FACTORY CALIBRATION PROCEDURE

CONTENTS:

190,A,B

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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For 190, 190A and 190B, 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).

ABBREVIATIONS:

a	amp	min	minimum
ac	alternating current	mm	millimeter
approx	approximately	mpt	metalized, paper tubular (capacitor)
b	base	msec	millisecond
bulb	light, lamp, etc.	mt	mylar, tubular (capacitor)
c	collector	mv	millivolt
ccw	counterclockwise or full counterclockwise	μ	micro (10^{-6})
cer	ceramic	μf	microfarad
cm	centimeter	μh	microhenry
comp	composition (resistor)	μsec	microsecond
cps	cycles per second	n	nano (10^{-9})
crt	cathode ray tube	nsec	nanosecond
cw	clockwise or full clockwise	Ω	ohm
db	decibel	p	pico (10^{-12})
dc	direct current	pbt	paper, "bathtub" (capacitor)
div	division	pcc	paper covered can (capacitor)
e	emitter	pf	picofarad (μμf)
emc	electrolytic, metal cased (capacitor)	piv	peak inverse voltage
fil	filament	pmc	paper, metal cased (capacitor)
freq	frequency	poly	polystyrene
gmv	guaranteed minimum value (capacitor)	pot	potentiometer
gnd	chassis ground	prec	precision (resistor)
h	henry	pt	paper, tubular (capacitor)
hv	high voltage	ptm	paper, tubular molded (capacitor)
inf	infinity	ptp	peak-to-peak
int	internal	sec	second
k	kilo (10^{3})	sn	serial number
k	kilohm	term	terminal
m	milli (10^{-3})	tub	tubular (capacitor)
ma	milliamp	unreg	unregulated
max	maximum	v	volt
mc	megacycle	var	variable
meg	megohm	w	watt
mh	millihenry	WW	wire wound
mid r	midrange or centered	x-former	transformer

FACTORY CALIBRATION PROCEDURE

(unabridged)

1. Control settings:

   METER CAL ADJUST pot back 3/4 turn from full cw.
   Frequency Range control to "Meter Zero" position.
   Meter Zero control to middle of range.
   Output Amplitude control fully ccw.
   (Attenuator head should be attached)
   (make sure to use only the 190A head with a 190A)

2. With the drum set so that a point one-eighth of an inch to the left of the 9 mc marking falls behind the scribed line on the plexiglass window, the main tuning capacitor plates should be fully meshed and no more. If necessary, move the drum on the shaft, being careful to push it down firmly against the rubber wheel while doing so. The drum should turn freely but not loosely.

3. Set all trimmer capacitors to mid range.

4. Measure power supply resistances to ground; there should be approximately 5 KΩ on the 105-volt supply and 10 KΩ or more on the 550-volt supply.

5. Turn on the instrument and measure the voltage at pin 5 of V6. The reading should be within 3% of 105 volts. The output of the unregulated 550 supply should be in the range of 550 to 575 volts.

6. The ripple voltage on the 105-volt supply should not exceed 35 millivolts. This may be measured with an oscilloscope. Measure at R44.

7. Connect the output jack of the attenuator head to a broad band (DC to 10 mc or better) oscilloscope with calibrated vertical sensitivity. Set the output frequency of the Type 190 to 350 KC and adjust the output controls so that the oscilloscope indicates by its vertical deflection a peak-to-peak signal of ten volts. Set the METER CAL ADJUST pot on the Type 190 so that the panel meter reads exactly ten volts. Then switch the range control to "Meter Zero" and zero the panel meter with the Meter Zero Adjust control. Repeat this sequence of adjustments until all the interaction has been eliminated. At that time, the Meter Zero Adjust control should be above the "nine o'clock" position.

8. Set the line voltage applied to the Type 190 to 117 and adjust the Output Amplitude control so that the panel meter reads exactly 8 volts. Raise the line voltage to 125; after enough time has elapsed to allow the filament temperatures to rise, note the meter indication. The indicated voltage should remain within 5% of 8 volts. Return the line voltage to 117 and if necessary readjust the Output Amplitude control for an exact 8-volt indication. Reduce line voltage to 105 volts and after allowing time for the tubes to cool, check for an indication within 5% of 8 volts.

   IN CASE OF IMPROPER RESULTS, SELECT V50 AND RECALIBRATE METER.

9. Return the line voltage to 117 and allow time for filament temperatures to stabilize. Then set the Output Amplitude control fully ccw and observe the meter reading as the Frequency Range control is moved through each of its positions. In all cases the indication should be less than 4 volts. Failure on any range may be corrected by repositioning the link on the coil for that range.

10. Since the wave amplitude is regulated to the input of the attenuator, an attenuator resistor-tolerance error may be found on settings of the Volts, Peak-to-Peak control below the ten-volt range. Using a broad-band oscilloscope with calibrated vertical sensitivity, apply from the Type 190 a 350 KC signal of exactly 10 volts amplitude. Then reduce the output from the Type 190 with the Volts, Peak-to-Peak control and with the test oscilloscope determine that the output is within 10% of the nominal value on each position.

11. Calibration of the drum frequency indication is accomplished by beating together the output of the Type 190 and time markers from a Type 180 Time-Mark Generator. This may be done with a diode mixer and a pair of headphones. Follow the chart below, starting on the lowest frequency range. A coil slug will be adjusted at the low end of each band, and a trimmer capacitor at the high end. These adjustments may interact slightly, making it advisable to repeat the sequence until the interaction is eliminated. Start out with the adjustment of the slug in each case.

NOTE FOR THE TYPE 190 ONLY: The slug should be set to the second major beat at the low end of the range as the slug is withdrawn from the coil.

NOTE FOR THE TYPE 190A ONLY: At the 50 KC position adjust L28 for a zero beat against the 100 μsec markers from the Type 180. In order to assure that the proper harmonic is being used, observe the 190 signal on an oscilloscope with a calibrated time base. The time duration of one cycle should be 20 μseconds.

FREQUENCY RANGE	180 marks	low end setting and adjustment	high end setting and adjustment
.35-.75	5 μsec	.40 mc /L30	.60 mc /C36 (or C30 on newer 190A)
.75-1.7	5 μsec	.80 mc /L31	1.6 mc /C31
1.7-4.0	5 μsec	1.8 mc /L32	4.0 mc /C32
4.0-9.0	1 μsec	4.0 mc /L33	9.0 mc /C33
9.0-21	5 mc sine	10 mc /L34	20 mc /C34
21 - 50	5 mc sine	25 mc /L35	50 mc /C35

Various markers from the Type 180 may be used to check points across the different bands. For example, a 5 μsec marker should produce a beat every 200 KC; a 1 μsec marker a beat every 1 mc.

12. Regulation of the output may be checked by terminating the attenuator head with a 52 Ω terminator and applying the signal directly to the vertical deflection plates of a crt with sufficient sensitivity. The sweep may be allowed to free run. Going from end to end of each range there should be no more than a 2% change in vertical deflection, except on the 21-50 mc range, where 4% is allowed.

(NOTE -- may be measured with an accurate meter and peak-to-peak rectifier.)

13. Set the output of the Type 190 to 10 volts. Using a broad-band scope with .05 v/cm sensitivity (Type 541 with K unit, or equivalent) observe the output waveform on each band with special filter chassis between output of Type 190 and input to K unit. Trim the filter for minimum output. Residual harmonics measured by test oscilloscope should be no more than 50 mv peak-to-peak. If this limit is exceeded on the .35-.75 mc range, it may be corrected by dressing the output link toward the chassis. Trouble on the 1.7-4.0 mc range may require modification of the instrument. The modification is to insert a 1.2 μh coil in place of the white and yellow wire from the switch to L32. This part will be designated as L26. (Later 190A instruments include L26.)

MISCELLANEOUS CALIBRATION INFORMATION

VERIFYING CONSTANT OUTPUT

March 9, 1962

There are a number of methods of demonstrating the constant output of the Type 190 (190A, 190B). Since equipment for this purpose is not widely available yet in customers' calibration labs, we (as in the new edition of the USAF T.O. on the 190) suggest the step as optional in customer calibration.

One method of demonstrating the output constancy of the Type 190 is with the Type 661. However, this method can only be recommended with reservations. First, of course, nobody (except us) has 661's yet, and they are a fairly costly investment for a calibration lab. Second, the actual sine-wave response of the 661 has not yet been fully evaluated. From pulse-response analysis, we can see where a roll-off of as much as 3% may take place between 3 mc and 30 mc in the 661; until further evaluation is undertaken, we would not like to recommend the 661 as a "1%" tool in this area. (Incidentally, the 661 must be triggered in order to respond properly -- do not use a free-running sweep.)

The N Unit in a 530 Series instrument can also be used for 190 calibration, using GR attenuators; however, the resolution is poor.

Whether the direct indicator (661, 3S76, N Unit) or detector (below) is used, the 190 should be checked throughout its frequency range with both 50 Ω loading and (using the P6026) with high-impedance loading with 10 pf in shunt. (Caution: The 190A and 190B can only supply 8 v regulated at 50 kc into a 50 Ω external load. Operate at reduced amplitude.)

Output variation should not exceed ±2% up to 30 mc, or ±5% to 50 mc. Proper response of the 190A or 190B attenuator should also be checked. The attenuator of the original 190 suffered capacitive feed-through in the ranges below 0.1 v, and therefore had a rising frequency characteristic in these attenuator positions. It is impossible to "certify" these ranges in the old 190's, and customers should be cautioned against relying on them. In the A and B models, only the 100 mv range shows any appreciable feed-through at 50 mc, and it is still within spec.

If the 190 shows severe roll-off into 50 Ω in the 10 v range but not in the lower attenuator ranges, the sampling diodes in the 190 attenuator head may be at fault. We have found that tubes now available for this application do give trouble, and work is in progress to convert to semiconductors here.

A less expensive tool for 190 calibration is a voltage-doubler test jig constructed of Type 1N87A or Type DR746 diodes.

This jig -- built inside a converted P6017 terminating box -- can check the 190's performance quite accurately throughout the 50 kc to 50 mc range. Using a John Fluke Type 801 or 803 differential voltmeter as an output indicator gives very good resolution of any output variation. The schematic and layout sketches are shown in Figures 1 and 2 below.

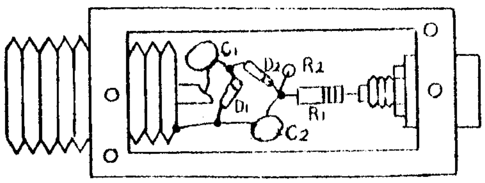

Fig. 1

Parts Arrangement: Lead lengths should be as short as possible without damaging components during assembly. Ground post (if desired) can be mounted in access hole opposite cover plate.

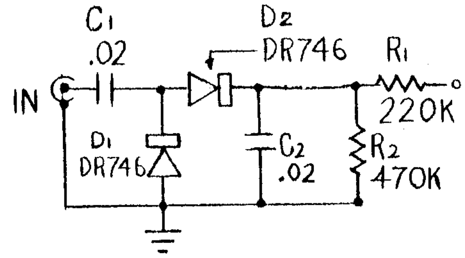

Fig. 2

Schematic Diagram: R_1 prevents output loading from materially affecting LF response or 190 output.

Customers should be cautioned against using such devices as power calorimeters, thermocouples, or peak-reading VTVM's to check the 190 output constancy. None of these devices can read the peak-to-peak output of the 190, and constant peak-to-peak output is all the 190 pretends to generate.

The textbook relations among peak, peak-to-peak, and RMS only hold for sine waves with no distortion. The distortion of the 190A is not specified (though typically 5% or less), and therefore no RMS or peak-reading device can indicate the actual peak-to-peak output.

Interestingly enough, though, it is possible to make 190 output constancy traceable to NBS via a traceable power calorimeter plus a source of distortion-free sine waves over a wide frequency range. This combination can be used to certify the performance of either a diode test jig or of a 661 over the necessary bandwidth. Thus certified, the jig or the 661 then can be used to check the 190.

The "clean" sine waves are obtainable by running an oscillator output through low-pass filters whose performance can be determined by the calorimeter. If a filter shows 95% rejection at 100 mc (and proportionately more at higher frequencies), for instance, then a 50 mc signal having 50% distortion can have no more than 2-1/2% distortion at the filter output. A 50 mc signal with 10% distortion could have no more than 1/2% distortion at the filter output, and so forth. Having set up the filters, the peak-to-peak indicators can then be checked against the RMS-reading calorimeter over the required range, and away we go.

The above procedure is not recommended for repair centers. However, our standards people are looking into the possibility of providing this type of traceability in our own standard indicators, so that scope bandwidth may eventually be made fully traceable.

Parts List:

283-004	C_1, C_2, .02 µf 150 v
152-075	D_1, D_2, DR-746 (6075) (1N87A may also be used)
302-224	R_1, 220 k 1/2 w or 1/4 w
--	Housing, P6017 Compensator box (use reject)
131-081	Input Connector, UHF Female, D-Mount
136-107	Output Connector, Banana Jack
210-898	Washer, Ins
210-465	Nut, 1/4-32
*355-507	Ground Connector, Stem
200-103	Cap
210-455	Nut, 1/4-28
210-011	Lock washer, 1/4

*Miniature phone jack 136-094 may be used instead of listed output and ground connectors and parts. Mount in access hole opposite cover plate, and use plug (Switchcraft No. 750), Tek 134-051.

Several precautions, however, are necessary using this device.

1. Rectification efficiency of this device is not constant, but varies with applied voltage and temperature. Therefore, the output of this device cannot be accurately calibrated in terms of voltage, but only in terms of relative output.

2. Because the rectification efficiency varies with applied voltage, it is not a linear indicator of variations of more than a few percent. At low input voltages, its linearity is very poor; at higher voltages, the problem becomes less. Therefore, it is useful for checking a constant-output device like the 190; but is not useful for direct measurements of output variations of more than a few percent, especially below 2.5 v ptp input. The jig tends to exaggerate changes in either direction..... which is good for our purposes, but makes it useless as a general-purpose "detector probe" device.

3. To measure actual output variation, particularly at the 1 v and lower ranges where the diode linearity is poor, use this technique:

   a. Set 190 attenuator to desired output range and install test jig.

   b. Set 190 output level for a meter reading of 7.0.

   c. Connect differential voltmeter to test jig and obtain null reading.

   d. Operate 190 over its full frequency range. Adjust 190 Output Amplitude as necessary to maintain null reading on differential voltmeter. Read 190 meter to determine the percent deviation (2% = 0.14 v; 5% = 0.35 v).

   This technique takes advantage of the fact that the 190's diodes -- operating at 7 volts -- are much more linear than the test jig's diodes operating at a lower voltage. The 190 diode, tube, and meter nonlinearity are insignificant for the very small changes involved.