INSTRUCTION MANUAL

TYPE 182B/183B

PHOTO - ROTATIONAL ANALYZER

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070-320

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

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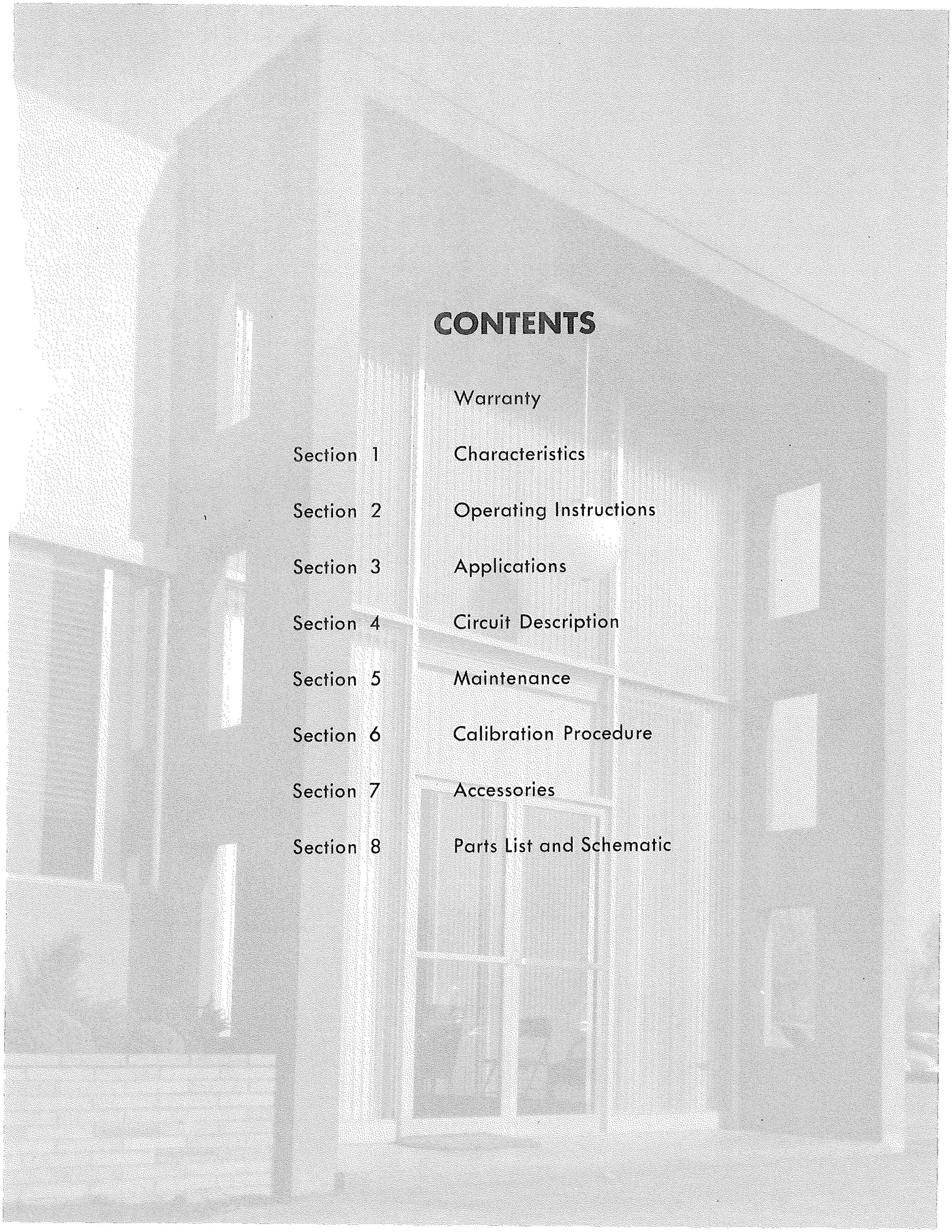

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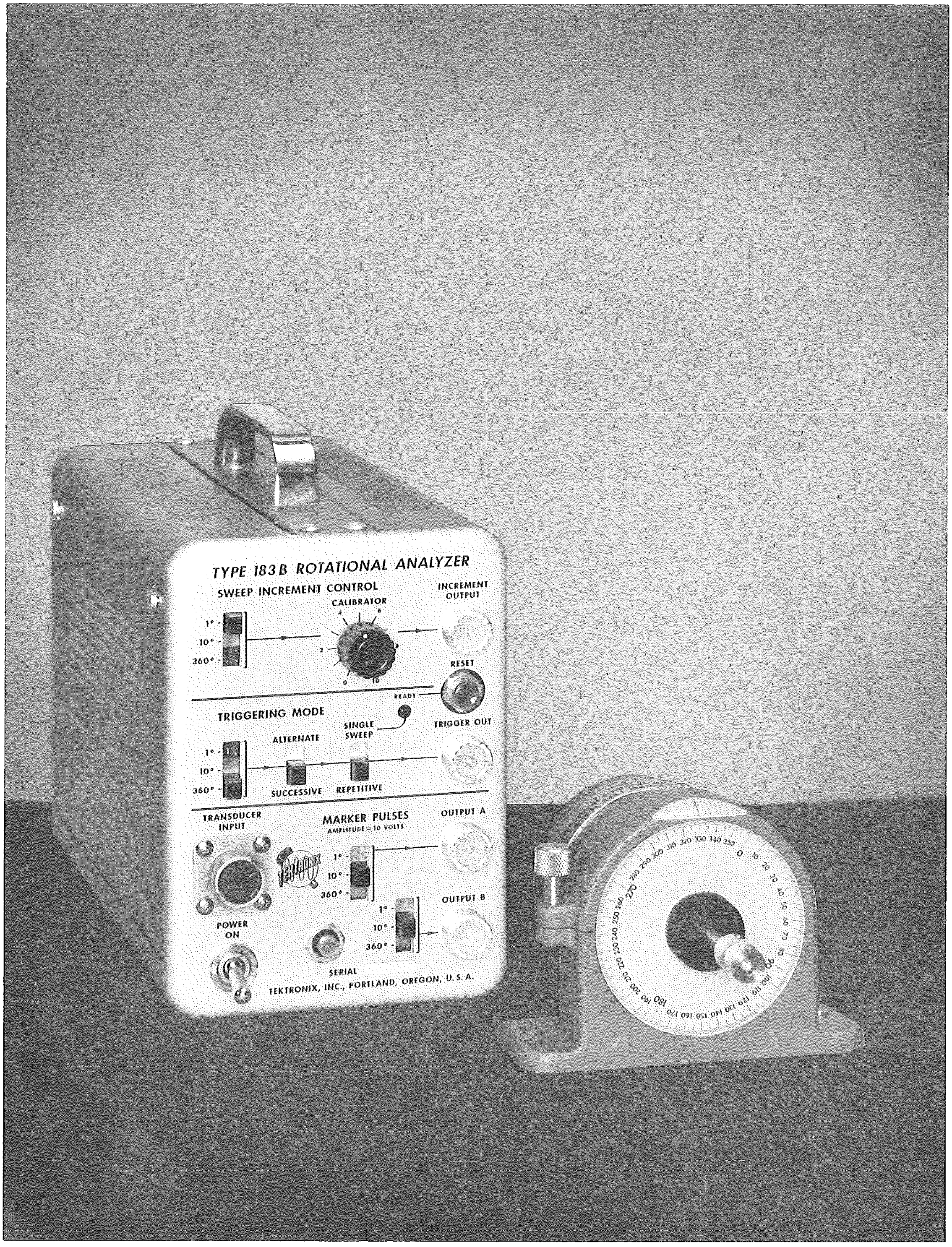
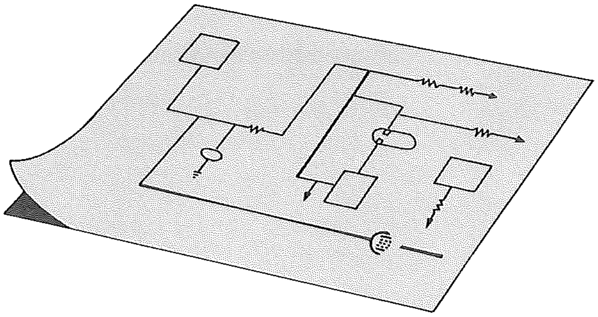

TYPE 183B ROTATIONAL ANALYZER
SWEEP INCREMENT CONTROL
CALIBRATOR
INCREMENT OUTPUT
RESET
READY
TRIGGERING MODE
SINGLE SWEEP
ALTERNATE
TRIGGER OUT
SUCCESSIVE
REPETITIVE
TRANSDUCER INPUT
MARKER PULSES
AMPLITUDE = 10 VOLTS
OUTPUT A
OUTPUT B
POWER ON
SERIAL
TEKTRONIX, INC., PORTLAND, OREGON, U. S. A.



SECTION 1

CHARACTERISTICS

General Information

The Tektronix Type 182B/183B Photo-Electric Rotational Analyzer (Rotan®) is designed to generate an oscilloscope sweep relating angular shaft displacement to other information signals. Data such as pressure, vibration, ignition voltage, torque or acceleration may be applied to the vertical deflection system of the oscilloscope. The resulting display references this data to the sweep which is made proportional to shaft displacement. The electronic approach to rotation studies minimizes error from inertia, has higher sensitivity, and yields greater accuracy than other systems.

The Type 182B operates at rotational rates from essentially zero to 20,000 rpm, producing output pulses at shaft increments of 1°, 10° and 360°. Front panel switching on the Type 183B provides easy selection from these three pulse channels for operation of the oscilloscope sweep and for triggering and output pulses. The SINGLE SWEEP triggering mode provides a triggering pulse for photographing a single trace of a continuously changing display. ALTERNATE-sweep triggering from the Analyzer aids in the analysis of 4-cycle reciprocating engines.

TYPE 182B ANGLE-ENCODING TRANSDUCER

Maximum Ambient Operating Temp.: 140° F., properly calibrated.

Input Voltages, supplied by the Type 183B:

Exciter lamps:	—4.8 v dc.
Photo-transistors:	—4.8 v dc.
Temperature-comp. transistors:	+2.5 v dc.
	—4.8 v dc.

Ground is Common with the Type 183B.

Output Signals:

Rate: 0 to 120,000 pulses/sec.

Voltage: 0.7 v peak-to-peak, nominal.

Mechanical:

Rate of rotation	0 to 20,000 rpm.
Moment of inertia:	10 gm-cm^2 nominal
Maximum marker error:	15 Minutes of arc.

Construction:

Machined die-cast aluminum-alloy body.

Die-cast aluminum alloy base with machined aperture.

Aluminum-alloy rear cover.

Increment-marker discs of acetate film.

Fiberglas printed circuit board.

Fiberglas exciter-lamp contact cover.

Anodized degree-indicator dial.

Blue vinyl-finish base and rear cover.

Dimensions

Height, maximum: $3\frac{1}{2}$ in.

Width of base, maximum: $4\frac{7}{8}$ in.

Length including shaft: $5\frac{1}{16}$ in.

Length of shaft exposed: $1\frac{1}{8}$ in.

Shaft diameter: $\frac{1}{4}$ in.

Weight: Approx. 3 lbs.

TYPE 183B PHOTO-ELECTRIC ROTATIONAL ANALYZER

Power Requirements: 105 to 125 volts ac or 210 to 250 volts ac, 50 to 800 cycles/sec., 50 watts.

Power Supply Output Voltages:

—12.5 volts dc; —4.8 volts dc (at Terminal D on TRANSDUCER INPUT); +2.5 volts dc (at Terminal E on TRANSDUCER INPUT); and +144 volts dc.

Input Signal:

Positive pulses received from the type 182B.

Output Signals:

INCREMENT OUTPUT: Standardized incremental pulses, produce a uniform sweep in the oscilloscope.

TRIGGER OUT pulses: Approximately 8-volt pulses at angular increments of 1°, 10° and 360°, either as REPETITIVE trigger or as SINGLE SWEEP. The trace may be triggered on every pulse (SUCCESSIVE) or on every other pulse (ALTERNATE).

OUTPUT A and OUTPUT B marker pulses:

10-volt positive pulses (from —12-volt dc level) at angular increments of 1°, 10° or 360°. For use as angular displacement markers or to activate or synchronize other equipment.

Construction:

Aluminum-alloy chassis and cabinet, blue vinyl-finish cabinet, photo-etched anodized front panel.

Dimensions of cabinet:

Height: 6½ in.
with handle: 7¾ in.

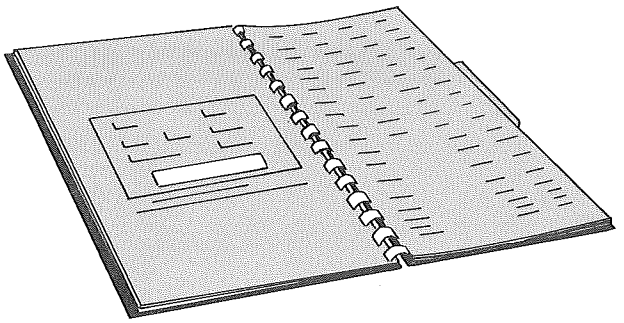
Width: 4½ in.

Length: 10 in.

Weight: Approximately 6 lbs.

Accessories Supplied:

1-Power Cord, 8 ft.	(161-010)
1-Transducer Cable, 15 ft.	(012-058)
2-P52 Coaxial Cable, 50 Ω, 42 in.	(012-001)
1-Phone Plug Cable.	(012-062)
1-3-Wire Adapter	(103-013)
1-Flexible Shaft Coupling	(376-023)



SECTION 2

OPERATING INSTRUCTIONS

General

The Tektronix Rotational Analyzer system may be operated with any oscilloscope which generates the sweep by means of a voltage runup. Added versatility or convenience for a particular application may be obtained by using an oscilloscope with a multi-trace vertical-deflection system or with delaying sweep or dual-beam circuitry. Since Tektronix oscilloscopes generally use a Miller runup sweep, the conversion and operation procedures mentioned here will all relate to this type of sweep circuitry.

NOTE

Due to a change in circuitry between the "A" and the "B" models of Types 182 and 183, a note concerning the matching of these units is necessary.

Types 182A and 183A were designed as matched pairs, by serial number. Types 182B and 183B have internal controls set at the factory, adjusting the outputs of the Transducer so that the units are completely interchangeable. Changes in circuitry and interconnection prohibit the use of "A" models with "B" models. For example, do not use a Type 182A with a Type 183B.

Conversion of the Sweep Circuit

Before the Rotational Analyzer can be used to produce an oscilloscope display with an angular-displacement base rather than a Time Base, it is first necessary to make a simple conversion in the sweep circuit of the scope. The timing resistors must be disconnected from the Miller tube grid, and the output from the INCREMENT OUTPUT of the Type 183B must be connected in their place.

A practical way of converting the oscilloscope for Rotational Analyzer operation is by means of the phone jack supplied with the Rotan units, mounted at some convenient point on the oscilloscope. Use lead lengths as short as possible, for long leads can disturb the timing on the fastest sweep rates when the oscilloscope is operated on a time-base. Conversion is schematically represented in Figure 2-1. Insertion of the phone plug into the jack disconnects the timing resistors from the circuit, and introduces the increment signal from the Rotational Analyzer. When the phone plug is removed, the timing resistors are reconnected to the Miller tube and normal operation of the sweep circuit is restored.

If an instrument with a "delaying sweep" (or TIME BASE B) is used, it is often desirable to make the modifications on this circuit, leaving the main sweep circuit on a time base.

If you do not have an oscilloscope which has been converted at the factory for use with the Rotan system, it is essential that your Tektronix Field Office be consulted to be sure that the correct type oscilloscope is used, and that the type, position and method of installation of the jack is correct.

The Incremental Sweep

The timing resistors, when connected to the grid of the Miller tube, operate in conjunction with the timing capacitors to produce the continuous trace of the Time Base. With the phone plug inserted in the conversion jack, these timing resistors are electrically removed from the circuit and the sweep is given an incremental (advance-stop-advance) nature by the pulses from the Type 183B. Since the horizontal deflection is incremental, the trace appears not as a continuous trace but as a series of dots which appear one increment apart. The distance between the dots on the crt screen depends upon the expansion of the trace intervals as selected with the TIME/CM switch of the modified circuit, the position of the MAGNIFIER control on the oscilloscope, and the setting of the CALIBRATOR control on the Rotational Analyzer.

The expansion or contraction of the increment spacing on the crt screen is determined by the selection of "timing" capacitors connected to the Miller tube grid of the converted sweep circuit. The TIME/CM switch selects the particular capacitor, but because each of these capacitors occupies more than one position on the switch, a change in the switch position will only change the expansion of the display when there is a change in the capacitance value. Coarse adjustment of the sweep expansion is made with the TIME/CM switch. Fine adjustment is then made with the CALIBRATOR control on the Type 183B, usually to correlate angular displacement to the graticule markings. The MAGNIFIER may be used to examine any portion of the trace more closely. Its use is limited, however, when viewing a trace composed of widely spaced dots.

Operating the Equipment

To operate the equipment properly, it is necessary to set up the electronic instrumentation in the area of the machine to be tested, with adequate facilities for electrical supply, protection of the instrument, etc. Reasonable care must be taken in attaching the Transducer to the machine under study in order to avoid damage to the unit, and to permit it to perform up to the high standard of precision to which it is built.

Every application of the Rotational Analyzer to a particular situation is generally unique with respect to the

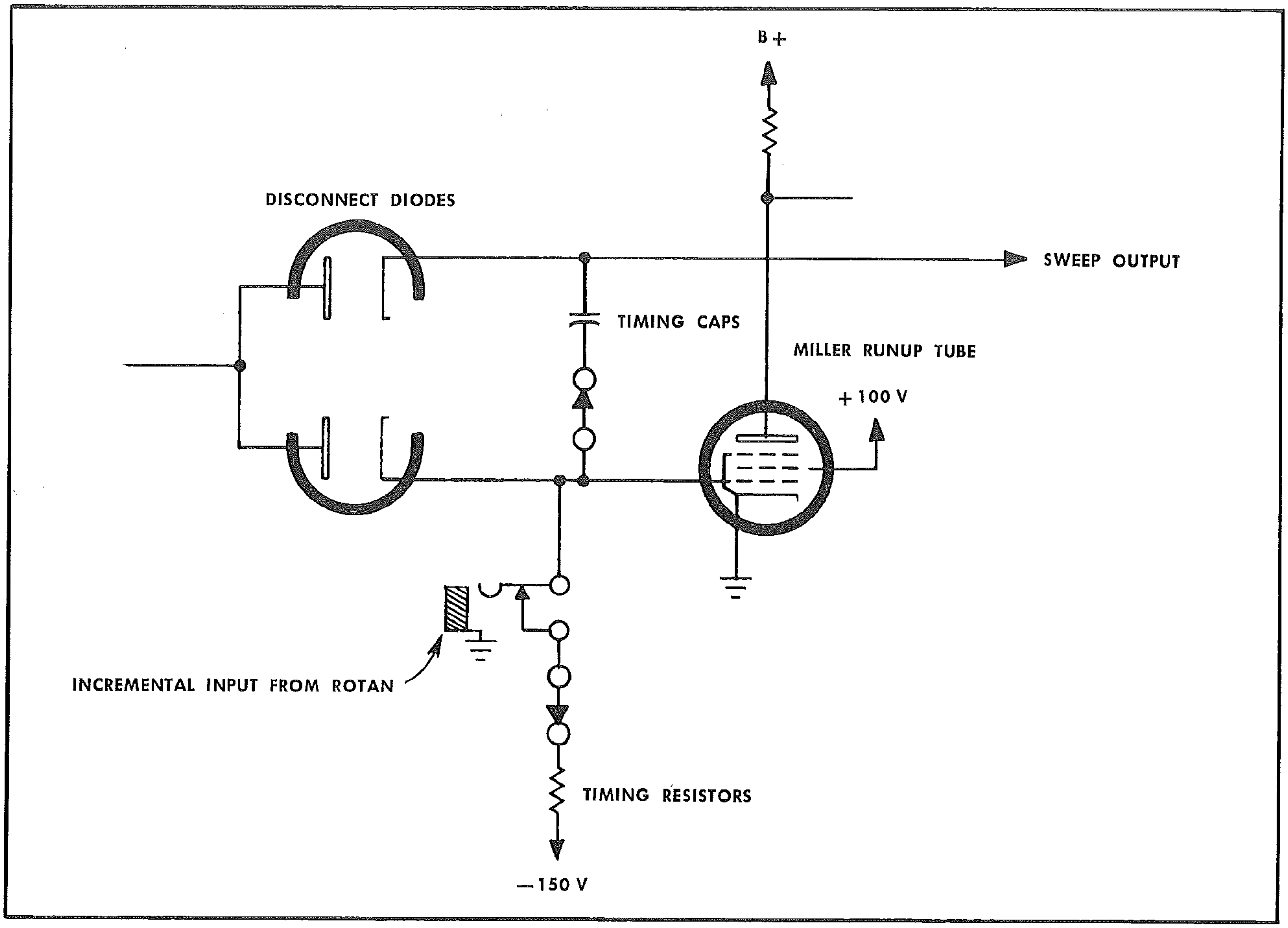


Fig. 2-1. Oscilloscope conversion for use with the Rotan system.

mechanical shaft connection and with respect to the electronic interconnections through which the vertical-deflection data is to be introduced to the circuitry. Transducing equipment for each application will also be highly individualized.

Mechanical Connections

Direct coupling to the shaft under study is essential. If the shaft to be connected to the Type 182B is not exactly 1/4 inch in diameter, coupling is usually most easily accomplished by machining down the end of the shaft (or only the center of the end of the shaft) to a diameter of precisely 1/4 inch. A length of about 3/8 inch is all that is necessary to permit direct coupling to the Transducer shaft, using standard Rotan equipment. If the end of the shaft is such that it cannot be machined to produce a projection at least 3/8 inch long and exactly 1/4 inch diameter, an alternate method of attachment must be used. Welding a small piece of metal to the shaft end or drilling a hole in the end of the shaft and driving in a short extension are possible alternatives. In either of these cases, it is best to start with the shaft extension slightly larger than 1/4 inch in diameter, positioned very close to the axis of the shaft. Then, by machining it around the axis of the shaft, the finished extension is exactly centered and presents no vibration to the Transducer.

A well balanced mechanical coupling which is slightly flexible, but which has no torsion or backlash, is necessary to prevent angular error and to minimize loading on the Transducer bearings. A flexible coupling of this type is included as standard equipment with the Rotan system. Though this coupling will take care of slight angular and lateral misalignment, it is important to align the two shafts carefully and to securely fasten down the Transducer base to some mount which is fixed with respect to the mount of the shaft under observation.

Electrical Connections

It is beyond the scope of this manual to describe the electrical system of each application of the Rotational Analyzer. However, some considerations of general application are included in the following paragraphs:

Transducer Connection: The transducer cable between the two units of the Rotational Analyzer supplies power to the circuitry of the Type 182B Transducer and applies the three channel pulses from the Transducer to the circuitry of the

Type 183B Analyzer. Be sure this cable is connected before turning on the POWER switch.

Incremental Sweep: The incremental step pulse from the Rotational Analyzer is applied to the sweep circuit of the oscilloscope through the 50 Ω coaxial phone cable connected from the INCREMENT OUTPUT connector of the Type 183B to the conversion jack on the oscilloscope.

Triggering: Pulses for triggering the sweep are applied to the oscilloscope through a 50 Ω coaxial cable connected from the TRIGGER OUT connector on the Type 183B to the TRIGGER INPUT connector on the modified sweep of the oscilloscope. The TRIGGER SLOPE switch will be in EXTernal position. Dc-coupling is used at the TRIGGER INPUT to obtain uniform triggering at all shaft speeds.

Vertical Signal: A voltage signal which is proportional to some phenomenon being investigated in the machine under study must be applied to the vertical INPUT of the oscilloscope in order to produce a vertical deflection on the crt. If the transducer used in a particular application produces output other than voltage change, the information must be converted to voltage before it can be applied to the vertical system of the oscilloscope. The Tektronix Type Q Plug-In Unit is recommended for conversion of capacitance, resistance and inductance. This unit, powered by a Type 127 or a Type 132 Plug-In Power Supply, may be used with any oscilloscope.

Marker Pulses: A 360° signal from OUTPUT A or OUTPUT B is applied to the vertical INPUT of the oscilloscope to adjust the incremental sweep to the graticule of the oscilloscope. Marker pulses may also be added to the vertical signal from OUTPUT A or OUTPUT B to provide angular reference marks with the trace. The method to be used in applying these pulses depends on the type of oscilloscope used.

First-Time Operation

To put the Rotational Analyzer system into operation (after the Transducer shaft has been attached), connect the cables as follows:

Transducer Cable, from Type 183B TRANSDUCER INPUT connector to Type 182B Transducer connector.

50 Ω Phone Plug Coax, from INCREMENT OUTPUT connector on Type 183B to conversion jack on oscilloscope.

50 Ω Coaxial Cable, from TRIGGER OUT connector on Type 183B to TRIGGER INPUT on oscilloscope.

50 Ω Coaxial Cable, from OUTPUT A connector on Type 183B to vertical INPUT connector on oscilloscope.

Power Cords, from instruments to line supplies for which they are wired (117 v or 234 v ac).

Set the controls of the 183B and the oscilloscope as follows (controls not mentioned can be in any position):

Oscilloscope:

POWER	off
HORIZONTAL DISPLAY	(modified sweep base)
MAGNIFIER	OFF (1X)
INTENSITY	fully counterclockwise
TIME/CM	1 MILLISEC
VARIABLE (TIME/CM)	CALIBRATED
VOLTS/CM (SENSITIVITY)	5 (VOLTS/CM)
VARIABLE (VOLTS/CM)	CALIBRATED
INPUT SELECTOR (or MODE), if any	INPUT connected to 183B OUTPUT.

Modified Sweep:

TRIGGER SLOPE	EXTernal+
TRIGGERING MODE	DC
STABILITY	fully clockwise
TRIGGERING LEVEL	fully clockwise (RECURRENT)

Type 183B Rotational Analyzer:

POWER	off
SWEEP INCREMENT CONTROL	1°
CALIBRATOR	centered
TRIGGERING MODE	360°
ALTERNATE-SUCCESSIVE	SUCCESSIVE
SINGLE SWEEP-REPETITIVE	REPETITIVE
MARKER PULSES, OUTPUT A	360°

Start the shaft under observation rotating and let it run at some moderate rotation rate. Turn ON the POWER switches of the oscilloscope and the Rotational Analyzer. After a brief warm-up period, center the display with the VERTICAL POSITION and HORIZONTAL POSITION controls. If the oscilloscope has Beam Indicator neons, use these as a guide. Rotate the INTENSITY control clockwise until the free-running display appears on the screen. Adjust the triggering controls of the oscilloscope for a triggered display. Allow at least 15 minutes warm-up before making accurate voltage measurements. (DC Balance and Gain of the vertical amplifier should also be checked before making any accurate measurements with the oscilloscope).

Adjust the TIME/CM switch so that the display on the crt is slightly more than one revolution (there are two markers in the display, one at the left edge and one near the right edge of the graticule). Adjust the CALIBRATOR control on the Type 183B and the HORIZONTAL POSITION control on the oscilloscope to obtain a display in which the two markers are precisely on the first and last lines of the graticule, respectively. This calibrates the angular sweep of the oscilloscope so that one rotation of the shaft under observation is represented by one complete sweep across the oscilloscope graticule. For most applications, the TIME/CM switch and the CALIBRATOR control will be left in these calibrated positions.

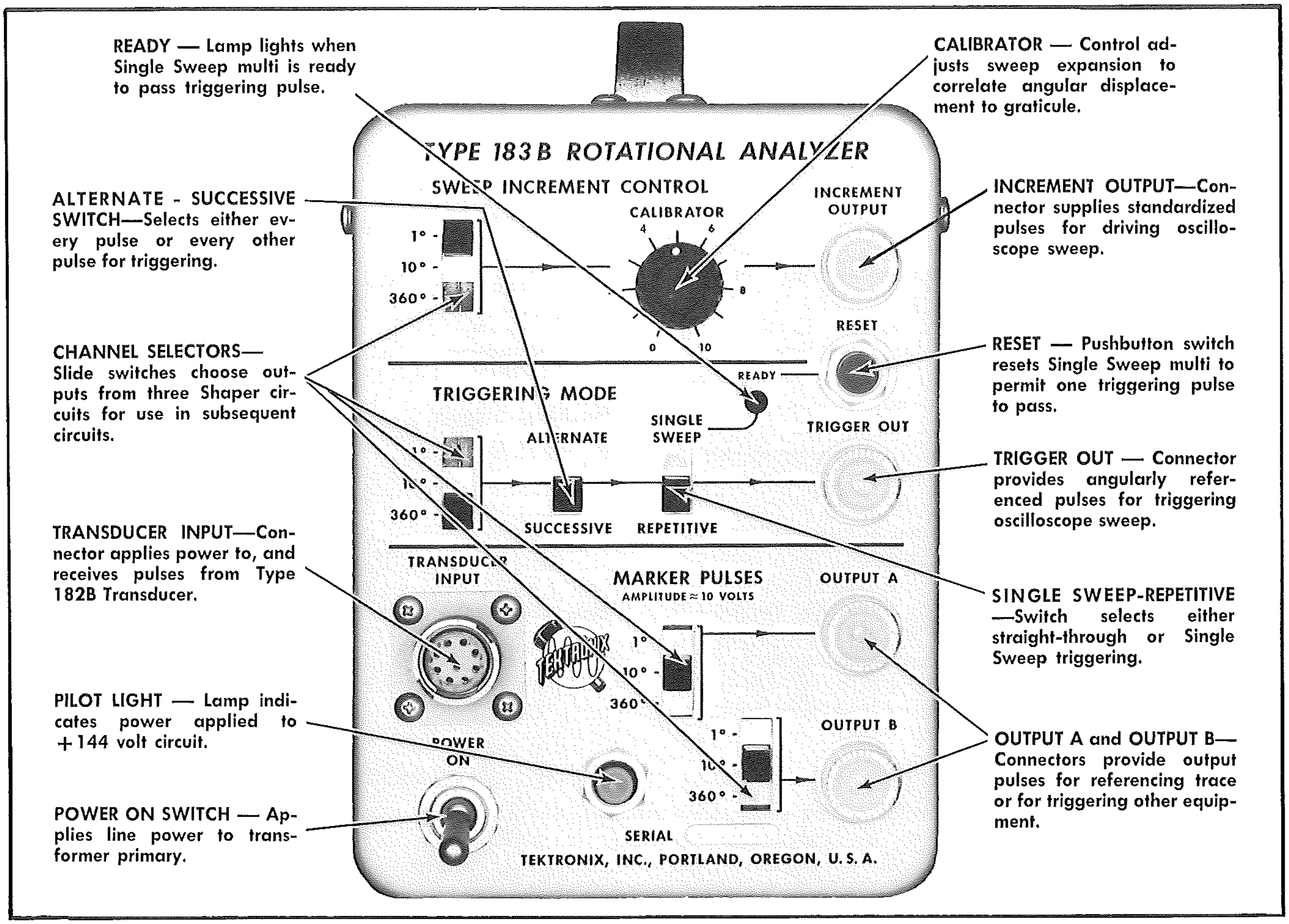


Fig. 2-2. Functions of parts and adjustments of Type 182B Transducer.

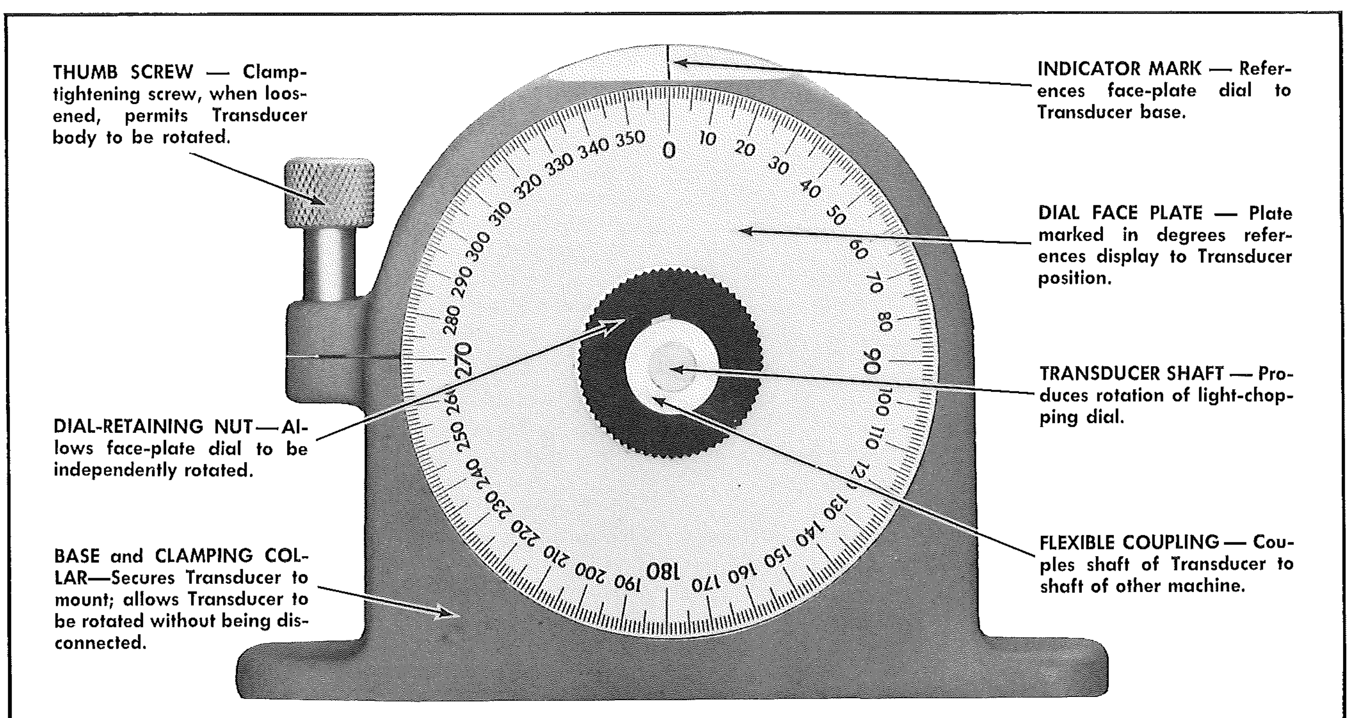
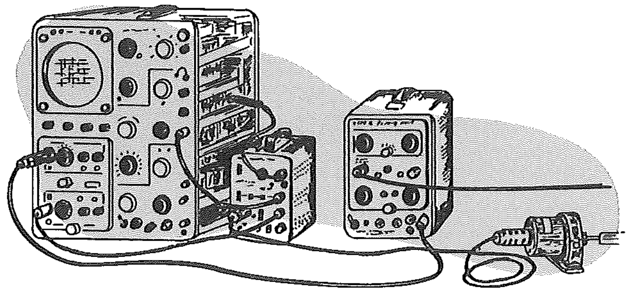


Fig. 2-3. Functions of front-panel controls and connectors of Type 183B Analyzer.



SECTION 3

APPLICATIONS

Angular Displacement Markers

There are several methods for introducing amplitude pulses for exact angular referencing of the crt display. One method is by applying the marker pulse through a capacitor to the same vertical INPUT connector that is receiving the voltage signal. This will superimpose the marker pulse on the display, referencing it accurately. See Fig. 3-1a. The value of capacitance to use depends on the impedance of the signal source, however the range from .1 μf to .001 μf should cover most cases. The use of 10° markers is of special interest for this application. For small data signals, it may be necessary to attenuate the marker pulses.

If a dual-beam or multi-trace system is used, the marker trace may be positioned near the data-signal trace for referencing (Fig. 3-1b). In this case, apply the signal from the Type 183B OUTPUT to one vertical INPUT connector and the data signal to another INPUT of the oscilloscope. Trigger the oscilloscope externally with the 360° triggering pulse from the Rotational Analyzer. This references the two signals to each other.

Intensity modulation of the trace may be introduced into some instruments with a CRT Unblanking Cable (012-061), available from Tektronix. Display the data signal on the oscilloscope screen, and apply the marker pulses from one of the OUTPUT connectors of the Type 183B to the crt unblanking connector on the back of the oscilloscope. Many instruments, however, require more than the 10 volts OUTPUT amplitude for intensity modulation. It may therefore be necessary to amplify the OUTPUT signal two or three times with a step-up transformer in order to use this method of marker application.

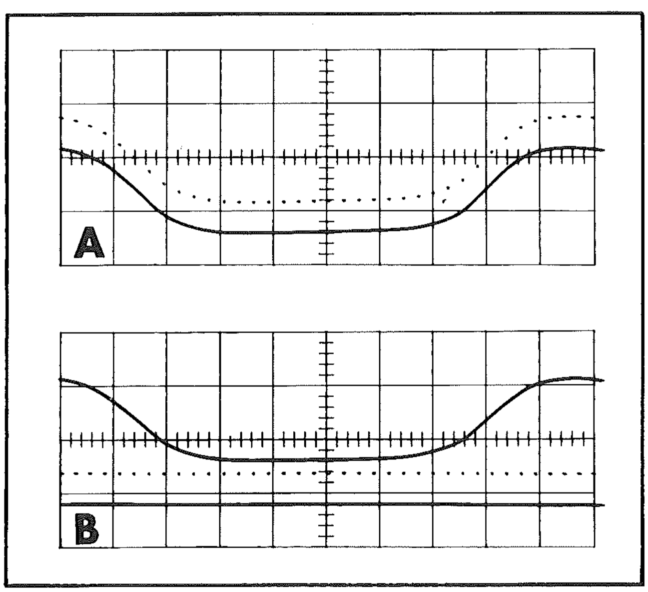


Fig. 3-1. Angular trace referencing, using 10° markers: a) superimposed on trace, b) adjacent to trace.

Comparison of Data Signals

Two or more data signals from the machine being observed may be compared by using dual-beam or multi-trace oscilloscopes. Trigger the oscilloscope with 360° triggering pulses. Both signals are then referenced to the same shaft position and thus are referenced to each other.

Changing Horizontal Reference

The triggering point of the display may be moved to correspond to any desired position of the shaft, without stopping the machine. To move the triggering point, loosen the clamp collar on the Transducer and rotate the whole body of the instrument. The trigger-producing phototransistor rotates with the body of the Transducer, thus rotating the triggering point with respect to the shaft under observation. Re-tighten the Transducer collar after obtaining the desired trace.

Angular Measurement

The adjustable angle-indicating dial on the Type 182B may be used to measure between significant points on the data-signal display. To do this, rotate the body of the Transducer until one of the points on the display corresponds with a convenient reference mark on the graticule. Loosen the knurled nut holding the angle-indicating dial on the Transducer and rotate the dial until the zero mark corresponds to the indicator mark on the Transducer collar. Tighten the dial. Now loosen the clamp collar and rotate the Transducer body until the second point on the display is at the same reference line on the graticule. The angular displacement between the two points is read directly from the Transducer dial.

Single Sweep

To view a single sweep of the trace, use the SINGLE SWEEP triggering pulse from the Rotational Analyzer. Angularly-referenced pulses provide triggering at the same selected point on the trace, each time the RESET button is pressed. First set up the desired display on the oscilloscope crt. With the TRIGGERING MODE channel switch at 360°, set the SINGLE SWEEP-REPETITIVE switch at SINGLE SWEEP. Pressing the RESET button on the Type 183B will trigger one sweep of the oscilloscope. If the trace does not trigger properly when the RESET button is pressed, rotate the TRIGGERING LEVEL control slightly counterclockwise until single sweep operation is correct. For photographic use, operate the shutter of the camera in conjunction with the RESET button.

ALTERNATE Triggering

In the study of 4-cycle reciprocating engines the two phases of the data signal can be easily separated by using the ALTERNATE triggering pulses supplied by the Type 183B. Set up the oscilloscope display as usual, triggering the oscilloscope with 360° SUCCESSIVE pulses from the Rotational Analyzer. Both phases of the 4-cycle data signal will be superimposed on the crt screen. Next, switch the ALTERNATE-SUCCESSIVE switch to ALTERNATE. With the switch in this position, the triggering circuitry of the Type 183B passes only one positive-going pulse for every two pulses received from the Shaper circuits. Thus the oscilloscope is triggered on every other revolution of the shaft. The precise time of operating the ALTERNATE switch determines which phase of the signal is displayed. There is a 50% chance of obtaining the desired display on the first try. If the wrong part of the waveform appears on the crt, switch back to SUCCESSIVE momentarily, than back to ALTERNATE. One or two tries should present the desired display. By changing the sweep expansion, it is also possible to observe the complete succession of both phases.

Rate of Rotation

With the oscilloscope operating on a time-base sweep (the conversion plug removed from its jack), marker pulses can be used to measure the rate of rotation of the shaft. Two practical methods of determining shaft speed are presented in the following paragraphs.

Connect a coaxial cable from either OUTPUT A or OUTPUT B to the vertical INPUT of the oscilloscope, and set the OUTPUT channel switch at 360°. Set the oscilloscope controls for internal triggering (INT.+), a sensitivity of 5 VOLTS/CM and a sweep rate of 1 MILLISEC/CM, MAG OFF. With the shaft rotating at the rate to be measured, free-run the trace to position it vertically, then adjust the triggering controls for a stable display. Rotate the TIME/CM switch counterclockwise, a step at a time, until approximately six or seven marker pulses appear on the crt screen.

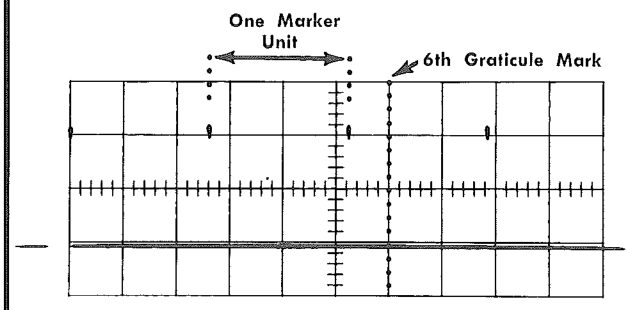


Fig. 3-2. Marker waveform for determining rotational rate.

CAUTION

Be careful not to burn the phosphors of the cathode-ray tube when using very slow sweep rates. If a slow sweep rate is required, increase the vertical sensitivity to 2 VOLTS/CM and position the dc portion of the trace below the viewing area of the screen, displaying only the markers. Adjust the intensity to a safe level.

With the HORIZONTAL POSITION control, adjust the display so that the first marker corresponds precisely with the edge mark of the graticule. Considering the distance between adjacent marker pulses to be one "Marker Unit", count the number of Marker Units between the zero and the six-centimeter* graticule marks (see Fig. 3-2). Multiply this number of Marker Units by the value of each Unit, found in Table 3-1. The value depends on the setting of the TIME/CM switch. For example, in Fig. 3-2, the number of Marker Units is 2.3 and the value of each is 1,000 rpm for the sweep rate of 10 MILLISEC/CM.

Therefore the Rate of Rotation is:

2.3 x 1,000 rpm = 2,300 rpm.

An alternate method of determining the rate of rotation of a shaft is the following: Set up the oscilloscope display as in the previous method, then rotate the TIME/CM switch until two or three markers appear on the crt screen. Determine the distance in centimeters between adjacent markers, then multiply this by the TIME/CM setting to obtain the time between markers. This is the time per revolution in seconds. Obtain the rate of rotation by inverting the Seconds/Rev. ratio and converting from seconds to minutes:

Rate of Rotation = (Rev/Sec.) x (60 Sec/Min.) = rpm.

* In this application, the 6-centimeter mark on the graticule has special significance, due to the conversion from seconds to minutes.

Table 3-1

Rate of Rotation Parameters

TIME/CM	1 mSEC	2 mSEC	5 mSEC	10 mSEC	20 mSEC	.1 SEC	50 mSEC	.2 SEC	.5 SEC	1 SEC
Value of Marker Unit (rpm)	10,000	5,000	2,000	1,000	500	200	100	50	20	10

The first of these methods, though more complicated than the second, is more convenient when making frequent observations of rotational rate. Instantaneous determination of shaft speed is possible, after only a little familiarization with the method.

Synchronizing Other Equipment

MARKER PULSES from OUTPUT A and OUTPUT B may be used to trigger and synchronize auxiliary equipment. An example of equipment which can be operated in this manner is a strobe light, for physical shaft referencing.

To apply one pulse per revolution to an auxiliary instrument, set up the oscilloscope display in the usual manner, triggered by 360° pulses from the Type 183B, and using an incremental sweep. Connect a cable from OUTPUT A or OUTPUT B to the triggering input of the auxiliary unit, then set the OUTPUT channel switch for 360°. The triggering pulse to the oscilloscope and the pulse to the other equipment occur simultaneously, with controls set in this manner. Loosen the clamp collar and rotate the body of the Transducer to move the display so the desired triggering point occurs at the left-edge mark of the graticule. A positive pulse to the auxiliary equipment will occur at this point.

Multiple Rotan System Application

Using two or more Rotan systems it is possible to determine torque and torsional vibration in long shafts, and to determine backlash and slippage in machines with gearing or several shafts.

This is accomplished by connecting Type 182B Transducers to the shaft ends to be compared, and displaying the OUTPUT pulses of the Type 183B Analyzer units differentially on an oscilloscope screen, or simultaneously on the screen of a multi-trace oscilloscope. Trigger the display with 360° pulses from one of the Rotan units, and apply 1° incremental pulses from the same unit to the sweep circuit of the scope. The angular relation between shafts appears as a relation between markers on the crt screen.

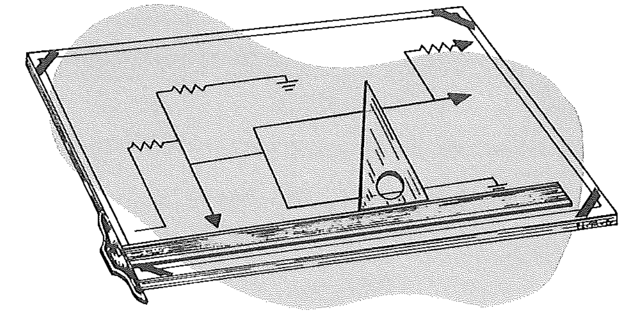
A time-base sweep with superimposed markers may also be used for relating OUTPUT pulses from two or more Rotan systems. For viewing a magnified portion of the trace, a time-base sweep must be used, with angular referencing provided by marker pulses.

To relate the angular displacements of the shafts at any selected time, set the OUTPUT channel switches at 360° and rotate one or more of the Transducers until the displayed marker pulses coincide.

Non-Uniform Rotation

On a time-base sweep there may appear to be fluctuation in marker positions. This is due to a variation in the rate of rotation of the shaft under observation. The extent of rotational variation may be determined from the display by proper use of sweep and marker controls.

NOTES



SECTION 4

CIRCUIT DESCRIPTION

General

The Tektronix Rotational Analyzer system references an oscilloscope display to the angular displacement of a rotating shaft. This is accomplished by means of the photo-electric Angle-Encoding Transducer, Type 182B, and the shaping, switching and standardizing circuitry in the Type 183B Rotational Analyzer. The block diagram in Figure 4-1 shows the relationships between all signal-carrying circuits.

TYPE 182B ANGLE-ENCODING TRANSDUCER

Power Supply

Power for the circuitry of the Transducer is supplied by the Type 183B through the transducer cable. Refer to the Characteristics section of this manual for the voltages.

Pulse-Producing System

The shaft of the rotating equipment under study is mechanically coupled to the shaft of the Angle-Encoding Transducer. Inside the Transducer a photographic-film disc, having three concentric tracks of opaque radial lines, rotates with the shaft. The lines of the three tracks are spaced at intervals of 1°, 10° and 360°, respectively. Each of the tracks has a corresponding phototransistor (Q323, Q333 and Q343) and an exciter lamp. This rotating dial and a similar stationary film which is its photographic negative, are located between the exciter lamps and the transistors. Together the two films act as a shutter to interrupt the light beams as the shaft is rotated.

Current through the phototransistors is proportional to the amount of light received. Since the normal state is at maximum illumination, hence maximum current, a passing opaque marker causes a decrease in illumination and produces an instantaneous decrease in current. The result is a positive-going voltage pulse at the emitter of the phototransistor, due to the emitter follower configuration. This is the output pulse for the particular channel of the Transducer. Ripple is eliminated by the use of a regulated dc supply for the transistors and exciter lamps.

Temperature Compensation Circuitry

Temperature has the same effect as light on a phototransistor—as the temperature increases, the current through it increases. To prevent an increase in phototransistor output with increasing ambient temperature, each phototransistor has a corresponding temperature-compensating transistor (Q313, Q353 and Q363). As the ambient temperature increases current through these transistors also increases. The circuit is arranged so that this increase in current reduces the bias on the phototransistors just enough to compensate for the increase in current which would be produced in the phototransistors by the same increase in ambient temperature. The output level of the circuit therefore remains relatively constant.

DC Output Control

The network associated with the temperature-compensating transistors also provides a means of adjusting the Transducer output dc levels. The potentiometers R324, R334 and R344 adjust the current through the temperature-compensating transistors. This in turn sets the current and the dc output level of the phototransistors.

The value of the resistor at the base of each phototransistor determines the amplitude of the output pulse for a given change in incident light. This resistor also determines the repetition rate of the light pulses that these transistors will accept. The value has been selected to give a high repetition rate with a moderate-size pulse.

TYPE 183B PHOTO-ELECTRIC ROTATIONAL ANALYZER

Power Supply

Both the Analyzer and the Transducer receive power from the power supply in the Type 183B. A half-wave rectifier furnishes the +144-volt and +2.5-volt supplies. This circuit is regulated by the gas diode voltage-regulator tube, V619. A full-wave bridge rectifier provides the —12.5-volt and —4.8-volt supplies through a transistorized series-regulated circuit. The Zener diode, D662, sets the reference voltage on the emitter of Q664. The output voltage is adjusted by a voltage divider at the base of this transistor.

Shaper Circuits

The Rotational Analyzer contains a separate shaping circuit for each of the three Transducer output signals. These Shapers are bistable Schmitt multivibrators consisting of two transistors each. Each of these multis is normally biased so that the input transistor of the circuit is conducting and the output transistor is cut off. The positive pulse from the

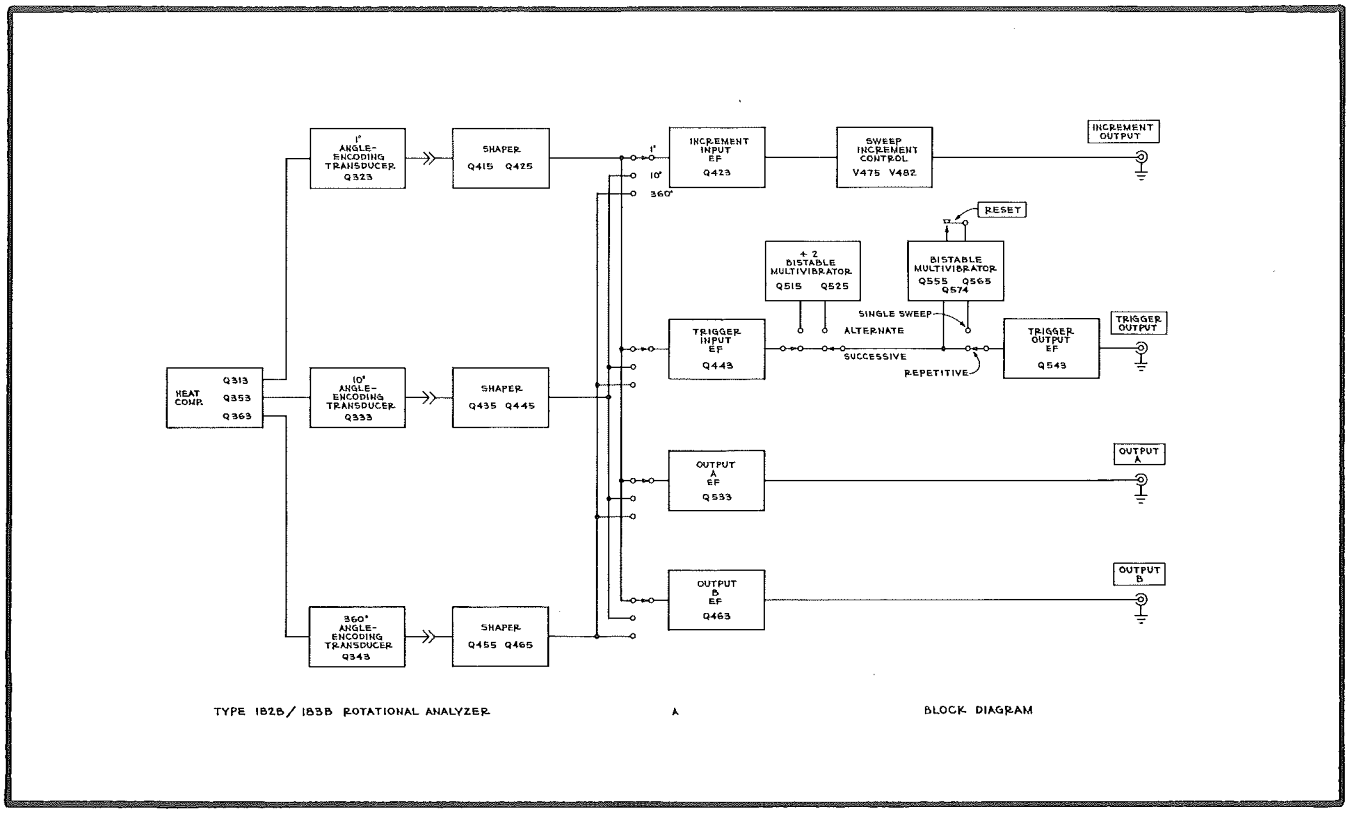


Fig. 4-1. Block Diagram of signal-carrying circuits.

Transducer cuts off the first transistor and causes the other to conduct, producing a positive-going output signal on the collector. The output does not return to its normal state until the dc level on the negative slope of the input signal has decreased to the point at which the input transistor turns on again. The output transistor then is cut off again and the voltage on the collector goes negative, remaining there until another positive signal arrives. The circuit converts a low amplitude sine-wave shaped pulse to a much larger square-wave pulse which enters directly into the switching circuitry of the Analyzer.

Angle-Channel Switching

Four front-panel slide switches on the Type 183B permit full versatility in choosing the Shaper output from any of the three signal channels. These may be used for producing sweep increment steps or triggering pulses, or for ouput pulses from OUTPUT A or OUTPUT B.

OUTPUT A and OUTPUT B

An emitter follower (Q533 or Q463) gives a dc-coupled low-impedance output at each OUTPUT connector. The output transistors also isolate the circuitry from the outputs. Thus, in the event of a short-circuit at the OUTPUT, no damage occurs, and the operation of other circuits is not disturbed.

Triggering

Direct Signal: With the TRIGGERING MODE switches at SUCCESSIVE and REPETITIVE, the Shaper output signal is conducted directly to the TRIGGER OUT terminal through the two emitter followers, Q443 and Q543.

Alternate: With triggering switches set at ALTERNATE and REPETITIVE, the triggering pulse is passed through a transistorized bistable multivibrator (PNP transistors Q515, Q525 and network). Each positive pulse from one of the Shaper multivibrators switches the ALTERNATE multi from one bistable state to the other. Thus, the output transistor, Q515, is switched into conduction by one incoming positive pulse and out of conduction by the next positive pulse. When Q515 starts to conduct, the collector goes sharply positive. When it cuts off, the collector goes sharply negative. Therefore the output signal taken off the collector of Q515 is alternately positive-going, then negative-going. Since an oscilloscope is triggered only by pulses of a single polarity, it will be triggered only once for every two pulses from the Shaper circuit.

Single Sweep: To view a single sweep trace, the triggering controls are set at SINGLE SWEEP and SUCCESSIVE or ALTERNATE, directing the signal into the transistorized bistable multivibrator (Q555 and Q565). The first triggering pulse causes Q555 to start conducting, Q565 to cut off, and back-biases diode D565. This results in a single positive TRIGGER OUT pulse, and prevents succeeding pulses from passing. Pressing the RESET button causes Q565 to start conducting, forward-biasing the diode and re-arming the multi for the next triggering pulse.

Sweep Increment Control

The incremental sweep-driving pulse is amplified and standardized in the vacuum tube Schmitt circuit of V475. Amplitude of the pulse output from the circuit is regulated by the CALIBRATOR potentiometer, R480, and the diode, D480 between the CALIBRATOR and the plate of V475. Varying the adjustment of the potentiometer sets the plate level of V475B at which the diode goes into conduction, thus limiting the positive swing of the plate output. This produces pulses of precisely constant amplitude for uniformly driving the sweep of the oscilloscope. The output from V475B charges C482, which discharges through V482A to transmit the step to the INCREMENT OUTPUT connector. Adjustment of C482 determines the amount of charge transferred to the oscilloscope for a particular setting of the CALIBRATOR control, thus setting the effective range of this control.

Operation of the Sweep

A brief description of the sweep mechanism is presented here to illustrate the differences between a time-base and an angular-displacement base sweep.

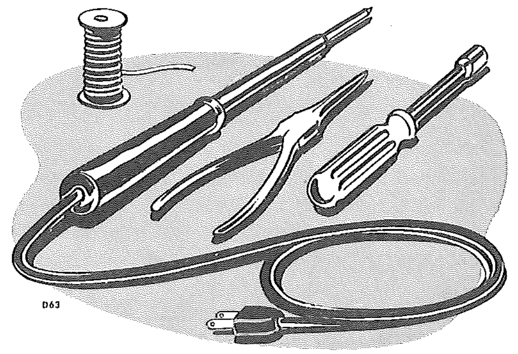
Normal Oscilloscope Operation

In the normal operation of a runup-sweep oscilloscope, the left-to-right travel of the spot on the crt screen is a horizontal representation of the change in output level of the sweep Generator tube as its plate makes a linear positive excursion of approximately 150 volts. Under quiescent conditions the grid of the Miller Sweep Generator tube is referenced to a level of approximately —3 volts across a Disconnect Diode. When a gating pulse cuts off the diode, the voltage on the grid immediately attempts to drop to —150 volts, but the initial small negative voltage change on the grid instantaneously produces a large positive swing in the plate circuit giving an inverse feedback action to the grid circuit through the timing capacitor and limiting the grid swing to a very small value. As the negative charge on the grid increases, the positive charge on the plate of the tube, essentially the output of the sweep circuitry, incrases proportionally to a final value equal to the grid swing times the gain of the tube. The rate at which this runup occurs is determined by the amount of current through the timing resistor and by the size of the timing capacitor being charged.

Incremental Sweep Operation

Since the constant current flow through the timing resistor is the source of charge increase on the Miller grid causing the linear sweep of a time base, it is necessary to electrically remove the timing resistor from the circuit to change to a sweep driven by the angularly-referenced pulses from the Rotan system. In the Type 183B, positive pulses received from V475B in the vacuum-tube Schmitt circuit are applied to C482. A positive pulse always charges this capacitor to its peak value through diode V482B, then when the voltage on the plate of V475B drops, the capacitor discharges through V482A into the timing capacitor of the oscilloscope. Each succeeding pulse from the Type 183B steps the voltage level on the Miller grid a uniform amount in the negative direction regardless of the time interval between pulses, producing a positive-going step in the plate circuit. This stepwise increase in the output level of the sweep circuit is the incremental runup. The resulting trace appears on the face of the crt as a series of dots, each of which with the adjacent interval of space represents a specified amount of angular shaft travel.

NOTES



SECTION 5

MAINTENANCE

PREVENTIVE MAINTENANCE

The Rotational Analyzer is a stable instrument, and will require complete calibration very infrequently. However, to be certain that the system is operating properly at all times, the calibration should be checked after each 500-hour period of operation (or every six months if used intermittently). A complete step-by-step procedure for calibrating the Type 182B/183B combination and checking its operation is given in the Calibration Procedure in this manual.

Visual Inspection

Many existing and potential troubles can be detected by a visual inspection of the instruments. For this reason, a complete visual check should be performed every time the unit is inoperative, needs repairs or needs recalibration. Apparent defects may include loose or broken connections, damaged connectors, improperly seated tubes or transistors, scorched or burned parts, and broken terminal strips. The remedies for these troubles are readily apparent except in the case of heat-damaged parts. Damage to parts due to heat is often the result of other less apparent troubles in the circuitry. The cause of the overheating must be found before replacing damaged parts.

COMPONENT REPLACEMENT

The procedures for replacing most parts in the Rotan are obvious and detailed instructions are not required. In some cases, additional information will aid in the replacement of parts. This information is given in the following paragraphs. Because of the nature of the instrument, replacement of certain parts will require that portions of the instrument be recalibrated for proper operation. Refer to the Calibration Procedure section of this manual for the procedures required.

Switches

If one of the front-panel switches on the Type 183B is found to be defective and needs to be replaced or repaired, use normal care in unsoldering and disconnecting the leads. The slide switches are removed from the rear of the panel by unscrewing the two retaining nuts holding each switch. It may be necessary to loosen the front panel in order to gain access to the retaining nuts.

Ceramic Terminal Strips

To replace a damaged ceramic terminal strip, unsolder all connections, then use a plastic or hard rubber mallet to tap the mounting clips out of the chassis. This is done by tapping on the ends of the clips protruding through the reverse side of the chassis. When a new strip is ordered, the mounting clips are furnished with and attached to the strip. In general, the original nylon collars may be reused, so it is not necessary to order new collars.

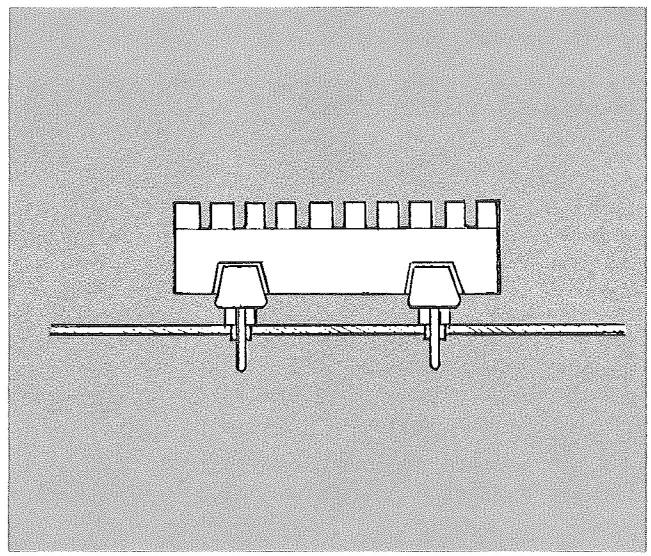


Fig. 5-1. Ceramic terminal strip mounting.

When the damaged strip and clip assembly have been removed, place the collars back into the holes in the chassis and insert the clips of the new assembly into the collars. Using a plastic mallet, tap the ceramic strip lightly above the mounting clips to drive the pins down through the nylon collars. Be sure that the clips are driven all the way into the collars. See Fig. 5-1. Cut off any excess length of the clip pins with a pair of diagonal cutters.

Soldering Precautions

In the production of Tektronix instruments, a special silver-bearing solder is used in the slots of the terminal strips to establish a bond with the ceramic. This bond may be broken by the repeated use of ordinary tin-lead solder, or by the application of too much heat. Occasional use of ordinary solder will not break the bond, however, if excessive heat is avoided. Do not use acid-flux solder for any work on electronic equipment.

If periodic maintenance work is to be performed on Tektronix instruments it is advisable to keep a stock of solder containing about 3% silver. This type of solder is often used for work on etched-circuit boards and should be readily available. It may also be purchased directly from Tektronix in one pound rolls (part number 251-514).

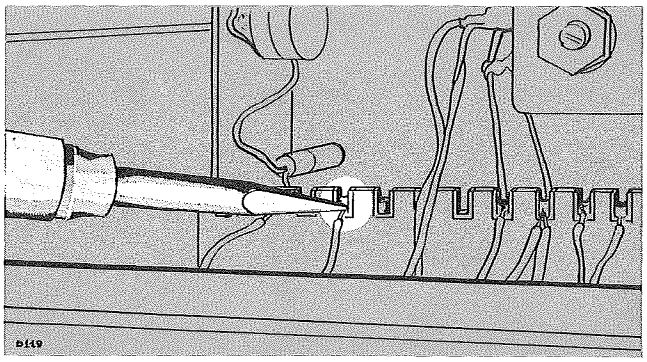


Fig. 5-2. Correct method of applying heat when soldering on a ceramic terminal strip.

Because of the shape of the terminal slots in the ceramic strips, the soldering iron should have a wedge-shaped tip for best transfer of heat. It is important to use as little heat as possible. Do not insert the tip of the soldering iron into the terminal slot, for any slight forcing or twisting may chip or break the ceramic strip. See Fig. 5-2 for method of applying heat when soldering on terminal strips. Apply only enough solder to cover the wires adequately, as shown in Fig. 5-3. Do not attempt to fill the notches.

When soldering on etched-circuit boards, use a low-wattage iron (about 30-watt) and apply as little heat as possible. Application of excess heat to a conducting strip can cause it to separate from the board. Solder containing silver should be used for this work.

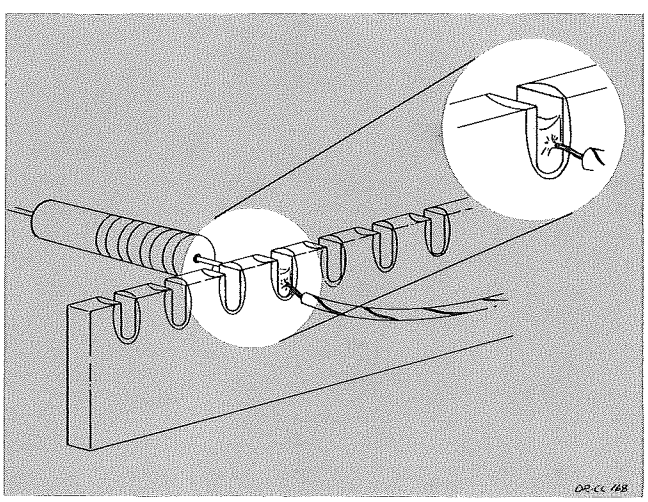


Fig. 5-3. Apply only enough solder to cover the leads adequately.

In soldering to metal terminals, use ordinary solder applied with only enough heat to allow the solder to flow slightly along the wire, forming a slight fillet at the junction. See Fig. 5-4.

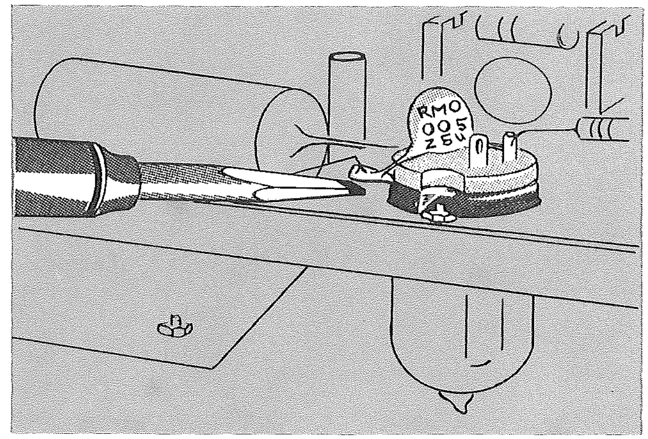


Fig. 5-4. Slight fillet of solder formed at junction.

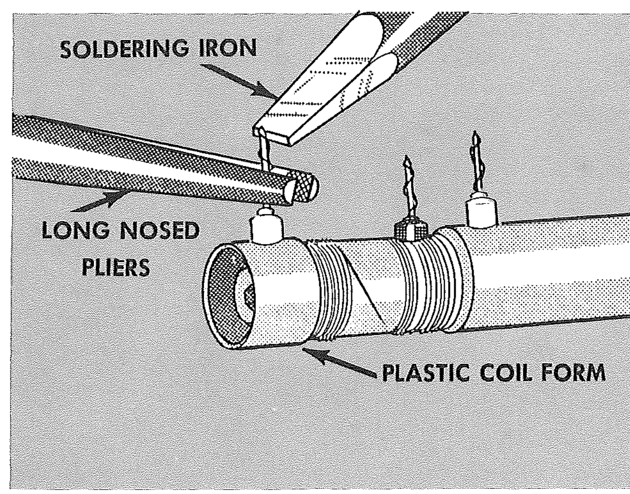


Fig. 5-5. Long-nosed pliers used to absorb heat when soldering to terminal mounted in plastic.

When soldering to terminal pins mounted in plastic, it is necessary to use some form of "heat sink" on the terminal between the soldering iron and the plastic, to avoid damaging the plastic. A pair of long-nosed pliers (Fig. 5-5) is convenient for this purpose.

A handy tool for holding bare wires in place while soldering is illustrated in Fig. 5-6. It can be made from a short length of wooden dowel with one end shaped as a wedge. After soldering a connection, clip off any excess length of the soldered leads. Be sure these ends are not dropped into the instrument where they could cause electrical shorting.

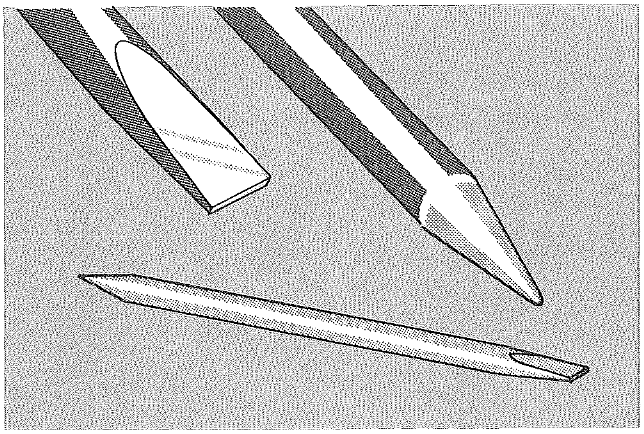


Fig. 5-6. A soldering aid for use when soldering bare leads.

Exciter Lamp Bulbs

To replace an exciter lamp in the Type 182B Transducer, it is necessary to remove the mechanical coupling from the Transducer shaft. Next remove the dial retaining nut (see Fig. 5-7), the metal washer, the angle-indicating dial and the cork washer. Then remove the six screws and the Fiberglas contact cover, exposing the bases of the exciter lamps. Locate the defective bulb and remove it. The 1° exciter lamp is nearest the outside of the Transducer, and the 360° lamp is nearest the shaft. Line up the key on the base of the new bulb with the slot in the proper hole and insert the bulb. Replace the contact cover and the angle-indicating dial assembly. Transducer output dc levels and shaper compensations of all channels must be recalibrated after replacement of any exciter lamp bulb.

Light-chopping Dial

To replace the rotating light-chopping dial in the Type 182B Transducer, first disconnect the transducer cable, then remove the rear cover from the unit. Use a $^{3}/_{16}$" nut-driver to remove the nut attaching the —4.8-volt lead to the circuit board (Fig. 6-4). Refer to Fig. 5-1 for the following steps: Unscrew the nuts holding the triangular mounting plate, then remove the plate and the three spacers from the stud screws. Pull off the complete assembly consisting of the circuit board and the white plastic mounting plate. Detach the light-chopping dial from the Transducer shaft by removing the Allen-head screw from the end of the shaft and sliding off the flanged retaining washer.

Replace all parts by reversing the order of the foregoing procedure. Be sure to replace the short metal spacer which fits on one of the stud screws between the circuit board and the plastic mounting plate.

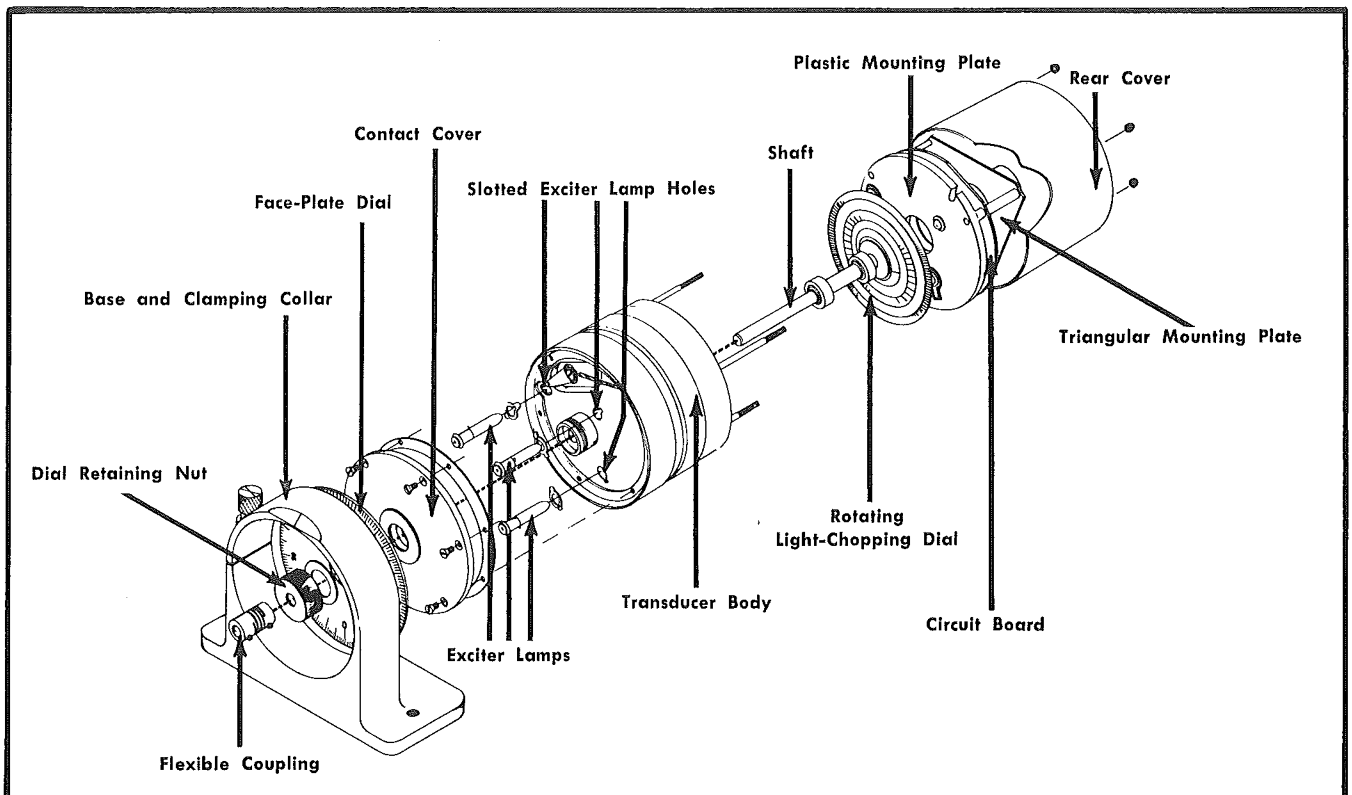


Fig. 5-7. Breakaway view of major sections of Type 182B Transducer.

REPLACEMENT PARTS

Standard Parts

Replacement for all parts used in the Rotational Analyzer can be purchased directly from Tektronix at current net prices. Many of the components, however, are standard electronic parts that can generally be obtained locally in less time than that required to obtain them from the factory. Before purchasing a part, be sure to consult the Parts List to determine the tolerance and rating required. The Parts List gives the values, tolerances, ratings, and Tektronix part number of all components used in the instruments.

Special Parts

In addition to the standard electronic components mentioned in the previous paragraph, special parts are also used. These parts are manufactured by Tektronix to satisfy particular requirements, or are manufactured especially for Tektronix by other companies. These parts (indicated by asterisks in the Parts List) and most mechanical parts should be ordered directly from Tektronix, since they are normally difficult to obtain from other sources. All parts may be obtained through your local Tektronix Field Engineering Office.

TROUBLESHOOTING

This portion of the manual is included to be used as an aid in troubleshooting the Rotational Analyzer in case trouble develops. When using the information contained in this section, correlate it with information in other sections of the manual. The procedures here are designed to serve as a general guide for isolating the trouble to a particular circuit, and indicating some probable causes of the trouble within that circuit. Observed symptoms of the system in operation are used as the basis for the guide.

A Schematic Diagram of the Analyzer circuitry is contained in the rear part of this manual. The reference designation (circuit number) of each component is shown on the diagram, as well as most component values and some important voltages and signal waveforms. When using the Schematic Diagram as a trouble-shooting aid, be sure to note the conditions for which the voltages and waveforms apply. The Circuit Description may also prove helpful in understanding the functions of specific parts in a particular circuit.

All wiring used in the Rotational Analyzer is color-coded to facilitate circuit tracing. In addition, all power supply leads are distinguishable by specific colors. The colors on these leads follow the standard RETMA code.

Preliminary Troubleshooting

Before attempting any troubleshooting, check all cable connections and check front-panel controls for proper settings. Be sure all instruments are receiving proper line voltage. If in doubt as to the connections to use, or the proper settings of controls, refer to the Operating Instructions and Applications sections of this manual.

When any troubles appear in the operation of the Rotational Analyzer system make the following preliminary checks on the instruments (leaving the system in operation):

1. Check oscilloscope operation. Remove the conversion plug from its jack on the oscilloscope and check the scope to see that it is operating correctly on a Time Base sweep.

2. Check mechanical coupling to the Transducer. Be sure the coupling is firmly attached to both shafts and is not slipping.

3. Check pilot light. If the bulb is lighted, the fuse is good and the power supply is functioning to some extent.

4. Check channel operation. Set the channel switches of the SWEEP INCREMENT CONTROL and the TRIGGERING MODE at each of the other channel positions and observe the results. If two channels appear to be operating and one does not, check the Transducer output on the corresponding terminal of the transducer cable. A high rate of rotation is required for generation of a sweep on the 360° channel.

5. Check power supply. Measure the output voltages of the power supply with a 20,000 Ω/volt dc voltmeter. See Table 6-1 for the proper values, and see Fig. 6-2 for locations of the voltage check points. (Do not measure ripple at this time). The voltages out of the power supply can give many indications of the location of trouble. Do not adjust the —12.5 V. Adj. control and do not disconnect the Transducer from the Analyzer. The following tentative assumptions may be made:

a. If the +144-volt and the +2.5-volt outputs are correct, the +144-volt rectifier and regulator circuits are probably operating properly. The voltage on the +2.5-volt lead is established by the current through the temperature-compensating transistors and the voltage-setting diode, D334. If this voltage is correct, the proper current is being drawn, so the transistors and the diode may be assumed to be operating correctly.

b. If the —12.5-volt supply is correct, the rectifier and regulator on the negative side of the power supply are probably functioning properly.

c. If the —4.8-volt lead has no voltage, the heater of V482 is probably open.

d. If the —12.5-volt and the —4.8-volt outputs are correct, the exciter lamps in the Transducer are operating with the proper current.

e. If the —4.8-volt lead has a higher voltage, one of the exciter lamps is probably burned out or not making contact. If the —12.5 V. Adj. control was not disturbed after the trouble developed, the following approximate correlations exist: A voltage of about —6.1 volts on the —4.8-volt lead indicates one bulb is out; approximately —7.7 volts indicates two bulbs out, and approximately —10 volts indicates all three out. Replace any bulbs which are found to be defective and recheck the power outputs. Method of replacement is given in the Component Replacement part of the Maintenance section.

f. If all output voltages are correct the current to the Transducer is correct, therefore the power leads in the transducer cable are continuous, the conducting strips on the circuit board are continuous, and current through components in the Transducer is approximately correct.

In the event that a component is replaced as a result of troubleshooting checks, the instrument will have to be partially recalibrated. Procedures for calibration are given in Section 6 of this manual.

The most probable causes of trouble in the circuitry are electron tubes, transistors, diodes and capacitors, in that order. The best method of checking a transistor or a tube is by direct substitution with a good component. A diode may be checked by unsoldering one end and checking resistance through it first in one direction, then in the other direction. The resistance measurement should be high in one direction and low in the other. The Zener diode, D662, is checked by measuring the voltage across it. A voltage drop between 10.4 and 11.6 volts should be indicated.

TROUBLESHOOTING PROCEDURES

In the procedures that follow, it is assumed that the Preliminary Troubleshooting checks have been made on connections, controls and power supply. The Transducer must be connected to the Analyzer and must be rotating in order to produce pulses for use in checking the circuitry.

No Sweep

Both Triggering and Increment pulses must be supplied to the oscilloscope by the Type 183B in order to produce a sweep. Leave the Rotan system controls in normal operating positions. Remove the conversion plug from the jack on the oscilloscope, if it has not already been removed. Disconnect the signal cable from the vertical INPUT of the scope and connect a 10X probe to the INPUT. Set the oscilloscope controls for internal triggering (INT.+), a sweep rate of approximately 50 μSEC/CM and 5 VOLTS/CM sensitivity. With the probe, check for signals on the bus wires on the rear of the SWEEP INCREMENT CONTROL and the TRIGGERING MODE channel switches. Adjust the triggering controls of the scope. The signals on these bus wires are the direct output from the Shaper circuits.

If incorrect signals or no signals are found on these bus wires, check back through all circuits having apparent difficulties. Keep in mind that if one or more of the exciter lamps is burned out, the dc output of the other channels is raised and the input to the Shapers is incorrect. Check the signals and voltages on terminals A, B and C on the transducer connectors at both ends of the transducer cable. With a dc voltmeter, the reading should be between —1.3 and —2.0 volts. See the Calibration Procedure for the correct waveforms.

If proper signals were found on all bus wires, either the Increment Control circuit or the Trigger emitter followers are the source of sweep trouble. With the probe, check the output signal at the TRIGGER OUT connector. If the signal has approximately the same amplitude and shape as the signal on the switching bus wire for the same channel, the Trigger E. F.s are operating properly. Check the Increment Control circuit for correct voltages and waveforms. Be sure to note the conditions for which the voltages and waveforms on the Schematic apply.

Irregular Sweep

If the Rotational Analyzer system is operating, but the sweep is irregular, there is trouble in the Increment Control circuit or in the Transducer or Shaper of the channel on which it is operating.

Non-linear: Check the Transducer output amplitude, the dc level and the amplitude variation of the channel being used, as outlined in the Calibration Procedure. Incorrect Transducer output, a damaged light-chopping dial or a defective multivibrator in the Increment Control circuit could cause irregularity.

Sweep compressed on right end: This condition indicates that the sweep-driving charge is being drained off the "timing" capacitor. Check to see that the conversion-jack circuit is correct and that nothing else is connected to the Increment Output. A probe can cause this sort of discharge.

No CALIBRATOR control of sweep expansion: Check the diode, D480. If this diode is open the CALIBRATOR will have no effect.

Irregular Triggering

If the system is operating properly except for irregular triggering, check that the oscilloscope is set for external triggering (on the modified sweep circuit) and that the Type 183B switches are set properly. Check calibration of the channel supplying the triggering pulses. With controls in SUCCESSIVE and REPETITIVE, the signal at the TRIGGER OUT connector should be nearly identical to that on the corresponding bus wire on the back of the TRIGGERING MODE channel switch.

Incorrect Alternate Sweep

If Successive triggering is operating properly, but Alternate triggering appears to be not functioning correctly, check the circuit by the method given in the Calibration Procedure. Check the circuit for correct voltages (on the Schematic Diagram), noting the conditions for which they apply. Check the transistors and diodes.

Incorrect Single Sweep

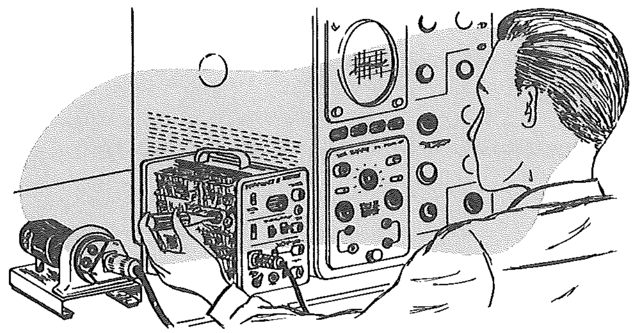
If Repetitive triggering is operating normally, but the Single Sweep appears to be giving trouble, check the operation of the circuit as in the Calibration Procedure. Check for the proper quiescent voltages given on the Schematic Diagram. Check the transistors and diodes.

No Vertical Deflection

If auxiliary equipment triggered by OUTPUT pulses from the Rotan units, or amplitude markers are not operating properly, check the signal at the OUTPUT connector. The amplitude and shape of the waveform should be nearly identical to that on the switching bus wire for the corresponding channel. These bus wires are located on the rear of the TRIGGERING MODE channel switch.

Power Supply Not Regulating

If there is trouble in regulation or output of the power supply, not caused by improper loading at the output, check back through the circuitry for voltages and ripple. Check to see that the voltage across the Zener diode is correct and the outputs of the rectifiers are correct. Check the electrolytic capacitors C612, C632 and C672. Adjust the —12.5 V. Adj. control to see its effect. The transistors and the tube, V619, may be checked by direct substitution if voltage readings indicate improper operation.



SECTION 6

CALIBRATION PROCEDURE

INTRODUCTION

Information contained in this section of the manual is provided as an aid to calibrating and checking the operation of the Rotational Analyzer. In addition, this section may be used as an aid in isolating troubles occuring in the circuitry.

Apparent troubles in the Analyzer system are occasionally the result of improper calibration of one or more circuits. Consequently, calibration checks will often aid in isolating troubles to a definite circuit or stage.

In the instructions that follow the steps are arranged in the proper sequence for a complete calibration of the units. Each numbered step contains the information required to make one check or adjustment. The steps are arranged to avoid unnecessary repetition.

In each calibration step only the required information is given. Detailed instructions pertaining to normal operation of the instruments are not included. If there is doubt as to the proper operation of controls, refer to the Operating Instructions section of this manual.

For the periodic calibration, the Transducer should be disconnected from the machine which it monitors, and should be driven by a small universal motor. Calibration should be done at the average ambient temperature at which the instruments are to be operated.

EQUIPMENT REQUIRED

The following equipment or its equivalent is required to perform a complete calibration of the Types 182B and 183B.

1. Test oscilloscope modified for Rotan system operation, with a bandpass to not less than 400 kc, calibrated sweep rates from .1 SEC/CM to 2 μSEC/CM, and a maximum sensitivity of 10 millivolts (or more) per centimeter.

2. Probe, 10:1 attenuation, with pincer tip.

3. Multimeter with a sensitivity of 20,000 Ω/volt, or an accurate 20,000 Ω/volt dc voltmeter and an ohmmeter.

4. Autotransformer with an output voltage between 0 and 125 volts (or 0 and 250 volts for 234-volt installation).

5. Small universal-type test motor with $^1/_4$-inch shaft or adapter, capable of at least 20,000 rpm.

6. Well-balanced flywheel for shaft of Type 182B Transducer. This may be a small pulley.

7. Chassis for mounting test motor with Transducer and flywheel.

8. Insulated screwdriver. See Accessories section of this manual.

9. Accessory cables supplied with the Rotational Analyzer.

PRELIMINARY PROCEDURE

Before making any adjustments of the internal controls of the Rotational Analyzer, perform the preliminary checks as follows, and mount the Transducer.

1. Remove the sides of the Type 183B and the rear cover of the Type 182B. Make a complete visual check of the instruments.

2. Connect the two instruments together by means of the transducer cable, but DO NOT connect to the line voltage.

3. Measure the resistance-to-ground values of the power supply leads. See Fig. 6-2 for the locations of the voltage check points. The transformer primary should have infinite resistance to ground, the +144-volt supply should be approximately 4 K to ground, and the —12.5-volt lead should be about 17 Ω to ground.

4. Mount the test motor on the chassis.

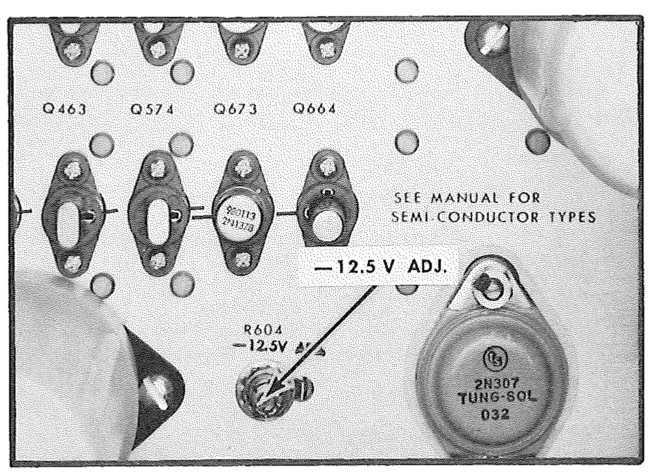


Fig. 6-1. Location of —12.5 V. Adj. control on right side of Type 183B Analyzer.

5. Install the flywheel on the Transducer shaft, and align the shaft with that of the test motor. Connect the shafts together either with the coupling provided or with a piece of 7/32-inch plastic tubing made semi-rigid by a 1-watt resistor (without leads) inserted into the tubing.

6. Attach the Transducer to the chassis, being sure to maintain accurate alignment of the two shafts.

7. Connect the autotransformer to the Type 183B with a power cord and set it for the voltage for which the Rotational Analyzer is wired (117-volts ac or 234-volts ac).

8. Connect the oscilloscope and the autotransformer to line voltage, then turn ON the POWER switches of the autotransformer, the Type 183B and the test oscilloscope.

9. Allow adequate warm-up time (at least 15 minutes) before making any calibration adjustments.

ADJUSTMENT PROCEDURE

Introduction

All of the following adjustment procedures and checks, except step 10, are performed with the oscilloscope operating on a Time Base sweep. Be sure the conversion plug is removed from its jack on the scope.

Control settings and instrument connections at the beginning of each step are listed in the step. Controls not mentioned may be in any position. The following connections remain the same throughout the Adjustment Procedure:

Connections		from:	to:
	Power cord	Oscilloscope	Power line
	Power cord	Autotrans-former	Power line
	Transducer cable	Type 183B	Type 182B
	Mech. coupling	Type 182B	Test motor

After step 3, leave the autotransformer connected to the test motor.

1. Adjust —12.5 V ADJ.

Connections		from:	to:
	Power cord	Autotrans-former	Type 183B
Controls	None		

Connect the dc voltmeter to the —12.5-volt bus wire on the left side of the Type 183B (Fig. 6-2) and to the chassis (or ground) of the Analyzer. Check for exactly —12.5 volts, and adjust with the —12.5 V. ADJ. control on the right side of the Type 183B (Fig. 6-1).

2. Check Power Supplies

Connections		from:	to:
	Power cord	Autotrans-former	Type 183B
	10X Probe		Vertical INPUT
Controls	Oscilloscope	Sweep rate	10 MILLISEC/CM
		MAGnifier	OFF (1X)
		Sensitivity	50 MILLI-VOLTS/CM
		INPUT coupling	AC
		Triggering	Internal (INT. +)

With the dc voltmeter, check for the proper output of each of the power supplies. The following table gives the maximum permissible variation of these supplies. Vary the output of the autotransformer between 105 and 125 (or 210 and 250) volts while checking to see that the power outputs remain within tolerance over the entire range.

Using the 10X probe, properly compensated, measure the amplitude of the ripple on each supply. If the oscilloscope has a VARIABLE sensitivity control, be sure it is in CALIBRATED position. Remember to consider the 10X attenuation of the probe.

TABLE 6-1. Output and Ripple Voltages

POWER SUPPLY	OUTPUT VOLTAGE	RIPPLE VOLTAGE (peak-to-peak typical)
+144 volts	+144 ±4 volts	60 mv
E	+2.5 ±0.4 volts	6 mv
D	—4.8 ±0.1 volts	10 mv
—12.5 volts	—12.5 volts	50 mv

Turn off the POWER switch of the Type 183B. Disconnect the unit from the autotransformer, then connect it directly to line voltage. Turn the POWER switch to ON position again.

3. Check Amplitude of Transducer Outputs

In order for the following circuitry to operate properly, the amplitude of the Transducer output pulses must lie within a certain range. Each output amplitude is checked by observing the signal at the Channel Test Point on the common emitter of the following Shaper multivibrator.

Connections		from:	to:
	Power cord	Autotrans-former	Test motor
	10X Probe		Vertical INPUT

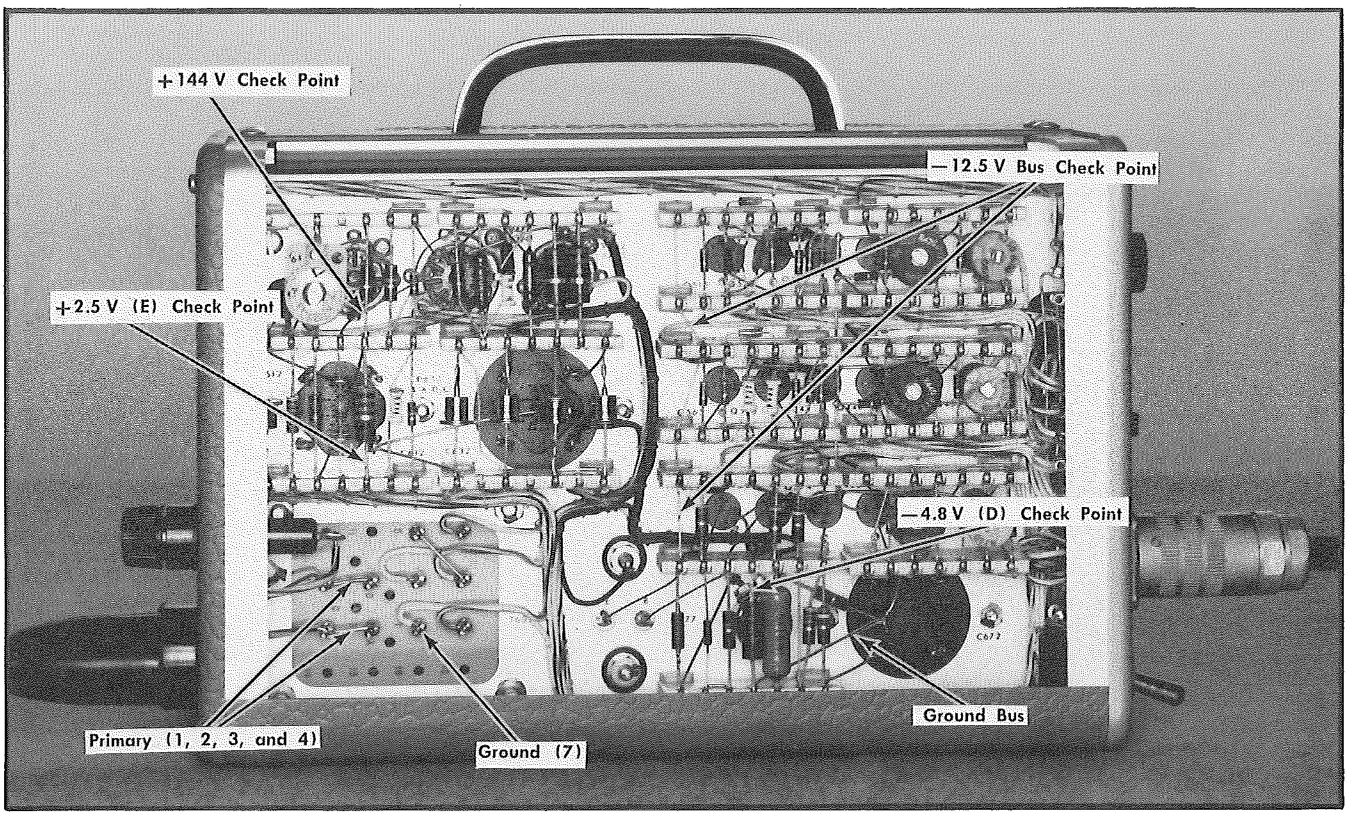


Fig. 6-2. Voltage Check Points on left side of Type 183B Analyzer.

Controls	Oscilloscope	Sweep rate	20 µSEC/CM
		MAGnifier	OFF (1X)
		Sensitivity	.05 VOLTS/CM
		INPUT coupling	DC
		Triggering	Internal (INT.+)
	Test motor	Rate	Zero rpm

With a screwdriver-type adjustment tool, center the adjustments of potentiometers R420, R440 and R460 in the Type 183B. See Fig. 6-3 for the location of these controls. Free run the trace to position it on the crt screen. Adjust the autotransformer to rotate the test motor and the Transducer at a moderate rate (about 1,000 rpm).

Beginning with the 1° channel, attach the probe pincer tip to the bus wire connecting the emitters of Q415 and Q425. This is the 1° Test Point (see Fig. 6-2). Attach the ground lead of the probe to the chassis or to a ground lead in the Type 183B. Adjust the triggering, intensity and focusing controls for an adequate display, then position the trace so that the amplitude of the pulses may be measured. If there is no vertical deflection, or if the waveshape is flattened at the top or bottom, adjust R324 in the Transducer (Fig. 6-4) to obtain the normal "sine wave" form. Fig. 6-4 shows typical Transducer output waveforms.

Adjust the speed of the motor with the autotransformer so that approximately 2½ cycles of the 1° waveform are displayed. This sets the rotation at approximately 2,000 rpm which is a convenient speed for calibrating the circuitry of the Rotational Analyzer. Note the output voltage of the autotransformer. This voltage can be used to set the rotational rate at approximately 2,000 rpm in later steps of this procedure. Measure the peak-to-peak amplitude of the waveform on the oscilloscope screen, and calculate the voltage amplitude. See Table 6-2 for the maximum and minimum permissible values for this pulse amplitude.

Perform similar amplitude checks on the Transducer output pulses for the 10° and the 360° channels, adjusting potentiometers R334 and R344, respectively.

If the pulse amplitude of any of the channels was found to be above or below the proper range, the corresponding exciter lamp must be replaced or exchanged. If there is one output which is high and another which is low, interchanging the two lamp bulbs may correct both conditions. See the text and Fig. 5-7 in the Maintenance section of this manual for the location and method of replacement of exciter lamp bulbs.

TABLE 6-2. Transducer Signal Amplitudes (2,000 rpm)

Channel	1°	10°	360°
Maximum	1.1 volts	1.0 volts	1.0 volts
Minimum	0.4 volts	0.2 volts	0.2 volts

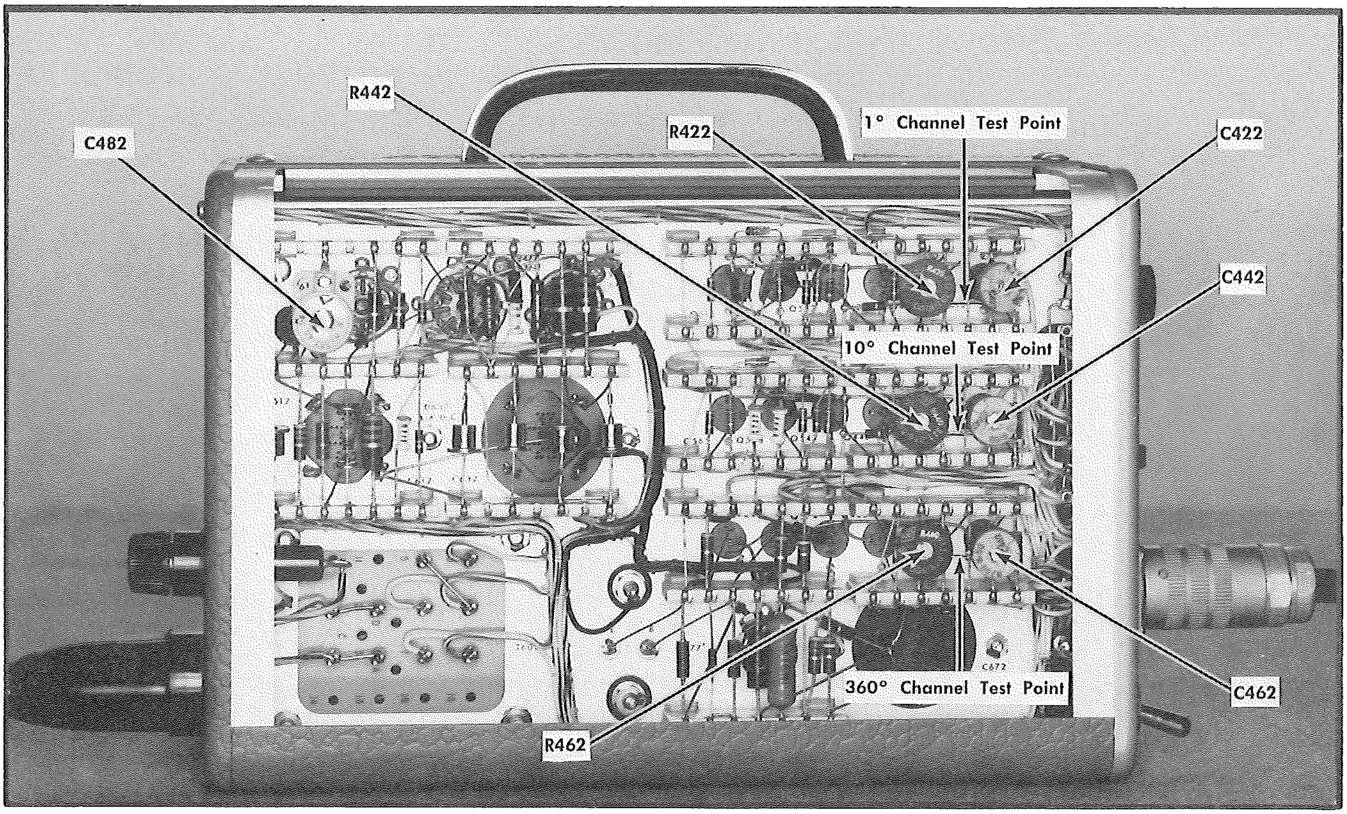


Fig. 6-3. Location of internal adjustments and Channel Test Points on left side of Type 183B Analyzer.

4. Adjust Transducer Output DC Levels

The input voltages that will switch the Shaper multis are fixed by the components of the Shaper circuits. It is therefore necessary for the dc level of each Transducer output to be of such a value that the excursion of the signal pulses will cross both switching (hysteresis) levels of the corresponding Shaper circuit. The dc levels of the Transducer signals are set by the potentiometers in the Transducer.

Connections	Same as for step 3		
Controls	Oscilloscope	Same as for step 3	
	Test motor	Rate	2,000 rpm

Attach the tip of the probe to the 1° Test Point. Trigger the oscilloscope at approximately 1/3 the amplitude of the pulses. The slight notches seen in the front and rear slopes of the pulses in Fig. 6-5 are the points at which the Shaper multivibrators switch. Adjust the sensitivity controls of the oscilloscope to obtain approximately 2 cm of vertical deflection. Adjust R324 in the Transducer to position the lower switching level (rear slope) slightly higher than 1/2 the amplitude of the pulses. If the amplitude of the Transducer output signal is correct, R324 should have enough range to position the switching levels all the way from the top to the bottom of the pulses. Fig. 6-5 shows the display with R324 properly adjusted.

Perform similar adjustments on the 10° and the 360° channels. For the 10° adjustment, observe the pulse at the 10° Test Point and adjust R334; for 360° observe the pulse at the 360° Test Point and adjust R344.

Remove the probe from the INPUT connector.

5. Adjust Shaper Compensation

The variable capacitors in the Shaper circuits compensate for attenuation in the circuits, providing an adjustment for obtaining a fast rise on the leading edge of the output waveform, without ringing.

Connections		**from:**	**to:**
	50 Ω Coax. cable	Rotan OUTPUT A	Vertical INPUT
Controls	Oscilloscope	Sweep rate	20 μSEC/CM
		MAGnifier	OFF (1X)
		Sensitivity	5 VOLTS/CM
		INPUT coupling	DC
		Triggering	Internal (INT.+)
	Type 183B	OUTPUT A	1°
	Test motor	Rate	2,000 rpm

Set up an adequate display with the oscilloscope controls, triggering the display at a point approximately 1/4 the amplitude of the pulse. Observe the leading edge of the

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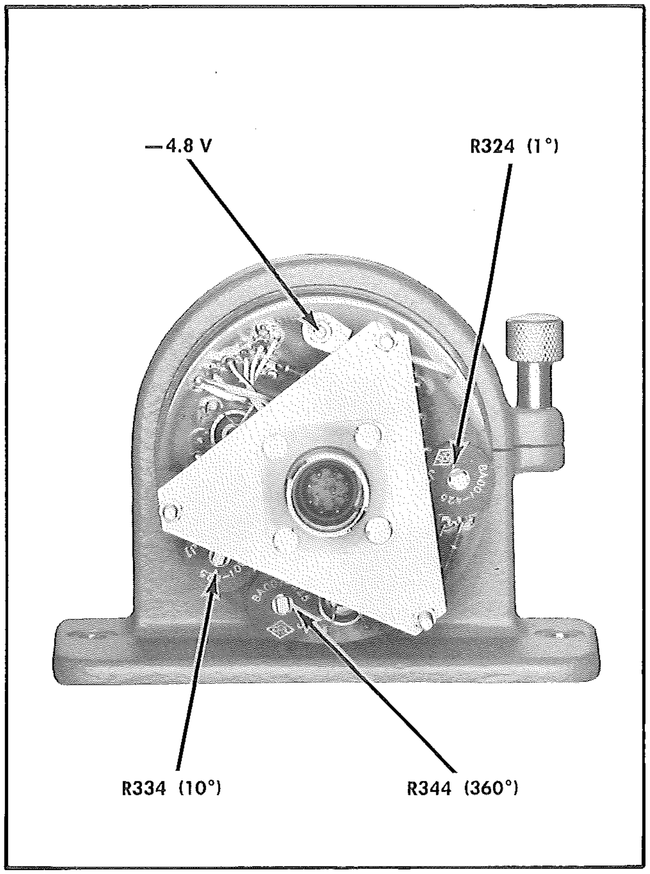


Fig. 6-4. Internal adjustments in Type 182B Transducer.

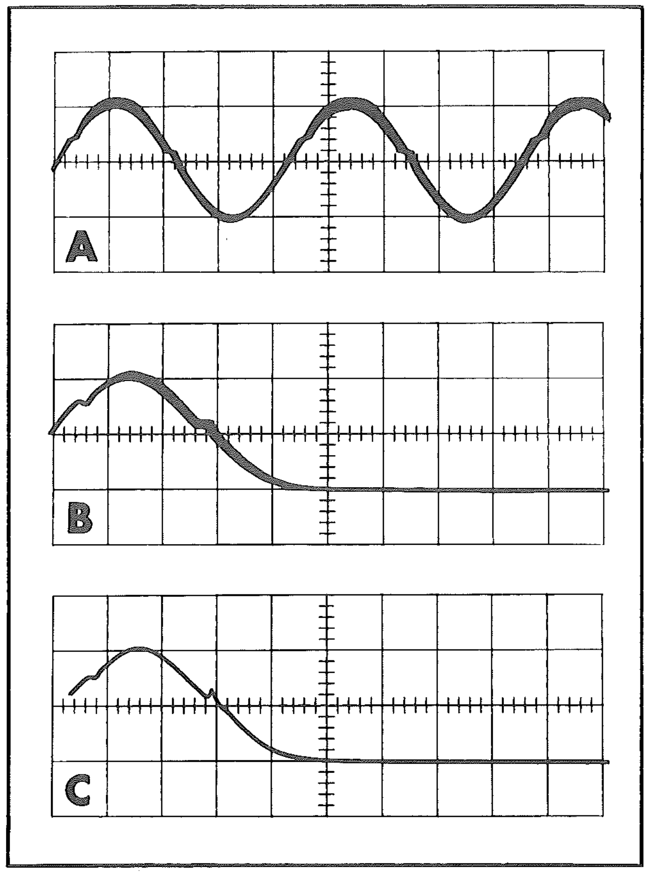


Fig. 6-5. Output waveforms of Type 182B Transducer, with dc levels properly adjusted: a) 1°, b) 10°, c) 360°.

OUTPUT waveform. Rotate the sweep rate switch to 2 μSEC/CM and adjust C422 (Fig. 6-3), first to the point where ringing is evident on the leading edge, then back off the adjustment until the ringing just disappears. Increase the speed of the test motor to 20,000 rpm (2½ cycles displayed) while watching the leading edge of the waveform. If any ringing appears, re-adjust C422 slightly until the ringing just disappears. Reduce the rate of rotation to normal.

Check the OUTPUT signals from the 10° and the 360° channels similarly, by switching the OUTPUT A channel switch. Adjust C442 for the 10° channel, and adjust C462 for the 360° channel. See Fig. 6-3 for the location of these controls.

Turn the sweep rate switch back to 20 μSEC/CM, and the OUTPUT A switch to 1°.

6. Check OUTPUT A and OUTPUT B

Amplitude of the MARKER PULSES should be no less than 10 volts for referencing the oscilloscope display and for triggering auxiliary equipment.

Connections	Same as for step 5.		
Controls	Oscilloscope	Same as for step 5	
	Type 183B	Same as for step 5	
	Test motor	Rate	2,000 rpm

Trigger the display properly and position it on the screen for measurement of the signal amplitude. Determine the amplitude of the OUTPUT A pulses on the 1° channel, then on the 10° and the 360° channels. Each of these should measure no less than 10 volts, peak-to-peak.

Move the cable from OUTPUT A to OUTPUT B connector. Determine the pulse amplitudes from OUTPUT B, using the same procedure as for OUTPUT A. Each channel should have a pulse amplitude of no less than 10 volts.

Remove the coaxial cable from OUTPUT B.

7. Check Trigger Outputs

The triggering pulses from the Type 183B must remain stable throughout the entire range of operating rotational rates in order to produce uniform triggering of the oscilloscope.

Connections		**from:**	**to:**
	50 Ω Coax. cable	Rotan TRIGGER OUT	Vertical INPUT
Controls	Oscilloscope	Same as for step 5	
	Type 183B	TRIGGERING MODE	1°, SUCCESSIVE and REPETITIVE
	Test motor	Rate	2,000 rpm

Adjust the oscilloscope triggering to obtain a display of the TRIGGER OUT waveform. Check for a pulse amplitude of no less than 8 volts. Next, increase the speed of the motor to 20,000 rpm, while watching the oscilloscope screen for stability of the display. Lack of stability usually indicates inadequate or misadjusted Transducer output. Jitter at the right edge of the graticule at slow rotational rates is caused by irregularity in the speed of the test motor.

Decrease the motor speed to normal. Perform these checks on the 10° channel with the TRIGGERING MODE switch at 10° and the sweep rate at .2 MILLISEC/CM. Also make the trigger checks on the 360° channel with the TRIGGERING MODE switch at 360° and the sweep rate at 2 MILLISEC/CM. Decrease the motor speed to normal.

Set the TRIGGERING MODE channel switch back to 1°

8. Check ALTERNATE Trigger

The ALTERNATE multivibrator is switched from one bistable state to the other only by positive pulses. Therefore every other trigger pulse switches the multi in one direction, and the next positive pulse switches it back, producing a square-wave output.

Connections	Same as for step 5		
Controls	Oscilloscope	Same as for step 5	
	Type 183B	Same as for step 5	
	Test motor	Rate	2,000 rpm

Turn the sweep rate switch to 50 μSEC/CM, then observe the change in the waveform as the ALTERNATE-SUCCESSIVE switch is changed to ALTERNATE. The comparison between the two waveforms should be similar to that shown in Fig. 6-6. Check the ALTERNATE display for not less than 7 volts amplitude, peak-to-peak.

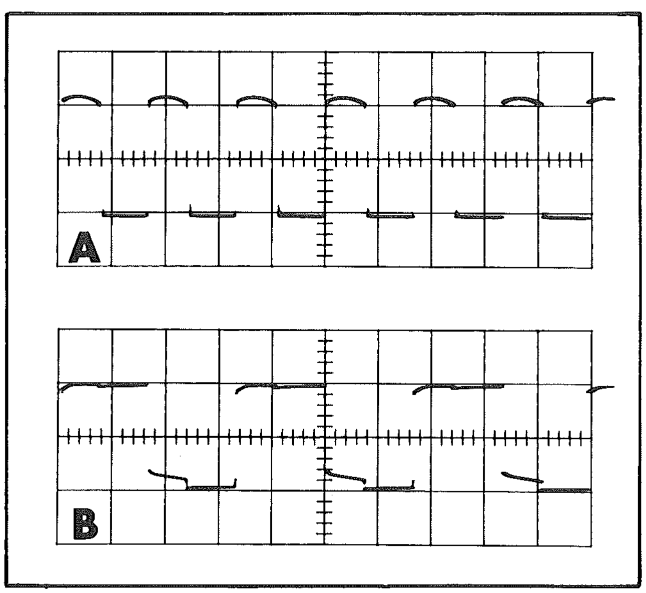


Fig. 6-6. Comparison of (a) Successive and (b) Alternate waveforms for the 1° channel.

Set the ALTERNATE-SUCCESSIVE switch at SUCCESSIVE, the TRIGGERING MODE channel switch at 10°, and the sweep rate at .5 MILLISEC/CM. Adjust the triggering level, then switch to ALTERNATE and check for the proper waveform having an amplitude of no less than 7 volts. Turn the oscilloscope sweep rate to .1 MILLISEC/CM and increase the speed of the test motor from 2,000 to 20,000 rpm. The ALTERNATE trigger should operate over the entire range. Decrease the motor speed to 2,000 rpm.

Set the ALTERNATE-SUCCESSIVE switch at SUCCESSIVE, the TRIGGERING MODE channel at 360° and the sweep rate at 20 MILLISEC/CM. Switch to ALTERNATE, after adjusting the triggering level, and observe the change in the waveform. Check for not less than 7 volts amplitude. Set the sweep rate at 5 MILLISEC/CM and increase the rotational rate to 20,000 rpm. ALTERNATE triggering should operate over the entire range. Decrease the motor speed again to 2,000 rpm.

Switch the sweep rate to 50 μSEC/CM and the TRIGGERING MODE to the 1° channel. Slowly increase the speed of the test motor until the ALTERNATE waveform becomes unstable. Back off slightly until the signal becomes stable again, and determine the rate of rotation at this time. This should not be less than 5,000 rpm.

Remove the cable from the TRIGGER OUT and vertical INPUT.

9. Check SINGLE SWEEP

In order to produce a single sweep of the display, with the triggering point referenced to the shaft angle, the SINGLE SWEEP bistable multi must pass only the first triggering pulse after the RESET button is pressed.

Connections		**from:**	**to:**
	50 Ω Coax. cable	Rotan TRIGGER OUT	External Trig. INPUT
	50 Ω Coax. cable	Rotan OUTPUT A	Vertical INPUT
Controls	Oscilloscope	Sweep rate	50 μSEC/CM
		MAGnifier	OFF (1X)
		Sensitivity	5 VOLTS/CM
		INPUT coupling	DC
		Triggering	External (EXT.+) DC
	Type 183B	TRIGGERING MODE	1°, SUCCESSIVE and REPETITIVE
		OUTPUT A	1°
	Test motor	Rate	2,000 rpm

Freerun the trace to position it on the crt screen, then adjust the oscilloscope triggering to obtain a stable display. Switch the SINGLE SWEEP—REPETITIVE to SINGLE SWEEP. If the trace is not extinguished, rotate the triggering level control of the oscilloscope slightly counterclockwise until the trace is just extinguished. Turn off the test motor by decreasing the output of the autotransformer to zero. Now press the RESET button on the Type 183B. The READY lamp should light and remain on, but the oscilloscope should not be triggered. If the oscilloscope is triggered when the RESET button is pressed, readjust the triggering level slightly until this no longer occurs. Next, turn the shaft of the Transducer slightly by hand. A single trace should be triggered on the oscilloscope screen, and the READY lamp on the Rotan should be extinguished.

Turn the TRIGGERING MODE switches to 10° and REPETITIVE. Readjust the speed of the motor to 2,000 rpm and perform the previous check on the 10° channel. Next, set the TRIGGERING MODE for 360° and REPETITIVE, set the motor and perform the check using the 360° pulses.

Switch the TRIGGERING MODE of the Rotan back to 1° and REPETITIVE. Turn on the test motor and check SINGLE SWEEP operation while increasing the motor speed up to 20,000 rpm. A single sweep should be triggered each time the RESET button is pressed, and at no other time. If the triggering level is set correctly, the sweep should be triggered at the same point on the display each time. The READY lamp should not appear to light (except at slow speeds) when the RESET button is pressed, due to the fact that it is instantaneously extinguished by the next pulse.

Perform these checks similarly on the 10° and the 360° channels while increasing the rotational rate up to 20,000 rpm. Also check SINGLE SWEEP operation on the 10° and the 360° channel with the ALTERNATE-SUCCESSIVE switch at ALTERNATE.

SINGLE SWEEP triggering should operate on all channels from zero to 20,000 rpm, and in all MODES except 1° ALTERNATE.

10. Adjust Incremental Output CALIBRATOR Range

The amplitude of the incremental output pulses must be properly adjusted for the system to operate on an angular displacement base, with the shaft angle referenced to the oscilloscope graticule.

Connections	Same as for step 9		
Controls	Oscilloscope	Same as for step 9.	
	Rotan	TRIGGERING MODE	360°, SUCCESSIVE and REPETITIVE
		OUTPUT A	360°
		SWEEP INCREMENT CONTROL	1°, CALIBRATOR mid-range
	Test motor	Rate	2,000 rpm

Connect the phone plug cable to the INCREMENT OUTPUT connector and insert the plug into the conversion jack on the oscilloscope. Adjust the triggering controls of the modified sweep for a stable display. Set the sweep rate switch at a position that produces a display with only two markers—one at the left edge of the graticule and one near the right edge. With C482 on the left side of the Type 183B (Fig. 6-3), and the HORIZONTAL POSITION control on the oscilloscope, adjust the display so that the left marker coincides with the left-edge graticule mark and the right marker coincides approximately with the right-edge graticule mark. Minor adjustment may be made with the CALIBRATOR control.

If the Rotan system is to be used for analysis of 4-cycle engines, adjust C482 so that the CALIBRATOR has a range allowing the right marker to be positioned either at the right-edge graticule mark or at the center graticule mark. This will permit viewing of either one or two revolutions of the shaft.

Remove the cable connecting OUTPUT A to the vertical INPUT, and remove the phone cable from the conversion jack and from the INCREMENT OUTPUT connector.

11. Check Transducer Amplitude Variation

Variation in the amplitude of the 1° and 10° pulses as the shaft rotates one revolution indicates that the rotating disc is either slightly off-center or is warped or damaged.

Connections		from:	to:
	50 Ω Coax. cable	Rotan TRIGGER OUT	External Trig. INPUT
	10X Probe		Vertical INPUT
Controls	Oscilloscope	Sweep rate	5 MILLISEC/CM
		MAGnifier	OFF (1X)
		Sensitivity	.05 VOLTS/CM
		INPUT coupling	DC
		Triggering	External (EXT.+) DC
	Type 183B	TRIGGERING MODE	360°, SUCCESSIVE and REPETITIVE
	Test motor	Rate	2,000 rpm

Attach the probe tip to the 1° Test Point, and the probe ground lead to a ground on the Type 183B. Adjust the oscilloscope controls for a triggered display. Observe a large number of 1° pulses, noting the amount of variation evident in the amplitude of the pulses. Variation should not exceed 20% of the average peak-to-peak amplitude. Measurement of amplitude variation is illustrated with 1° pulses in Fig. 6-7.

Move the probe tip to the 10° Test Point and check the variation in amplitude of the 10° pulses. This variation should not exceed 20% of the average amplitude.

If either of these channels has variation in excess of 20%, the rotating dial must be adjusted or replaced. See the Maintenance section of this manual for the location of the dial and the method of removal.

Remove the probe from the vertical INPUT connector.

12. Check Marker-Position Error

To determine the overall error in the positioning of the 1° and 10° markers, a magnified view of the OUTPUT

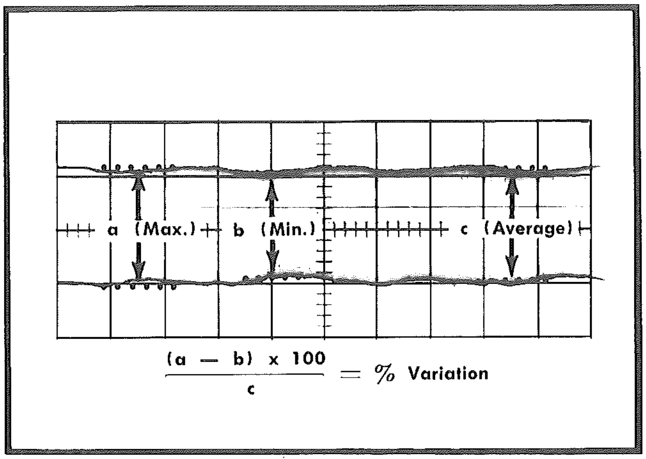


Fig. 6-7. Measurement of 1° marker amplitude variation in one revolution.

signals may be observed. By operating the Transducer at a relatively high rate of rotation and allowing the oscilloscope to be triggered on any of these pulses, the display will randomly compare the positions of all markers against those of all other markers of the particular channel.

Connections		from:	to:
	50 Ω Coax. cable	Rotan TRIGGER OUT	External Trig. INPUT
	50 Ω Coax. cable	Rotan OUTPUT A	Vertical INPUT
Controls	Oscilloscope	Sweep rate	1 MILLISEC/CM
		MAGnifier	OFF (1X)
		Sensitivity	5 VOLTS/CM
		INPUT coupling	DC
		Triggering	External (EXT.+) DC
	Type 183B	TRIGGERING MODE	1°, SUCCESSIVE and REPETITIVE
		OUTPUT A	1°
	Test motor	Rate	Zero rpm

Install a flywheel on the shaft of the Transducer. Adjust the autotransformer output to rotate the test motor and the Transducer at approximately 6,500 rpm, to display approximately 1 revolution of the shaft on the crt screen. Now magnify the display at least 20X (up to 50X)* and examine the trace for jitter caused by marker position variation. Since the repetition rate of the sweep will tend to synchronize with the rotation rate of the Transducer at certain shaft speeds, it will be necessary to vary the rotational rate slightly to find the speed at which the jitter is most readily observed. With the HORIZONTAL POSITION control (or the DELAY-TIME MULTIPLIER) move the trace to look at each portion of the display. Determine the maximum extent of the jitter, measured in minutes of arc. This is conveniently determined by comparing the jitter with one cycle of the 1° waveform, which is equal to 60 minutes of arc. Figure 6-8 shows a display with marker-position variation.

Set the Type 183B OUTPUT A switch at 10° and the TRIGGERING MODE at 10°. Determine the position variation of the 10° markers.

If the jitter in either of these checks is in excess of 15 minutes of arc, note the variation found in Transducer output amplitudes in step 11. Error in marker position may be caused either by an off-center or warped marker dial, or by error in position of the markers on the dial. Readjustment or replacement of the dial is necessary if the jitter is excessive. See the Maintenance section of this manual for the location of the marker dial and the method of removal.

Remove the flywheel from the Transducer shaft.

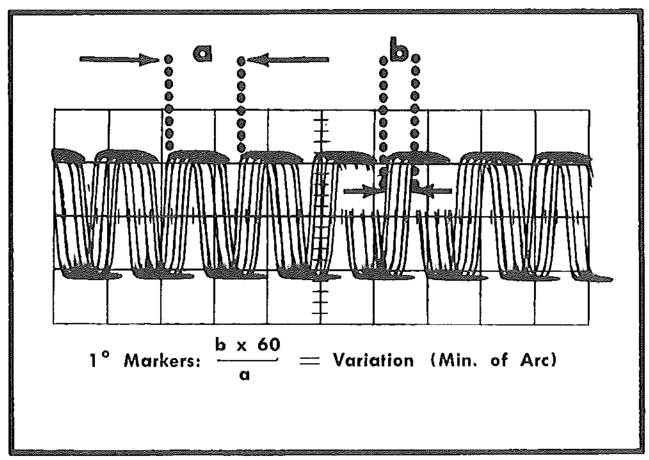
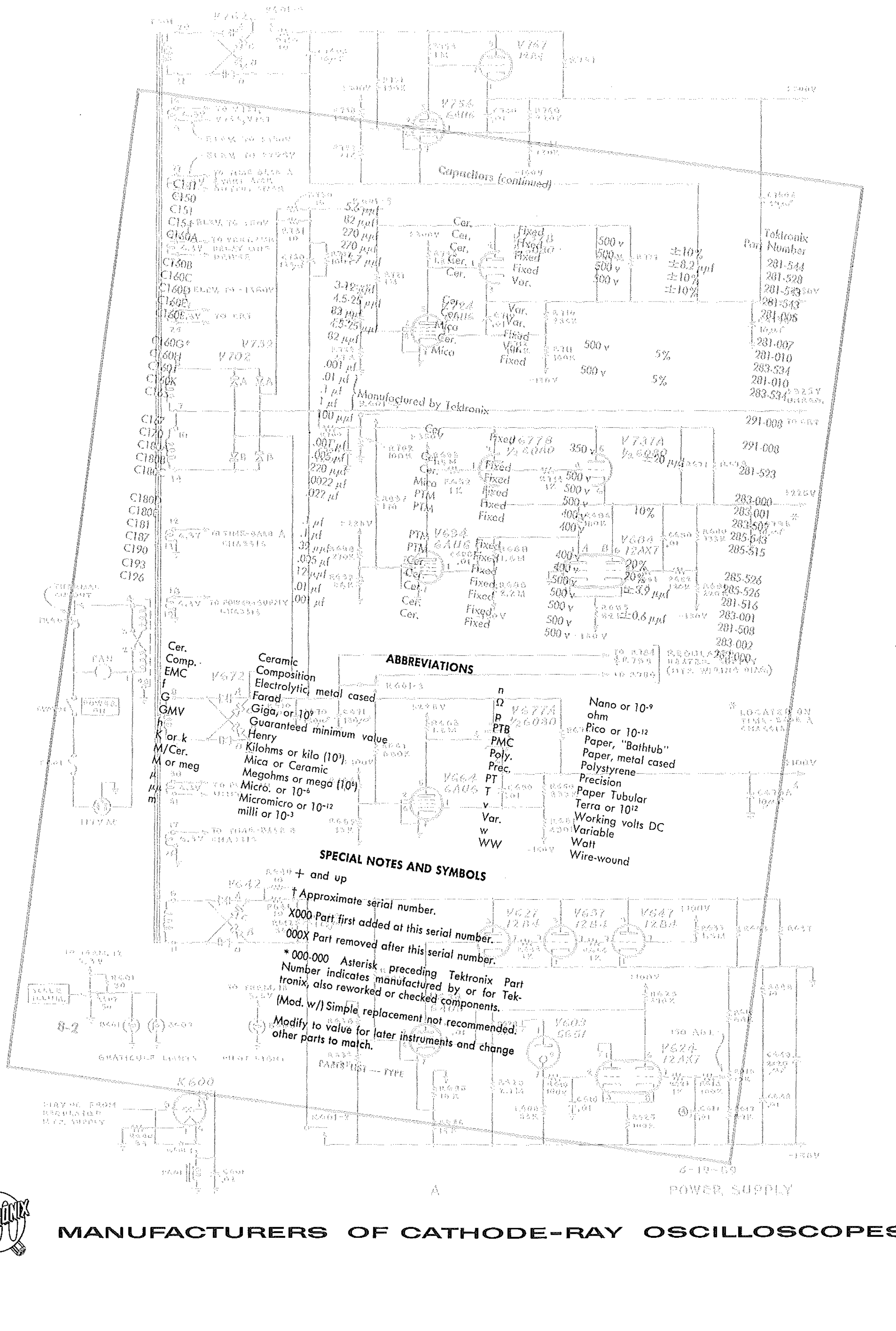


Fig. 6-8. Jitter measurement for determining marker error.

* The magnification may be produced either by a MAGNIFIER or with a delaying sweep. Operation of magnification controls is described in the manual supplied with the oscilloscope.

PARTS LIST *and* DIAGRAMS



MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

HOW TO ORDER PARTS

Replacement parts are available through your local Tektronix Field Office.

Improvements in Tektronix instruments are incorporated as soon as available. Therefore, when ordering a replacement part it is important to supply the part number including any suffix, instrument type, serial number, plus a modification number where applicable.

If the part you have ordered has been improved or replaced, your local Field Office will contact you if there is a change in part number.

PARTS LIST

Values are fixed unless marked Variable.

Bulbs

Ckt. No.	Tektronix Part Number	Description		S/N Range
B323	*150-024	Assembly		
B333	*150-024	Assembly		
B343	*150-024	Assembly		
B574	150-002	NE-2	READY	
B601	150-019	Neon, IEG3	Pilot Light	

Capacitors

Tolerance ±20% unless otherwise indicated.
Tolerance of all electrolytic capacitors are as follows (with exceptions):

3 V — 50 V = —10% +250%
51 V — 350 V = —10% +100%
351 V — 450 V = —10% +50%

C313	283-017	1 μf	Discap		3 v	
C345	283-017	1 μf	Discap		3 v	
C422	281-022	8-50 μμf	Cer.	Var.		
C442	281-022	8-50 μμf	Cer.	Var.		
C462	281-022	8-50 μμf	Cer.	Var.		
C471	281-523	100 μμf	Cer.		350 v	
C475	281-534	3.3 μμf	Cer.			±.25 μμf
C482	281-012	7-45 μμf	Cer.	Var.		
C515	283-000	.001 μf	Discap		500 v	
C525	283-000	.001 μf	Discap		500 v	
C528	283-000	.001 μf	Discap		500 v	
C555	283-028	.0022 μf	Discap		50 v	
C558	281-523	100 μμf	Cer.		350 v	
C565	283-003	.01 μf	Discap		150 v	
C568	281-523	100 μμf	Cer.		350 v	
C612A,B	*290-129	2 x 40 μf	EMC		350 v	
C632	*290-087	2000 μf	EMC		30 v	
C672	*290-087	2000 μf	EMC		30 v	

Diodes

D334	152-058	SG22		
D480	152-008	T12G		
D515	152-008	T12G		
D525	152-008	T12G		
D555	152-008	T12G		
D565	152-008	T12G		
D612	152-048	1N2864		
D632A,B,C,D	152-047	1N2862		
D662	152-055	11 V	¼ w	5%

Fuse

Ckt. No.	Tektronix Part Number	Description				S/N Range
F601	159-025	.5 Amp 3 AG Fast-Blo				

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R313	316-821	820 Ω	1/4 w			
R320	316-123	12 k	1/4 w			
R323	316-472	4.7 k	1/4 w			
R324	311-278	5 k	.1 w	Var.		
R325	316-123	12 k	1/4 w			
R326	316-103	10 k	1/4 w			
R327	316-222	2.2 k	1/4 w			
R330	316-123	12 k	1/4 w			
R333	316-472	4.7 k	1/4 w			
R334	311-278	5 k	.1 w	Var.		
R335	316-123	12 k	1/4 w			
R336	316-103	10 k	1/4 w			
R340	316-123	12 k	1/4 w			
R343	316-472	4.7 k	1/4 w			
R344	311-278	5 k	.1 w	Var.		
R345	316-123	12 k	1/4 w			
R346	316-103	10 k	1/4 w			
R413	316-221	220 Ω	1/4 w			
R414	302-681	680 Ω	1/2 w			
R417	316-153	15 k	1/4 w			
R420	311-131	1 k	.1 w	Var.		
R421	316-102	1 k	1/4 w			
R422	301-133	13 k	1/2 w		5%	
R424	316-472	4.7 k	1/4 w			
R427	316-472	4.7 k	1/4 w			
R433	316-221	220 Ω	1/4 w			
R434	302-681	680 Ω	1/2 w			
R437	316-153	15 k	1/4 w			
R440	311-056	500 Ω	.1 w	Var.		
R441	316-102	1 k	1/4 w			
R442	301-133	13 k	1/2 w		5%	
R444	316-472	4.7 k	1/4 w			
R447	316-472	4.7 k	1/4 w			
R453	316-221	220 Ω	1/4 w			
R454	302-681	680 Ω	1/2 w			
R457	316-153	15 k	1/4 w			
R460	311-056	500 Ω	.1 w	Var.		
R461	316-102	1 k	1/4 w			
R462	301-133	13 k	1/2 w			
R464	316-472	4.7 k	1/4 w		5%	
R467	316-472	4.7 k	1/4 w			
R470	316-474	470 k	1/4 w			
R471	316-104	100 k	1/4 w			
R473	301-512	5.1 k	1/2 w		5%	
R474	304-182	1.8 k	1 w			

Ckt. No.	Tektronix Part Number	Description				S/N Range
R475	309-012	970 k	½ w	Prec.	1%	
R476	309-101	330 k	½ w	Prec.	1%	
R478	301-512	5.1 k	½ w		5%	
R480	311-016	10 k	2 w	Var.	CALIBRATOR	
R481	306-123	12 k	2 w			
R484	302-104	100 k	½ w			
R485	302-152	1.5 k	½ w			
R513	316-821	820 Ω	¼ w			
R514	316-472	4.7 k	¼ w			
R515	316-473	47 k	¼ w			
R517	316-273	27 k	¼ w			
R518	316-563	56 k	¼ w			
R524	316-472	4.7 k	¼ w			
R525	316-473	47 k	¼ w			
R527	316-273	27 k	¼ w			
R528	316-563	56 k	¼ w			
R533	316-472	4.7 k	¼ w			
R543	316-472	4.7 k	¼ w			
R553	316-122	1.2 k	¼ w			
R554	316-472	4.7 k	¼ w			
R555	316-473	47 k	¼ w			
R556	302-473	47 k	½ w			
R557	316-273	27 k	¼ w			
R558	316-563	56 k	¼ w			
R564	316-472	4.7 k	¼ w			
R565	316-473	47 k	¼ w			
R567	316-273	27 k	¼ w			
R568	316-563	56 k	¼ w			
R570	302-104	100 k	½ w			
R572	302-393	39 k	½ w			
R573	316-474	470 k	¼ w			
R574	302-473	47 k	½ w			
R575	302-392	3.9 k	½ w			
R601	302-473	47 k	½ w			
R602	308-166	16 Ω	5 w	WW	5%	
R603	*308-141	1 Ω	½ w	WW	5%	
R604	311-120	2.5 k	.2 w	Var.	—12.5 v ADJ.	
R606	302-822	8.2 k	½ w			
R619	308-018	2.5 k	10 w	WW	5%	
R618	306-223	22 k	2 w			
R620	302-221	220 Ω	½ w			
R622	304-333	33 k	1 w			
R660	302-102	1 k	½ w			
R664	302-471	470 Ω	½ w			
R667	302-472	4.7 k	½ w			
R673	302-103	10 k	½ w			
R678	307-036	6.8 Ω	1 w		5%	
R679	303-680	Selected	68 Ω nominal			

Switches

Ckt. No.	Tektronix Part Number	Description		S/N Range
	Unwired			
SW470	260-251	Slide	SWEEP INCREMENT CONTROL 1° —10° —360°	
SW510	260-251	Slide	TRIGGERING MODE 1° —10° —360°	
SW515	260-212	Slide	ALTERNATE—SUCCESSIVE	
SW543	260-145	Slide	SINGLE SWEEP—REPETITIVE	
SW555	260-016	Red Button	RESET	
SW585	260-251	Slide	MARKER PULSES OUTPUT A	
SW587	260-251	Slide	MARKER PULSES OUTPUT B	
SW601	260-134	Toggle	POWER ON	

Transformer

T601	*120-173	Power

Transistors

Q313	151-004	2N214
Q323	151-053	2N469A/2N1392 (or equal)
Q333	151-053	2N469A/2N1392 (or equal)
Q343	151-053	2N469A/2N1392 (or equal)
Q353	151-004	2N214
Q363	151-004	2N214
Q415	151-047	2N1631
Q423	151-005	2N212
Q425	151-047	2N1631
Q435	151-047	2N1631
Q443	151-005	2N212
Q445	151-047	2N1631
Q455	151-047	2N1631
Q463	151-005	2N212
Q465	151-047	2N1631
Q515	151-042	2N1378
Q525	151-042	2N1378
Q533	151-005	2N212
Q543	151-005	2N212
Q555	151-042	2N1378
Q565	151-042	2N1378
Q574	151-005	2N212
Q664	151-047	2N1631
Q673	151-042	2N1378
Q677	151-014	2N307

Electron Tubes

V475	154-078	6AN8
V482	154-016	6AL5
V619	154-001	OA2

Type 182B/183B
Mechanical Parts List

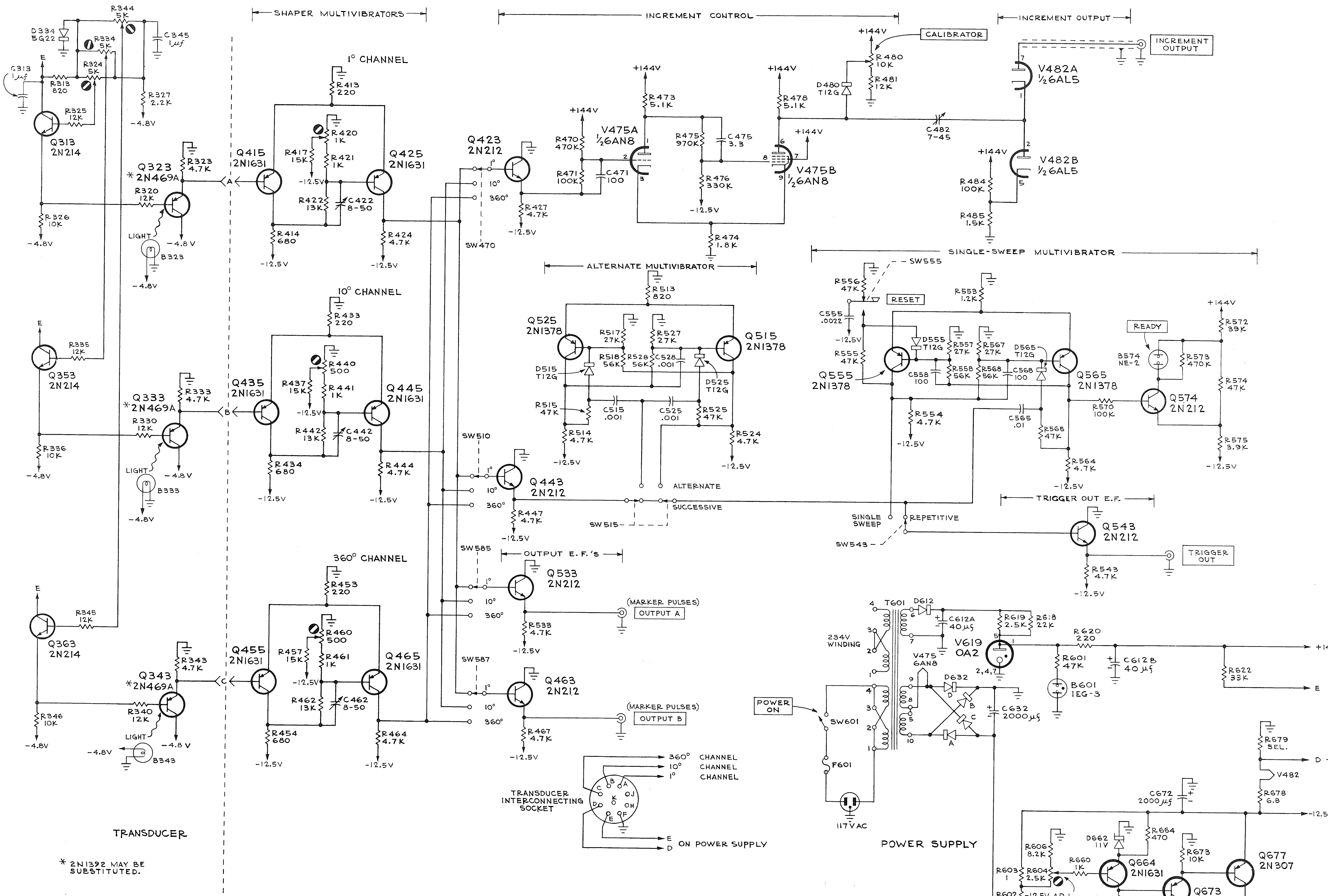
	Tektronix Part Number
ADAPTOR, 3 to 2 wire	103-013
BALL, ACRYLIC 1/4 DIA.	214-190
BAR, 3/16 x 1/2 x 1	381-084
BAR, TOP SUPPORT	381-174
BASE, TRANSFORMER	432-041
BEARING, MUELLER	401-018
BODY, ROTAN	204-106
CABLE HARNESS, 110 VOLT	179-421
CABLE HARNESS, ROTAN	179-545
CABLE CONNECTOR, 5-CONDUCTOR	012-058
CAP, FUSE	200-015
CAP, DELRIN .628 x 7/64	200-307
CHASSIS	441-388
CONNECTOR, CHASSIS MTD., 1 CONTACT, FEMALE, UHF	131-081
CONNECTOR, CHASSIS MTD, 3 WIRE TEK MOTOR BASE	131-102
CONTACT, LAMP, .010 x 3/4 x 7/16 PHOS. BRONZE	214-186
CONTACT, LAMP, .010 x 1 1/8 x 3/8 PHOS. BRONZE	214-187
CORD, POWER	161-010
COUPLING, SHAFT	376-023
COVER, TRANSDUCER	200-297
COVER, FUSE	200-237
DIAL, PLATE, .040 x 2 61/64 W/3/4 HOLE	331-075
DIAL, LIGHT CHOPPING (STATIONARY)	331-081
DIAL, LIGHT CHOPPING (ROTATING)	331-082
EYELET, TAPERED BARREL	210-601
FOOT, RUBBER, BLACK 1/2	348-013
GASKET, SEAL 1/64 VELLUMOID 2 7/8 x 2 3/8	214-188
GROMMENT, RUBBER 5/16	348-003
GROMMET, POLY	348-030
HANDLE, DRAWER	367-007
HOLDER, NEON BULB, SINGLE	352-008
HOLDER, FUSE	352-010
HOLDER, LENS & PHOTO TRANSISTOR	352-034

	Tektronix Part Number
KNOB, SMALL BLACK, .694 DIA. W/1/4 HOLE PART WAY	366-033
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, INT. #8	210-008
LOCKWASHER, INT., POT, 3/8 x 1/2	210-012
LUG, SOLDER, SE4	210-201
LUG, SOLDER, POT, PLAIN, 3/8	210-207
LUG, PEE WEE, BANANA	210-215
NUT, HEX, 4-40 x 3/16	210-406
NUT, HEX, 6-32 x 1/4	210-407
NUT, HEX, 8-32 x 5/16	210-409
NUT, HEX 3/8-32 x 1/2	210-413
NUT, HEX, 15/32-32 x 9/16	210-414
NUT, HEX, 5-40 x 3/16	210-441
NUT, 12 SIDED, 15/32-32 x 5/64	210-473
NUT, HEX, 6-32 x 5/16 x .194 (5-10 W. RESISTOR)	210-478
NUT, ACORN, HEX, 5-40	210-544
NUT, KNURLED, 3/4-32 x 1 (BLACK)	210-554
PANEL, FRONT	333-664
PIN, LOCKING 1/4 NYLON, 1/4 x 3/16	214-196
PLATE, TRANSISTOR MOUNTING	386-978
PLATE, SUB-PANEL, FRONT	387-208
PLATE, SUB-PANEL, REAR	387-209
PLATE, OVERLAY, REAR	387-210
PLATE, CABINET, BOTTOM	387-211
PLATE, CABINET, SIDE	387-212
PLATE, MOUNTING 1/8 x 2 55/64	387-416
PLATE, MOUNTING, .065 x 2 1/2, TRIANGLE	387-417
PLATE, ETCHED CIRCUIT BOARD COVER	387-454
PLATE, ETCHED CIRCUIT BOARD	388-516
POST, TERMINAL, TRANSISTOR MOUNTING	129-049
RING, RETAINING FILM	354-118
RING, SPACER, LOCKING	354-119

	Tektronix Part Number
RING, RETAINING FOR 5/8 HOUSING	354-120
ROD, SPACER 9/32 x 3 1/4	385-157
SCREW, 4-40 x 3/16 BHS	211-007
SCREW, 4-40 x 3/4 RHS	211-017
SCREW, 4-40 x 1/4 FHS	211-023
SCREW, 4-40 x 3/8 FHS	211-025
SCREW, 4-40 x 1 FHS	211-031
SCREW, 4-40 x 5/16 PHS W/LOCKWASHER	211-033
SCREW, 2-32 x 5/16 PHS, PHILLIPS	213-113
SCREW, 4-40 x 3/8 PHS, PHILLIPS	211-071
SCREW, 6-32 x 1/4 BHS	211-504
SCREW, 6-32 x 5/16 BHS	211-507
SCREW, 6-32 x 5/16 PHS W/LOCKWASHER	211-534
SCREW, 6-32 x 1/4 FHS 100°	211-541
SCREW, 6-32 x 5/16 FHS, 100°, CSK, PHILLIPS	211-538
SCREW, 6-32 x 5/16 THS, PHILLIPS	211-542
SCREW, 6-32 x 5/16 RHS	211-543
SCREW, 6-32 x 1 1/2 RHS, PHILLIPS	211-553
SCREW, 8-32 x 5/16 BHS	212-004
SCREW, SET, 1/4-20 x 3/16 x 1/8 CUP POINT KEY, ALLEN	213-017
SCREW, 4-40 x 1/4 PHS, THREAD CUTTING, PHILLIPS	213-035
SCREW, 5-32 x 3/16 PHS, THREAD CUTTING, PHILLIPS	213-044
SCREW, 2-56 x 3/16 PHS, THREAD CUTTING, PHILLIPS	213-055
SCREW, 4-24 x 1/4 THS, THREAD CUTTING, PHILLIPS	213-080
SCREW, 4-40 x 1/4 FHS, CAP, W/ALLEN SOCKET FLAT POINT	213-092
SCREW, 4-40 x 1/4 PHS	213-088
SCREW, THUMB, 10-24 W/1/2 KNURLED HEAD	214-195
SOCKET, STM7G	136-008
SOCKET, STM9G	136-015
SOCKET, 9 PIN CHASSIS MOUNTED	136-089
SOCKET, 4 PIN TRANSISTOR	136-095
SOCKET, PLUG-IN	136-111
SPACER, NYLON 3/16 FOR CERAMIC STRIP	361-008
SPRING, .025 x 5/16 x 3/16, MUSIC WIRE	214-197

Mechanical Parts List *(continued)*

	Tektronix Part Number
STRIP, CERAMIC 3/4 x 7 NOTCHES, CLIP MOUNTED	124-089
STUD, LEADLOY	355-069
TAG, S/N INSET (182B)	334-774
TAG, VOLTAGE RATING	334-650
TRANSDUCER BASE ASS'Y	119-019
TUBE, SPACER TIE ROD, 5/16 x 3/16	166-233
TUBE, SPACER TIE ROD, 23/32 x 3/16	166-234
WASHER, STEEL 8S x 3/8 x .032, CAD. PLATED	210-804
WASHER, STEEL, .390 x 9/16 x .020	210-840
WASHER, RUBBER FOR FUSE HOLDER	210-873
WASHER, BAKELITE, .129 x 1/2 W/3/8 SHOULDER (TRANSISTOR MTG)	210-900
WASHER, STEEL, .470 x 21/32 x .030	210-902
WASHER, ALUM., 3/4 x 9/64 x 15/64	210-924
WASHER, ALUM., 3/4 x 7/32 x 21/64	210-925
WASHER, BRASS, 1 1/32 x 3/4 x .016	210-927
WASHER, CORK, 1 1/4 x 3/4 x 1/32	210-929
WASHER, DELRIN, 1/2 x .246	210-931
WASHER, FIBER, .140 x .375 x .078 W/SHOULDER	210-935
WASHER, FIBER, .140 x .375 x .063	210-936



TYPE 182B TRANSDUCER

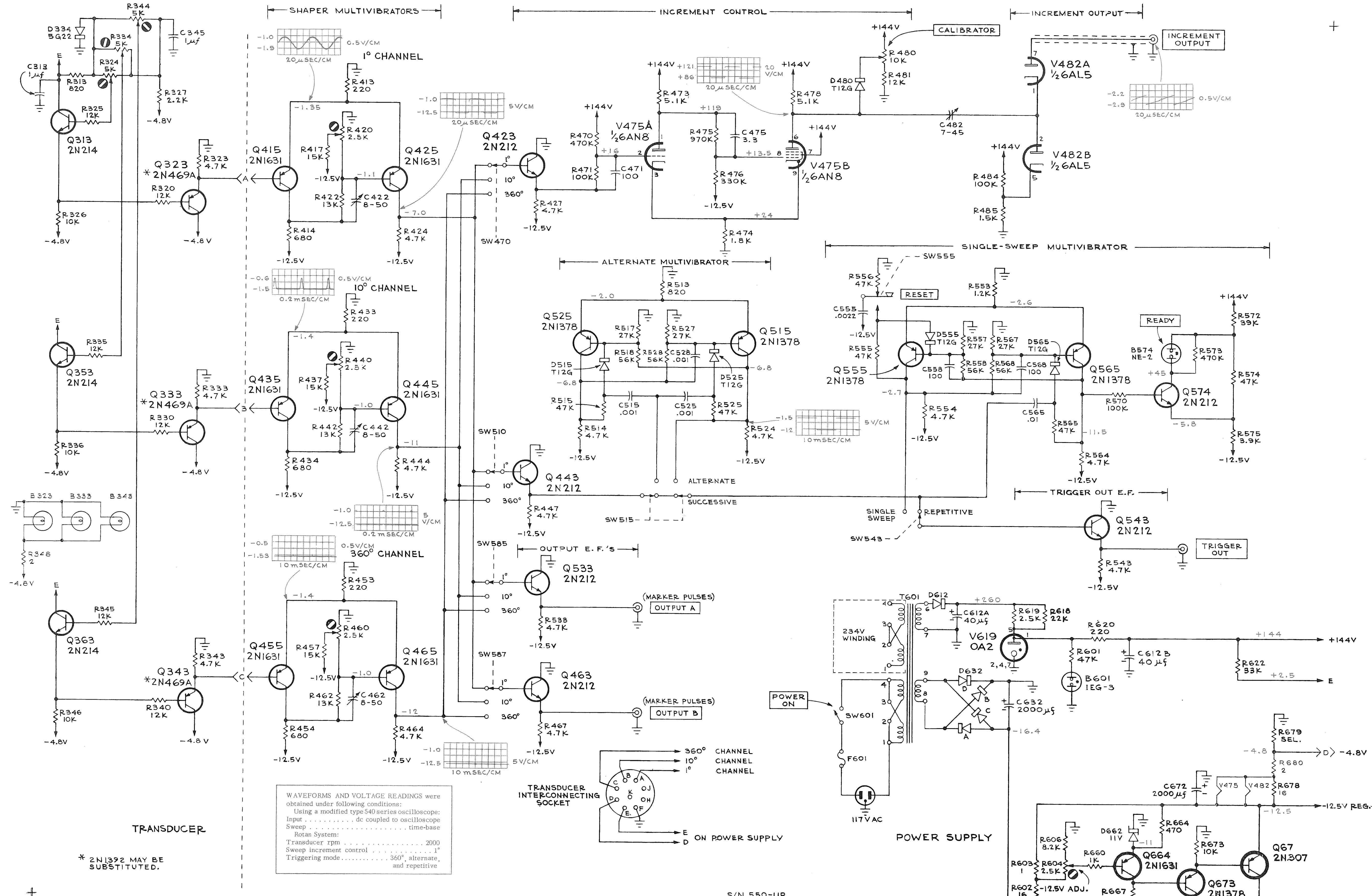
TYPE 183B ANALYZER

B

PHOTO-ELECTRIC ROTATIONAL ANALYZER
S/N 501-549

GAB
3-22-62

CIRCUIT DIAGRAM



TYPE 182B TRANSDUCER

TYPE 183B ANALYZER

A

S/N 550-UP

PHOTO-ELECTRIC ROTATIONAL ANALYZER

GAB
10-22-62

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

CORRECTIONS TO FIG. 6-3.

Control labeled R422 should read R420; control labeled R442 should rear R440; control labeled R462 should read R460.

CORRECTION TO MAINTENANCE SECTION (TROUBLESHOOTING)

Preliminary Troubleshooting

Change paragraph 5c to read, "If the -4.8-volt lead has improper voltage, the heater of V475 or the heater of V482 may be open, or one of the exciter lamps may be burned out or not making contact."

Delete paragraph 5e.

CORRECTIONS TO CALIBRATION PROCEDURE

2. Check Power Supplies

TABLE 6-1. Output and Ripple Voltages

POWER SUPPLY	OUTPUT VOLTAGE	RIPPLE VOLTAGE (p-p voltage)
+144 volts	+144 ± 4 volts	80 mv
E	+2.5 ±0.4 volts	25 mv
D	-4.8 ±0.3 volts	50 mv
-12.5 volts	-12.5 volts	150 mv

3. Check Amplitude of Transducer Outputs

TABLE 6-2. Transducer Signal Amplitudes (2,000 rpm)

Channel	1°	10°	360°
Maximum	1.8 volts	1.8 volts	1.8 volts
Minimum	0.4 volts	0.2 volts	0.2 volts

4. Adjust Transducer Output DC Levels

Adjust R324, R334 and R344 as described in the Instruction Manual, unless these controls do not have sufficient range to make the adjustment properly. Additional range may be obtained with the Shaper circuit controls located in the Type 183B. For the 1° channel, if R324 does not adjust the waveform properly, also adjust R420* shown in Fig. 6-3. For the 10° channel, first adjust R334, then R440 if necessary. For the 360° channel, adjust R344 then R460. These controls are shown in Fig. 6-3*.

* Please note the correction in control labels noted under "CORRECTIONS TO FIG. 6-3" above.

PARTS LIST CHANGES
MOD 6427, S/N 550-up

Diodes

Change	D632A,B,C,D	to	152-035	1N1563A			

Fuses

Change	F601	to	159-032	.5 Amp	3 AG	Slo-Blo	

Resistors

Add	R348		308-240	2Ω	3w	WW	5%
Change	R420	to	311-010	2.5k	.1w	Var.	
Delete	R421						
Change	R440	to	311-010	2.5k	.1w	Var.	
Delete	R441						
Change	R460	to	311-010	2.5k	.1w	Var.	
Delete	R461						
Change	R678	to	308-166	16Ω	5w	WW	5%
Change	R679	to	304-560	Selected (56Ω nominal)			
Add	R680		308-119	2Ω	5w	WW	5%

Transformers

Change	T601	to	120-293	Power			