TECHNICAL MANUAL

FOR

CPB-1 AND CPB-1A

COMMON POINT

IMPEDANCE BRIDGE

MANUFACTURED UNDER U.S. PATENT NO. 3,249,863

DELTA ELECTRONICS, INC.
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INSTRUCTION MANUAL
FOR
COMMON POINT IMPEDANCE BRIDGE
MODELS CPB-1 AND CPB-1A

SECTION I

GENERAL DESCRIPTION

1-1 Scope

This manual covers the description, installation, operation and maintenance for Common Point Impedance Bridge, Models CPB-1 and CPB-1A, manufactured by Delta Electronics, Inc.

1-2 General Description

1-2-1 CPB-1

The Delta Electronics Model CPB-1 Common Point Impedance Bridge is an instrument designed for permanent installation in the common point of a directional antenna, or at the input of any high power RF load. The CPB-1 will handle a through power of up to 5 kw, 100% amplitude modulated, at any frequency between 540 and 1650 kc.

1-2-2 CPB-1A

The CPB-1A is the same bridge with the coupler box designed to handle up to 50 kw of power over the same frequency range.

1-3 Reference Data

1-3-1 Electrical Data

Frequency Range:	500 - 1650 kc
Power Rating:	CPB-1 - 5 kw - 100% amp. mod. continuous CPB-1A - 50 kw - 100% amp. mod. continuous
Resistance Range:	30 - 100 ohms
Reactance Range:	±50 ohms (1000 kc)

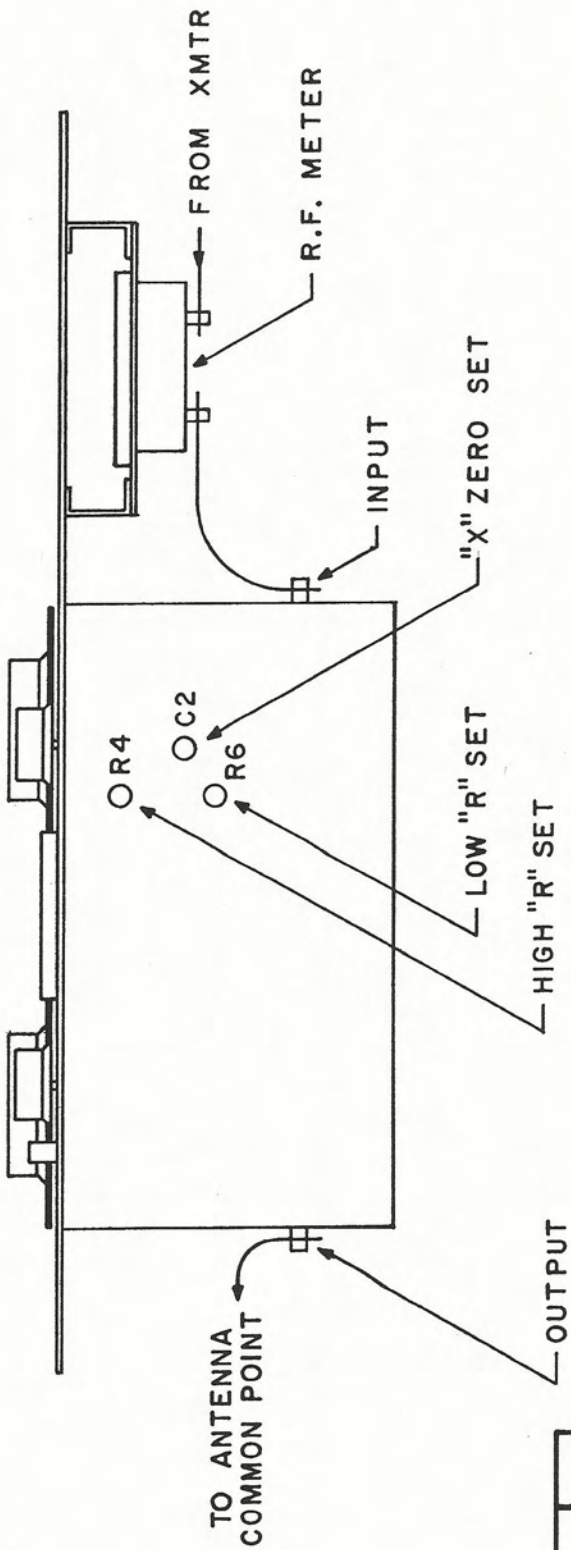

FIGURE 1

TOP VIEW
CONNECTIONS AND
ADJUSTMENTS

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Accuracy:	Resistance	±2% ±1 ohm
	Reactance	±5% ±1 ohm

1-3-2 Mechanical Data

Dimensions:	Bridge Box: 7" H x 9" W x 9¼" D (Normally supplied mounted on 7" x 19" rack panel).
Terminals:	CPB-1 10-32 studs CPB-1A 1/2" copper straps
Weight:	9½ lbs. (Bridge only) 10½ lbs. (With Panel)

1-4 Application

1-4-1 As Continuous Load Impedance Monitor

It has been observed on many occasions, that the common point and line input impedances of directional antenna systems vary from time to time because of changes in ground conditions and minor variations in the tuning elements of the antenna. The ordinary procedure is to wait until after normal operating hours and re-measure the antenna common point impedances with a normal RF bridge. If this is not done frequently, the station may operate for extended periods with less than the licensed power. The procedure for measuring the power and impedance of the transmission lines to each antenna is quite complex. The CPB-1 and CPB-1A bridges make these measurements very simple. The station operator can measure the operating impedances and power at any time during normal operating hours.

1-4-2 In Making Power Measurements

Provision is made for mounting an RF ammeter on the bridge panel. The load current can be read from this meter and used along with the measured resistance to compute the total RF power delivered to the load. Both models of the common point impedance bridge have a very low insertion effect; that is, their installation will cause a very minor disturbance of the load being measured. The bridges can, therefore, be installed at the input of separate antenna transmission lines. The input impedance and the input power of the lines can then be measured. For example, if a directional antenna is a three-tower array, one bridge may be inserted at the common point for determining the total input power to the antenna system, and a bridge may be inserted in each transmission line to determine the power delivered to each tower. The engineer then has a complete picture of the total power and the power distribution of the antenna system.

1-4-3 In Determining Impedance Match and VSWR

The main use of the CPB-1 and CPB-1A is for continuous monitoring of the common point impedance, as described above. This permits the station operator to know and regulate his transmitter power at all times. It also permits him to detect changes in his antenna system which might otherwise go unnoticed. The instruments can be mounted in the input of any transmission line of a complex antenna system. They are then useful in determining the power distribution throughout the antenna system, the impedance match (and thus VSWR) on the transmission line.

SECTION II

INSTALLATION

2-1 Initial Inspection

Before installing the CPB-1 or CPB-1A, inspect for physical damage and make sure that all connections are secure.

2-2 Power

The CPB-1 and CPB-1A require no power other than RF energy coupled into the unit from the transmission line.

2-3 Mechanical Installation

The CPB-1 and CPB-1A are normally supplied mounted on a standard 7" x 19" rack panel. A cutout can be made in the antenna phasing equipment for mounting this panel.

Both bridges are also available without the rack panel. A drill template is provided (see Figure 3) permitting the station engineer to mount the bridge in the existing panel of the antenna phasor. To do this, it is necessary to remove the bridge knobs. When replacing the R and X dials, care must be taken to lock the dials on the shaft in the proper position. This operation is facilitated by index marks provided at the extreme left of each dial scale. These marks must be under the pointers when the capacitor is fully meshed and the resistor is rotated clockwise to the limit of its travel.

The output connection of the bridge must be made to the common point of the antenna system by flexible 1/2" copper strap or flexible coaxial cable in order to prevent mechanical strain being applied to the output insulator. The input is similarly connected to the transmitter.

Caution should be taken not to mount the bridge so that it will be directly in the high RF field of the antenna tank circuit, or other inductor carrying a large RF current. Also the input and output leads should either be shielded or widely separated from each other in order to prevent line current from bypassing the bridge through stray capacity. A front panel hole and recessed insulated mounting plate is supplied with the bridges for mounting the common point ammeter. These components are designed to fit standard Weston Type 308 meters, or any other meters having similar mounting holes. Where the operating power is sufficiently low, the meter may, if desired, be mounted directly on the panel and the insulated mounting plate discarded.

SECTION III

OPERATOR'S SECTION

3-1 General

The Common Point Impedance Bridge enables continuous monitoring of the operating impedance of the antenna system at any desired point.

3-2 Function of Controls and Connections

Meter	Gives visual indication of bridge balance (null).
X Dial	When bridge is at null shows component of load impedance. $\frac{X}{f_{mc}}$
R Dial	When bridge is at null, shows R component of load impedance.
Tune Control	Enables the detector circuit to be resonated at the operating frequency.
SEN. Control	Provides potentiometer control of the detected signal coupled to the meter.
BNC Connector	Provides for the convenient use of a receiver or other external sensitive RF detector for the bridge circuit.
(CPB-1) 10-32 stud screws	Makes input and output connections to the bridge.
(CPB-1A) 1/2" copper straps	Makes input and output connections to the bridge.

3-3 Operating Procedure for the CPB-1 and CPB-1A

The sensitivity and tuning controls are first adjusted to give an on-scale reading near the high end of the meter scale. The R and X dials are then alternately adjusted for minimum meter reading. As the null point is approached, the sensitivity and tuning controls should be advanced to maintain as high an on-scale reading as possible. The bridge is at null when adjustment of the R and X dials results only in an increase in meter reading. The resistive component of the load impedance is read directly from the R dial and is independent of frequency. The reactive component is found by multiplying the X dial reading by the operating frequency in megacycles.

SECTION IV

PRINCIPLE OF OPERATION

4-1 Bridge Section

The CPB-1 operates on an extension of the directional coupler principle. A sample of the direct and reflected energy in the main transmission line is picked up by a secondary line. Additional waves are caused to flow on the secondary line by reflections from fixed and variable terminations of that line. When the variable terminations are manipulated so that the waves they cause are equal and opposite to the waves induced from the primary line, a null is shown on the detector circuit. For a complete description of the bridge, as well as a mathematical derivation, the reader is referred to "Unique Bridge Measures Antenna Operating Impedance", Electronics, February 22, 1963.

4-2 Detector Section

The detector consists of a tunable "L" network, a diode which rectifies the capacitor voltage, and a meter to read the rectified voltage. A potentiometer is provided for sensitivity control of meter indication.

4-3 Improving Bridge Accuracy

The CPB is factory calibrated to accuracies of ±2% ±1 ohm for the R dial and ±5% and ±1 ohm for the X dial. The CPB R and X dial accuracies may be improved for a particular installation and over a limited range, if the antenna common point impedance is first measured with a high accuracy RF bridge, and the R and X values logged. Then, with the CPB bridge installed, set the R and X dials to the previously measured values and adjust the appropriate screwdriver control (s) for meter null. Only one screwdriver control (C_2) is provided for the X dial. For the R dial, R4 should be adjusted if the load resistive component is between 50 and 100 ohms; R_6 should be adjusted if the load resistive component is between 30 and 50 ohms. These adjustments should be made only by the responsible station engineer, or the station's consulting engineer.

SECTION V

MAINTENANCE

5-1 Preventive Maintenance

Since the CPB is a passive device and adequate dust covers are provided, no preventive maintenance should be required.

5-2 Corrective Maintenance

It is recommended that field maintenance of the bridge section of this unit be limited to the adjustments described in paragraphs 5-2-1, 5-2-2, and 5-2-3. Parts may not be changed in the bridge section without jeopardizing the accuracy of the bridge.

5-2-1 Calibration of Low Resistance End of R Dial

Connect a signal generator to approximately 1 mc to the bridge input. Terminate the output with an accurately known resistor of from 30 to 35 ohms. Set the bridge R dial to the resistor value. Obtain bridge null by alternately adjusting the X dial and R_6.

5-2-2 Calibration of High End of R Dial

Follow above directions but use a terminating resistor of from 80 to 100 ohms. Obtain null by adjusting X dial and R_4.

5-2-3 C Zero Set

Follow above directions but use any value of resistor within the range of the bridge to terminate the output. This resistor must be a low inductance type such as a carbon film resistor. Set the X dial to zero and obtain null by adjusting R dial and C2.

5-2-4 Normal maintenance may be performed on the detector section.

5-2-5 See Trouble Shooting Chart (Table I) for listing of some of the troubles which may occur and their possible causes and corrections.

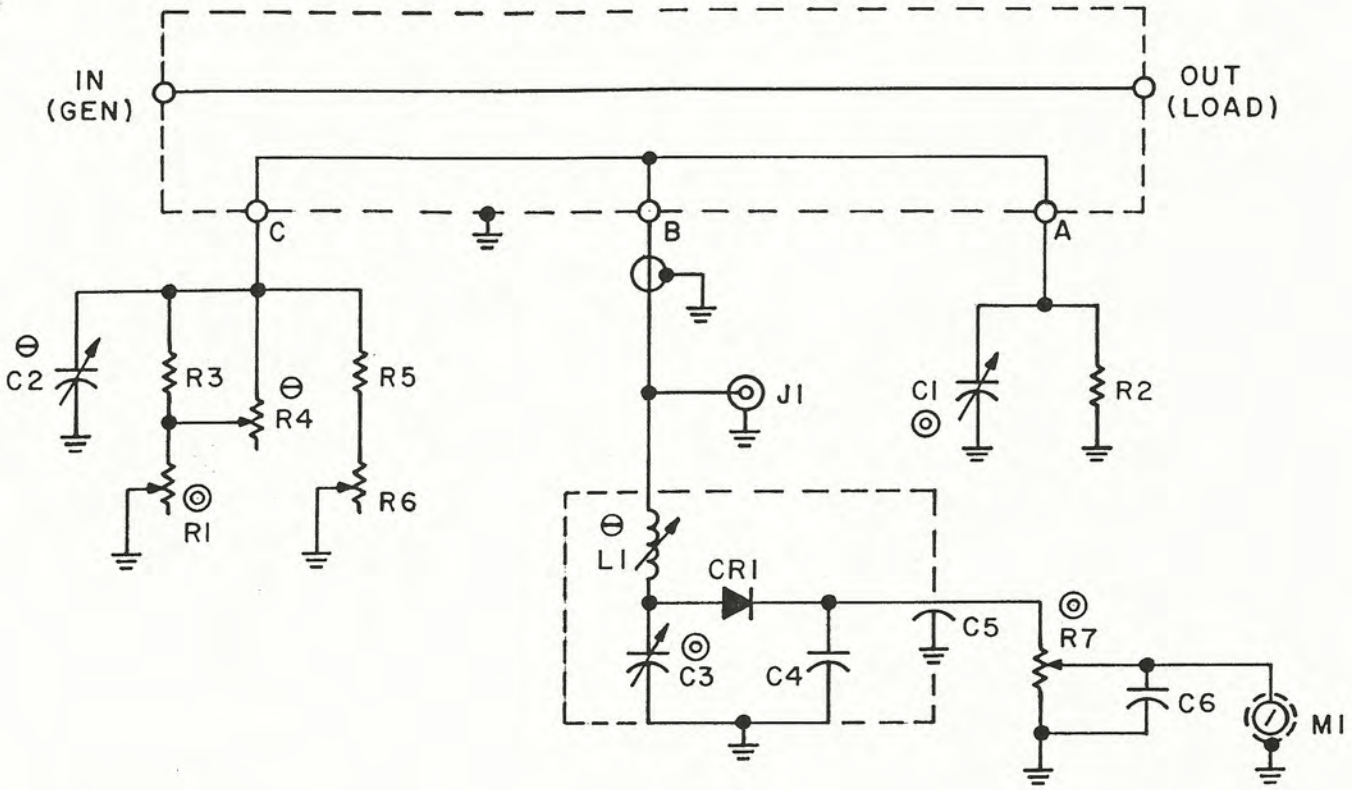
TABLE I

TROUBLE SHOOTING CHART

Symptom	Possible Cause	Test & Correction
Incorrect X reading	Dial not properly positioned on capacitor shaft	Check to see if dial index mark is under pointer with capacitor fully meshed.
" " "	C_2 misadjusted	See para. 5-2-3
Incorrect R reading	Dial not properly positioned on variable resistor shaft	Check to see if dial index is under pointer for maximum C.W. positions of shaft.
" " "	R_6 and/or R_4 misadjusted	See para. 5-2-1 & 5-2-2
No meter indication	L_1 open	Check with ohmmeter
" " "	CR_1 open or shorted	" " "
" " "	C_4 shorted	" " "
" " "	R_7 open	" " "
" " "	C_6 shorted	" " "
" " "	M_1 open	compare with standard meter

NOTICE

A precision ceramic embedded carbon potentiometer is used as a variable standard resistance in this bridge. A relatively high contact resistance is a characteristic of precision potentiometers of the composition type. For this reason, the user may notice an apparent "noise" when obtaining a deep null with an external detector. This is normal and does not affect the rated accuracy of the instrument. DO NOT attempt to break the seal on the potentiometer for cleaning purposes.



* R1 – 500 OHM, SPECIAL
* R2 – 4750 OHM, 1W, 1%
* R3 – 221 OHM, 1W, 1%
* R4 – 500 OHM, 2W, VARIABLE
* R5 – 1000 OHM, 1W, 1%
* R6 – 500 OHM, 2W, VARIABLE
  R7 – 100K OHM, 2W, VARIABLE
* C1 – 50 – 1500 pfd., VARIABLE
* C2 – 265 – 880 pfd., VARIABLE
  C3 – 10 – 365 pfd., VARIABLE
  C4 – .01 mfd., DISC CERAMIC
  C5 – .001mfd, DISC CERAMIC
  C6 – .01 mfd., DISC CERAMIC
  CR1 – IN34A DIODE
  M1 0 – 100 MICRO AMP D.C.

NOTES:

◎ INDICATES FRONT PANEL CONTROL

⊖ INDICATES SCREWDRIVER ADJUSTMENT

* INDICATES REPLACEMENT REQUIRES RECALIBRATION

FIGURE 2

CPB-1 SCHEMATIC

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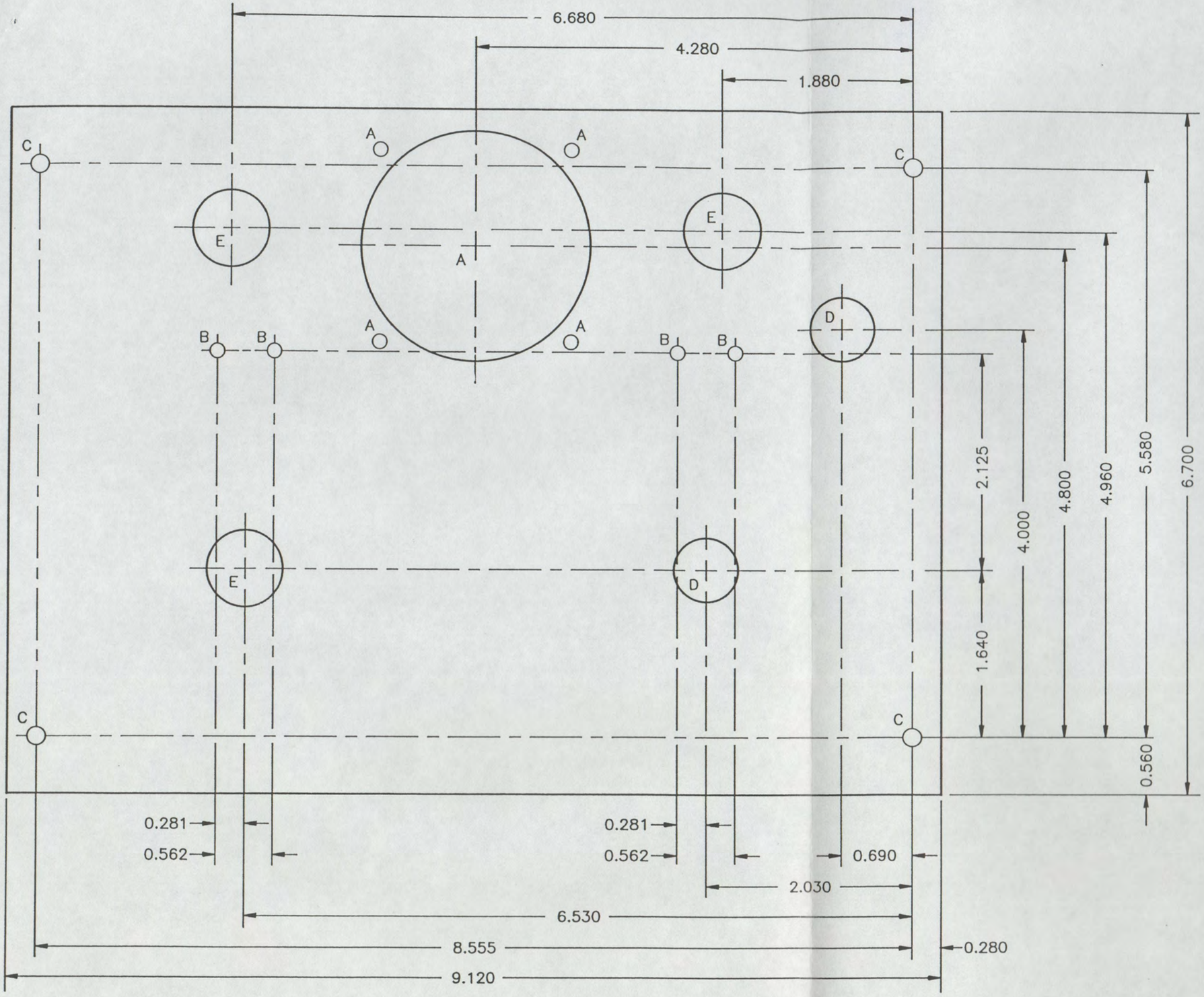

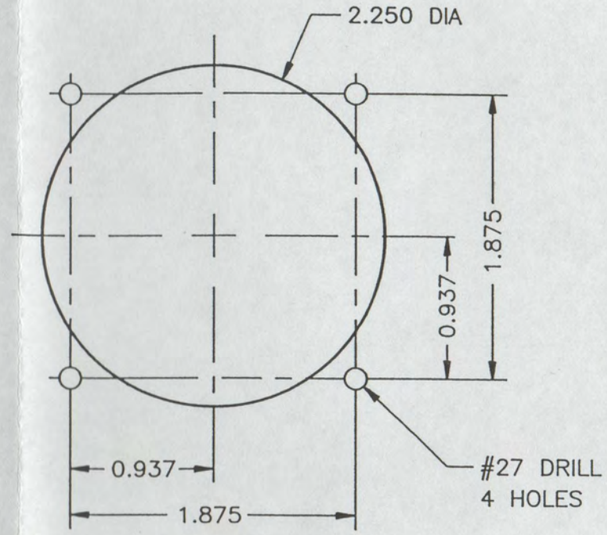

DETAIL A

HOLE DATA	
HOLE	DESCRIPTION
A	SEE DETAIL A
B	#29 DRILL, 4 HOLES
C	#15 DRILL, 4 HOLES
D	0.625 DIA, 2 HOLES
E	0.750 DIA, 3 HOLES

FIGURE 3

PANEL TEMPLATE

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