N75-25700

TEST REPORT NO. 22146-1

FOR

LK39F1 S/N U-1 INFRARED DETECTOR

FOR

NASA
JOHNSON SPACE CENTER

CUSTOMER P.O. NO.
NAS 9-14180

FINAL REPORT
April, 1975

4-14-75
PRODUCT ASSURANCE
ENGINEER

PROJECT ENGINEER

PROGRAM MANAGER

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NOTE: PLEASE READ HANDLING AND USE PRECAUTIONS BEFORE USING THIS DETECTOR.

1.0 INTRODUCTION

The multilayered (Hg,Cd)Te detector is sensitive to three infrared bands. Nominal cut-off wavelengths for each band are as follows:

Channel 1 - 3 microns
Channel 2 - 6 microns
Channel 3 - 11 microns.

The multilayered detector is mounted in a Honeywell LK39 glass dewar. Accompanying the detector/dewar assembly is a three-channel preamplifier package capable of switching each detector to the single channel input of the HRB Singer Reconfax IV Mark IV Infrared Scanner.

TEST REPORT NO. 22146-1 (DEVICE) LK39F1 (SERIES) K1 (S/N) U-1

PA 22146

CONTRACT NO. NAS9-14180

CUSTOMER NASA/Johnson Space Center

2.0 DESCRIPTION OF DETECTOR

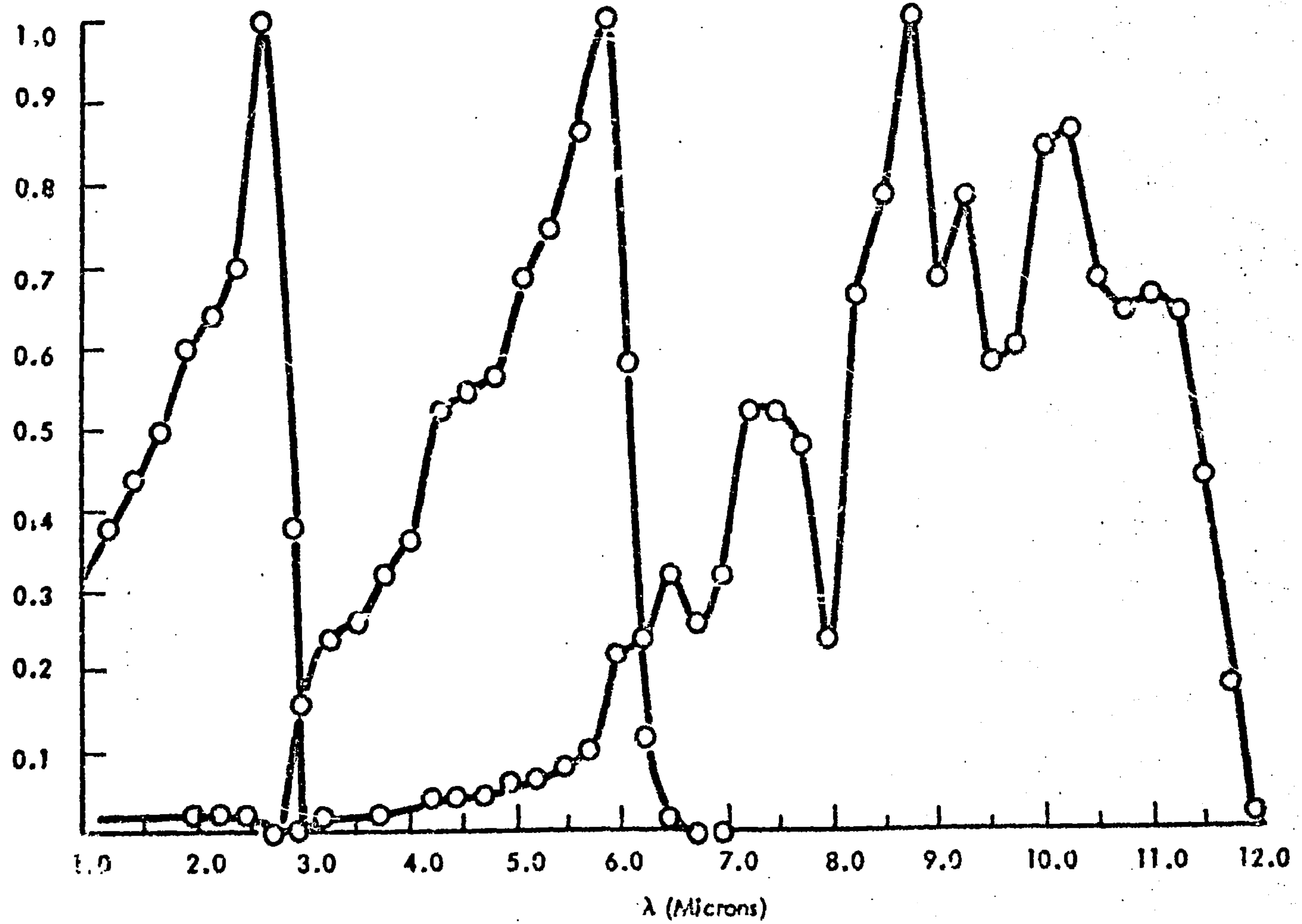
HRC Identification Number	50572S43D2
Type of Detector	Photoconductive (Hg,Cd)Te
Date of Manufacture	April, 1975
Window Material	Irtran II

Element

Length	.49	MM
Width	.53	MM
Area	.26	MM^2
Distance to Window	4.8	MM
Field of View	40.0	Degrees
Liquid Nitrogen Hold Time (Nominal)	8.0	Hours

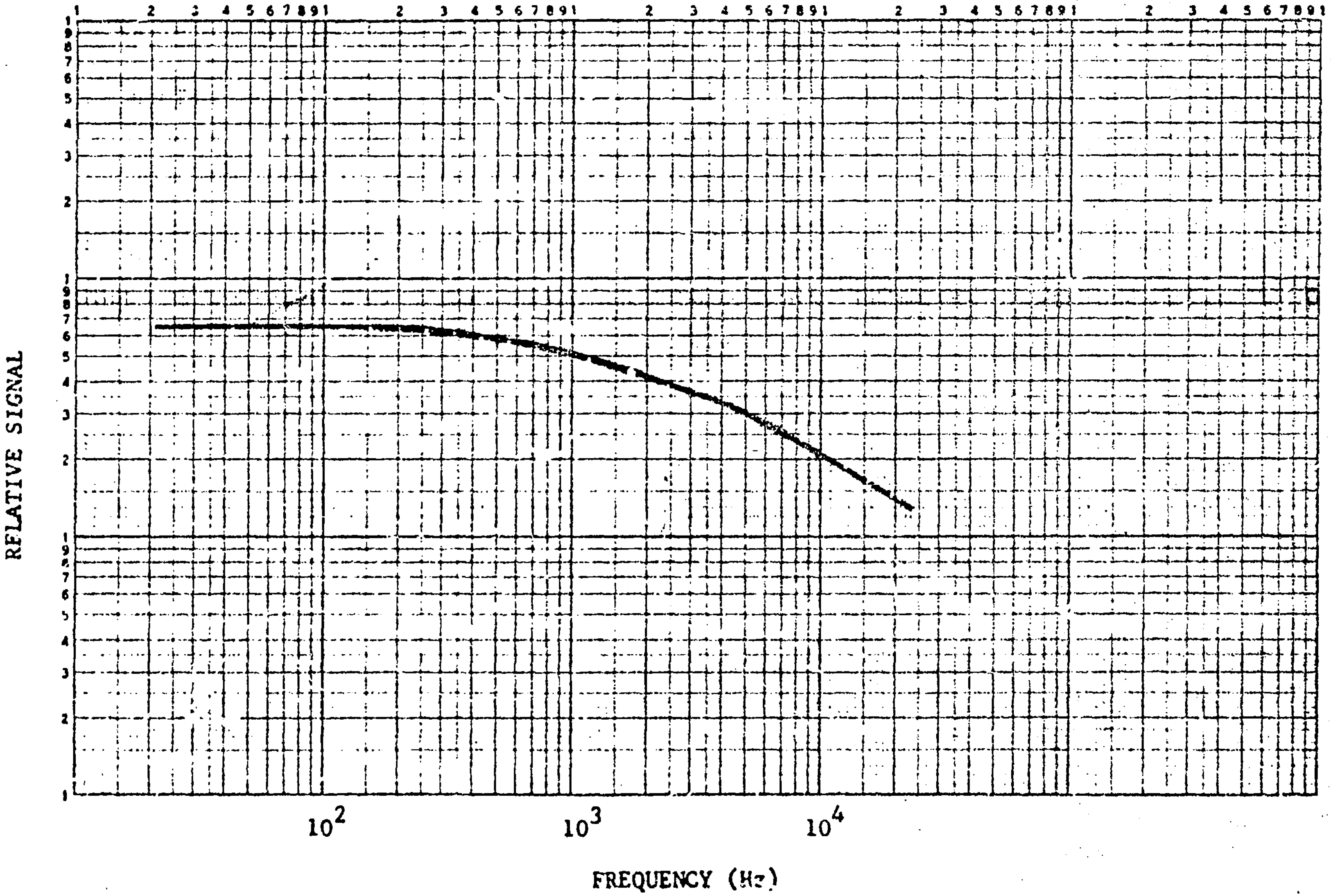
3.0 PERFORMANCE TABLE

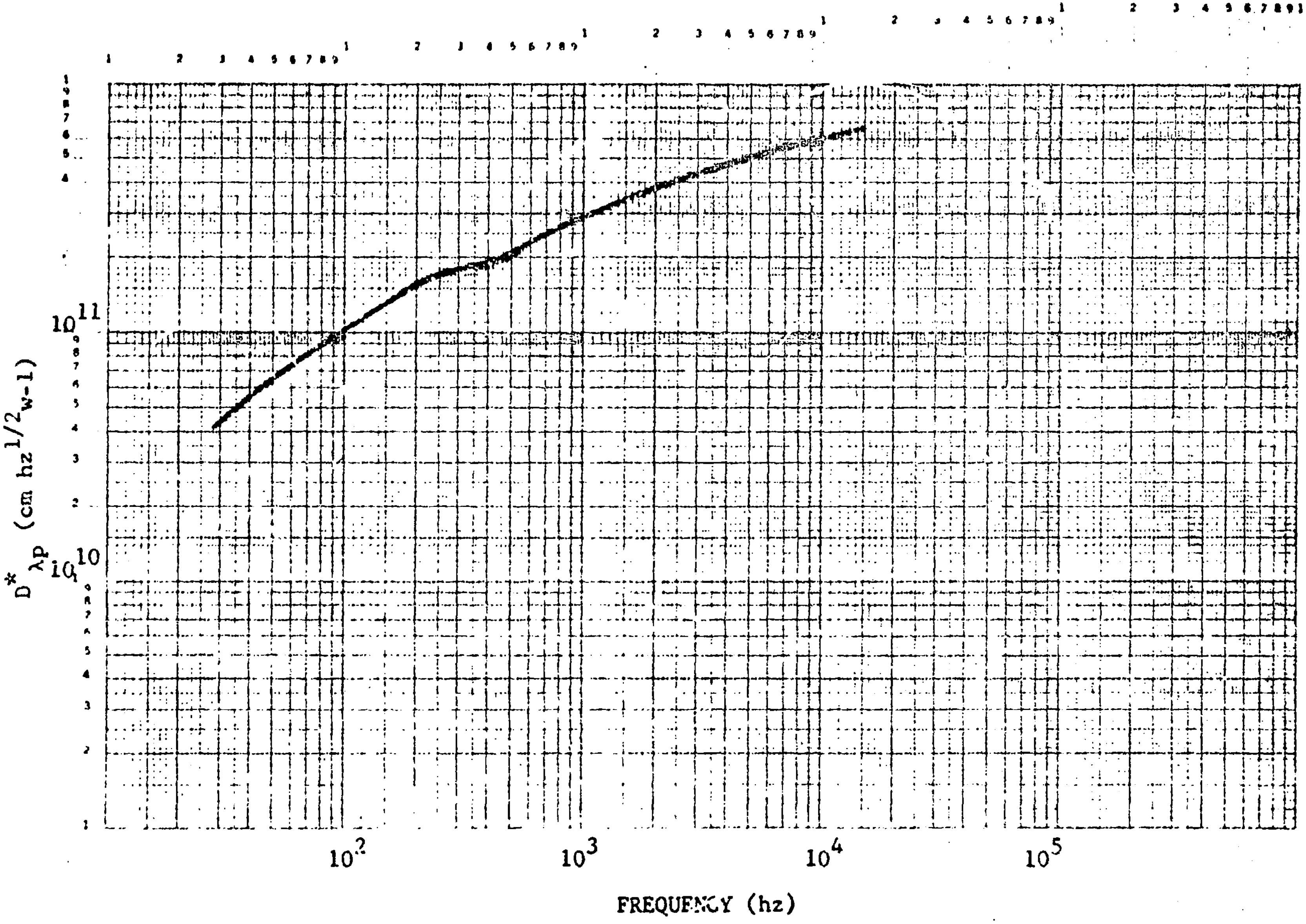
Channel	$\lambda_{cut-off}$ (microns)	300°K R[Ω]	77°K R[Ω]	Optimum Bias [ma]	$D^*_{\lambda p}$ $[10^{10}]$ (1 KHz)	$D^*_{\lambda p}$ $[10^{10}]$ (10 KHz)	$R_{\lambda p}$ [2 KHz]
1	2.9	1680	707	1	29	48	436,000
2	6.0	76	43	8	2.14	4.48	872
3	11.4	20	33	8	2.24	2.66	944



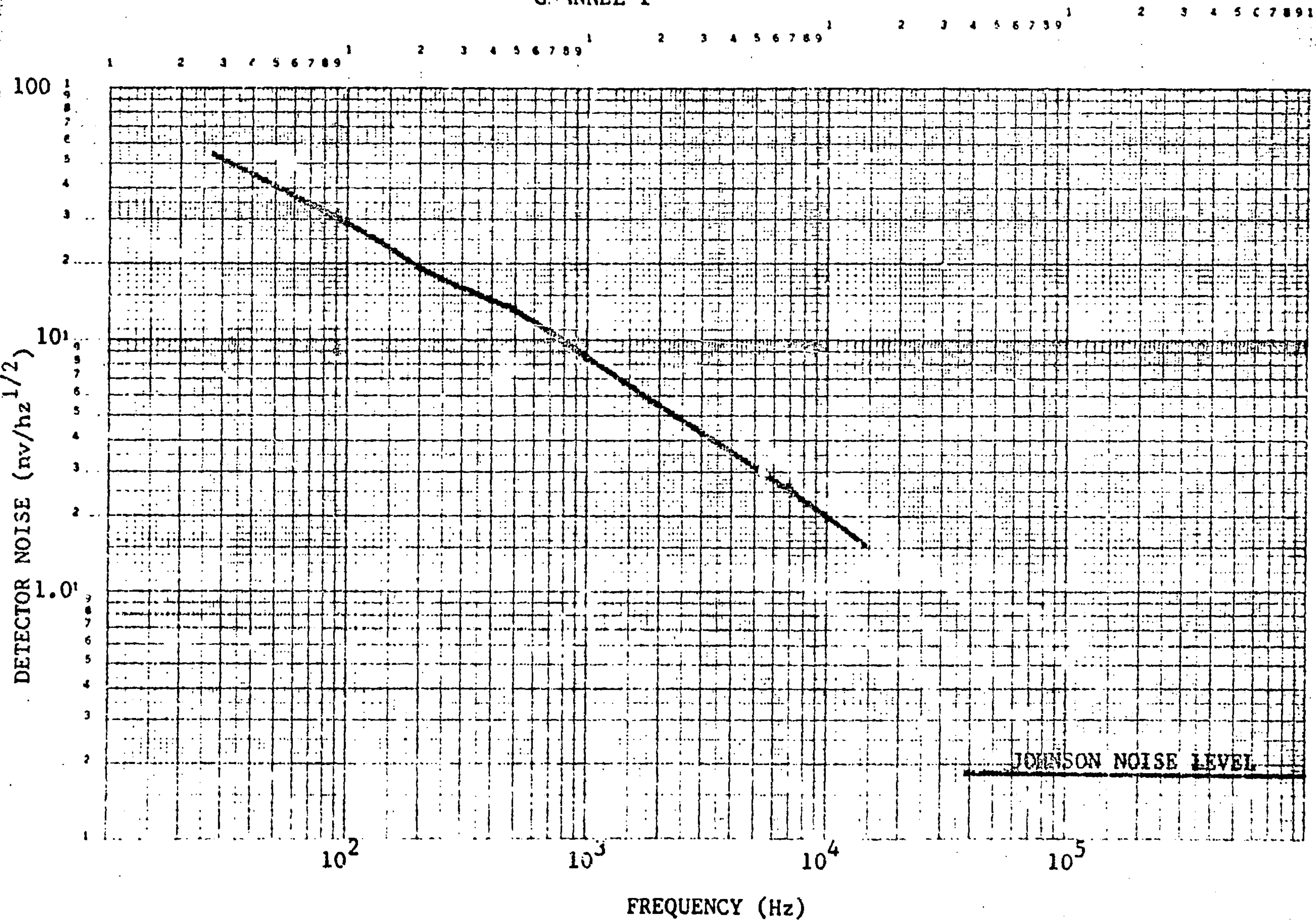
RELATIVE RESPONSE VS WAVELENGTH FOR THE 3-CHANNEL DETECTOR

RELATIVE SIGNAL VS. FREQUENCY
CHANNEL 1

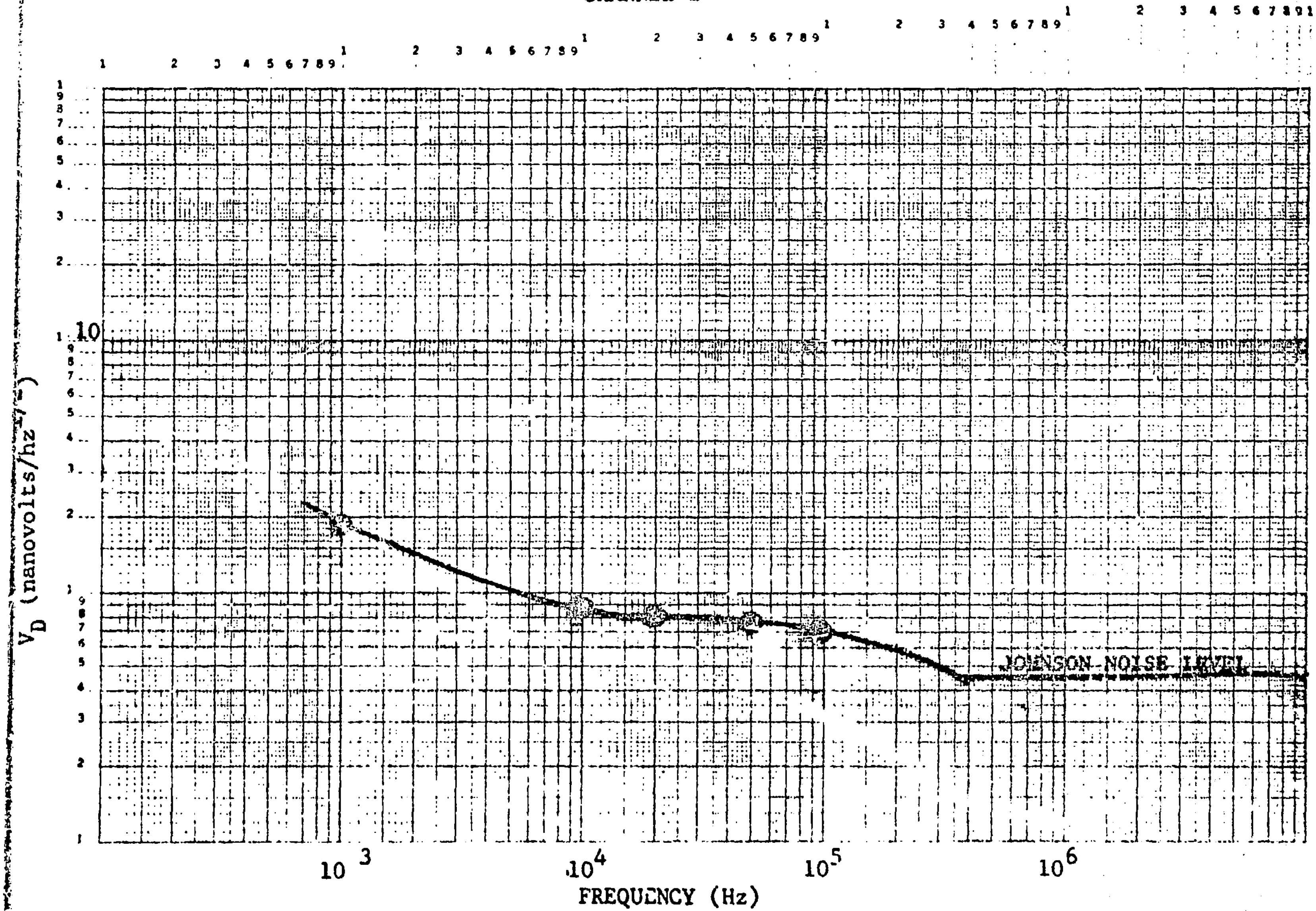



$D^*_{\lambda p}$ (cm hz$^{1/2}$w^{-1})
10^{11}
10^{10}
10^2
10^3
10^4
10^5
FREQUENCY (hz)

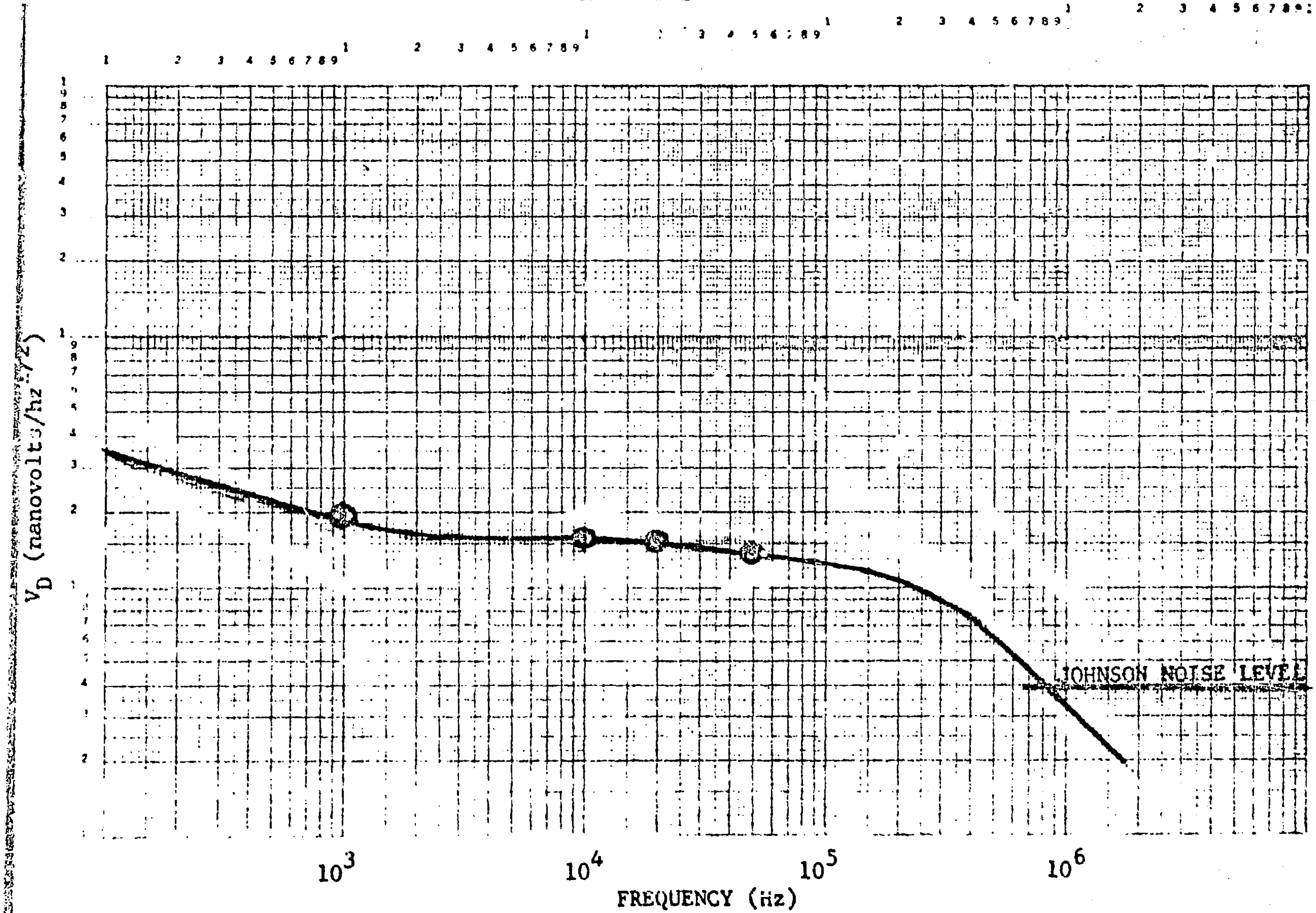
NOISE VS. FREQUENCY
CHANNEL 1



NOISE VS. FREQUENCY
CHANNEL 2



NOISE VS. FREQUENCY
CHANNEL 3



4.0 CONDITIONS OF MEASUREMENT

Detector Temperature	77°K
Chopping Frequency	Specified
Detector Area (A_D)	Specified
Orifice Area A_{BB}	Specified
Blackbody Temperature (T_B)	
Background Temperature (T_C)	300 °K
Emissivity	
Blackbody (ϵ_B)	1.0
Chopper (ϵ_C)	1.0
Noise Bandwidth (Δf)	Specified
Chopper RMS Factor (K_1)	0.35
Detector to Orifice Distance (D)	Specified
Stefan-Boltzman Constant (σ)	$5.67\text{x}10^{-12}$
RMS Noise Correction (K_3)	1.12
Amplifier Gain (same for signal & noise)(G)	Specified

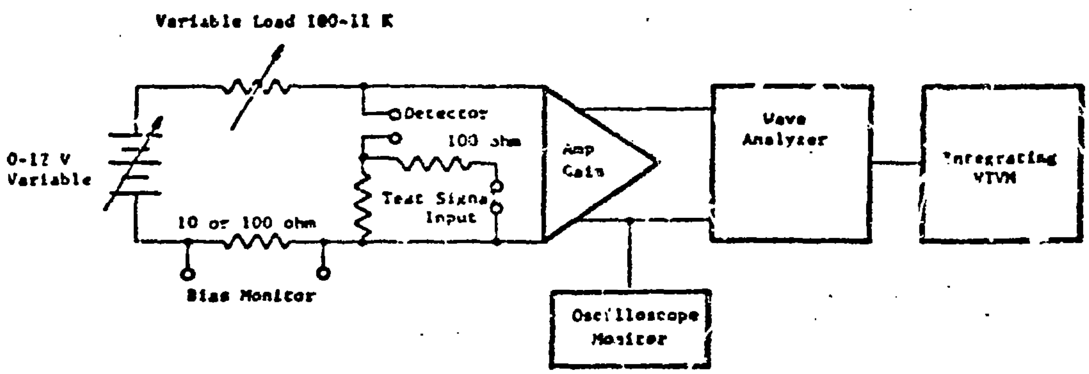
D* Formula:

$$D^*bb = \frac{(\Delta f)^{\frac{1}{2}}(A_D)^{\frac{1}{2}}}{P_1} \times \frac{S}{N} \times \frac{1}{K_3}$$

$$P_1 = \frac{K_1 \quad \sigma(\epsilon_B T_B{}^4 - \epsilon_C T_C{}^4) A_{BB} A_D}{\pi D^2} \times \tau_W$$

$$Resp_{BB} = \frac{S}{A_D G \, F_1}$$

5.0 DETECTOR READOUT CIRCUITRY



6.0 HANDLING AND PRECAUTIONS FOR HRC PRECISION I.R. DETECTORS

This precision infrared detector was built in the laboratories of the Honeywell Radiation Center under the utmost care. This device was produced using some of the most modern technology in existence. However, as with any precision piece of equipment, there are tolerance limitations to which it can be subjected physically, thermally, and electrically.

6.1 Operating Temperature

The device is designed to operate at the approximate temperatures noted in Section 2.0 of this report.

6.2 Storage

This unit is designed to be stored at temperatures up to 185°F (85°C) for short periods of time. Do not exceed this limit. Prolonged exposure to high temperatures may produce a degradation of device performance.

6.3 Window and Housing

Parts may crack or break if subjected to high impact. Always transport device in the container in which it was shipped.

6.4 Detector Element Burnout

The detector element is capable of dissipating only milliwatts of power. <u>Do not overbias</u>.

A. Caution: If lead from detector device should break contact with the test circuit:

1. Turn off bias and amplifier power source.
2. Discharge coupling capacitor by shorting test leads.
3. Reconnect detector element to bias supply.
4. Turn bias power on again.

B. When the detector is connected to any power source, there must be no voltage differential between the contacts until after circuit is complete.

C. Do not use any amplifier circuitry that will produce current into detector or generate current surges.

D. The detector should be operated only in the cooled condition. If it is possible that the cooling unit may malfunction without operator's knowledge, the manufacturer suggests that a current/voltage limiter be installed in the bias circuit to prevent a runaway condition when the detector element warms.

6.5 Protection from Meter Voltage

Normally, the meters used to measure resistance utilize a 1.5 volt battery. The current generated by the battery is sufficient to cause detector burnout. Therefore, if it is necessary to measure resistance, observe the following:

A. Use a Wheatstone bridge with an external battery to produce a current/voltage level compatible with the manufacturer's test results.

B. When the device is in an operating circuit or system, use a VTVM with selector switch set to voltage. Read voltage drop across detector and compute resistance by Ohm's Law. Be cautious of power ground loops between VTVM and detector circuitry. Connect common ground first; then connect VTVM to high side of detector. If VTVM is of a high impedance, it is advisable to use a series limiting resistance in VTVM lead. Resistance values up to 1% of VTVM input impedance will cause no voltage reading errors.

6.6 Moisture

Before cooling, remove all traces of moisture in the dewar well. This will minimize thermal transfer problems and prevent dewar well breakage caused by the expansion of water when it freezes.

7.0 OPERATING INSTRUCTIONS FOR THE EK46 PREAMPLIFIER PACKAGE

The amplifier assembly contains three low noise preamplifiers (Honeywell EK28) and bias circuits. The package has the capability of switching each detector to a single channel output. Design allows that only one detector can be biased at any one time. Detector bias limit resistors are located internally in the EK28 preamplifiers. Nominal bias limits are as follows:

Channel 1 - 1 milliamperes
Channel 2 - 8 milliamperes
Channel 3 - 8 milliamperes.

1.) <u>Detector Bias Circuits</u>

Detector Bias currents are set by the "Bias Control" and monitored by the bias current meter on the front panel. More accurate settings are made using a DVM at the "Detector Test Point Terminals." The "I" position of the "I", "E", and "OFF" switch associated with the test jacks allows the detector current to be measured in terms of a voltage drop across a precision .1% 100 Ω resistor in series with the detector. The "E" position allows direct reading of the voltage drop across the detector. The "OFF" position removes the DVM from the circuit.

2.) <u>Detector Selector Switch</u>

This is used to alternately switch Channels D1, D2, and D3 to their proper preamplifier, the output of which is connected to the "Signal Output." The switch passes through a shorting position to insure that any extraneous charge at the preamplifier input is grounded out prior to connecting the detector.

3.) Amplifier Power

On-Off switches for the amplifier power supply.

4.) MTR Short

Switch that will short out the current meter, if desired.

5.) Detector Short

This is a protective switch used to place a short across any detector at the input. It should be in "shorted" position when connecting or disconnecting detectors.

6.) Test Gain Input 1000/1

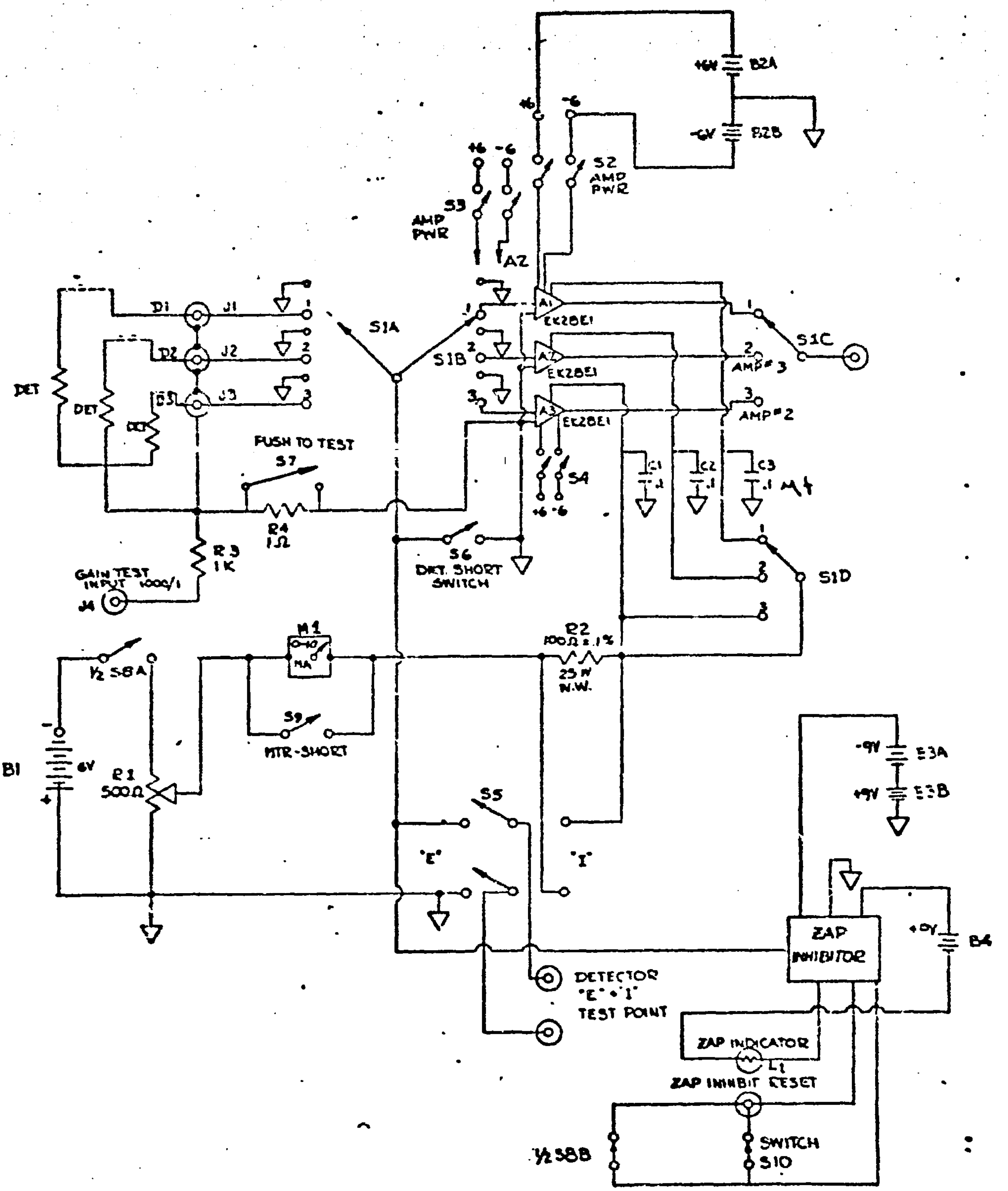
A normally shorted 1 Ω - 1% resistor is wired in series with the detector return leads. It is fed by a 1000 Ω 1% resistor connected to J4. This provides a 1000/1 signal attenuation and allows a means of injecting a signal in the amplifier input with its detector in the circuit and calibrating the gain of each amplifier without significantly changing the input resistance.

7.) Zap Inhibitor Circuit

Since application of excessive power to the detectors will cause degradation or complete burnout, a protective circuit is provided that will short out the detector if the voltage across the detector rises above a preset value. Should this occur, the "Bias Power" switch must be shut off and the "Bias Control" must be set to zero; the short can then be removed by the "Anti-Zapper" reset switch.

NOTE: During shipment, the batteries were disconnected. The back panel can be unscrewed; the outside of the housing can then be slightly pull' forward and up to allow the batteries to be connected to the circuits. Batteries and wires are labeled.

EK46A1 SCHEMATIC



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