# FACTORY CALIBRATION PROCEDURE

CONTENTS:



E

INTRODUCTION:

This isn't a field recalibration procedure as is the procedure in your instruction manual. This is a guide in calibrating brand-new instruments, just assembled instruments that have never been turned on before. Therefore it calls out many procedures and adjustments that are rarely required for subsequent recalibration.

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supersedes
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For all serial numbers.

Even though we wrote this procedure primarily for our own factory test department, it's valuable to others also if used with some caution:

1. **Special test equipment,** if mentioned, is not available from Tektronix unless it's listed also in our current catalog. This special equipment is used in our test department to speed calibration. Usually you can either duplicate its function with standard equipment in your facility, devise alternate approaches, or build the special test equipment yourself.

2. **Factory circuit specifications** are not guaranteed unless they also appear as catalog or instruction manual specifications. Factory circuit specs usually are tighter than advertised specs. This helps insure the instrument will meet or exceed advertised specs after shipment and during subsequent field recalibrations over several years of use. Your instrument may not meet factory circuit specs but should meet catalog or instruction manual specs.

3. **Presetting internal adjustments,** if mentioned, usually is unnecessary. This is helpful for "first-time" calibration only. If internal adjustments are preset, you'll have to perform a 100% recalibration. So don't preset them unless you're certain a "start-from-scratch" policy is the best.

4. Quality control men steps Factory calibration procedures are for our test department calibrators who first calibrate the instrument. Quality control men then check the initial calibration and perform additional fine points such as trimming resistor leads, installing shields, etc. In some cases a factory calibration procedure instructs the calibrator not to perform these fine points. You'll ordinarily have to include these fine points in your calibration.

In this procedure, all front panel controls for the instrument under test are in capital letters (SENSITIVITY) and internal adjustments are capitalized only (Gain Adj).

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The numbers listed beside the specifications are the factory calibration procedure steps where the check or adjustment is made.

OUTPUT DC LEVEL:

7a. 65 to 70 v.

VERTICAL POSITION RANGE:

8a. Within ±90° of mr after adjustment.

"VARIABLE" BALANCE:

9a. Within ±90° of mr after adjustment.

MICROPHONICS:

10a. No ringing type, .5 cm max ordinary type due to rotation of front panel controls.

DIFFERENTIAL BALANCE:

13c. Rejection ratio at 10 kc: 50,000 to 1 min.

13d. Rejection ratio at 1 kc: 50,000 to 1 min.

GAIN:

14b. With GAIN ADJUST max: 4.4 cm min deflection.

15a. MILLIVOLTS/CM accuracy: ±2%.

FREQUENCY RESPONSE:

| MILLIVOLTS/CM | APPROXIMATE FREQUENCY RESPONSE | | frequency at -3 db point |
|---|---|---|---|
| 16b. | HIGH | LOW | |
| .05 | 20-60 KC | .06 CPS | 20 kc min |
| .1 | 20-60 KC | .06 CPS | 40 kc min |
| .2 | 20-60 KC | .06 CPS | 50 kc min |
| .5 to 10 | 20-60 KC | .06 CPS | 60 kc min |
| 16c. | | | |
| 10 | 10 KC | .06 CPS | 10 kc ±30% |
| 10 | 1 KC | .06 CPS | 1 kc ±30% |
| 10 | 250 CPS | .06 CPS | 250 cps ±30% |
| 10 | 50 CPS | .06 CPS | 50 cps ±30% |
| 10 | 20-60 KC | 80 CPS | 80 cps ±20% |
| 10 | 20-60 KC | 8 CPS | 8 cps ±30% |
| 10 | 20-60 KC | .8 CPS | .8 cps ±30% |
| 10 | 20-60 KC | .2 CPS | .2 cps ±30% |
| 10 | 20-20 KC | .06 CPS | .06 cps max |

NOISE AND HUM:

17b. 4 mm max.

CALIBRATION

NOTES

## 1. EQUIPMENT REQUIRED:

a. 1 Tektronix type 530 series or 540 series oscilloscope as plug-in scope
1 Tektronix type 530 series or 540 series oscilloscope with a type B wide-band high-gain plug-in and a 10X probe as test scope

1 T connector, UHF male to 2 female (103-026)
2 Cable, 52 Ω (012-001)
1 Cable, 2-conductor shielded, with connector (012-022)

1 Triplett type 630 multimeter, 20,000 Ω/v dc, checked for ±1% accuracy
1 Krohn Hite type 440A low frequency oscillator

1 E Unit input cable (special)
1 B1500A step attenuator (special)
1 Standard calibrator (special)

## 2. PRELIMINARY INSPECTION:

a. Check for unsoldered joints, rosin joints, lead dress and long leads. Check controls for smooth mechanical operation and proper indexing. Check for fit into plug-in scope.

## 3. E UNIT PRESETS:

| | |
|---|---|
| a. VERTICAL POSITION | mr |
| MILLIVOLTS/CM | 10 |
| VARIABLE millivolts/cm | cw |
| APPROXIMATE FREQUENCY RESPONSE: | |
| HIGH | 20-60 KC |
| LOW | 8 CPS |
| DIFF BAL | mr |
| "VARIABLE" BALANCE | mr |
| GAIN ADJUST | mr |
| Vert Pos Range R3845 | mr |
| Heater Bal R4075 (sn 1055 up) | mr |
| C3095 and C3155 | min capacity |

4. RESISTANCE CHECKS:

a. Check resistances to ground:

| use | Amphenol connector pin | approx resistance |
|---|---|---|
| output | 1 | 82 k |
| gnd | 2 | 0 |
| output | 3 | 82 k |
| unused | 4 to 8 | inf |
| -150 v | 9 | inf |
| +100 v | 10 | inf |
| +225 v | 11 | 5 meg |
| unused | 12 to 14 | inf |
| +75 v fil | 15 | 200 Ω |
| unused | 16 | inf |

5. PLUG-IN SCOPE PRESETS:

a. Sweep: 1 millisec/cm.
Trigger: +int, automatic.

b. Determine plug-in scope's vertical amplifier electrical center by either:
(1) Inserting a test load unit, pushing PRESS TO SHORT INPUT button and noting trace vertical position, or
(2) Shorting Amphenol connector pins 1 and 3 together and noting trace vertical position.

6. SETUP:

a. Insert E Unit in plug-in scope and turn power on. Connect B1500A step attenuator (special) to E INPUT connector with E Unit input cable (special). Set B1500 1 to OFF, 2 to OFF and 3 to OFF (E Unit INPUTS grounded).

7. OUTPUT DC LEVEL:

a. Connect meter between Amphenol connector pin 1 and ground. Read 65 to 70 v. Connect meter between pin 3 and ground. Read 65 to 70 v. Disconnect meter.

8. VERTICAL POSITION RANGE:

a. Keep VERTICAL POSITION mr and push TRACE RESTORER. Keep it pushed while adjusting Vert Pos Range R3845 to center trace to plug-in scope's vertical amplifier electrical center (step 5b). Release TRACE RESTORER. Vert Pos Range R3845 should end up within ±90° of mr after adjustment.

9. "VARIABLE" BALANCE:

a. Change MILLIVOLTS/CM to .05 and rotate VARIABLE millivolts/cm control back and forth through its range while adjusting "VARIABLE" BALANCE so trace remains stationary. "VARIABLE" BALANCE should end up within ±90° of mr after adjustment.

10. MICROPHONICS:

a. Keep MILLIVOLTS/CM at .05 and VARIABLE cw. Rap lightly on E Unit front panel. View microphonics: no ringing type allowed, disregard any slow vertical shift, .5 cm max ordinary micro.

11. PRELIMINARY NOISE AND HUM:

a. Keep MILLIVOLTS/CM at .05 and VARIABLE cw. Change plug-in scope to 20 ms/cm, +line. View noise and hum: 4 mm max.

12. HEATER BALANCE (sn 1055 up):

a. Connect T connector (103-026) to B1500A INPUT connector. Connect 1 kc from low frequency, through a 52 Ω cable (012-001), to one side of T. Connect other side of T, through a 52 Ω cable, to test scope. B1500A 2 to ON and 3 to ON.

b. Keep MILLIVOLTS/CM to .05. Set B1500A 2 to ON and 3 to ON (double-ended output). View test scope and set low frequency oscillator for 800 mv.

c. Adjust Heater Bal R4075 for minimum plug-in scope deflection.

13. DIFFERENTIAL BALANCE:

a. Keep MILLIVOLTS/CM at .05. Adjust DIFF BAL for minimum deflection. View no 1 kc deflection.

b. Change low frequency oscillator to 10 kc; keep 800 mv output. Adjust C3095 for minimum deflection. If C3095 doesn't decrease deflection, return it to min and adjust C3155 for min deflection.

c. Change B1500A to 94 db attenuation, 2 ON, 3 OFF (Single-ended output). Note deflection. Change B1500A back to 0 db, 2 ON, 3 ON (double-ended output). View deflection remains same or less than noted above, indicating 50,000 to 1 rejection ratio.

d. Change low frequency oscillator back to 1 kc, keep 800 mv. Change B1500A to 94 db, single-ended. Note deflection. Change B1500A back to 0 db, double-ended. View deflection remains same or less than noted above, indicating 50,000 to 1 rejection ratio.

e. Remove low frequency oscillator.

14. GAIN:

a. Change plug-in scope to .2 millisec/cm. Keep E Unit MILLIVOLTS/CM at .05 and VARIABLE cw. Connect standard calibrator (special) to B1500A. Set standard calibrator for .2 mv.


b. Rotate GAIN ADJUST cw (max gain). View 4.4 cm deflection min. Then adjust GAIN ADJUST for exactly 4 cm vertical deflection.

13c. POOR DIFFERENTIAL BALANCE:

1. Change setting of Heater Bal R4075 (step 12) and DIFF BAL (step 13), and then repeat step 13.

2. Select V3015.

15. MILLIVOLTS/CM ACCURACY:

a. Check MILLIVOLTS/CM attenuator accuracy as follows:

| standard calibrator | MILLIVOLTS/CM | deflection |
|---|---|---|
| .2 mv | .05 | 4 cm (adjusted) |
| .2 | .1 | 2 ±2% |
| .5 | .2 | 2.5 |
| 2 | .5 | 4 |
| 2 | 1 | 2 |
| 5 | 2 | 2.5 |
| 20 | 5 | 4 |
| 20 | 10 | 2 |

b. Remove standard calibrator.

16. FREQUENCY RESPONSE:

a. Set B1500A for single-ended output. Connect low frequency oscillator to B1500A.

b. Set low frequency oscillator for 400 mv and B1500A for single-ended output. Keep APPROXIMATE FREQUENCY RESPONSE: HIGH 20-60 KC and LOW .06 CPS. Check frequency response as follows:

| MILLIVOLTS/CM | db attenuator | frequency at -3 db point |
|---|---|---|
| .05 | 66 db | 20 kc |
| .1 | 60 | 40 |
| .2 | 54 | 50 |
| .5 | 46 | 60 |
| 10 | 20 | 60 |

c. Keep MILLIVOLTS/CM to 10, B1500A to 20 db and check frequency response as follows:

APPROXIMATE FREQUENCY RESPONSE

| HIGH | LOW | frequency at -3 db point |
|---|---|---|
| 10 KC | .06 CPS | 10 kc ±30% |
| 1 KC | .06 CPS | 1 kc ±30% |
| 250 CPS | .06 CPS | 250 cps ±30% |
| 50 CPS | .06 CPS | 50 cps ±30% |
| 20-60 KC | 80 CPS | 80 cps ±20% |
| 20-60 KC | 8 CPS | 8 cps ±30% |
| 20-60 KC | .8 CPS | .8 cps ±30% |
| 20-60 KC | .2 CPS | .2 cps ±30% |
| 20-60 KC | .06 CPS | .06 cps max |

d. See Miscellaneous Information section for alternate method of checking low frequency response.

e. Remove low frequency oscillator.

17. NOISE AND HUM:

a. Set B1500A 1 to OFF, 2 to OFF and 3 to OFF (E Unit INPUTS grounded). Change plug-in scope to 20 millisec/cm, +line. Set E Unit MILLIVOLTS/CM to .05, HIGH to 20-60 KC and LOW to .06 CPS.

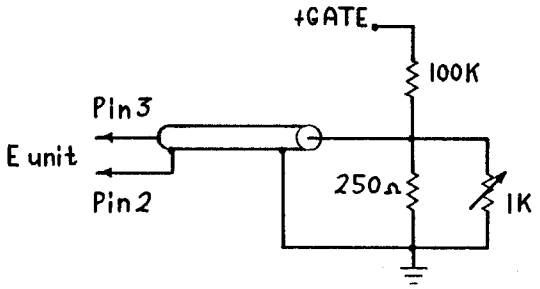
b. View noise and hum: 4 mm max.

18. THE END.

16d. LOW FREQUENCY RESPONSE, ALTERNATE METHOD:

1. Rather than using a low frequency oscillator to check E Unit low frequency response, you can use the +GATE of the plug-in (or test) scope.

2.




Since 37% of 4 cm comes out very close to 1.5 cm (1.47), attenuating the 20 v (or more) gate to 40 mv with a network similar to that shown above will work out very conveniently.

3. Time constants are as follows:

| -3 db point | display time constant (approx) |
|---|---|
| .06 cps | 2.65 sec |
| .2 | 795 msec |
| .8 | 200 msec |
| 8 | 20 msec |
| 80 | 2 msec |

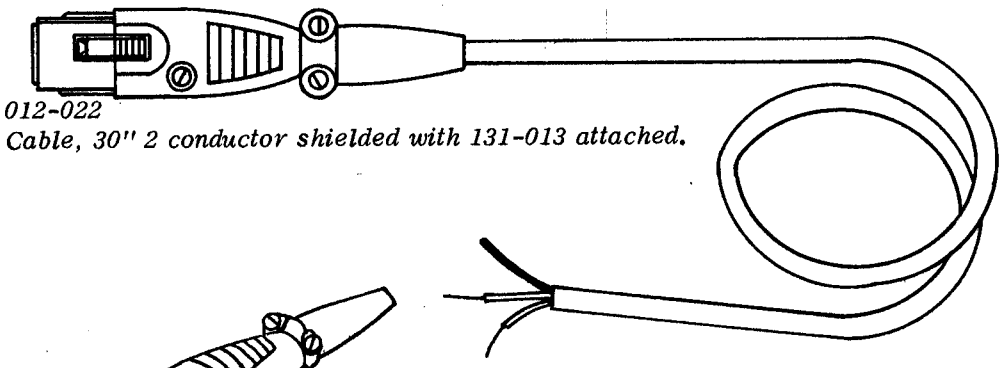
4. Measure: Time required for level to fall from +4 cm to +1.5 cm.

NOTE: -3 db points are only specified as "approximate" and time constants normally may vary ±20 or 30%.

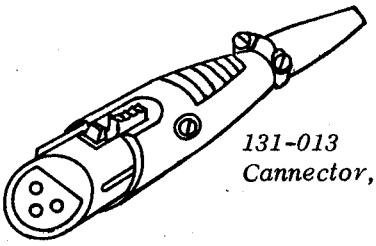
5. The sweep should be run single-shot, or at a low enough rep rate from the delaying sweep (if available) so the E Unit has time to recover from the transient introduced by the fall of the gate waveform before the next repetition.

6. The same type of measurement can be done using an external battery and attenuator instead of the +GATE.

## E UNIT INPUT CABLE:



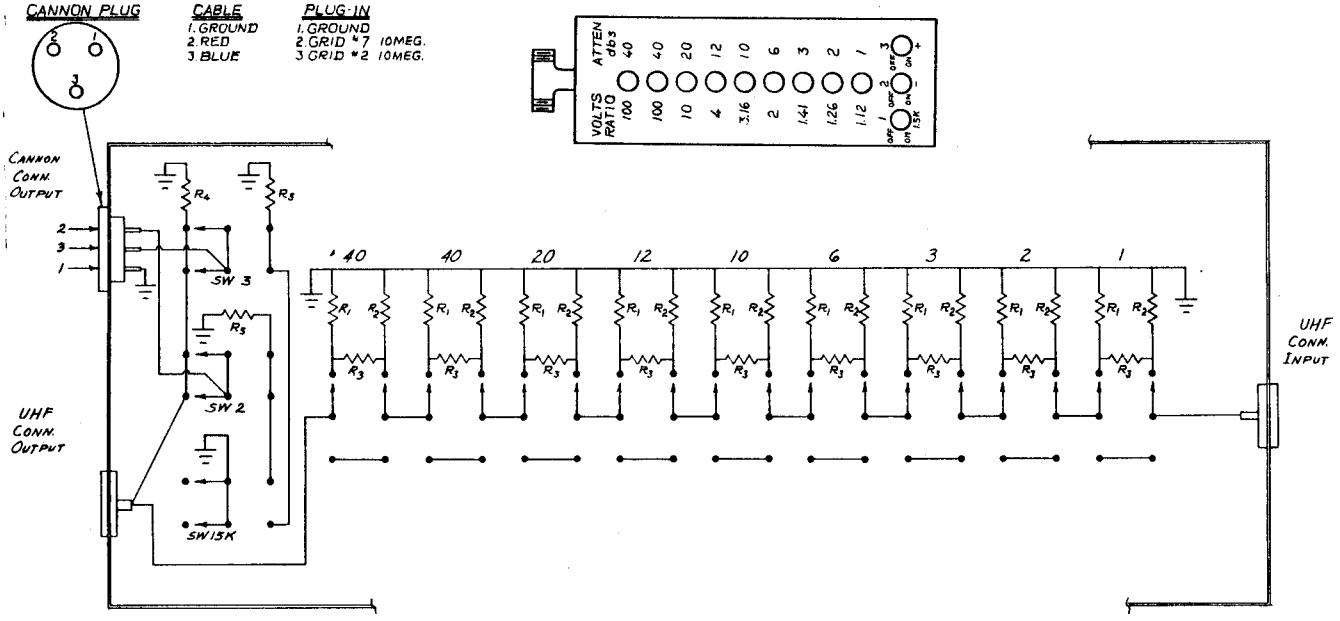
*012-022*
*Cable, 30" 2 conductor shielded with 131-013 attached.*



*131-013*
*Cannector, cable end, cannon XL-3-11 3 contact female.*

## B1500A STEP ATTENUATOR:

Dwg 525-B, 4-26-61.

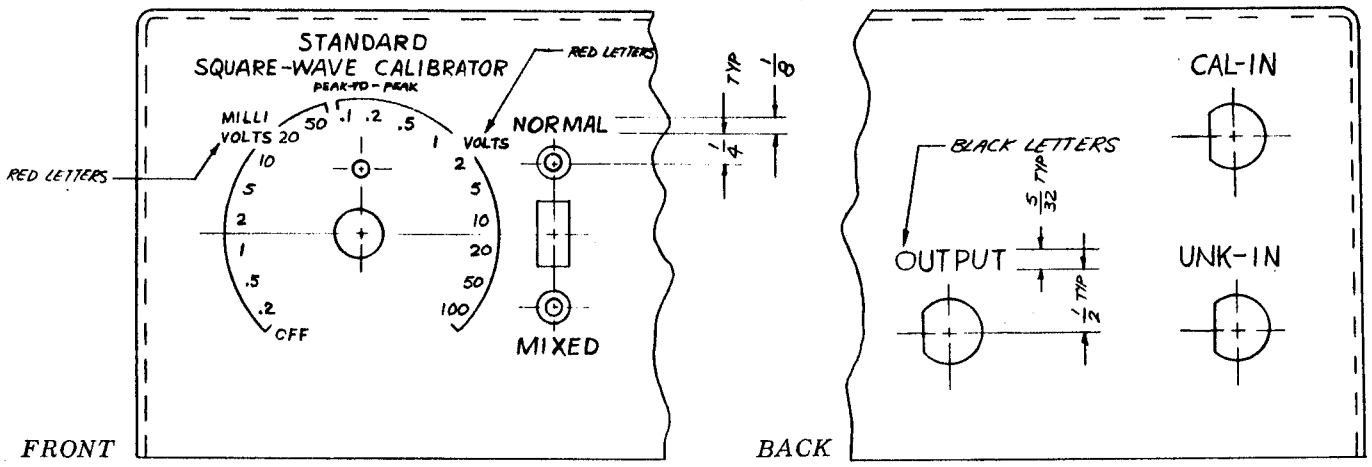


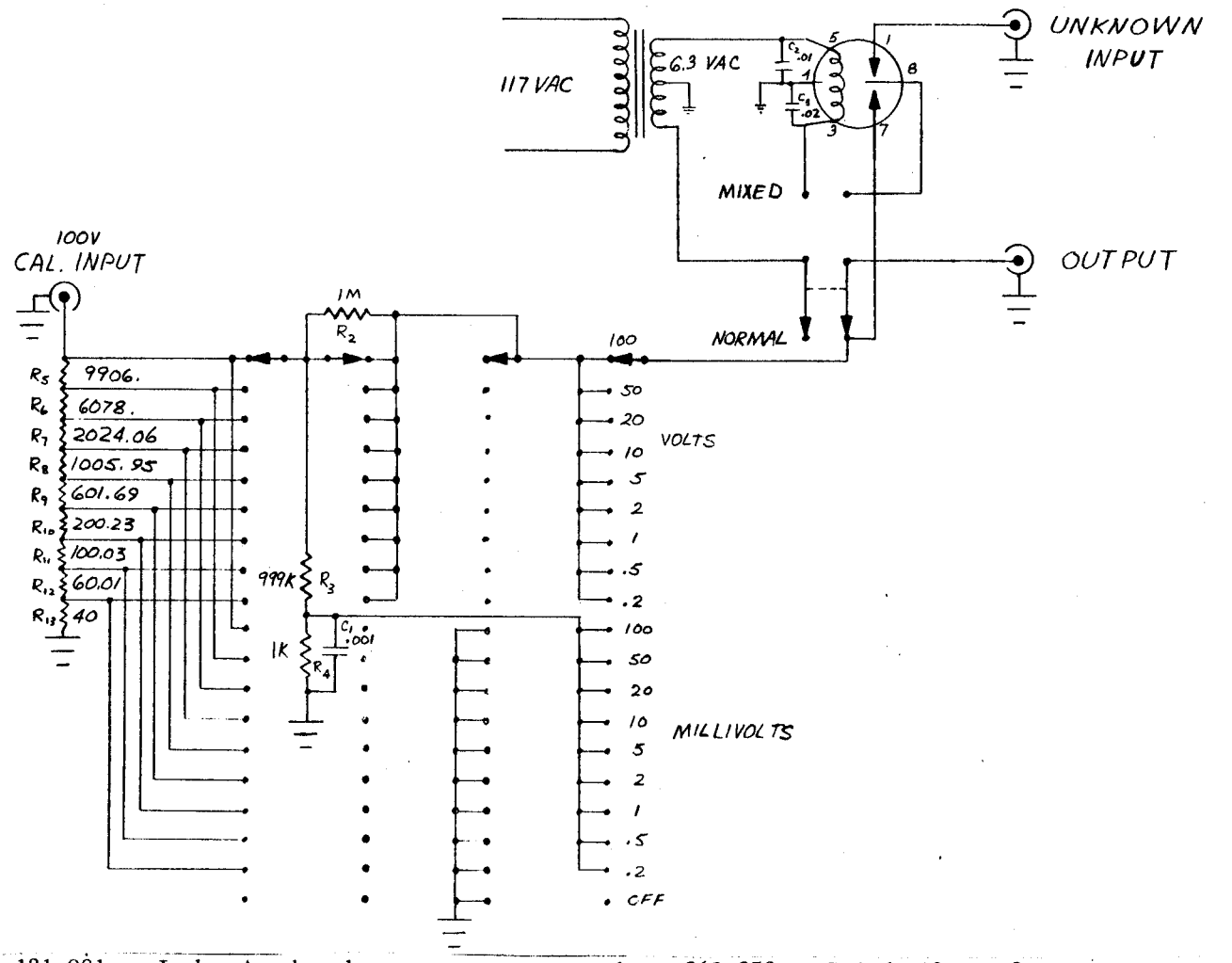

| db | voltage ratio | R1 and R2 | R3 |
|---|---|---|---|
| 40 | 100 | 1.53030 k | 74.9925 k |
| 40 | 100 | 1.53030 k | 74.9925 k |
| 20 | 10 | 1.83333 k | 7.42500 k |
| 12 | 3.98107 | 2.50635 k | 2.79741 k |
| 10 | 3.16228 | 2.88743 k | 2.13437 k |
| 6 | 1.99526 | 4.51414 k | 1.12056 k |
| 3 | 1.41254 | 8.77206 k | .528444 k |
| 2 | 1.25893 | 13.0863 k | .348448 k |
| 1 | 1.12202 | 26.0864 k | .173076 k |

| | | |
|---|---|---|
| | R1, R2, R3 | Resistors, Tek made specials |
| 1 ea. | | Cannon plug (131-014) |
| 2 ea. | | Uhf coax connectors (131-012) |
| 12 ea. | | Switches, toggle (260-014) |
| 1 ea. | | Uhf T connector (103-026) |
| 1 ea. | R4 | Resistor, 1.5 k .1% Tek made special |
| 2 ea. | R5 | Resistors, 15 k 1w 10% (304-153) |

STANDARD CALIBRATOR:

Dwgs 600-B, 7-10-61 (front and rear panels); 601-B, 7-10-61 (schematic); 918-A, (parts).




| | | | | | |
|---|---|---|---|---|---|
| 3 | 131-081 | Jacks, Amphenol | 1 | 260-253 | Switch, 19 pos. 3 sec. rotary |
| 1 | 131-093 | Receptacle, plug | 1 | 283-003 | Capacitor, .01 μfd Discap |
| 1 | 136-011 | Socket, octal | 1 | 309-115 | Resistor, 1k 1/2w 1% |
| 2 | 210-406 | Screws, 4-40 1/4" | 1 | 309-014 | Resistor, 1meg 1/2w 1% |
| 6 | 210-457 | Nuts, 6-32 Kep-type | 1 | 310-100 | Resistor, 1meg 1w 1% |
| 2 | 211-023 | Nuts, 4-40 | 1 | 366-057 | Knob, large black |
| 9 | 211-507 | Screws, 6-32 | 1 | 283-004 | Capacitor, .02 Hi-Kap 150v |
| 1 | 260-228 | Switch, dpdt slide | 1 | 283-000 | Capacitor, .001 μfd Discap 500v |