be sure to consult your instruction manual first to see what tolerances are required.

We specially select some of the components, whose values must fall within prescribed limits, by sorting through our regular stocks. The components so selected will have standard RETMA color-code marks showing the values and tolerances of the stock they were selected from, but they will not, in general, be replaceable from dealers stocks.

Such selected parts, as well as the parts we manufacture at Tektronix, are identified in the parts lists either by notes or by our own stock numbers. Order these parts from the Tektronix factory in Portland, Oregon.

## Soldering Precaution

The solder used on our ceramic terminals in this instrument must contain a small percentage of silver. If for any reason you resolder, be sure the solder you use contains silver. Silverbearing solder is used in printed-circuit techniques, and is therefore available from all solder manufacturers. Repeated use of ordinary tin-lead solder will dissolve the fused bond of silver that makes the solder adhere to the porcelain, especially if the soldering iron is quite hot.

## Color Coding

We use color-coded wires in this instrument to help you identify the various circuits. The ac power leads are yellow and coded 1-1-0
(brown-brown-brown) following the RETMA resistor color code. The +140 bus is white and coded 1-4-0 (brown-yellow-brown, beginning with the widest stripe). The -135 -volt bus is black and coded $1-4-0$. The heater leads are coded 6-1, 6-2, etc., not to indicate that the voltages are different but to differentiate between the leads. All signal leads have a single stripe. A few wire colors are indicated by small, lower-case letters on the diagrams.

## Fan Motor

The fan-motor bearings will require oiling every few months or every thousand hours of operation. Use a good grade of light machine oil, and apply only a drop or two.

## Adjustment Procedure

Allow ten to twenty minutes for the Type 180 Time-Mark Generator to warm up before making any adjustments. The following procedure is based on that used at the factory. Adjustments should be made in the order shown.

## Power Supply Adjustment

Check the power supply voltages before making any adjustments. These voltages can be checked on the four-terminal ceramic strip at the bottom of the left-hand chassis near the front. Use a voltmeter accurate to at least $3 \%$.

Measure the -135 -volt supply and adjust to 135 volts with the control labeled -135 V ADJ. on the left side of the bottom chassis. The +140 -volt supply and +225 -volt supply should now read within about $5 \%$ of their rated voltage.

## 2. High-Frequency-Divider Bias Adjustments

The bias on the first four dividers is adjustable to provide maximum stability.
a. Remove V301 at the top of the right hand chassis near the front to remove the rf drive.
b. Check the free run point of the 5 -microsecond multivibrator. To do this measure the voltage at pin 2 of V302 with a vacuumtube voltmeter. Starting at about -10 volts, reduce the voltage toward zero with the control labeled 5 MICROSEC. At some point between -7 and about -5 volts the voltage will jump to a less negative value ( -3 volts to -1 volt). This is a free running point, and if it occurs at a bias of more than -7 volts, V302 should be changed. Set the bias to -9 volts.
c. Check the free-run point of the 10 -microsecond multivibrator. Measure the voltage at the grid, pin 2, of V306. The voltage change will be less noticeable than in the previous stage as the multivibrator free runs. If in doubt, watch with an oscilloscope for the occurrence of markers at the 10microsecond pin connector. If free running occurs with more than -8 volts bias on the grid, V306 should be changed. Set the bias to -10 volts.
d. Check the free-run point of the 50 -microsecond multivibrator. Measure the voltage at the grid, pin 2, of V309. If free running occurs with more than -8 volts bias on the grid, V309 should be changed. Set the bias to -10 volts.
e. Check the free-run point of the 100 -microsecond multivibrator. Measure the voltage at pin 2 of V312. If free running occurs with more than -20 volts bias on the grid, V312 should be changed. Set the bias to - 22 volts.
f. Measure the voltage on the plates, pin 6 of V302, V306, and V309. If the voltage exceeds +115 volts replace the tube with one which gives a reading of less than +115 volts. If a tube is replaced, reset the bias for that stage.
g. Observe the 1-megacycle waveform at pin 5, of V301 with an oscilloscope. Adjust L207 for maximum amplitude at this point.
h. Install V301, removed in step "a".

## 3. High-Frequency-Divider Capacitance Adj.

The high-frequency dividers have variable capacitors in the timing circuits to adjust the switching frequency.
a. Connect an oscilloscope to the SIGNAL OUT connector.
b. Trigger the oscilloscope from the TRIGGER OUTPUT connector using external triggering. Set the TRIGGER RATE SELECTOR to 10 KC .
c. Turn the 1-and 5-microsecond switches on.
d. Set the oscilloscope sweep speed to 5 microseconds/cm and adjust C304 so that every fifth marker is at maximum amplitude.
e. Reduce the oscilloscope sweep speed to 50 microseconds/cm and adjust C304 slightly so the 5 microsecond markers all have very nearly the same amplitude.

## 10 Microsecond

a. Turn the 10 -microsecond switch on and the 1-microsecond switch off.
b. Adjust C320 so that the amplitude of every second marker is increased. Leave C320 at the point where the shorter marker is pulled down slightly.

## 50 Microsecond

a. Turn the 50 -microsecond switch on and the 5 -microsecond switch off.
b. Adjust C327 so the amplitude of every fifth marker is increased.
c. Reduce the oscilloscope sweep speed to 500 microseconds/cm and readjust C327 slightly so that all 50 -microsecond markers have equal amplitude.

## 100 Microsecond

a. Turn the 100 -microsecond switch on and the 10 -microsecond switch off.
b. Turn the TRIGGER RATE SELECTOR to 1 KC .
c. Adjust C337 so that the amplitude of every other marker is increased and these $100-$ microsecond markers have equal amplitudes.
4. Intermediate- and Low-Frequency-Divider Adjustments.

The remaining dividers are adjusted by varying the resistance in the resistance-capacitance time-determining circuit. The controls should be set at the middle of the range over which the frequency is correct.

## 500 Microsecond

a. Turn the 500 -microsecond switch on and the 50 -microsecond switch off.
b. Adjust the control labeled 500 MICROSEC on the left-hand chassis near the rear for increased amplitude in every fifth marker.

1 Millisecond
a. Turn the 1-millisecond switch on and the 100 -microsecond switch off.
b. Adjust the 1 MILLISEC control so that alternate markers are reinforced.

## 5 Millisecond

a. Turn the 5 -millisecond switch on and the 500-microsecond switch off.
b. Turn the TRIGGER RATE SELECTOR to 100 cycles and set the sweep speed to 5 milliseconds/cm.
c. Adjust the 5 MILLISEC control so that every fifth marker is reinforced.

10 Millisecond
a. Turn the 10 -millisecond switch on and the 1 -millisecond switch ott.
b. Adjust the 10 MILLISEC control so that alternate markers are reinforced.

## 50 Millisecond

a. Turn the 50 -millisecond switch on and the 5 -millisecond switch off.
b. Turn the TRIGGER RATE SELECTOR to 10 CYCLES and set the oscilloscope sweep speed to 50 milliseconds/cm.
c. Adjust the 50 MILLISEC control so that every fifth marker is reinforced.

## 100 Millisecond

a. Turn the 100 -millisecond switch on and the 10 -millisecond switch off.
b. Adjust the 100 MILLISECOND control so that alternate markers are reinforced.

500 Millisecond
a. Turn the 500 -millisecond switch on and the 50 -millisecond switch off.
b. Turn the TRIGGER RATE SELECTOR to 1 CYCLE and set the oscilloscope sweep speed to 500 milliseconds/cm.
c. Adjust the 500 MILLISEC control so that every fifth marker is reinforced.

## 1 Second

a. Turn the 1 -second switch on and the 100millisecond switch off.
b. Adjust the 1 SEC control so that every other marker is reinforced.


## CALIBRATION

## PROCEDURE

## General

Normally, it will not be necessary to make all of the adjustments in this procedure at any one time. However, any adjustment which you do make should be made in the indicated sequence.

## EQUIPMENT REQUIRED

The following equipment or its equivalent is recommended for a full recalibration of the Type 180A.

1. Tektronix Type 540 Series Oscilloscope, Tektronix Type L Plug-In Preamplifier, or Tektronix Type K Plug-In Preamplifier, and Type B Preamplifier.

If a Type 540 Series is not available, an oscilloscope having the following characteristics may be substituted: Calibrated vertical-deflection factors from .005 volts per centimeter to .2 volts per centimeter; Calibrated sweep rates from .02 microseconds per centimeter to 5 seconds per centimeter; Bandpass of 30 megacycles.

## 2. Tektronix Type P410 or P6000 Probe.

The Type P410 or P6000 probe has an attenuation ratio of 10:1, an input resistance of 10 megohms, and an input capacitance of approximately $11 \mu \mu \mathrm{f}$ when connected to a Type B Plug-In Unit.
3. Accurate rms-reading ac voltmeter, $0-150$ volts, calibrated for an accuracy of $\pm 1 \%$ at 117 volts.
4. Dc voltmeter of at least 20,000 ohms per volt, calibrated for an accuracy of $\pm 1 \%$ at 150 volts and 300 volts.
5. An autotransformer (Powerstat, Variac, etc.) capable of varying the line voltage to the instrument being calibrated from 105 to 125 volts.
6. A 50 -ohm Terminating Resistor and a Type P93 93 -ohm cable.
7. Any good stable communications receiver having a C.W. oscillator.

## RECALIBRATION PROCEDURE

## 1. Power Supply Voltage Adjusłment

There are three regulated power supplies in the Type 180A, and two bias supplies. The output voltage of the

- 150 volt supply is adjustable and is used as a reference voltage for the +225 -volt supply and the +350 -volt supply.

The -8 volt bias is taken from the -150 volt supply through a voltage divider. The -17 volt bias is taken from the cathode of V433.

To adjust the output voltages of the supplies, remove the side panels from the cabinet and connect the instrument to the output of the autotransformer. Adjust the autotransformer for an output voltage of 117 volts. Turn the POWER switch of the Type 180A to ON.

To adjust the -150 -volt supply connect the meter between ground and the -150 -volt supply. Connections to the -150 -volt supply should be made as shown in Figs. $5-1$ or 5-3. Adjust the -150 ADJ. for an output voltage of exactly -150 volts.

Check the output of the +225 -volt supply by connecting the meter between ground and +225 as shown in Fig. 5-1 or 5-3. The output voltage of this supply should be within $2 \%$ of 225 volts.

Check the output voltage of the +350 -volt supply by connecting the meter between ground and +350 -volts as shown in Fig. 5-1. or 5-3. The output voltage of this supply should be within $3 \%$ of 350 volts.

To check the output of the -17 volt supply, connect the voltmeter between ground and the -17 volt point as shown in Fig. 5-1 or 5-3. The voltage should be -17 volts $\pm 2$ volts.

Measure between the junction of R774 and R776 and ground to check the -8 volt supply. The voltage should be -8 volts $\pm 1$ volt.

## 2. Power Supply Ripple

The power supply regulating circuits of the Type 180A are capable of holding the ripple present on the output voltage to a very low level. Measurement of the ripple on the supplies provides a convenient check upon the operation of the regulating circuits.

Set the front-panel controls of the test osilloscope and plug-in as shown below:

Type 540 Series Oscilloscope

| STABILITY | PRESET |
| :--- | ---: |
| TRIGGERING MODE | AUTOMATIC |
| TRIGGER SLOPE | + LINE |
| TIME/CM | 5 MILLISEC |
| $5 X$ MAGNIFIER | OFF |



Fig. 5-1 Left side view showing voltage reading points and calibration adjustments. This covers S/N 5001 to 5478.

## HORIZONTAL DISPLAY

INTERNAL
SWEEP

## HORIZONTAL POSITION

POWER
SQUARE-WAVE CALIBRATOR (black knob)

Type B:

| INPUT SELECTOR | INPUT A, AC |
| :--- | ---: |
| VOLTS/CM | .005 |
| VARIABLE | CALIBRATED |
| VERTICAL POSITION | centered |

To measure the ripple on the -150 -volt supply, connect the test oscilloscope input between ground and the - 150 volt bus at the point indicated in Fig. 5-1. The Tektronix Type A-100 Clip-Lead Adapter (part number 013-003) or a XI probe is convenient for this purpose. Vary the line voltage from 105 to 125 volts while viewing the ripple on the test oscilloscope. The ripple should not exceed 10 millivolts at any time.

To measure the ripple on the +225 -volt supply, connect the test lead between ground and +225 . The ripple present on the output voltage should not exceed 80 millivolts.

To measure the ripple on the +350 -volt supply, connect the test lead between ground and +350 . The ripple present on the output voltage should not exceed 100 millivolts.

```
centered
            ON
any
    position
```

INPUT A, AC .005
ALIBRATED centered


TYPE 180A

## TEXT CORRECTION

The following should replace the indicated sections of the CALIBRATION PROCEDURE.
3. Dividing Rate Adjustments:

Page 5-3, third paragraph, right hand column, last line.
Amplitude of all trigger pulses should be 6 volts ( 2 volts for instruments, SN 5001-5478).
4. Sine Wave Output Adjustment:

Page 5-4, last paragraph, first line.
The Type 180A provides triggering pulses of 6 volts amplitude ( 2 volts for instruments, SN 5001-5478).


Fig. 5-2 Left side view showing voltage reading points and calibration adjustments. This covers S/N 5479 to 6386.

```
TRIGGERING MODE
TRIGGER SLOPE
TIME/CM
5X MAGNIFIER
HORIZONTAL POSITION
HORIZONTAL DISPLAY
```


## POWER

Type L:
INPUT SELECTOR
VOLTS/CM
VARIABLE
VERTICAL POSITION

AC SLOW
+EXT
1 MICROSEC
OFF
centered
INTERNAL SWEEP

ON

INPUT A, AC

CALIBRATED
centered

Connect the Type 6000 or P410 Probe to the INPUT connector of the Type L or K and to the MARKER OUT connector on the Type 180A.

Turn the TRIGGERING LEVEL control of the oscilloscope slowly to the left until the trace reappears. This should result in a stable display. Slight readjustment of the controls may be necessary from time to time, particularly after shifting to a display of different amplitude.

Depress the $1 \mu \mathrm{sec}$ and $5 \mu \mathrm{sec}$ buttons and adjust the $5 \mu \mathrm{sec}$ pot until the count shows as indicated in Table 5-1 for $5 \mu \mathrm{sec}$.

As soon as the one and five $\mu$ sec markers are adjusted for timing, release both buttons by pressing the red button.

Now depress first the one then the red button, and then the five $\mu \mathrm{sec}$ buttons, noting the amplitude of the pulses in each case. Now adjust C116 while the $1 \mu \mathrm{sec}$ button is depressed so the amplitude is the same as the five $\mu \mathrm{sec}$ markers. When both the one and five $\mu$ sec markers are displayed at the same time, the one $\mu \mathrm{sec}$ markers will be about $60 \%$ as tall as the five $\mu \mathrm{sec}$ markers.

Table 5-1 indicates the necessary front-panel control settings for the test oscilloscope and the Type 180A. It also indicates the appropriate screwdriver adjustment for each setting of the front-panel push button on the Type 180A. To adjust the Type 180A divider circuits, set the front-panel controls as indicated in the table. Then, adjust the corresponding screwdriver adjustment (see Fig. 5-3) for a display similar to the one shown in the right-hand column.

Output amplitude on all ranges should be 4 volts or more. The trigger pulses are supplied from the TRIGGER OUT connector at the bottom of the front panel, and selected by means of the lowest row of push buttons. The amplitude of the trigger pulses may be checked after the dividing rate and amplitude of the multivibrators have been checked. Amplitude of all trigger pulses should be 6 volts or more.

The open circuit voltage at the pin-jacks under each push button will be about 20 to 25 volts.

## 4. Sine Wave Output Adjustment

The Type 180A provides three sine-wave frequencies: $5 \mathrm{mc}, 10 \mathrm{mc}$, and 50 mc . These are connected to the MARKER OUT connector on the front panel of the Type


Fig. 5-3 Left side view showing voltage reading points and calibration adjustments. This covers S/N 6386 up.

180A by means of push button switches. Double-tuned transformers in the plates of the multiplier tubes provide the adjustments for the frequency and output amplitude of the sine-waves.

Make the following front-panel control settings of the Type 540 Series Scope and the Type K or L Unit:

## OSCILLOSCOPE:

## STABILITY <br> triggering level

TRIGGERING MODE
TRIGGER SLOPE
TIME/CM
5X MAGNIFIER
HORIZONTAL DISPLAY
HORIZONTAL POSITION
POWER
SQUARE-WAVE CALIBRATOR
Type K or L:
VOLTS/CM
VARIABLE
AC-DC
VERTICAL POSITION
. 1
CALIBRATED
PRESET
full right or full left
AC FAST

+ EXT
1 MICROSEC
ON
INTERNAL SWEEP
centered
ON OFF
$A C$
centered

Connect the TRIGGER OUT conector of the Type 180A to the TRIGGER INPUT connector of the oscilloscope with a Type P93 cable. Connect the Probe to the INPUT connector of the Type K or L. Connect a $50 \Omega$ Terminating Resistor to the MARKER OUT connector of the Type 180A. Insert the tip of the Probe into the Terminating Resistor. Attach the probe ground connection to the body of the terminating resistor.

Display a five-megacycle sine wave.
Obtain a stable display on the test oscilloscope. Adjust C 123 and C 129 (see Fig. $5-3$ ) for a five-megacycle display (one cycle per centimeter) of maximum amplitude (two volts or more).

> Display a ten-megacycle sine wave.

Switch the TIME/CM switch of the test oscilloscope to the 1 MICROSEC range and turn the 5 X MAGNIFIER to OFF. Adjust C133 and C139 for a ten-megacycle (one cycle per centimeter) display of maximum amplitude.

Switch the 5X MAGNIFIER to ON and display a fiftymegacycle sine wave from the Type 180A. Adjust C143 and Cl 47 for a fifty-megacycle display (one cycle per centimeter) of maximum amplitude. At fifty megacycles, the display will be about 1.2 centimeters in amplitude.

## 5. Trigger Pulling Adjustment

The Type 180A provides triggering pulses of two volts amplitude. The pulses should be adjusted so that they

TABLE 5-1
TIME-MARKER DIVIDER ADJUSTMENTS

| $\begin{aligned} & \hline \text { OSCILLOSCOPE } \\ & \text { TIME/CM } \\ & \hline \end{aligned}$ | TRIGGER | MARKERS | TYPE 180A ADJUSTMENT | DISPLAYED WAVEFORM |
| :---: | :---: | :---: | :---: | :---: |
| $1 \mu \mathrm{SEC}$ | 100 KC | 1 and $5 \mu \mathrm{SEC}$ | $5 \mu \mathrm{~S}$ | $\omega u$ |
| $2 \mu \mathrm{SEC}$ | 100 KC | 5 and $10 \mu \mathrm{SEC}$ | $10 \mu \mathrm{~S}$ |  |
| $10 \mu \mathrm{SEC}$ | 10 KC | 10 and $50 \mu \mathrm{SEC}$ | $50 \mu \mathrm{~S}$ |  |
| $20 \mu \mathrm{SEC}$ | 10 KC | 50 and $100 \mu$ SEC | $100 \mu \mathrm{~S}$ |  |
| $100 \mu$ SEC | 1 KC | 100 and $500 \mu \mathrm{SEC}$ | $500 \mu \mathrm{~S}$ |  |
| $200 \mu$ SEC | 1 KC | $500 \mu$ SEC and 1 MS | 1 MS |  |
| 1 MS | 100 cycles | 1 and 5 MS | 5 MS |  |
| 2 MS | 100 cycles | 5 and 10 MS | 10 MS |  |
| 10 MS | 10 cycles | 10 and 50 MS | 50 MS |  |
| 20 MS | 10 cycles | 50 and 100 MS | 100 MS |  |
| 100 MS | 1 cycle | 100 and 500 MS | 500 MS |  |
| 200 MS | 1 cycle | 500 MS 1 SEC | 1 SEC |  |
| 1 SEC | * | 1 and 5 SEC | 5 SEC |  |

* Trigger oscilloscope internally from the displayed waveform.
will not cause pulling of the waveform being observed when the Type 180A is used to provide a source of external triggers.
To adjust the trigger pulses for minimum pulling set the front-panel controls as described in Step 4 to obtain 50 megacycle output. In addition to being marked with the appropriate frequency, each trigger push button is marked with its value in time. For example, the 100 KC trigger button is also marked $10 \mu \mathrm{~S}$. Trigger the test oscilloscope from each trigger rate in turn, adjusting the appropriate stage should any sign of trigger pulling be evident. In the case of the 100 KC trigger rate it may not be possible to obtain a single trace. It should, however, be possible to
reduce the display to a double trace. Very slight adjustment of the $5 \mu \mathrm{~S}$ pot will often help minimize trigger pull on the $10 \mu \mathrm{~S}$ range.


## 6. Adjustment of the Crystal Oscillator

Accuracy of the time markers in the Type 180A depends upon the precise adjustment of the frequency of the 1 MC crystal oscillator. Variable capacitor, C105 permits exact setting of the frequency of the crystal oscillator.

Precise adjustment of the crystal frequency can be accomplished by beating or 'heterodyning' the crystal oscillator


Fig. 5-4 Right side view showing calibration adjustments, S/N 5001 up.


Fig. 5-5 Suggested instrument setup for adjusting crystal oscillator frequency, all serial numbers.
signal against a standard frequency signal as transmiitted by WWV, the National Bureau of Standards. This station transmits continuously on frequencies of $5,10,15$, and 20 MC. Use of a dependable communication receiver and an oscilloscope permits extreme accuracy of adjustment as both audio and visual checks are available. A suitable procedure for calibrating the crystal oscillator is as follows:

Connect the equipment as shown in Fig. 5-5. You will note that there is no direct electrical connection between the Type 180A and either the receiver or the oscilloscope. Before starting to calibrate the crystal oscillator, be sure the Type 180A has been turned on continuously for at least an hour so all the components as well as the crystal can stabilize.

Tuning of the crystal oscillator will be accomplished by beating a harmonic of the crystal oscillator against the frequency of WWV. Now tune the receiver to 5, 10, 15, or 20 MC , whichever is strongest. It is best to use the higher frequencies if possible, as greater accuracy can be attained. The signal of WWV can be recognized first by the clicks which occur once each second. For a portion of each minute, a 440 cycle tone is also heard. During the time the tone is being heard is a good time to adjust the vertical sensitivity of the oscilloscope to about 4 CM of deflection. Now turn on the CW or Beat Note Oscillator in the receiver. Tune the receiver carefully so only the 440 cycle tone can be heard. Turn off the CW oscillator. Now install a 50 ohm terminating resistor on the MARKER OUT terminal of the Type 180A and insert a short (12 or 15 inch) piece of wire in the center of the terminator. Press the Red button to release any buttons on the 180A
which might have been depressed. Now press the $1 \mu \mathrm{sec}$ button. The short wire will act as a radiator for the 1 MC signal and will be picked up by the receiver. If the signal is too strong from the 180A, it may block out the signal from WWV. If this occurs, shorten the radiating wire until WWV can again be heard. If the frequency of the crystal oscillator is several cycles off you may hear a tone in the receiver, even when the tone from WWV stops.

Set the sweep rate of the oscilloscope for 2 Milliseconds/ CM. Now wait for WWV to stop the tone transmission. Using an insulated aligning screwdriver, turn C105 through its range and you will note that one point will be found where the tone decreases in pitch and then rises as a center point is reached and passed. The deflection on the oscilloscope will also drop to a straight line as this center point is reached. Adjust Cl 05 to this center point. If you have the receiver tuned to 10 MC or higher, the crystal is sure to be within $\pm 10$ cycles of 1 MC . For example, if you have the receiver tuned to 15 MC , you will be comparing the 15 th harmonic of the crystal oscillator to the frequency of WWV and a 1 cycle error in the crystal oscillator will show up as a 15 cycle error on the oscilloscope.

After the crystal frequency has been adjusted, do not disturb any of the components in the oscillator circuit. If V100 or any other component in the oscillator is changed, the frequency of the crystal oscillator should be checked. This adjustment of Cl 05 will not effect the other markers as they are timed by this basic frequency and will follow small changes.

NOTES







$$
\begin{aligned}
& \text { 50-M.S TO }
\end{aligned}
$$











+ TYPE 180A TIME-MARK GENERATOR






[^0]:    Part Number
    210-802

