NBSIR 74-379

COMPLETION OF THE PROGRAM TO EVALUATE / IMPROVE INSTRUMENTATION AND TEST METHODS FOR ELECTROEXPLOSIVE DEVICE SAFETY QUALIFICATION

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Electromagnetics Division
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Final Report
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DEPARTMENT OF THE AIR FORCE
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U.S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

FOREWORD

This program was initiated at the National Bureau of Standards in response to a request from the Aeronautical Systems Division (AFSC) of the Air Force, Wright-Patterson AFB. Funding for the effort was provided by the Air Force (Contract No. F 33615-72-5013). The general objective was to provide the Air Force with optimum test procedures, instrumentation, and test devices for qualification of weapon systems with respect to electroexplosive device (EED) safety.

Phases I and II of this project were concerned with evaluation of existing test instrumentation and the development of a new go, no-go device to fill a test instrumentation need. These have been described in the NBS Report NBSIR 73-323. Phase III, the subject of this report, is the conclusion of the project. During this phase, instrumentation was developed to provide the Air Force with a means for obtaining quantitative measurements of the stray rf power within a weapon. The instrumentation to be described uses solid-state diode detectors to measure both pin-to-pin power and pin-to-case rf voltages. Both of the measured quantities are plotted on a strip chart recorder.

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ABSTRACT

Qualification of weapon and missile systems for electro-explosive device (EED) safety has been a continuing problem in the military services. Quantitative measurement of stray energy in EED's has been hampered by limitations of existing sensors. This report describes a new video diode detector instrumented EED (VIDEED) which responds to both the normal pin-to-pin energy (which would heat an EED bridgewire) and to the pin-to-case voltage (which might cause EED ignition due to arcing).

Also described in this report are the amplifiers, cables, adapters and recorders which make up the rest of the measuring system. Mention is also made of the test procedures used in testing the VIDEED system.

Key words: Electroexplosive device safety; electromagnetic compatibility; electromagnetic interference; stray energy sensor.

COMPLETION OF THE PROGRAM TO EVALUATE/IMPROVE INSTRUMENTATION AND TEST METHODS FOR ELECTROEXPLOSIVE DEVICE SAFETY QUALIFICATION

1. INTRODUCTION

Military testing of weapons for Electroexplosive Device (EED) safety has depended for a number of years on two types of test monitors. One was a type of EED which ejected a piston when the explosive was actuated. Extension of this piston indicated that the currents on the firing cable exceeded that required to detonate the device but gave no indication of the magnitude of the current. There was no way to determine by how much the firing current was exceeded or how often prior to firing the critical current was approached. The second device was an EED in which the explosive charge was replaced by a thermocouple temperature sensor. In this device, the heat from the bridgewire was continuously monitored to determine if it exceeded the firing point of the removed explosive. The thermocouple device provided a quantitative indication of currents in the firing circuits (pin-to-pin) but offered no indication of the pin-to-case voltages which might also initiate the EED due to arcing or dielectric heating of the charge.

The video diode detector instrumented EED (VIDEED) described in this report monitors hazardous rf signals in both the pin-to-pin and pin-to-case configurations. It is useful from below 1 GHz to 9 GHz, has a pin-to-pin sensitivity of better than 0.5 volt per watt and a pin-to-case sensitivity better than 7 millivolts per milliwatt of absorbed power. The impedance was designed to be 2 ohms pin-to-pin and 500 ohms from either pin to the case. During the testing phase of the project a technique had to be developed to calibrate the VIDEED in both the pin-to-case mode (simply a standard unbalanced coaxial configuration) and the pin-to-pin mode, which is a balanced transmission line. These are described in the text along with the more usual "one pin grounded" configuration.

2. THE VIDEED SYSTEM

Figure 1 shows the complete VIDEED system including the VIDEED, cable adapter, carbon-impregnated teflon output leads, interface amplifier and strip chart recorder.

The VIDEED was designed to replace the normal EED in a weapon, measure the stray rf power on the firing wires and make these measurements available to a remotely located strip chart recorder.

The dc voltage generated by the VIDEED is transmitted to the recorder on a cable composed of carbon-teflon conductors. Because of the high losses in this cable, the rf pickup is attenuated, reducing the measurement error that might have been caused due to rf leakage into the weapon. This cable also appears nearly transparent to rf fields so that it can be located near the measurement site without distorting the field environment.

The carbon-teflon cables suffer from the difficulties normally associated with high-impedance circuits. They are sensitive to static pickup, and noise is generated in them when flexed. They will couple to 60 Hz signals, and these will affect the detector circuits as well as the recorder. To combat these difficulties, loading resistors were located near the detector to shunt these voltages to ground. Since these resistors were too large a value to make in a thin-film structure, lumped constant resistors had to be used and were mounted in a separate cable adapter unit. The addition was successful in reducing the noise pickup to an acceptable amount.

The dc voltages produced by the diodes are recorded by a dual channel strip chart recorder. One channel is used to indicate the pin-to-pin (p-p) voltage, and the other indicates the larger of the two possible pin-to-case (p-c) voltages. Since the carbon-teflon cables have a high resistance (.4 MΩ to 4 MΩ per channel), they cannot supply sufficient current to drive most recorders directly, and an interface amplifier is required. This amplifier has more than 40 megohm input impedance and an output impedance low enough to drive the recorder inputs (above 300 ohms). The "OR" gate shown in figure 1 is actually an analog "OR" gate which selects the higher of the two p-c signals. The recorder can be any convenient two-channel strip chart recorder with 300 ohms or more input resistance and chart speeds about 1 mm per second. Each of these parts will be described in greater detail.

3. VIDEED

The VIDEED shown in figure 1 is a small [7 mm (.275") dia. X 15.875 mm (5/8") long] rf sensor designed to be installed in a weapon system in place of the normal EED. The two input leads extend out of the plastic* header and can be connected to the normal firing circuit in the weapon.

The entire detector circuit is constructed on a small ceramic substrate (6.35 mm X 6.35 mm X 0.254 mm). Figure 2a shows the p-c side of the substrate, and figure 2b shows the opposite side with the p-p circuitry on it. Four wire leads

*copolymer of polyethelyne and teflon chosen for rf characteristics and moldability are shown entering the plastic header and are fastened to the substrate with conductive epoxy. The two outer leads are grounds and are epoxied to the case as a final step in the construction. After the contact to the case has been established and tested these two leads are cut and not used in actual practice. The dc outputs are brought out through a specially designed plastic plug. All circuit components are connected to the substrate circuit with conductive epoxy.

The diodes D1 and D2 (fig. 1) form half-wave rectifier circuits and serve to measure the rf voltages between either of the input leads and the case which can be grounded to the weapon. Diodes D3 and D4 (fig. 1) form a bridge circuit with their associated capacitors and detect voltages appearing across the 2-ohm resistor.

The 2-ohm resistor is a thin metallic film deposited on a ceramic substrate and takes the place of the EED bridgewire. The bridgewire in a normal EED is mounted between the two input leads and causes the pin-to-pin input impedance to vary quite severely over the frequency range of 1 GHz to 10 GHz. Mention of the impedance measurement is made later in this report, but, for the present, it is sufficient to point out that the bridgewire will absorb rf energy optimally when its impedance matches that of the rf source. Without prior knowledge as to what the source impedance might be in any given weapon, it was decided to try to make a VIDEED with a low, constant rf impedance. This would simplify the interpretation of the measured data in that the impedance of the VIDEED would be more or less constant.

During the later months of the project, a need was expressed for a VIDEED with a 500 ohms or higher impedance pin-to-pin. It seems desirable in future work of this type to use both a high and a low impedance VIDEED. In this way it will be possible to estimate the Thevenin equivalent circuit for the rf source impedance in the weapon. This could lead to a more complete analysis of the EED rf problem.

EED firing in the pin-to-case mode is normally attributed to arcing, and a measure of the pin-to-case open circuit voltage would be useful in detecting the possibility of this occurring. However, during the design phase of this circuit it became apparent that the impedance of the diode and capacitor would drop to about 500 ohms at 10 GHz instead of the desired open circuit. Rather than allow the impedance to vary from tens of kilohms at low frequencies down to 500 ohms at 10 GHz, a 500-ohm shunting resistor was deposited onto the substrate. The combination impedance varied between 500 ohms at the low frequencies to about 250 ohms at 10 GHz. This shunt resistance somewhat reduces the VIDEED sensitivity to the high rf voltage which would be present before an arc occurs, but still allows a meaningful measurement to be made. The advantage of the circuit is the more nearly constant impedance as the rf frequency increases.

In the pin-to-case mode no more than 7 milliwatts of rf power is required to produce an output of 50 millivolts, which is a minimum convenient readable signal. One watt of input power will produce several volts of dc output.

In the pin-to-pin mode a similar 50 millivolt output required an input net power of 90 milliwatts. This is, of course, due to the low input impedance, but this low sensitivity was not entirely satisfactory for Air Force use. To compensate for this difficulty, the interface amplifier gain was increased from unity to ten. With this change it is easy to resolve ten to fifteen milliwatts of power. Ninety milliwatts of rf power now produces full-scale deflection of the recorder (.5 volts).

More complete details of the calibration procedure and results are given later in this report.

4. CARBON-TEFLON CABLE

During a typical field safety test, the VIDEED is located within a weapon structure, and the recording devices are external. The telemetering device chosen was a carbon-loaded teflon conductor which has a very high rf attenuation and is transparent to rf fields. This type of teflon conductor has been used at NBS for a number of years and has been proven reliable. The conductive portion of the particular leads for this project is made-up of .711 mm (0.028") diameter teflon which has been loaded with a sufficient amount of carbon to reduce its resistance to 66 kilohms per meter. A nylon jacket .076 mm (0.003") thick protects the soft teflon from abrasion and prevents shorting between adjacent wires in the cable. The cable itself is made up of six teflon conductors held in a bundle by a heat-shrinkable outer jacket.

Connectors having seven pins were used to interconnect the cables. The six pins, arranged hexagonally, connect to the six cable wires. The seventh pin (center) is jumpered to ground at the connector and forms the interlock for the instrumentation amplifiers.

Since the conductor is teflon, adhesives such as conductive epoxy are not successful in making connection to the pins of the plug. Instead, a slip fit was designed where the teflon wire was drilled coaxially about 6.35 mm into its end.

The hole provided a snug fit for the #28 copper wire inserted into it. After the 6.35 mm long wires were soldered to the connector pins the teflon wires could be slipped onto them, making reliable contact. The connectors were filled with a nonconductive epoxy, forming a good bond between the brass connector and the nylon jackets on the teflon wires. The cable was finished by heat shrinking a teflon sleeve over the connector and cable.

Figure 1 shows the connection of the six cable wires. The ground wire connects the VIDEED case (which may also be the weapon ground) to the amplifier case ground. It is effective grounding only for interference coming from a very high impedance source, e.g., static pickup. For ground loop voltages from a low impedance source a resistive ground wire is totally ineffective, and the difference of potential between the weapon ground and instrumentation ground must be measured and subtracted from the measurement. The purpose of the common lead in the cable is to carry the weapon ground voltage to the input of the differential amplifiers, where it is subtracted from the p-c voltages. The other four wires in the cable carry the p-p and both p-c voltages to the instrumentation amplifiers.

5. CABLE ADAPTER

The signal produced by the diode detector undergoes a voltage division due to the series resistance of the cable wire (.4 to 4 megohm) and the input impedance of the instrumentation amplifier. The equation is the very familiar

$$V_{ampl} = \frac{Z_{ampl}}{Z_{ampl} + Z_{cable}} V_{detect} \quad . \tag{1}$$

There are two different lengths of cable, and these can be combined in many different ways. Some have resistances 10 times that of a single cable length. It is important that Z_{cable} does not have significant effect in equation 1. The only way to do this is to make Z_{ampl} as large as possible (at least 10 times larger in actual amplifiers); then the ratio of impedances is nearly unity and

$$V_{ampl} = V_{detect} \ .$$

This high input impedance of the amplifiers has the adverse property of allowing the amplifier input voltage to vary when the driving source impedance is very high. For example, static charge on persons using the equipment could be coupled through the small capacitance between hand and wire and produce a measurable output on the recorder. Also, nearby power leads could induce 60 Hz signals into the system.

To reduce these difficulties the cable is terminated with one megohm resistors at the VIDEED. These resistors tend to balance out stray signals. Ideally, these resistors should be placed inside the VIDEED itself, but it was not possible to make stable, high-resistance devices in a small enough size with the resistor materials presently available. As an alternative a small [7 mm (0.275") dia. X 22.23 mm (7/8")] adapter containing the four 1/8 watt, 1 megohm resistors was constructed and attached to the VIDEED. Figure 1 shows the p-p wires shunted together by one resistor. Each of the p-c lines are shunted to the common point or ground. Notice that pickup on either p-c lead is bypassed to weapon ground through the 1 megohm resistors. Therefore, pickup on the common lead is grounded in a similar fashion by inserting the series 1 megohm resistor in that line. Pickup is kept more nearly equal this way, and the difference voltage applied to the amplifiers is much smaller. The last bit of pickup ripple is filtered in the amplifier, but this filtering was kept to a minimum to allow faster system response.

Besides containing the shunting resistors, the adapter provides an interface between the five-pin connector configuration of the VIDEED and the seven-pin connectors on the cables.

6. INSTRUMENTATION AMPLIFERS

The fundamental purpose of the instrumentation amplifiers is to present a high impedance to the cable voltages and a low driving impedance to the recorder with a unity gain. It was later decided that the p-p amplifiers would be more desirable having a gain of 10.

Notice in figure 3 that there are no shunting resistors on the input to the amplifiers. This allowed the full 40 megohms input impedance to appear at the cable. When the cables were not connected, operating these amplifiers without an input ground return occasionally damaged them. Each amplifier was interlocked to the cable so that the power would be removed from the amplifier as soon as the cable was disconnected.

The circuitry is standard for instrumentation amplifiers with two exceptions. The first unusual circuit is the analog "OR" gate. The two p-c voltages appear at their respective inputs to the "OR" gate. Whichever voltage is more positive appears at A and reverse biases the opposite diode. Beside biasing the diode off, it feeds back a signal to the op-amp having the lower input signal and effectively shuts off that amplifier. The end result is a unity gain circuit for the larger signal and a circuit which approaches zero gain for the smaller signal. The final amplifier is simply a driving source for the recorder.

Secondly, a circuit was required to sense when the amplifiers were being driven into saturation. The saturated amplifiers produced a net zero output in the differential amplifiers, giving an indication of no signal present when in fact there was a very large signal. Saturation of any amplifier lights an LED on the amplifier front panel as a warning. The circuit is shown in figure 4 and connects to the amplifier at tie points 1, 2, 3, 4, 5 and 6.

The diode matrix allows the output of each op-amp to be sensed without causing an interaction between them. The transistors are emitter followers which light the LEDs through the appropriate zener diode. The LED is energized when zener breakdown is exceeded; this occurs when the amplifier outputs reach 10 volts.

For this particular circuit the saturation light will also glow when the differential signal exceeds three or four volts. This is not indicative of saturation but does indicate operation which could damage the SEMs and is a cause to check the measurement setup. Saturation due to excessively large signals coming through the input cable has not caused damage to the amplifiers. This is probably due to the high impedance of the cable, which limits the input current to a safe value.

The accuracy of the gain (unity for p-c and 10 for p-p) in the amplifiers is better than can be resolved on the recorders presently used with the system and is considered more than adequate for EED measurement requirements.

7. RECORDERS

Almost any strip chart or x-y recorder can be used to indicate the output. The one used should have at least 300 ohms input impedance and an appropriate time axis motion. Coax cables are supplied with the amplifiers to connect each unit to its designated recorder input.

8. TESTING THE VIDEED SYSTEM

8.1. DC Testing

The VIDEED system was first dc tested. Two test units were built to evaluate the various parts of the system, and these are shown in figures 5 and 6.

The test unit in figure 5 generates dc voltages that represent outputs of the diode detector and tests all components of the system with the VIDEED removed. Each potentiometer controls the voltage to the marked pin of the cable or amplifier and should produce the correct response on the recorder.

The common-mode control should produce no effect on recorder until saturation. The unit in figure 6 supplied appropriate voltages to the diode detector and evaluates the VIDEED itself. R1 and R2 are used to obtain various combinations of p-p and p-c voltages as they might appear on the firing circuits. R3 controls the common mode voltage which appears to the VIDEED as a p-c voltage without a p-p component. These two units are convenient for troubleshooting the VIDEED system.

8.2. RF Sensitivity Testing

The final test for the VIDEED is its response to rf signals. The problem of whether to measure voltage, current or power was discussed, and power was chosen since it could be measured more accurately with the instrumentation available. Power is a proper measurand, since it requires power to produce explosive ignition either by bridgewire heating or by sustained arc. Further research into the relative merits of measuring VIDEED response to rf voltages and/or currents was considered beyond the scope of this project.

Basically, two measurements had to be made. One applied power in push-pull to the input leads, which would apply a difference of potential across the 2-ohm resistor. The diodes sense this voltage as a pin-to-pin excitation. However, the pin-to-case circuits will also sense a signal and produce an output. The other test mode applied power to the input leads in-phase, so that while there are voltages between either pin and ground, there should be no difference of potential across the 2-ohm resistors. If the common-mode rejection were good enough, no output should be produced by the p-p detector when the VIDEED is excited in this mode.

Figure 7 shows the basic components of the measuring system. RF power was fed into the VIDEED on two 50-ohm transmission lines. The input leads themselves form the center conductors of these lines and so maintain a 50-ohm match up to the VIDEED header. The two transmission lines formed in this way were driven from the two outputs of a 180° hybrid junction. These particular types of hybrids have the property that the outputs will be in phase when the input is applied to the 0° port, and they will be 180° out of phase when the input is applied to the 180° port. In this way both modes could be easily tested simply by switching the input. The generator and couplers connected as a reflectometer are standard. More accurate measurements can be made if the reflectometer is tuned, but a simple one was considered adequate in view of the accuracy requirements of this project.

The power absorbed by the coupler and VIDEED combined was measured as the difference between the incident and reflected powers. Power absorbed by the hybrid is small and most of the measured net power actually is absorbed by the VIDEED.

The incident power applied to the hybrid is partly absorbed by the VIDEED and partly reflected. This reflected power appears back at the input port and propagates back toward the generator so that it can be measured as shown in figure 7. Some power appears at the fourth arm of the hybrid (normally terminated), which is the difference between the two reflections. Since the VIDEED is constructed to be electrically balanced, the reflections are nearly equal and the difference very small. Measurements made at 1 GHz indicate that the reflected power due to unbalance is more than 20 dB below the reflected power actually being measured, and therefore negligible error is incurred by ignoring it.

Figure 8 shows the results of measurements made by applying 7 milliwatts of absorbed rf power to the VIDEED at various frequencies. The power was applied in the pin-to-case mode or the 0° input of the hybrid. The pin-to-pin output, which should be small in this configuration, is indeed small up to 4 GHz and becomes approximately equal to the p-c voltage at 5 GHz. At these frequencies the stray capacitances in the microcircuit (VIDEED) and the imperfections in the test jig begin to produce a large effect on the measurement. Figure 9 shows a similar test made by applying 200 milliwatts of absorbed power to the VIDEED in the pin-to-pin or 180° mode. In this case the two outputs are expected to be approximately the same as they are up to 8 GHz.

Figures 10 and 11 show the linearity of the VIDEED detectors as a function of input power. These data were taken at 1 GHz and are considered generally true for all frequencies although a detailed calibration would have to be performed on each unit to provide any real certainty. The curves are the average of results taken from several representative VIDEEDs. It should be noted that the p-p output when the input is pin-to-case is in fact smaller than the p-c output and has its own scale on the right edge of the graph.

It should be pointed out that until more work is done on the complete evaluation of the hybrid and test fixture, these curves should not be construed as "calibration curves" in the usual sense. Until this evaluation is complete, the VIDEED is useful as an indicator of relative values of rf power and should not be used to determine absolute rf power levels. However, for the purpose of this project, the VIDEED is capable of fulfilling the requirement for a relative rf power sensor.

8.3. RF Impedance

It is obvious that the impedance of the VIDEED must be different for the two firing modes and some work was done to measure these impedances. Attempts to measure the VIDEED impedance "through" the hybrid coupler produces results that indicate a need for further research in measuring unbalanced impedances in the microwave region. However, for this research, separate funds would be required. Also, further analysis and measurement on the Automatic Network Analyzer could resolve some of the difficulties presently experienced in this type of measurement.

9. CONCLUSION

As of the completion of this report all five recorders, 15 amplifiers (in 3 packages), 15 cable assemblies and adapters will have been delivered to the sponsor. Eleven VIDEED units have already been sent. Because of production difficulties the remaining units were faulty at construction and have been disassembled for repair. Of these, 20 units should be ready for the final shipment. The major fault was due to a flowing of the conductive epoxy used in the construction. During the heat curing, the epoxy often migrated into thin spaces with a capillary type of action. The migrated epoxy could then short-circuit vital components on the circuit board. These units have been repaired to the extent that time and funding permitted.

10. ELECTRICAL AND MECHANICAL SPECIFICATION SUMMARY

A. Diode Detector

Mechanical (see figure 12)

Length -- 14.99 mm (0.590") (excluding input leads)

Diameter -- 7.0 mm (0.276")

Lead wires -- 48.26-mm (1.90")-long #18 tinned copper

Case -- thin-wall brass

Socket and header -- injection molded plastic. Socket to mate with special 5-pin plug on cable adapter

Electrical

DC resistance

pin to pin 2.0 ohms ± 0.5 ohms

pin to case 275 ohms ± 75 ohms

Useful frequency range -- below 1 GHz to 9 GHz. (Lower frequency limit has not yet been determined.)

RF input -- no greater than 7.0 V RMS for pin to case voltages, no greater than 500 mW pin to pin power, for duration not to exceed 1 minute.

Sensitivity (minimum) -- pin to case approximately 50 mv dc output for an incident power of 7 mW supplied from a 50 Ω system. The pin-to-pin sensitivity is greater than 100 mV for 200 mW input.

B. Cable Adapter

Mechanical (see figure 2)

Length -- 21.97 mm (0.865")

Diameter -- 8.89 mm (0.350")

Connectors -- special 5-pin plug on diode detector end of adapter. Cable end uses miniature 7-pin connector to mate with cable connector.

C. RF Transparent Cable

Mechanical

Cable length -- 15 meters (50 feet) or 6 meters (20 feet) (one complete set includes two 15-meter lengths and three 6-meter lengths). These can be connected in series in any combination.

Cable diameter -- 3.56 mm (.140") maximum

Connector diameter -- 8.97 mm (0.353")

Length of connector (measured from mating plane of connector to point on cable where it can be bent safely) -- 38 mm (1.5")

Radius of bending -- 12.7 mm (0.5")

Cable jacket material -- teflon

Number of wire -- 6 teflon carbon wires

Resistance -- 400 kΩ for 6-m (20 foot) length
1.0 MΩ for 15-m (50 foot) length

D. <u>Cable-Recorder Interface</u> (unit includes 5 amplifiers with power supply)

Mechanical

Dimensions -- width 206.375 mm (8 1/8"), height 158.75 mm (6 1/4"), depth 323.85 mm (12 3/4"), weight 5.85 kg (13 lbs.)

Electrical

Power -- 120 volts, 60 Hz, 125 mA. Main power controlled with front panel switch. Each amplifier turned on when input cable is attached.

Input -- each interface amplifier accepts dc inputs from one diode detector, one pin-to-pin voltage and both pin-to-case voltages.

Input amplitude -- ± 10 volts maximum either differential or common mode.

Output amplitude -- ± 10 volts maximum

Pin-to-pin output -- 10 times the pin-to-pin input voltage.

Pin-to-case output -- the higher of the two pin-to-case inputs.

Amplifier saturation -- indicated by LED's on front panel.

Gain -- unity to within ± 2% on p-c and 10 ± 2% on p-p.

Common mode rejection -- 70 dB when not in saturation.

E. Dual Channel Recorder

(Any recorder having electrical specifications below can be used.)

Electrical

Power -- 120 VAC 60 Hz.

Input -- 100 mV full scale, 2 channel.

Input connector -- general-purpose jack terminal.

Chart speed -- minimum speed at least as slow as 1 mm/sec.

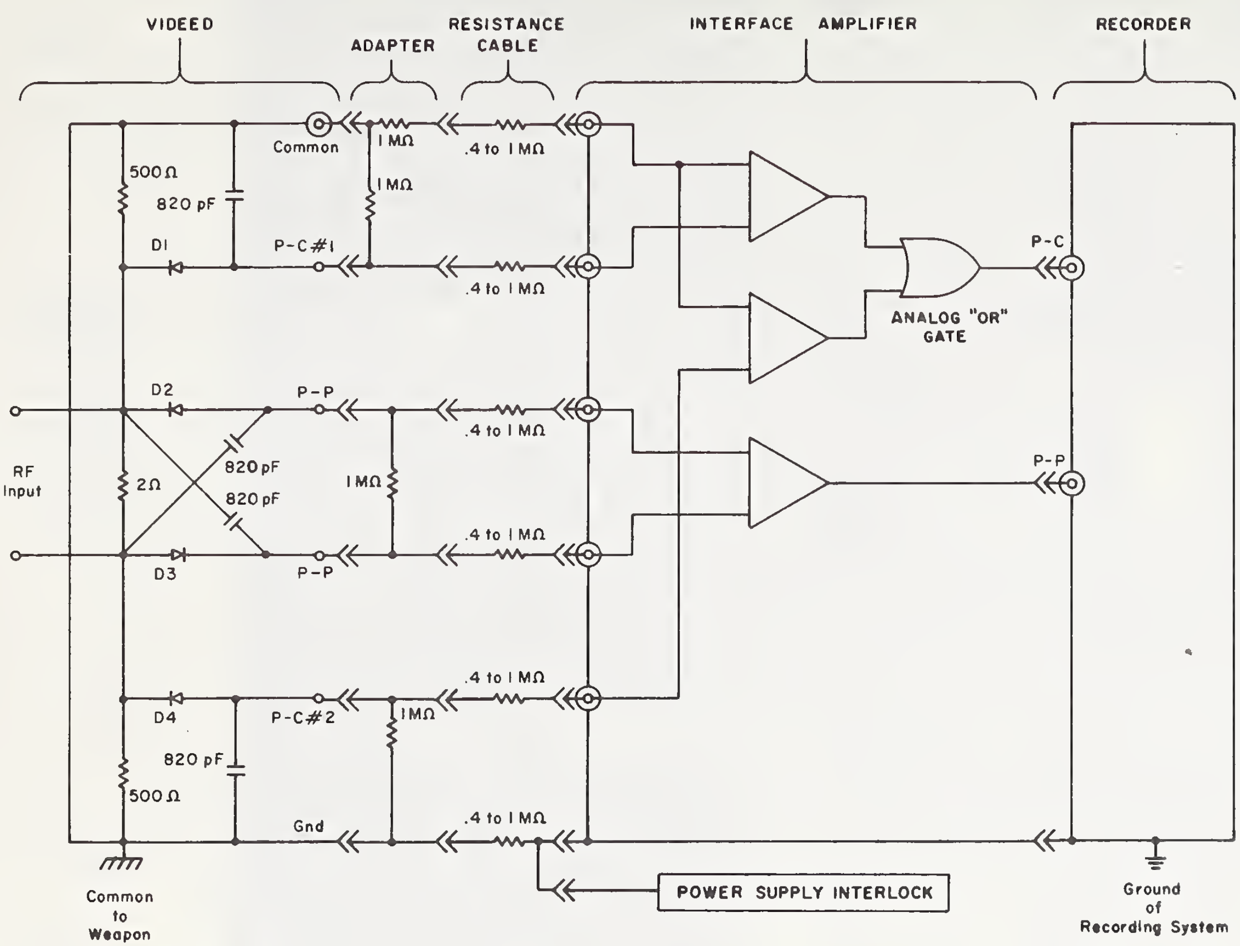
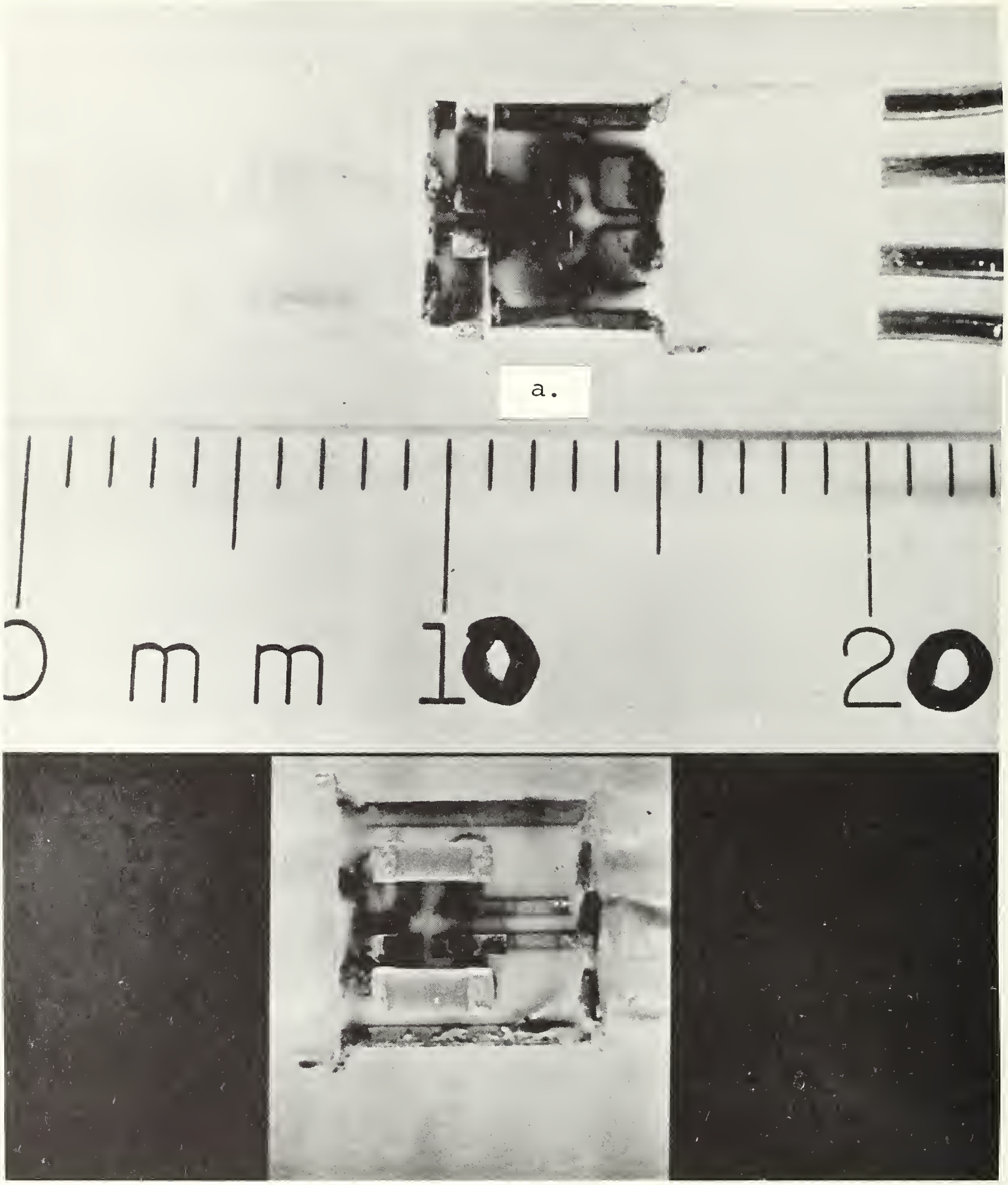


Figure 1. VIDEED system.



b.

Figure 2. VIDEED
a. p-c side
b. p-p side.

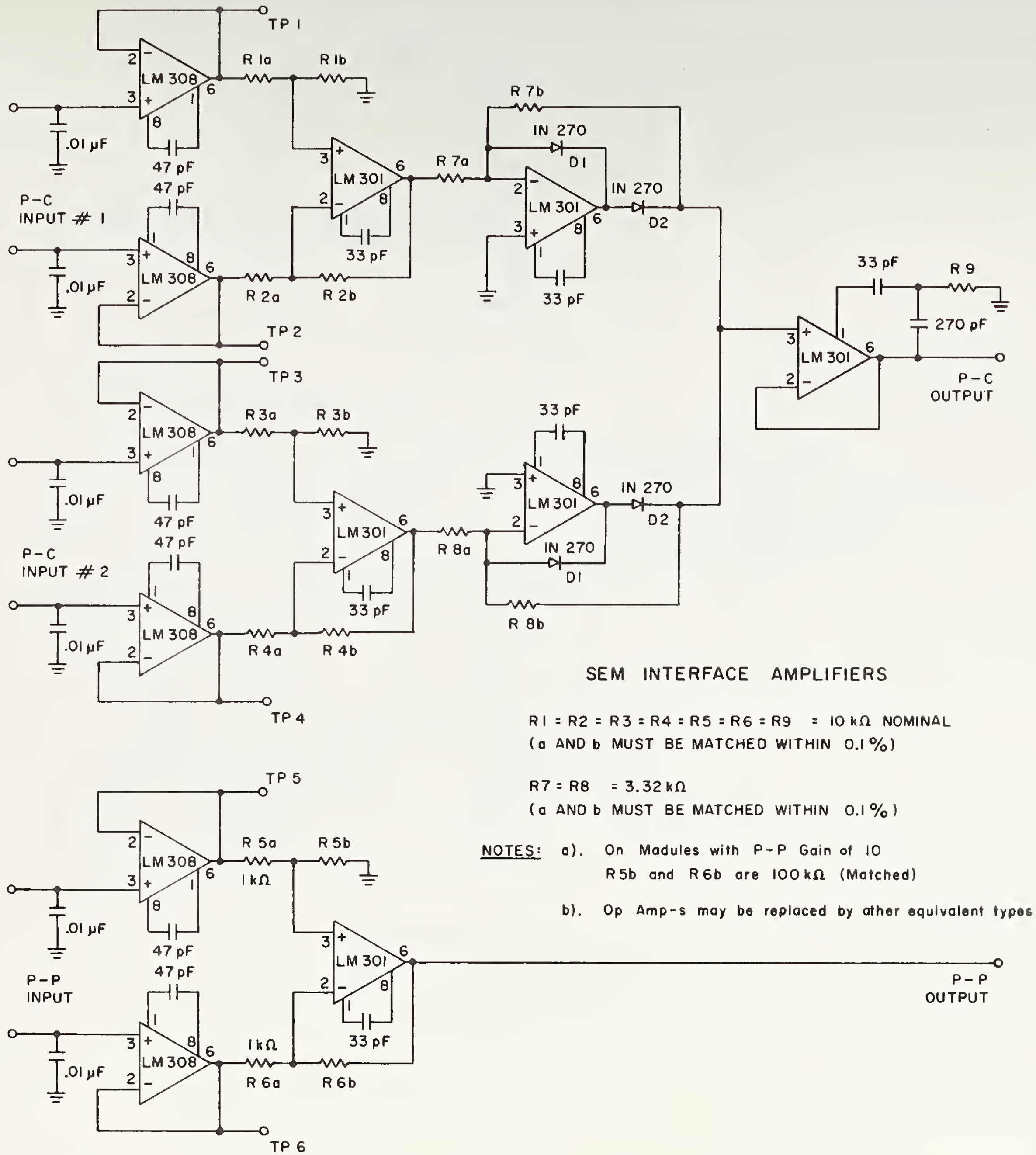


Figure 3. Interface amplifier circuit.

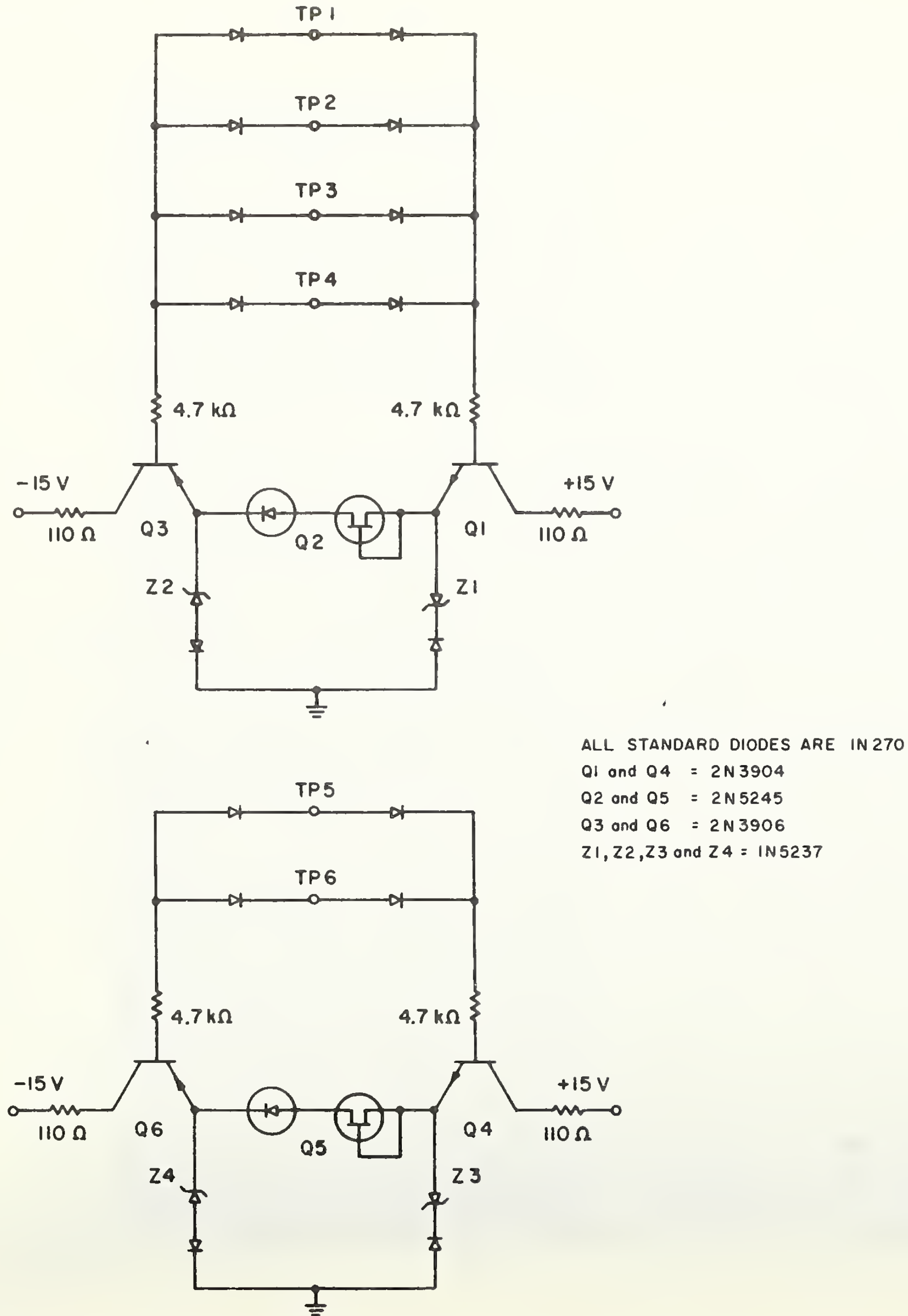
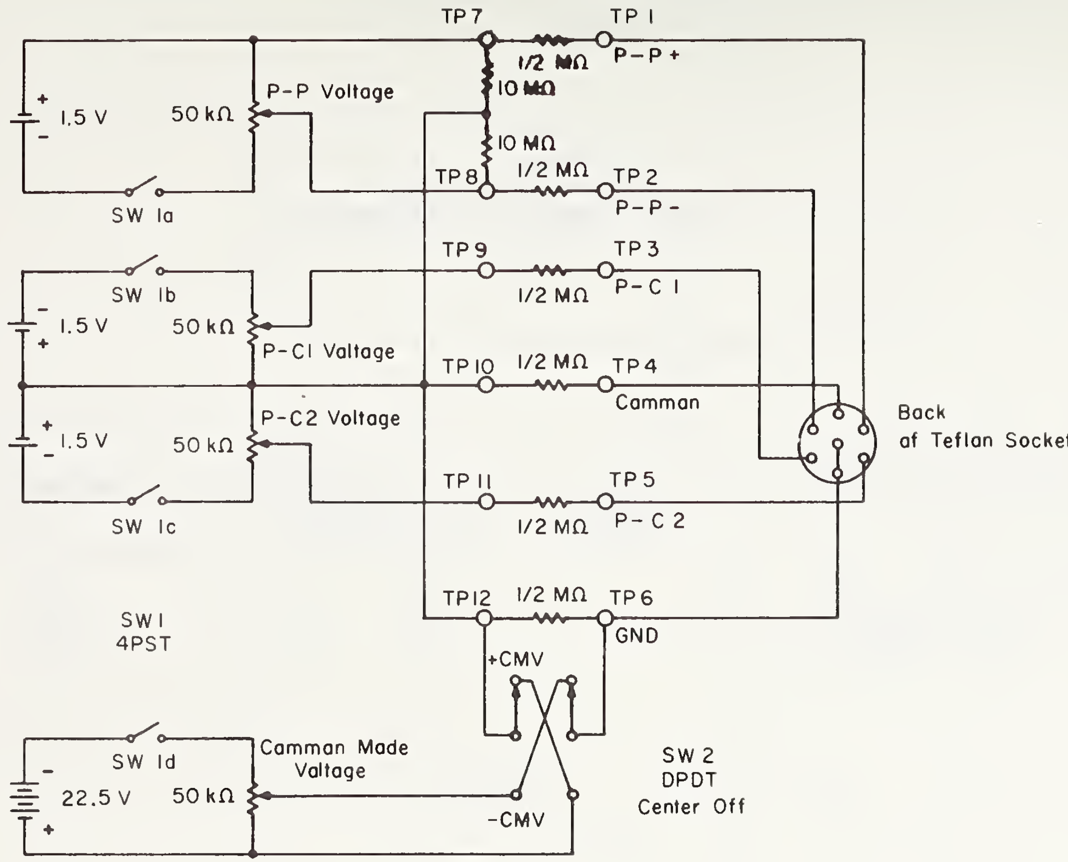
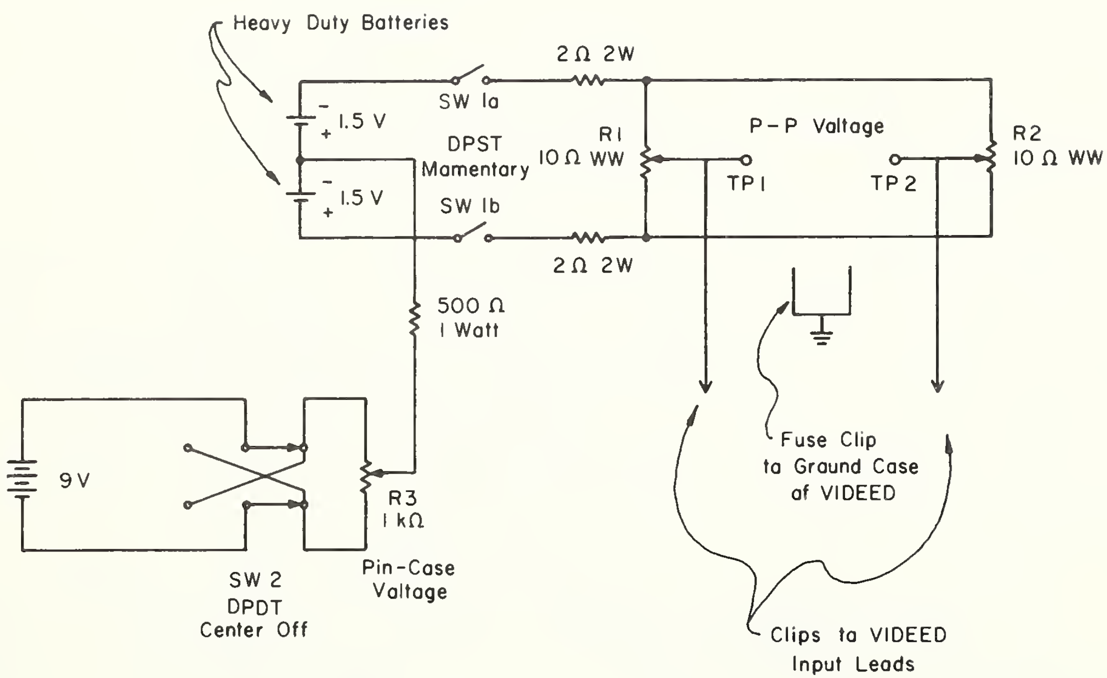


Figure 4. Saturation indicator circuit.



Test P-P Valtage between TP 7 and TP 8
" P-C " " TP 9 and TP 10
or TP 11 and TP 10
Test Cammon Mode Valtage between TP 12 and TP 6

Figure 5. Cable and amplifier test unit.



To test P-P Voltage, measure between TP1 and TP2
" " P-C " , " " TP1 and Gnd
or TP2 and Gnd

Set R1 and R2 midrange while testing P-C Voltages (R3)
Set SW2 off while testing P-P Voltages (R1, R2)

(Can also test combinations of P-P with P-C Voltages)

Figure 6. VIDEED test unit.

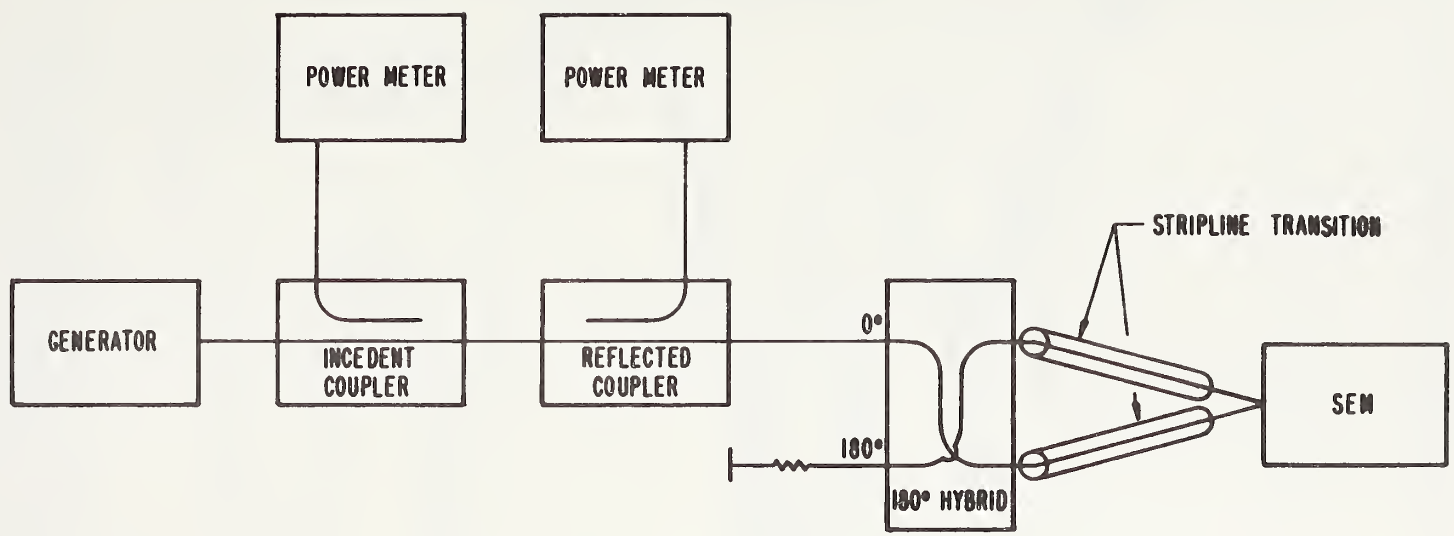


Figure 7. RF test setup (p-p).

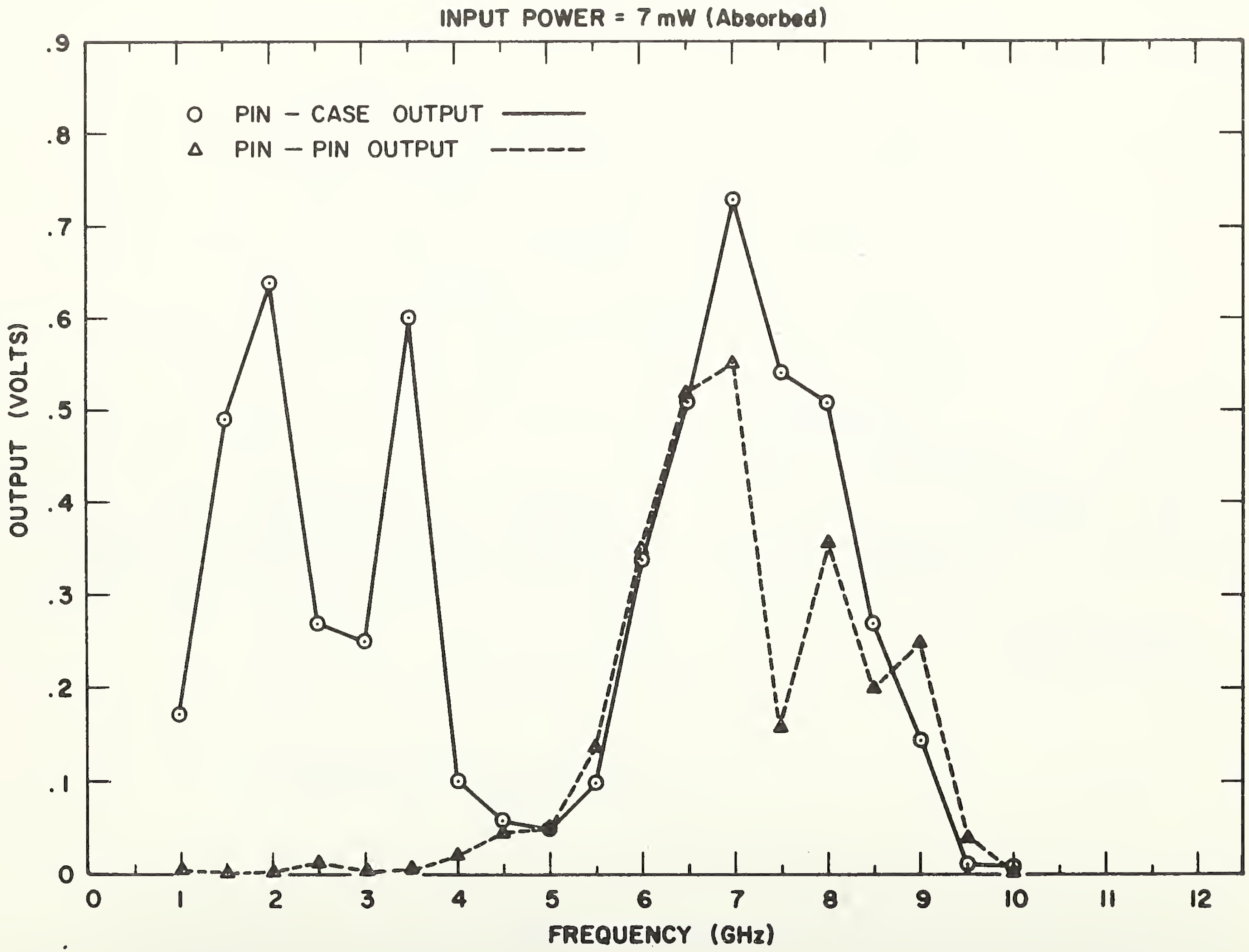


Figure 8. VIDEED output vs frequency (0° between input leads).

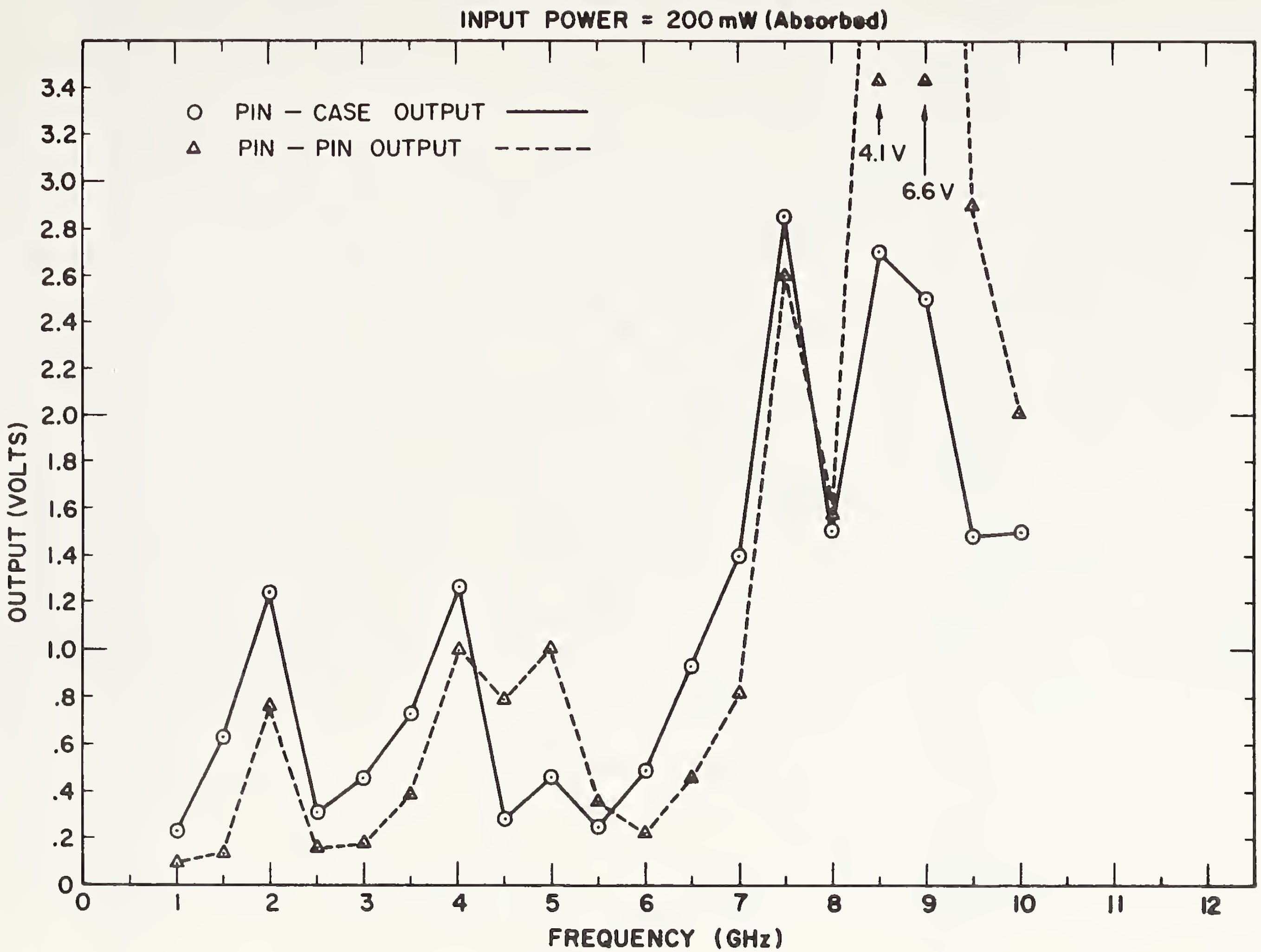


Figure 9. VIDEED output vs frequency (180° between input leads).

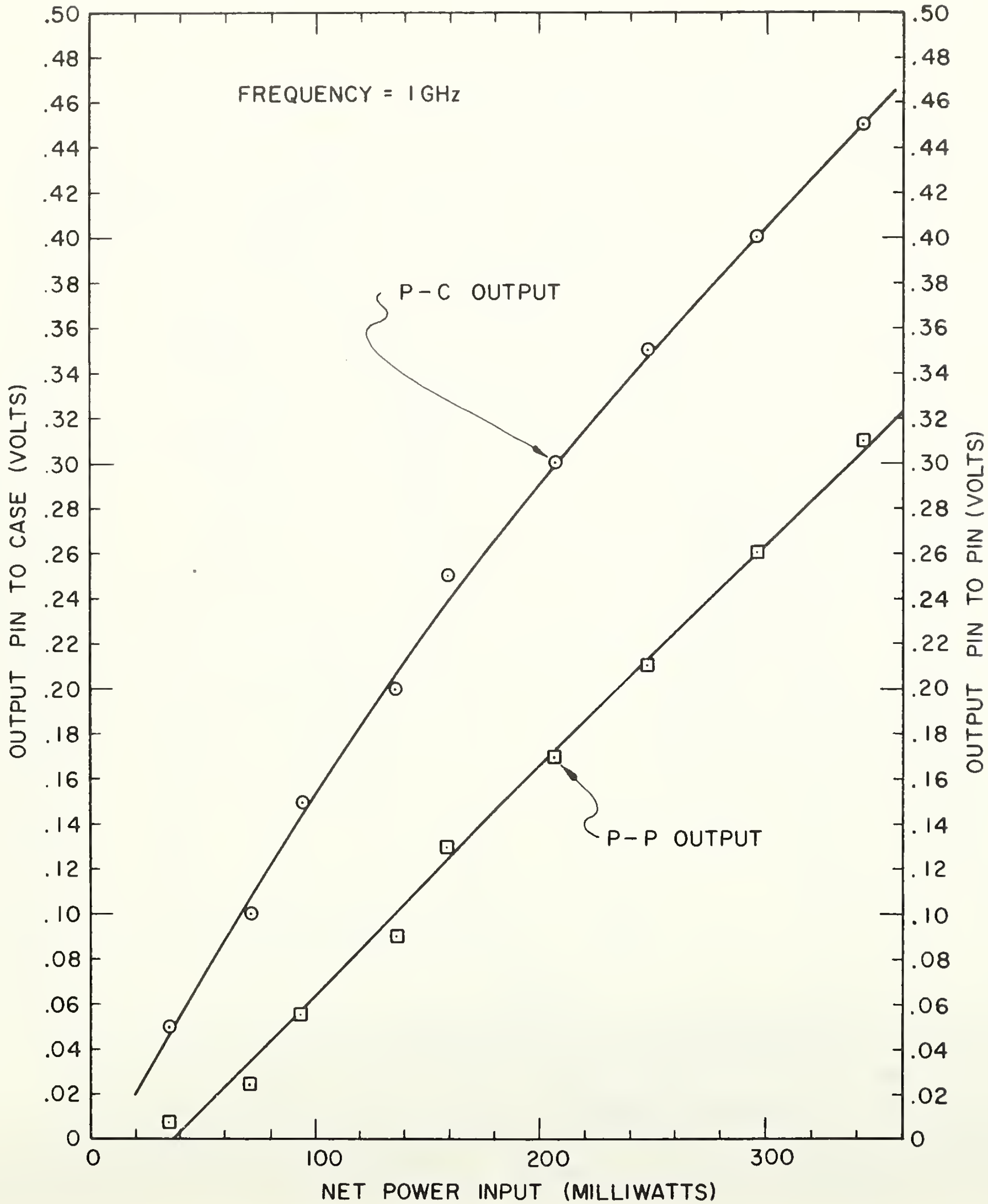


Figure 10. VIDEED output vs power input (180° between input leads).

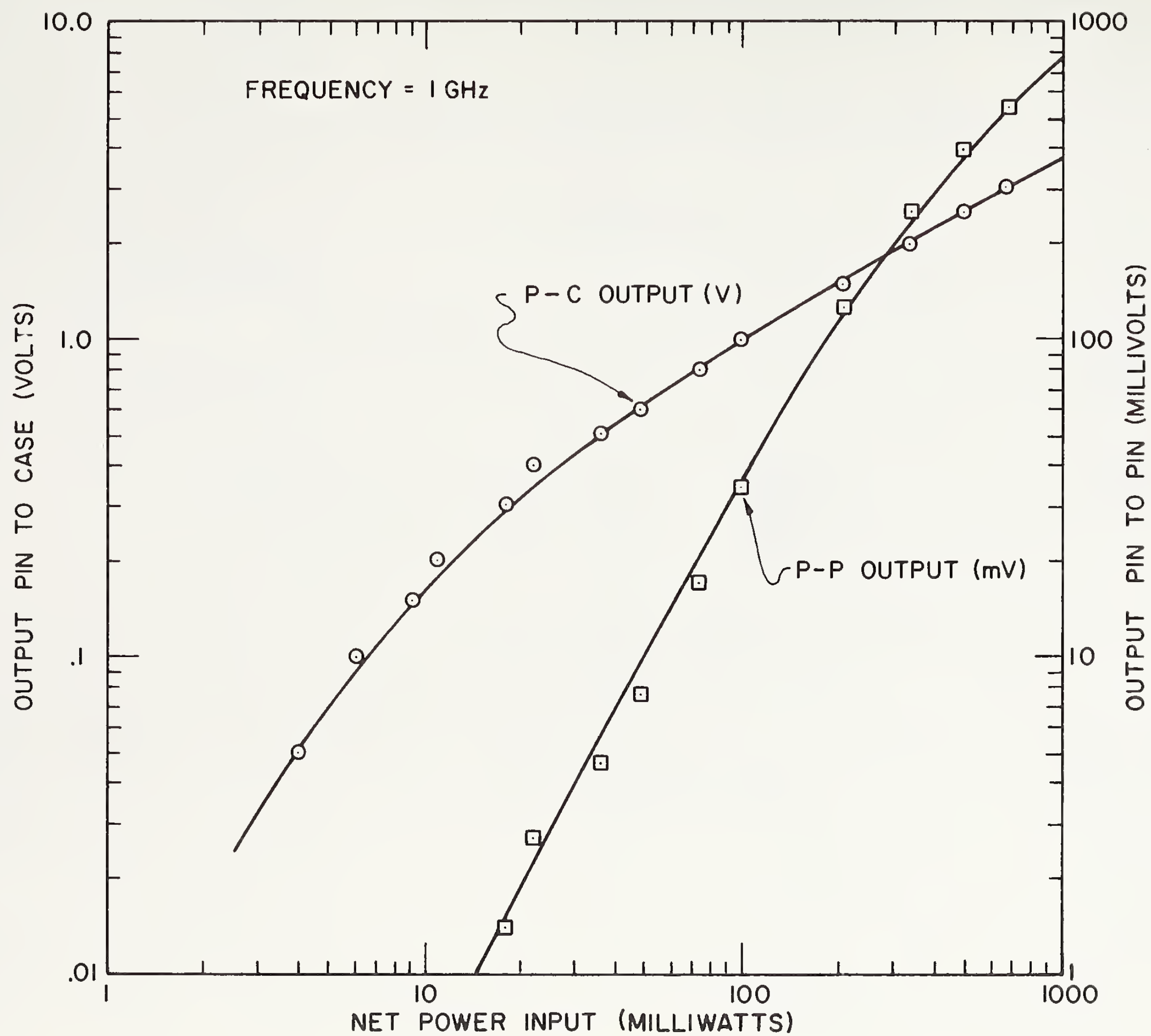


Figure 11. VIDEED output vs input power (0° between input leads).

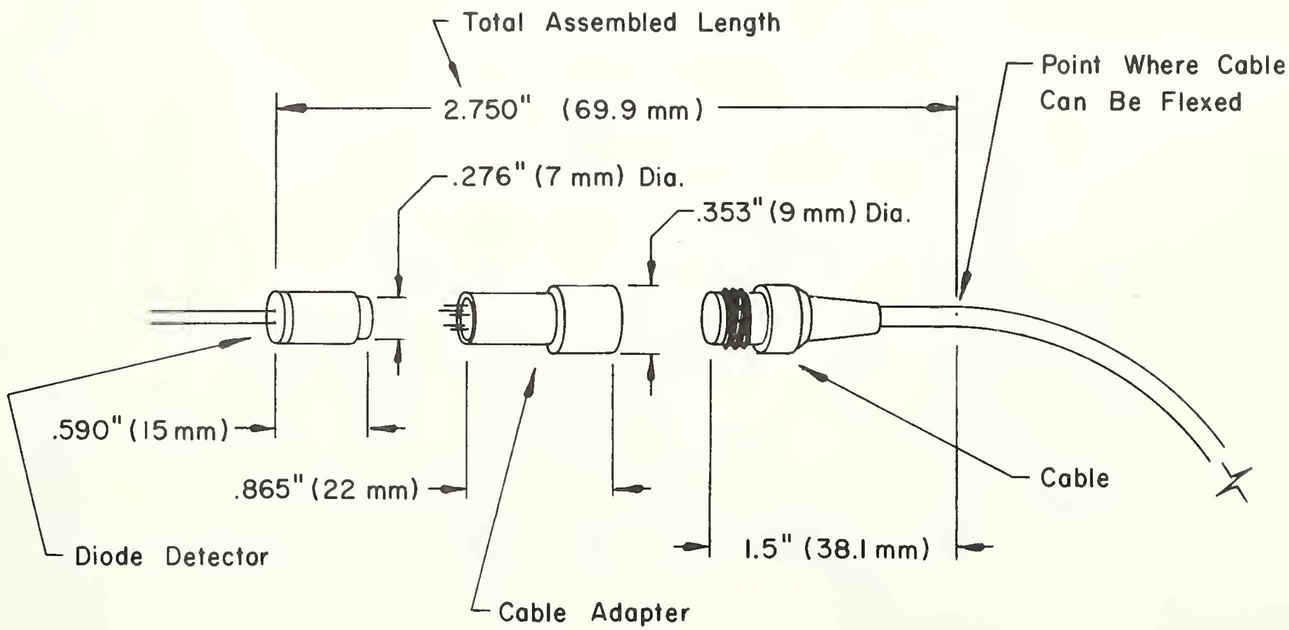


Figure 12. Mechanical details of VIDEED.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

Qualification of weapon and missile systems for electroexplosive device (EED) safety has been a continuing problem in the military services. Quantitative measurement of stray energy in EED's has been hampered by limitations of existing sensors. This report describes a new video diode detector instrumented EED (VIDEED) which responds to both the normal pin-to-pin energy (which would heat an EED bridgewire) and to the pin-to-case voltage (which might cause EED ignition due to arcing).

Also described in this report are the amplifiers, cables, adapters and recorders which make up the rest of the measuring system. Mention is also made of the test procedures used in testing the VIDEED system.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Electroexplosive device safety; electromagnetic compatibility; electromagnetic interference; stray energy sensor.

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