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NOLC REPORT 602
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PROPERTIES OF PHOTODETECTORS

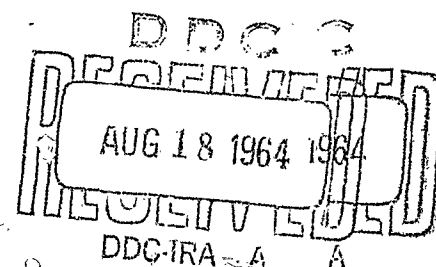
PHOTODETECTOR SERIES, 61ST REPORT

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FOREWORD

This report, which was prepared as part of the Joint Services Infrared Sensitive Element Testing Program, is one of a series that consists of a collection of data sheets presenting various physical properties of photodetectors. The work reported here was performed from September 1963 through April 1964. It was authorized by WepTask RMGA-41-049/211-1/R008-03-002 and covered by the following funds:

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R. F. POTTER
Head, Infrared Division
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Santa Barbara Research Center

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W281-D.	796	12

Davers Corporation

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Minneapolis-Honeywell

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Germanium:

Santa Barbara Research Center

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INTRODUCTION

This report presents the results of measurements made on ten photodetectors. It includes data sheets on lead sulfide cells from Infrared Industries, Inc; indium antimonide cells from the Santa Barbara Research Center, Davers Corporation, and Minneapolis-Honeywell; germanium cells from the Santa Barbara Research Center; and a thermocouple from Beckman Instruments, Inc.

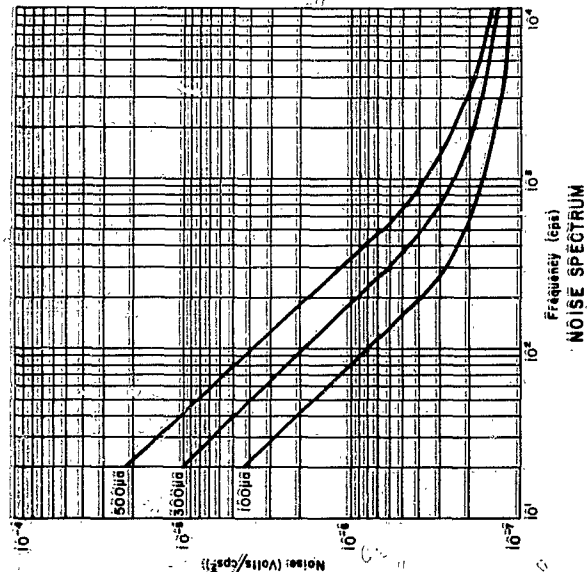
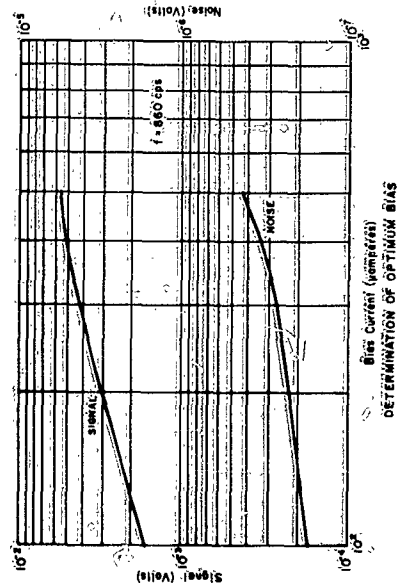
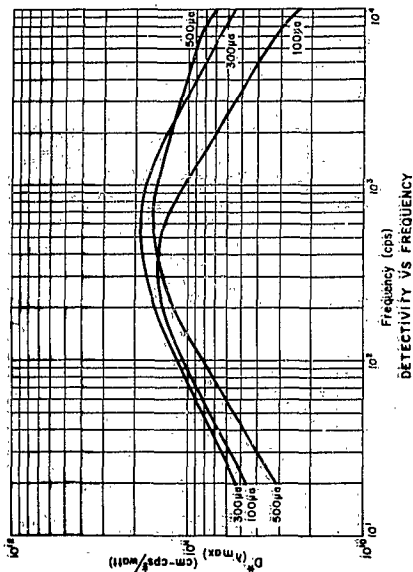
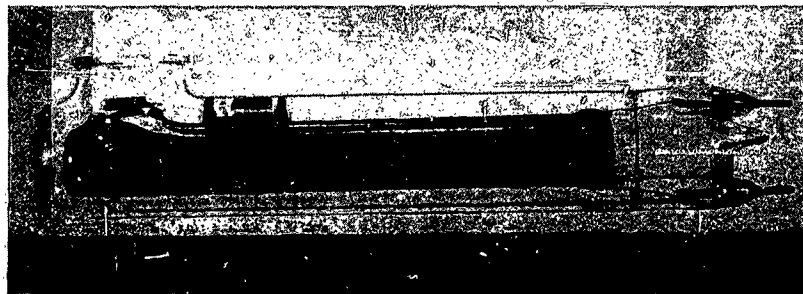
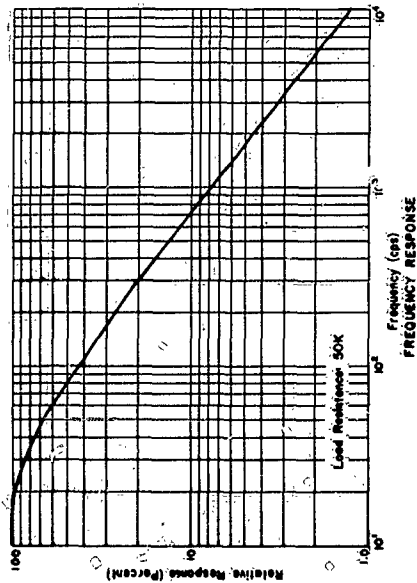
A summary of the data obtained is given in Table 1.

TABLE I. Summary of Data

Data sheet No.	Cell type	Cell No. ¹	Area (cm ²)	Cell temp. (°K)	Blackbody response (500, 860)				R _A max / R _{Bb}	Peak wave-length (μ)	Peak detective modulation frequency (cps)	D* mm (cm-cps ^{1/2} / watt)
					R, responsivity (volts/watt)	H _N , noise equivalent irradiance (watts / (cps ^{1/2} · cm ²))	P _N , noise equivalent power (watts / cps ^{1/2})	D* (cm-cps ^{1/2} / watt)				
792	PbS	IRI A	5.0 × 10 ⁻²	77	9.1 × 10 ³	6.1 × 10 ⁻¹⁰	3.0 × 10 ⁻¹¹	7.4 × 10 ⁹	22	2.4	7 × 10 ²	1.9 × 10 ¹¹
793	PbS	IRI B	1.2 × 10 ⁻¹	77	3.5 × 10 ³	5.1 × 10 ⁻¹⁰	6.2 × 10 ⁻¹¹	5.6 × 10 ⁹	20	2.6	7 × 10 ²	1.5 × 10 ¹¹
794	InSb	SBRC, CM0111	6.3 × 10 ⁻⁴	77	2.0 × 10 ⁵	4.8 × 10 ⁻⁹	3.0 × 10 ⁻¹²	8.4 × 10 ⁹	17	4.6	4 × 10 ³	1.7 × 10 ¹¹
795	InSb	SBRC 62-4-35	1.5 × 10 ⁻³	77	4.6 × 10 ⁵	7.6 × 10 ⁻¹⁰	1.2 × 10 ⁻¹²	3.4 × 10 ¹⁰	5.4	5.0	> 10 ⁴	2.3 × 10 ¹¹
796	InSb	SBRC W281-D	2.5 × 10 ⁻³	77	4.3 × 10 ⁴	2.4 × 10 ⁻⁹	5.9 × 10 ⁻¹²	8.5 × 10 ⁹	5.7	5.4	> 10 ⁴	6.4 × 10 ¹⁰
797	InSb	DC 0964	4.9 × 10 ⁻²	77	2.4 × 10 ⁴	2.1 × 10 ⁻¹⁰	1.0 × 10 ⁻¹¹	2.1 × 10 ¹⁰	5.2	4.5	> 2 × 10 ²	1.1 × 10 ¹¹
798	InSb	MH 01	1.18	77	3.7 × 10 ³	8.3 × 10 ⁻¹¹	9.7 × 10 ⁻¹¹	1.1 × 10 ¹⁰	5.2	5.0	> 10 ⁴	8.0 × 10 ¹⁰
799	Ge (Hg-doped)	SBRC A	7.8 × 10 ⁻³	4	1.8 × 10 ⁵	1.9 × 10 ⁻⁹	1.5 × 10 ⁻¹¹	6.0 × 10 ⁹	1.7	10.4	> 10 ⁴	1.1 × 10 ¹⁰
800	Ge (Hg-doped)	SBRC 22-8	7.8 × 10 ⁻³	4	1.3 × 10 ⁵	2.5 × 10 ⁻⁹	2.0 × 10 ⁻¹¹	4.5 × 10 ⁹	1.8	11.2	> 10 ⁴	9.4 × 10 ⁹
801	Thermocouple	BI 2352	6.9 × 10 ⁻³	296	1.1 [†]	1.9 × 10 ⁻⁸ †	1.3 × 10 ⁻¹⁰ †	6.5 × 10 ⁸ †	1.1	1.8	< 2	1.1 × 10 ⁹

¹ Abbreviations: IRI—Infrared Industries, Inc.; SBRC—Santa Barbara Research Center; DC—Davies Corp.; MH—Minneapolis-Honeywell; BI—Beckman Instruments, Inc.

† Blackbody response measured at 500, 10.



Infrared Industries Cell A, PbS
Data Sheet No. 792-A, September 1963

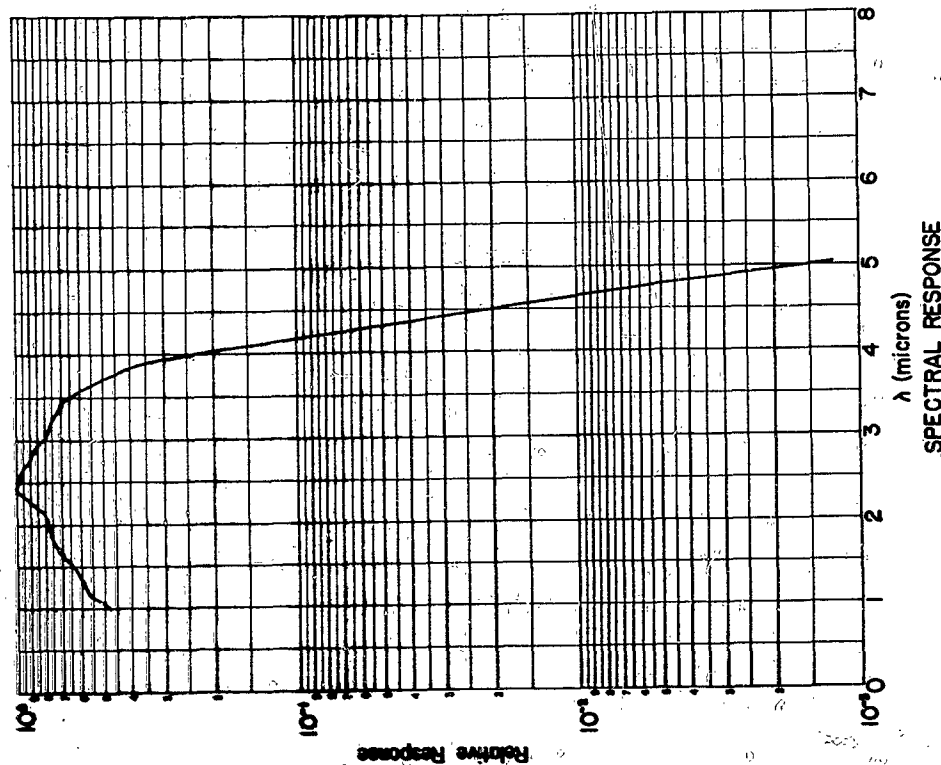
NOISE SPECTRUM

DETERMINATION OF OPTIMUM BIAS

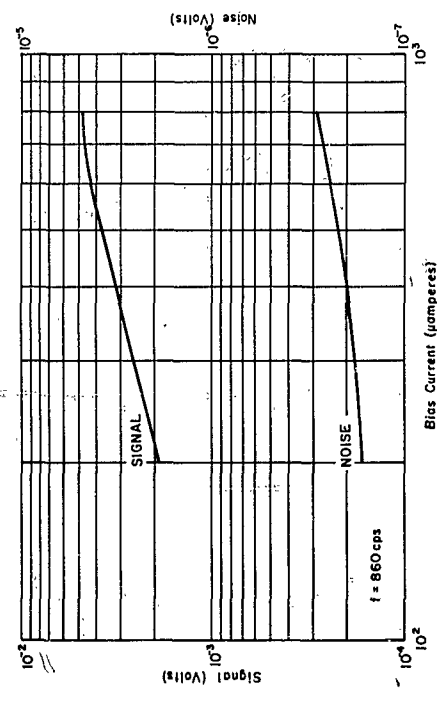
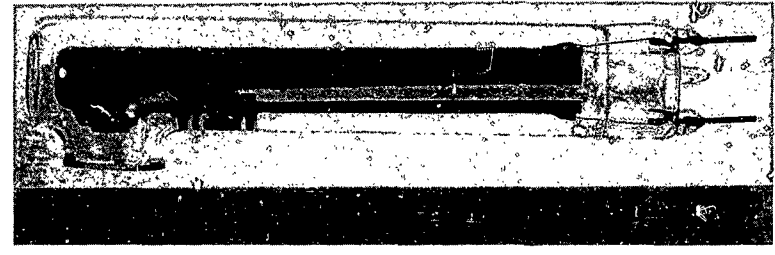
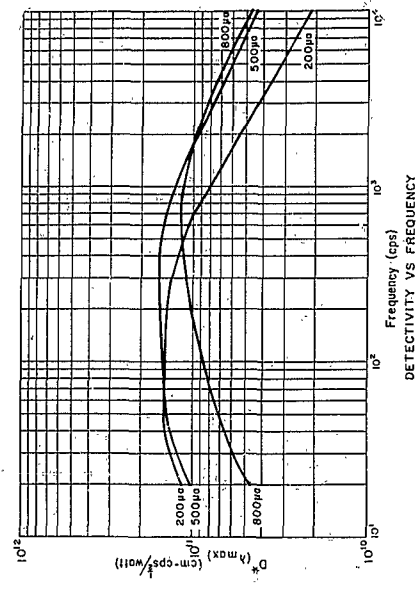
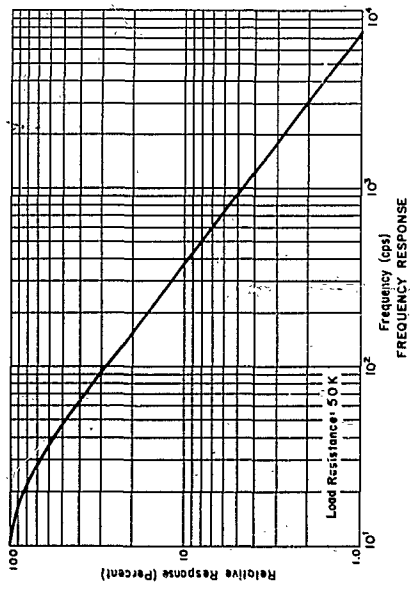
TEST RESULTS

CONDITIONS OF MEASUREMENT

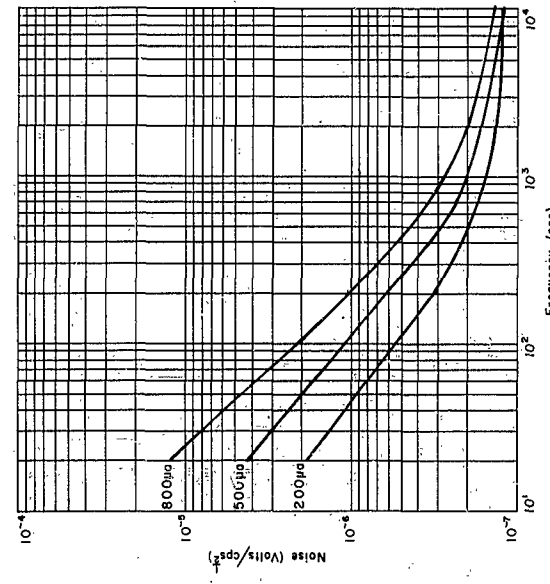
R (volts/watt) (500, 860)	9.1×10^3	Blackbody temperature (°K)	500
H_N (watts/cm ² , cm ²) (500, 860)	6.1×10^{-10}	Blackbody flux density (μwatts/cm ² , rms)	9.0
P_N (watts/cm ²) (500, 860)	3.0×10^{-11}	Chopping frequency (cps)	860
D_N (cm·cps ^{1/2} /watt) (500, 860)	7.4×10^8	Noise bandwidth (cps)	5
Responsive time constant (μsec)	3.4×10^3	Cell temperature (°K)	77
$\frac{R_{Nmax}}{R_{N0}}$	22	Cell current for 860-cps data (μa)	300
Peak wavelength (μ)	2.4	Cell current for D _N mm (μa)	300
Peak detective modu- lation frequency (cps)	7.0×10^2	Load resistance (ohms)	2.5×10^5
D_N mm (cm·cps ^{1/2} /watt)	1.9×10^{11}	Transformer	---
Type	PbS	Relative humidity (%)	37
Shape of sensitive area (cm)	0.10×0.50	Responsive plane (from window)	---
Area (cm ²)	5.0×10^{-2}	Ambient temperature (°C)	23
Dark resistance (ohms)	2.5×10^5	Ambient radiation on detector	296°K only
Dynamic resistance (ohms)	---		
Field of view	---		
Window material	Sapphire		



Infrared Industries Cell A, PbS
Data Sheet No. 792-B, September 1963



DETERMINATION OF OPTIMUM BIAS



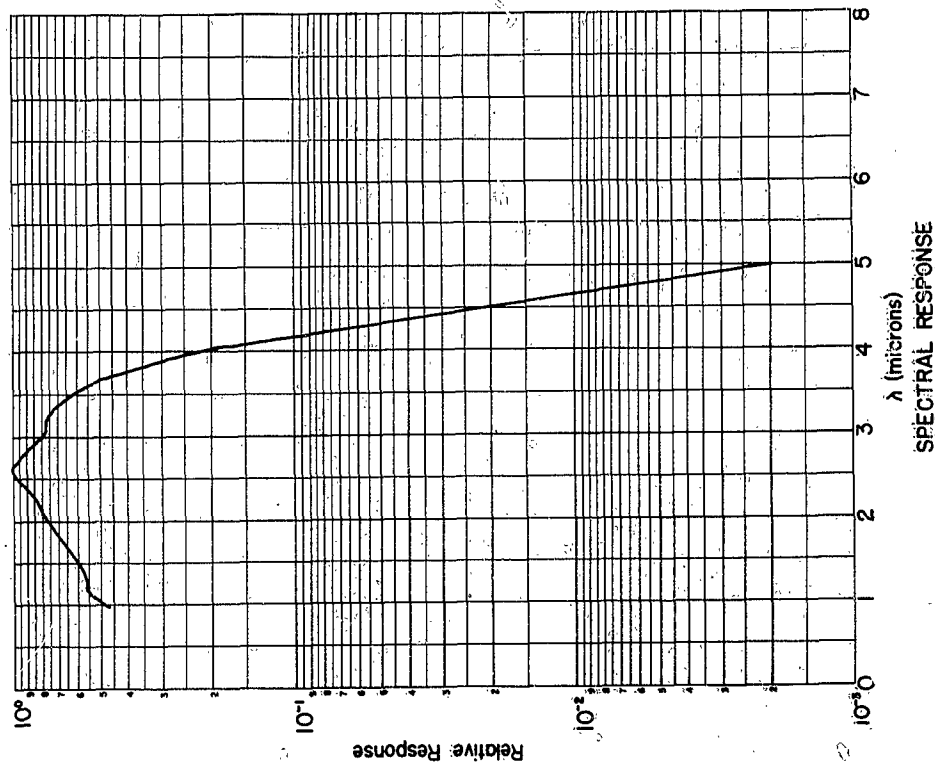
Infrared Industries Cell B, PbS
Data Sheet No. 793-A, October 1963

TEST RESULTS

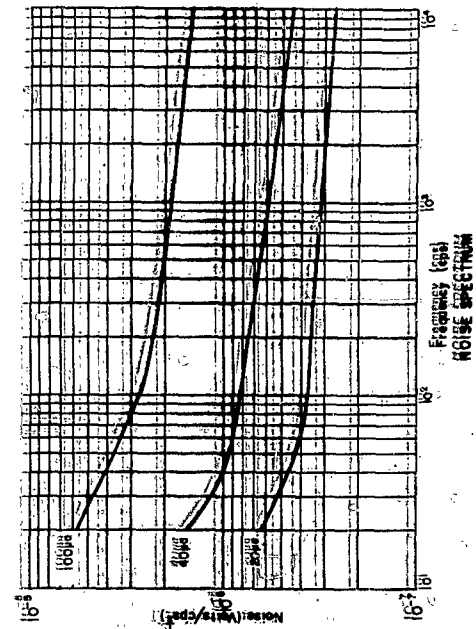
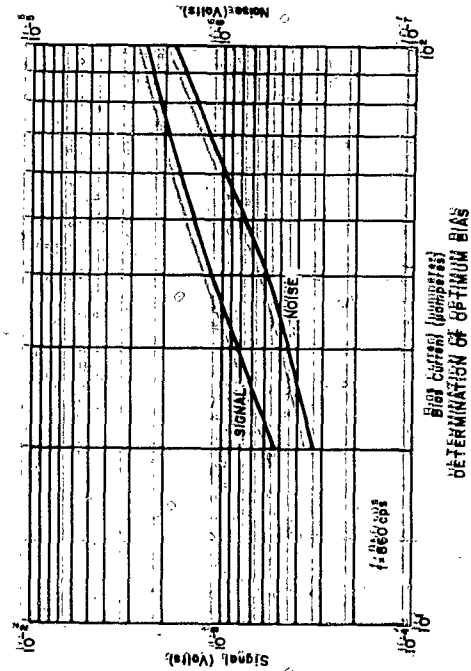
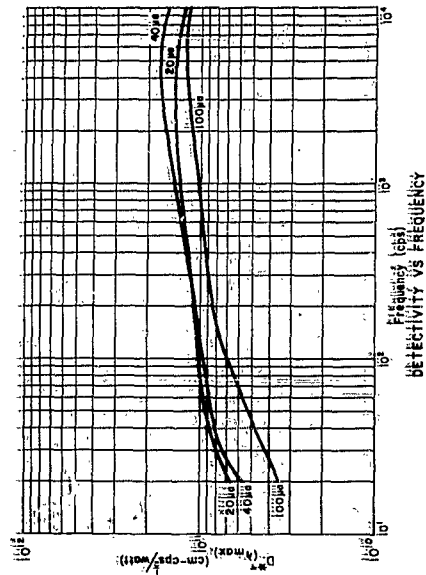
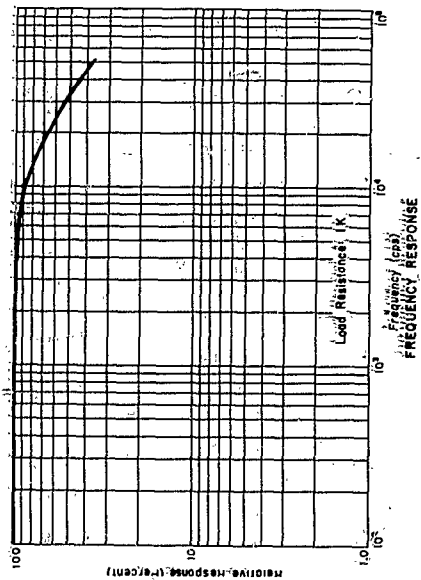
R (volts/watt) (500, 860)	3.5×10^3	Blackbody temperature (°K)	500
H_N (watts/cps $^{1/2}$ ·cm 2) (500, 860)	5.1×10^{-10}	Blackbody flux density (μwatts/cm 2 , rms)	9.0
P_N (watts/cps $^{1/2}$) (500, 860)	6.2×10^{-11}	Chopping frequency (cps)	860
D^* (cm-cps $^{1/2}$ /watt) (500, 860)	5.6×10^9	Noise bandwidth (cps)	5
Responsive time constant (μsec)	5.6×10^3	Cell temperature (°K)	77
$R_{\lambda max}$ R_{bb}	20	Cell current for 860-cps data (μa)	500
Peak wavelength (μ)	2.6	Cell current for D^* min (μa)	-500
Peak defective modu- lation frequency (cps)	7.0×10^2	Load resistance (ohms)	2.5×10^4
D^* min (cm-cps $^{1/2}$ /watt)	1.5×10^{11}	Transformer	---
		Relative humidity (%)	41
		Responsive plane (from window)	---
		Ambient temperature (°C)	23
		Ambient radiation on detector	296°K only

CELL DESCRIPTION

Type	PBS
Shape of sensitive area (cm)	0.244×0.50
Area (cm 2)	1.22×10^{-1}
Dark resistance (ohms)	2.6×10^4
Dynamic resistance (ohms)	---
Field of view	---
Window material	Sapphire



Infrared Industries Cell B, PbS
Data Sheet No. 793-B, October 1963



Santa Barbara Research Center Cell 6M0111, InSb
Data Sheet No. 794-A, September 1963

TEST RESULTS

R (volts/watt)
(500, 860) 2.0×10^5

H_N (watts/cm²·cm²)
(500, 860) 4.8×10^{-9}

P_N (watts/cm²)
(500, 860) 3.0×10^{-12}

D* (cm·cps^{1/2}/watt)
(500, 860) 8.4×10^9

Responsive time
constant (μsec) 9.0

$R_{\lambda \max}$
R_{bb} 17

Peak wavelength (μ) 4.6

Peak detective modulation
frequency (cps) 4×10^3

D* mm (cm·cps^{1/2}/watt) 1.7×10^{11}

CELL DESCRIPTION

Type InSb

Shape of sensitive
area (cm) 0.00635×0.099

Area (cm²) 6.3×10^{-4}

Dark resistance
(ohms) 4.1×10^3

Dynamic resistance
(ohms) ==

Field of view 30°

Window material Silicon plus gold
interference filter

CONDITIONS OF MEASUREMENT

Blackbody temperature 500
(°K)

Blackbody flux density
(μwatts/cm², FHz) 9.0

Shopping frequency
(cps) 860

Noise bandwidth (cps) 5

Cell temperature (°K) 77

Cell current for
860-cps data (μA) 40

Cell current for
D* mm (μA) 40

Load resistance (ohms) 5×10^4

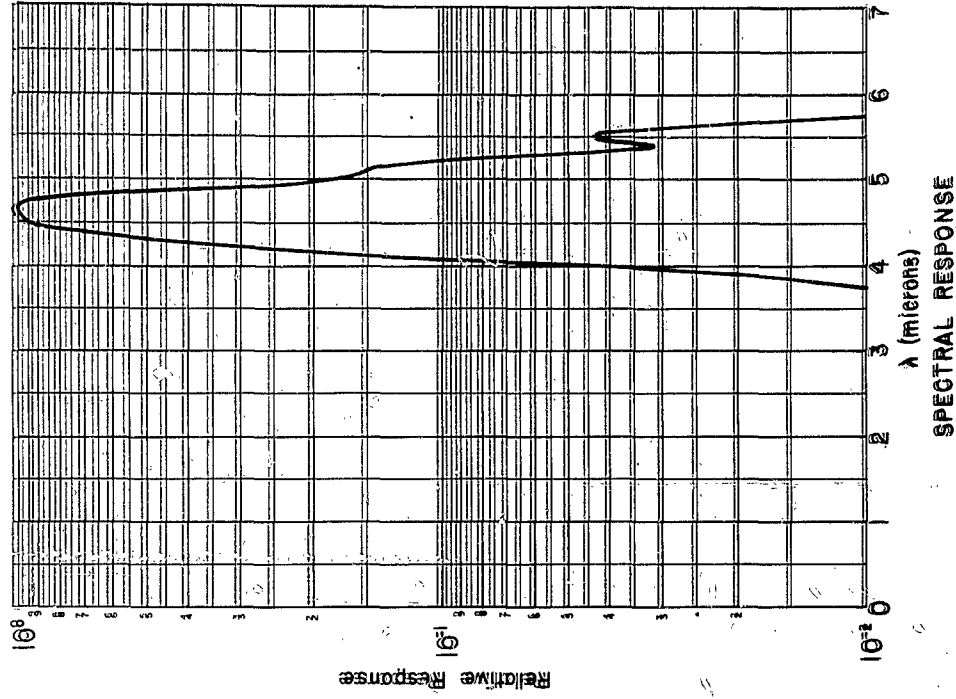
Transformer ==

Relative humidity (%) 39

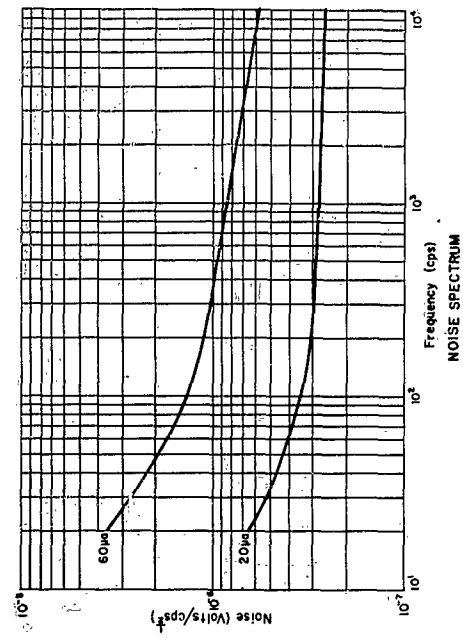
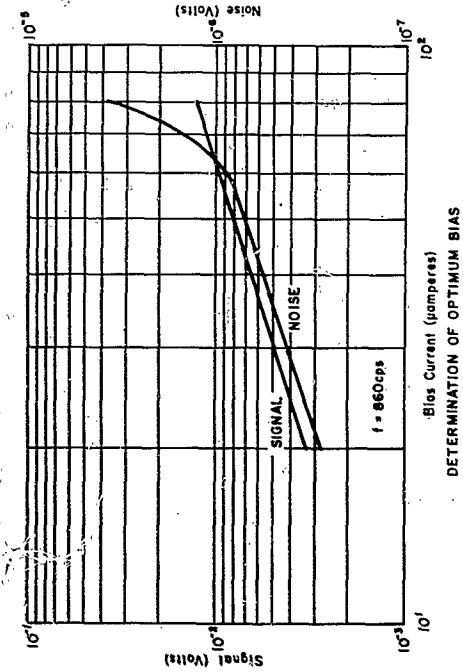
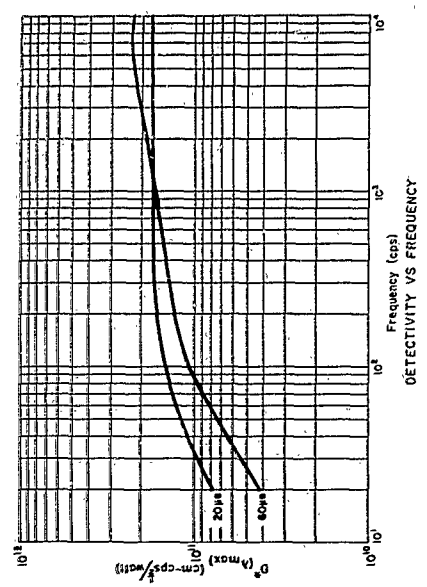
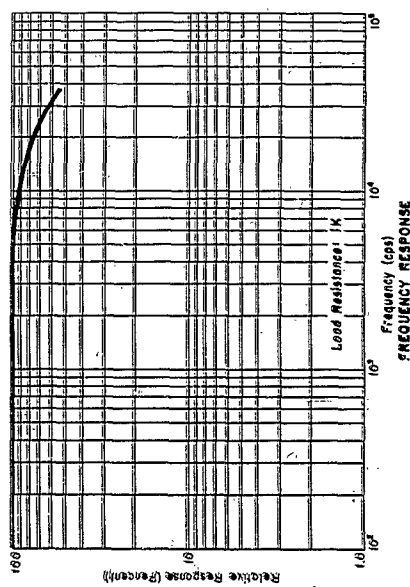
Responsive plane
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Ambient temperature
(°C) 23

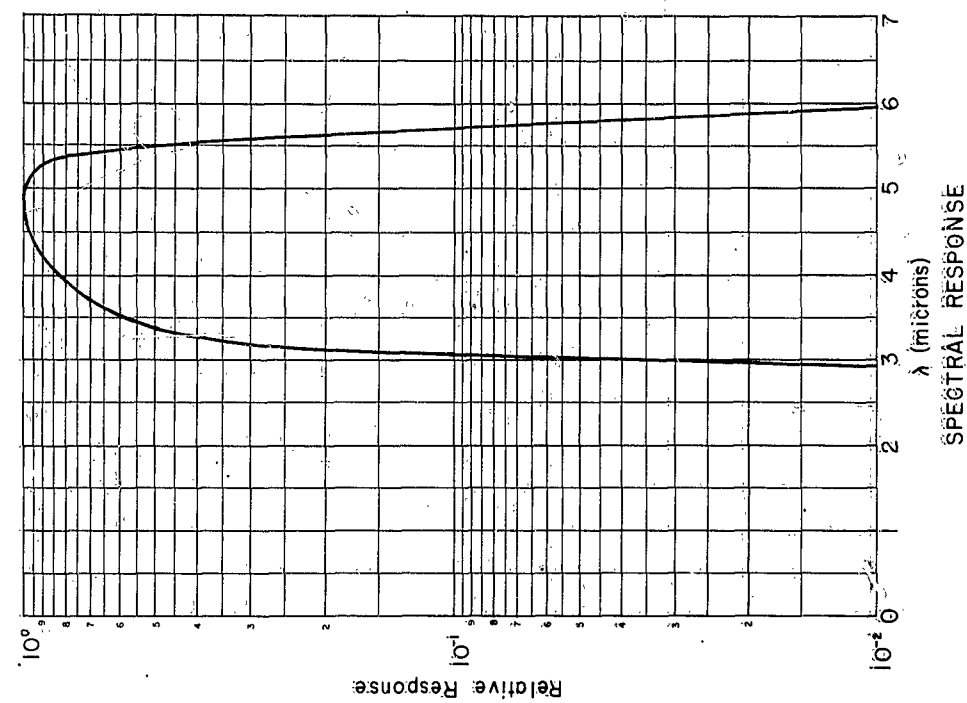
Ambient radiation
on detector 297°K only



Santa Barbara Research Center Cell CM0111, InSb
Data Sheet No. 794-B, September 1963



Santa Barbara Research Center Cell 62-4-35, InSb
Data Sheet No. 795-A, January 1964



CONDITIONS OF MEASUREMENT

Blackbody temperature (°K)	500
Blackbody flux density (μ watts/cm ² , rms)	9.0
Chopping frequency (cps)	860
Noise bandwidth (cps)	5
Cell temperature (°K)	77
Cell current for 860-cps data (μ A)	40
Cell current for D^* mm (μ A)	80
Load resistance (ohms)	1.0×10^5
Transformer	---
Relative humidity (%)	29
Responsive plane (from window)	---
Ambient temperature (°C)	23
Ambient radiation on detector	296°K only

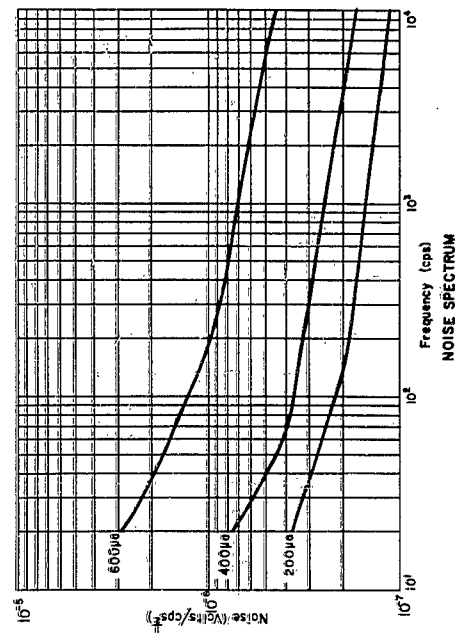
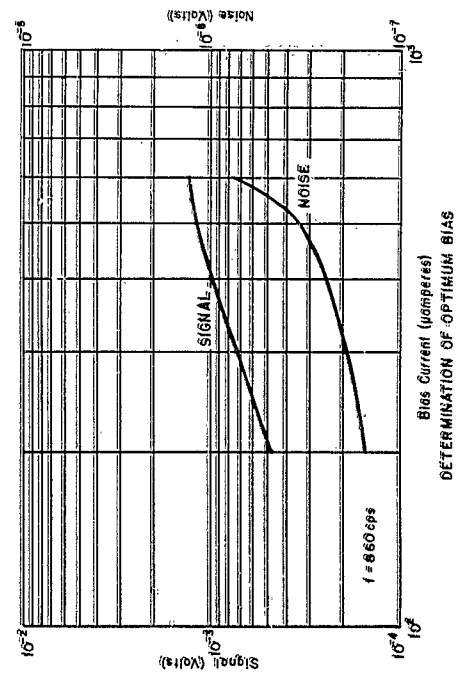
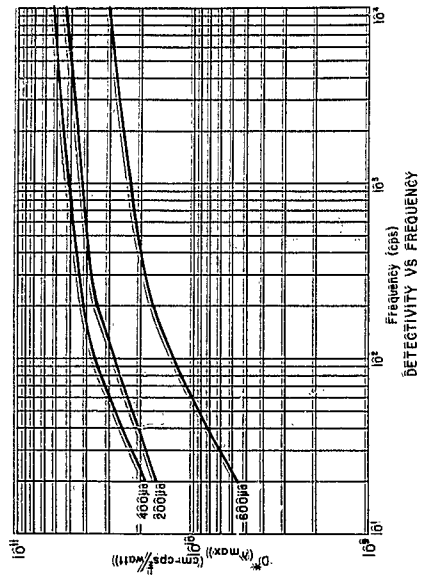
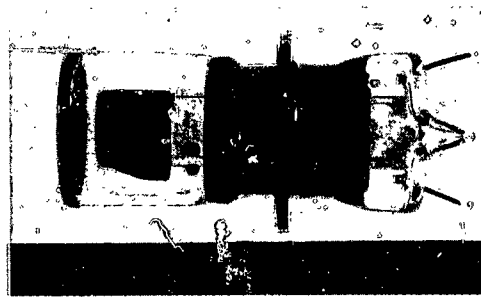
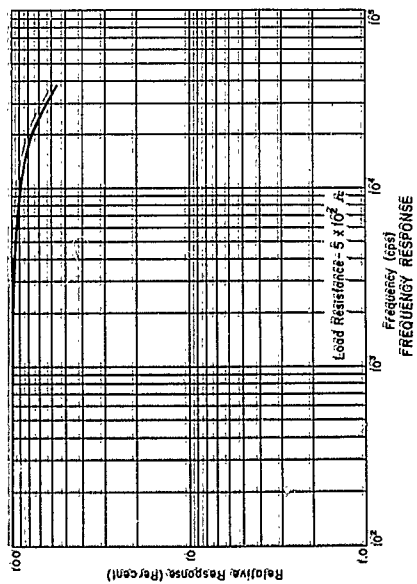
TEST RESULTS

R (volts/watt) (500, 860)	4.6×10^5
H_N (watts/cps ^{1/2} cm ²) (500, 860)	7.6×10^{-10}
P_N (watts/cps ^{1/2}) (500, 860)	1.2×10^{-12}
D^* (cm-cps ^{1/2} /watt) (500, 860)	3.4×10^{10}
Responsive time constant (μ sec)	7
R_{Amax} R_{Cb}	5.4
Peak wavelength (μ)	5.0
Peak detective modulation frequency (cps)	$> 10^4$
D^* mm (cm-cps ^{1/2} /watt)	2.3×10^{11}

CELL DESCRIPTION

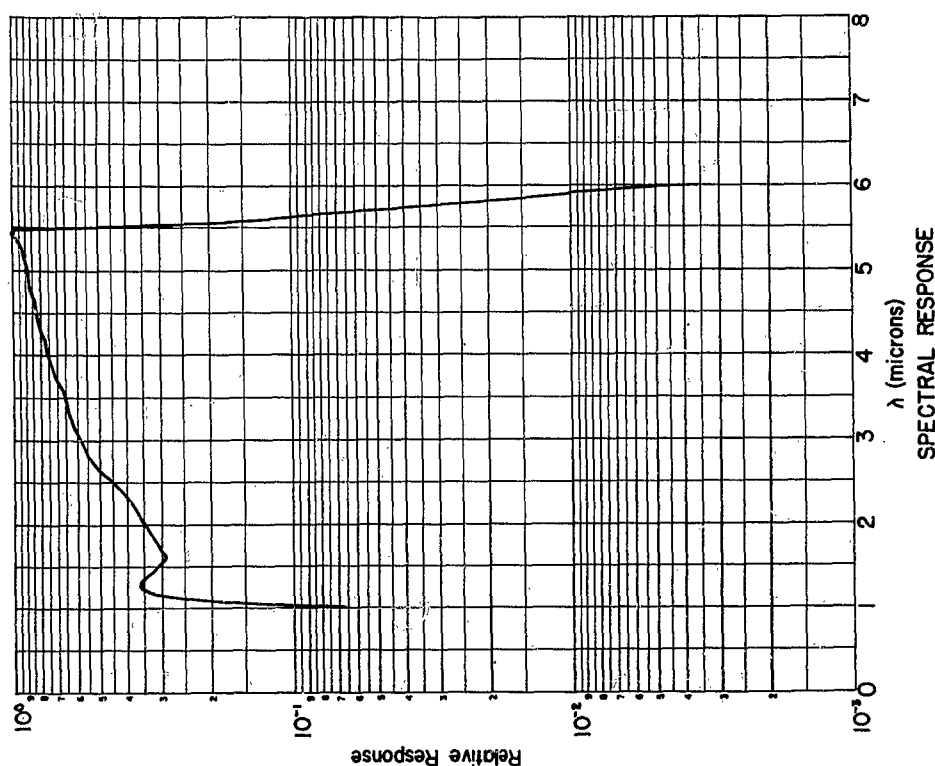
Type	InSb
Shape of sensitive area (cm)	0.01×0.15
Area (cm ²)	1.5×10^{-3}
Dark resistance (ohms)	8.0×10^4
Dynamic resistance (ohms)	---
Field of view	30°
Window material	Silicon plus cold interference filter

Santa Barbara Research Center Cell 62-4-35, InSb
Data Sheet No. 795-B, January 1964

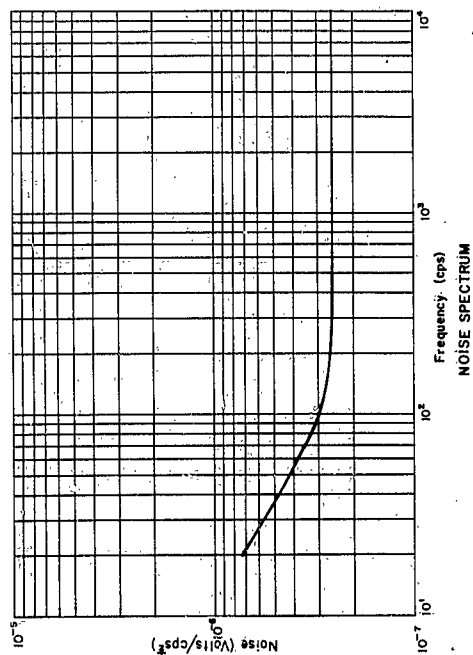
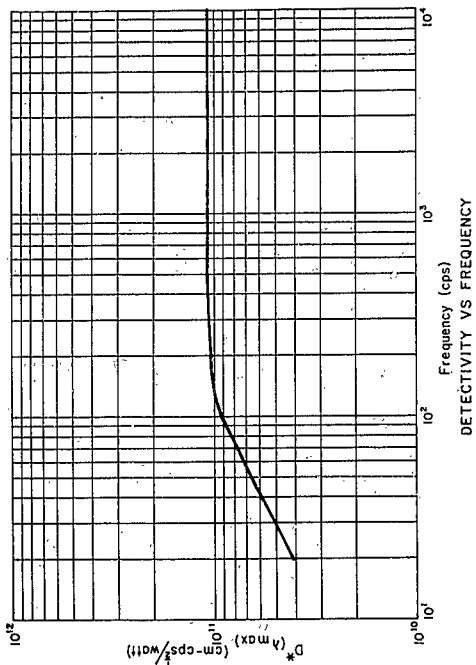
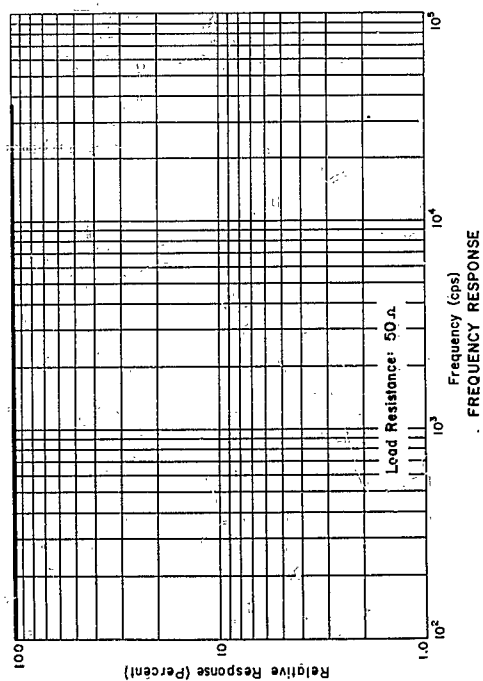


Santa Barbara Research Center Cell W281-D, InSb
Data Sheet No. 796-A, September 1963

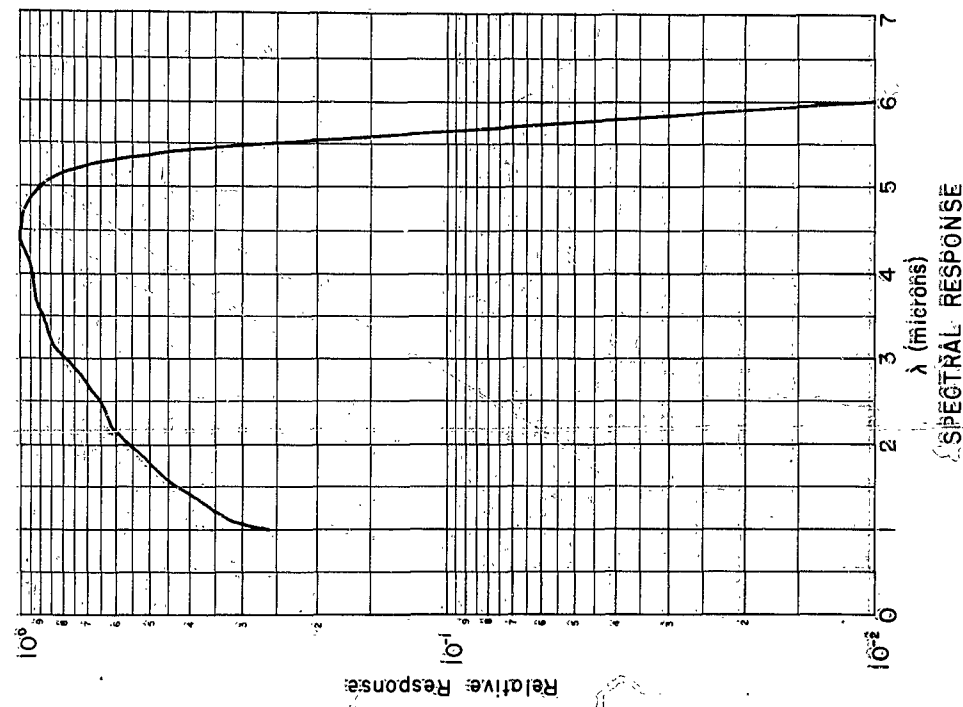
TEST RESULTS		CONDITIONS OF MEASUREMENT	
R (volts/watt) (500, 860)	4.3×10^4	Blackbody temperature (°K)	500
H _N (watts/cps ^{1/2} ·cm ²) (500, 860)	2.4×10^{-9}	Blackbody flux density (μwatts/cm ² , rms)	9.0
P _N (watts/cps ^{1/2}) (500, 860)	5.9×10^{-12}	Chopping frequency (cps)	860
D* (cm-cps ^{1/2} /watt) (500, 860)	8.5×10^9	Noise bandwidth (cps)	5
Responsive time constant (μsec)	7.0	Cell temperature (°K)	77
$\frac{R_{\lambda\max}}{R_{bb}}$	5.7	Cell current for 860-cps data (μa)	400
Peak wavelength (μ)	5.4	Cell current for D* _{mm} (μa)	400
Peak detective modulation frequency (cps)	$> 10^4$	Load resistance (ohms)	5.0×10^3
D* _{mm} (cm-cps ^{1/2} /watt)	6.4×10^{10}	Transformer	---
CELL DESCRIPTION		Relative humidity (%)	39
Type	InSb	Responsive plane (from window)	---
Shape of sensitive area (cm)	0.05×0.05	Ambient temperature (°C)	23
Area (cm ²)	2.5×10^{-3}	Ambient radiation on detector	296°K only
Dark resistance (ohms)	3.9×10^3		
Dynamic resistance (ohms)	---		
Field of view	60°		
Window material	Silicon		



Santa Barbara Research Center Cell W281-D, InSb
Data Sheet No. 796-B, September 1963



Davers Corporation Cell 0964, InSb
Data Sheet No. 797-A, December 1963



CONDITIONS OF MEASUREMENT

Blackbody temperature (°K)	500
Blackbody flux density (μ watts/cm ² , rms)	9.0
Chopping frequency (cps)	860
Noise bandwidth (cps)	5
Cell temperature (°K)	77
Cell current for 860-cps data (μ a)	---
Cell current for D^* min (μ a)	---
Load resistance (ohms)	---
Transformer UTC A-27, 500/100 k	
Relative humidity (%)	25
Responsive plane (from window)	---
Ambient temperature (°C)	23
Ambient radiation on detector	296°K only

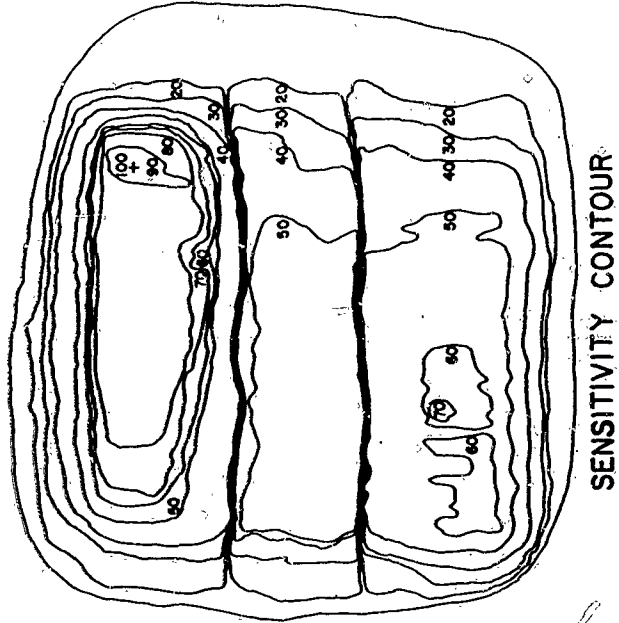
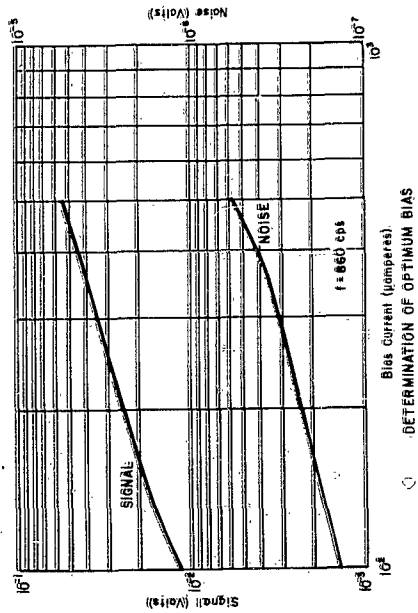
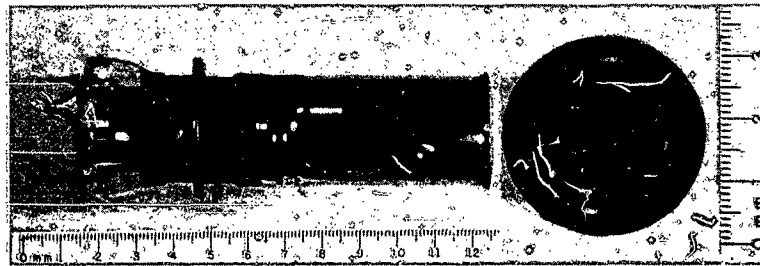
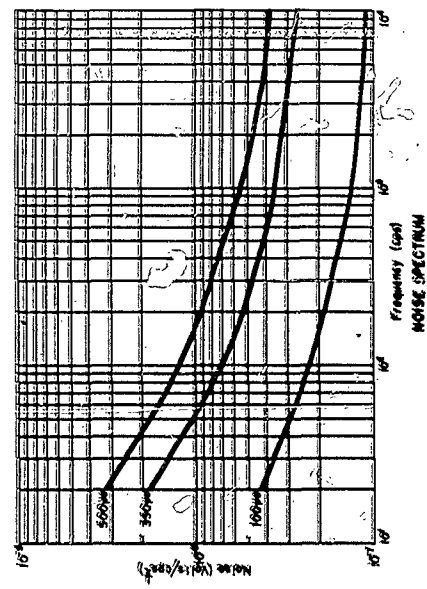
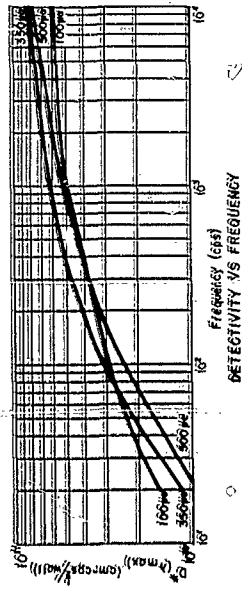
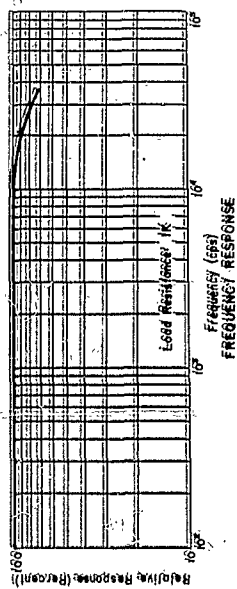
TEST RESULTS

R (volts/watt) (500, 860)	2.4×10^4
H_N (watts/cps ^{1/2} -cm ²) (500, 860)	2.1×10^{-10}
P_N (watts/cps ^{1/2}) (500, 860)	1.0×10^{-11}
D^* (cm-cps ^{1/2} /watt) (500, 860)	2.1×10^{10}
Responsive time constant (μ sec)	< 1
$R_{\lambda \max}$ R_{bb}	5.2
Peak wavelength (μ)	4.5
Peak detective modulation frequency (cps)	> 200
D^* min (cm-cps ^{1/2} /watt)	1.1×10^{11}

CELL DESCRIPTION

Type	InSb
Shape of sensitive area (cm)	0.25 diam.
Area (cm ²)	4.9×10^{-2}
Dark resistance (ohms)	---
Dynamic resistance (ohms)	2.0×10^4
Field of view	~80°
Window material	Sapphire

Davers Corporation Cell 0964, InSb
Data Sheet No. 797-B, December 1963



Minneapolis-Honeywell Cell 01, InSb
Data Sheet No. 798-A, January 1964

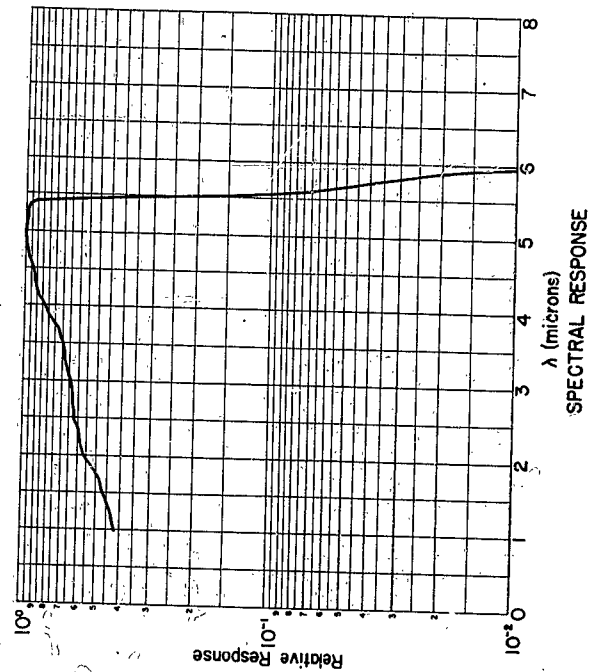
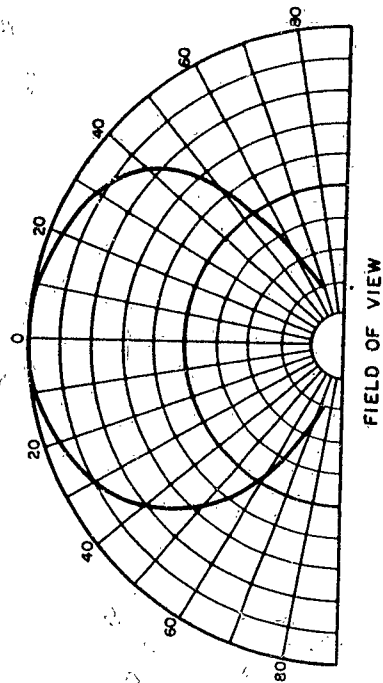
TEST RESULTS

CONDITIONS OF MEASUREMENT

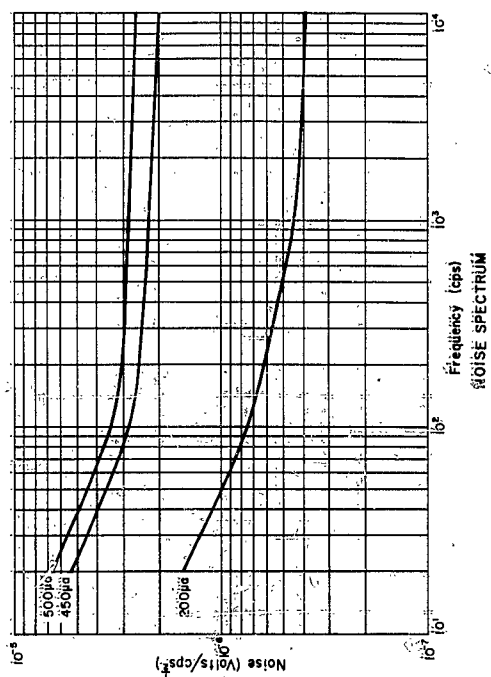
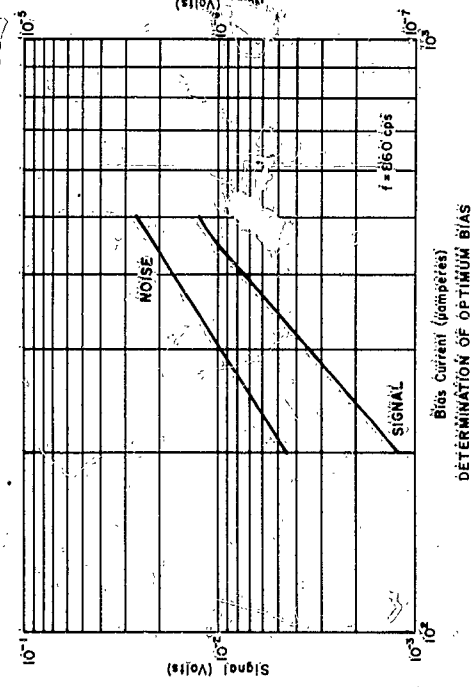
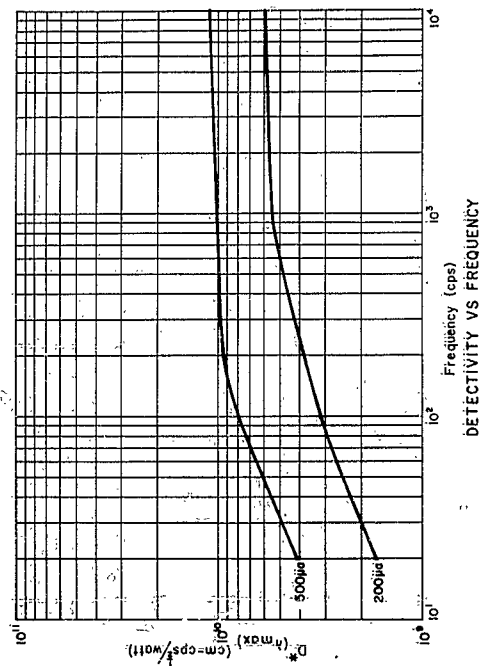
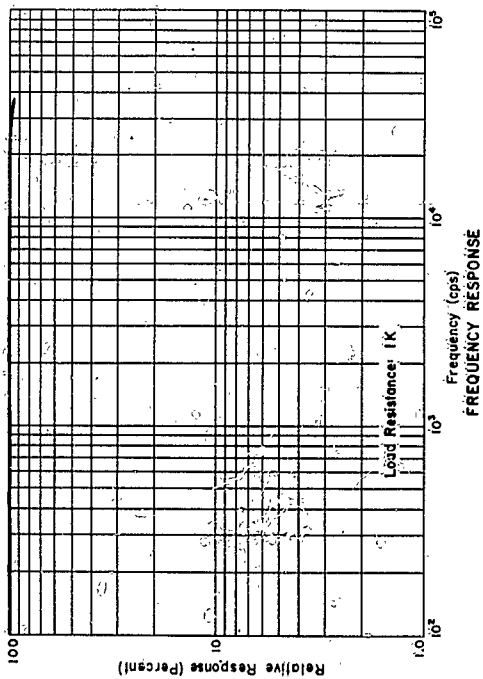
R (volts/watt) (500, 860)	3.7×10^3	Blackbody temperature (°K)	500
H _N (watts/cps ^{1/2} .cm ²) (500, 860)	8.3×10^{-11}	Blackbody flux density (μwatts/cm ² , rms)	9.0
P _N (watts/cps ^{1/2}) (500, 860)	9.7×10^{-11}	Chopping frequency (cps)	860
D* (cm-cps ^{1/2} /watt) (500, 860)	1.1×10^{10}	Noise bandwidth (cps)	5
Responsive time constant (μsec)		Cell temperature (°K)	77
R _L max R _{bb}	5.2	Cell current for 860-cps data (μa)	350
Peak wavelength (μ)	5.0	Cell current for D* mm (μa)	350
Peak detective modulation frequency (cps)	$> 10^4$	Load resistance (ohms)	5.0×10^4
D* mm (cm-cps ^{1/2} /watt)	8.0×10^{10}	Transformer	---
		Relative humidity (%)	26
		Responsive plane (from window)	---
		Ambient temperature (°C)	23
		Ambient radiation on detector	296°K only
		*Detector consisted of three sensitive areas of equal size and shape.	

CELL DESCRIPTION

Type	InSb
Shape of sensitive area (cm)	0.34×1.12
Area (cm ²)	1.18
Dark resistance (ohms)	7.1×10^4
Dynamic resistance (ohms)	---
Field of view	≈90°
Window material	Sapphire

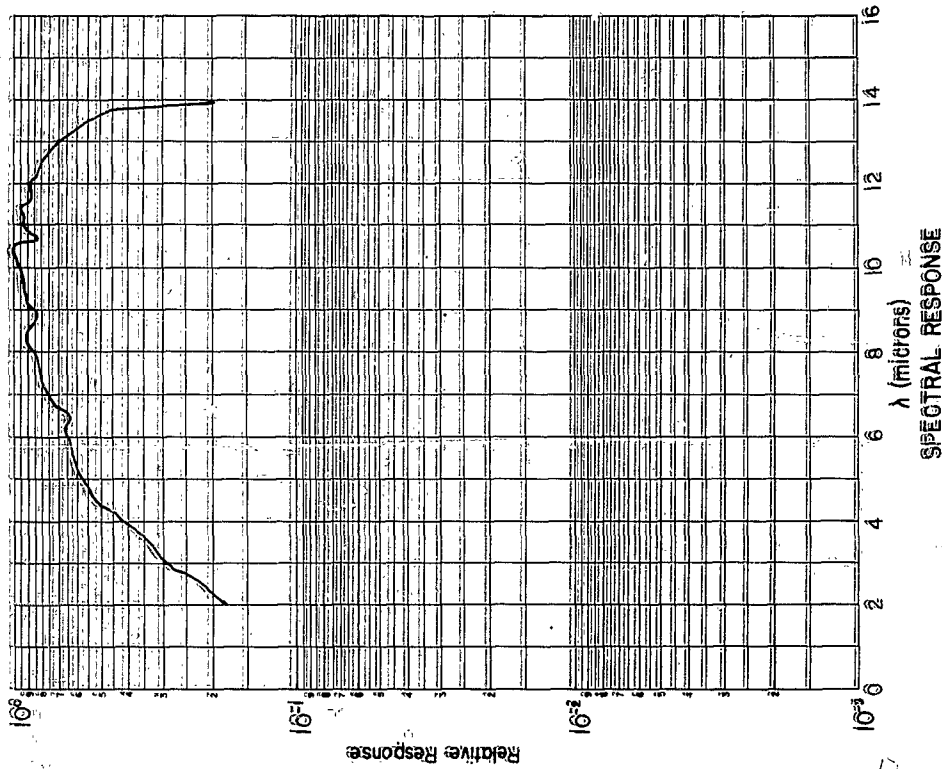


Minneapolis-Honeywell Cell 01, InSb
Data Sheet No. 798-B, January 1964



DETERMINATION OF OPTIMUM BIAS

Santa Barbara Research Center Cell A; Ge
Data Sheet No: 799-A; September 1963



TEST RESULTS

Blackbody temperature 500

Blackbody flux density
($\mu\text{watts}/\text{cm}^2, \text{rms}$) 9.0

Chopping frequency 860.

Noise bandwidth (cps) 5

Cell temperature ($^{\circ}\text{K}$) 4

Cell current for
860-cps data (μA) 500.

Cell current for
 D^* mm (μA) 500

Load resistance (ohms) 2.5×10^4

Transformer

Relative humidity (%) 39

Responsive plane
(from window) ---

Ambient temperature ($^{\circ}\text{C}$) 23

Ambient radiation
on detector 295 $^{\circ}\text{K}$ only

CELL DESCRIPTION

Type Ge (Hg-doped)

Shape of sensitive
area (cm) 0.10 diam.

Area (cm^2) 7.8×10^{-3}

Dark resistance (ohms) 3.2×10^4

Dynamic resistance (ohms) ---

Field of view $\approx 150^{\circ}$

Window material Intran II

Peak wavelength (μ) 10.4

Peak detective modu-
lation frequency (cps) $> 10^4$

D^* mm ($\text{cm-cps}^{1/2}/\text{watt}$) 1.1×10^{10}

CELL DESCRIPTION

Type

Shape of sensitive
area (cm)

Area (cm^2)

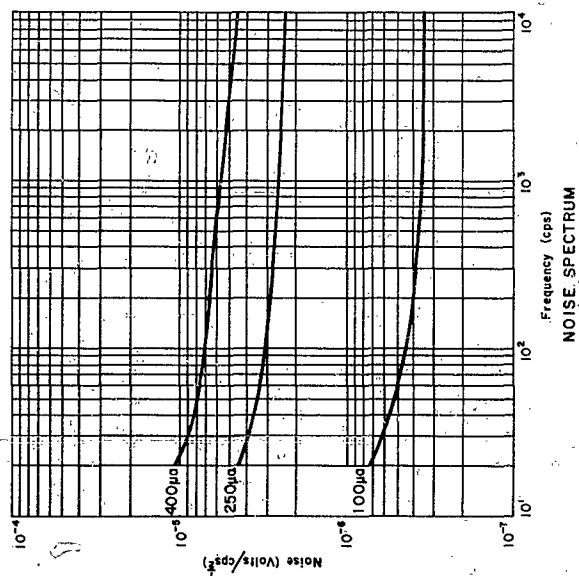
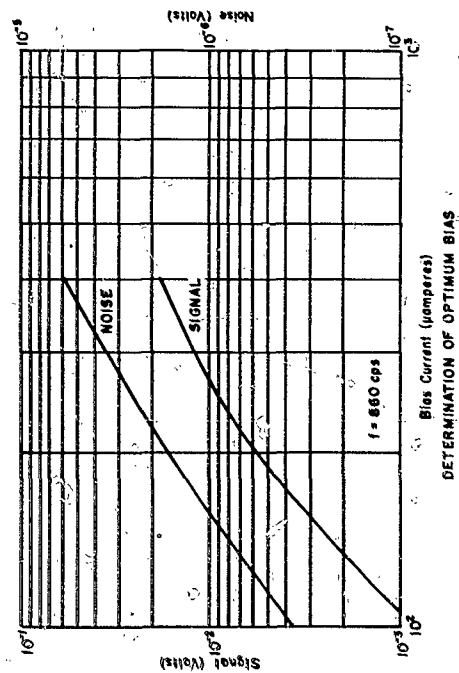
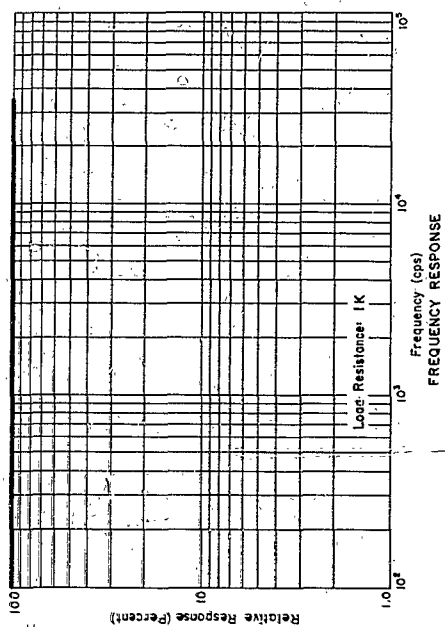
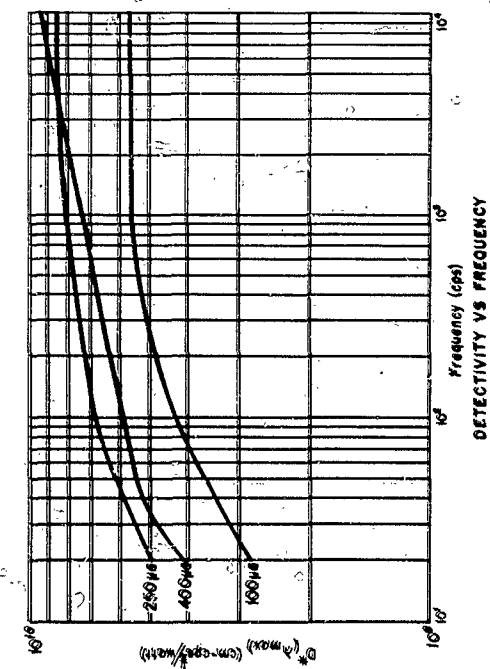
Dark resistance
(ohms)

Dynamic resistance
(ohms)

Field of view

Window material

Santa Barbara Research Center Cell A, Ge
Data Sheet No. 799-B, September 1963

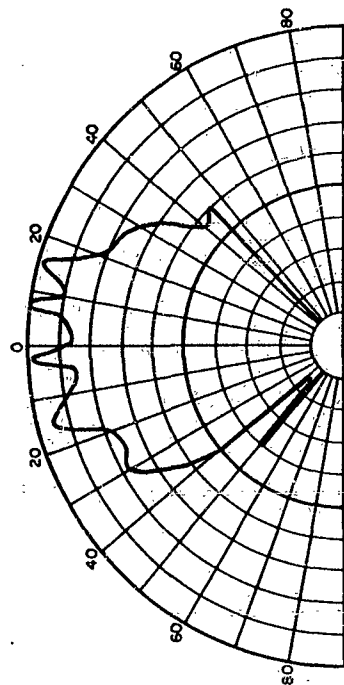


Santa Barbara Research Center Cell 22-8, Ge
Data Sheet No. 800-A, April 1964

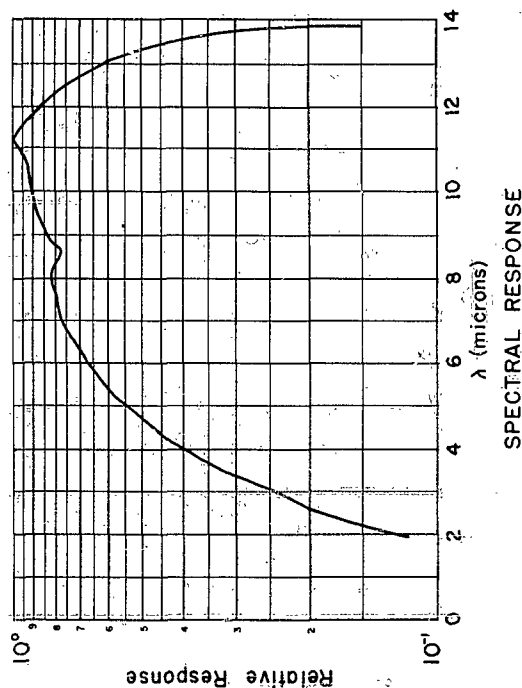
TEST RESULTS

CONDITIONS OF MEASUREMENT

R (volts/watt) (500, 860)	1.3×10^5	Blackbody temperature (°K)	500
H_{λ} (watts/cps $^{\frac{1}{2}}$ ·cm 2) (500, 860)	2.5×10^{-9}	Blackbody flux density (μwatts/cm 2 , rms)	9.0
P _N (watts/cps $^{\frac{1}{2}}$) (500, 860)	2.0×10^{-11}	Chopping frequency (cps)	860
D* (cm·cps $^{\frac{1}{2}}$ /watt) (500, 860)	4.5×10^9	Noise bandwidth (cps)	5
Responsive time constant (μsec)	< 1	Cell temperature (°K)	4
$\frac{R_{\lambda_{\max}}}{R_{bb}}$	1.8	Cell current for 860-cps data (μa)	250
Peak wavelength (μ)	11.2	Cell current for D* mm (μa)	400
Peak detective modulation frequency (cps)	> 10 4	Load resistance (ohms)	5.0×10^4
D* mm (cm·cps $^{\frac{1}{2}}$ /watt)	9.4×10^9	Transformer	---
CELL DESCRIPTION		Relative humidity (%)	22
Type	Ge (Hg-doped)	Responsive plane (from window)	---
Shape of sensitive area (cm)	0.1 diam.	Ambient temperature (°C)	23
Area (cm 2)	7.8×10^{-3}	Ambient radiation on detector	296°K only
Dark resistance (ohms)	5.4×10^4		
Dynamic resistance (ohms)	---		
Field of view	85°		
Window material	Intran II		

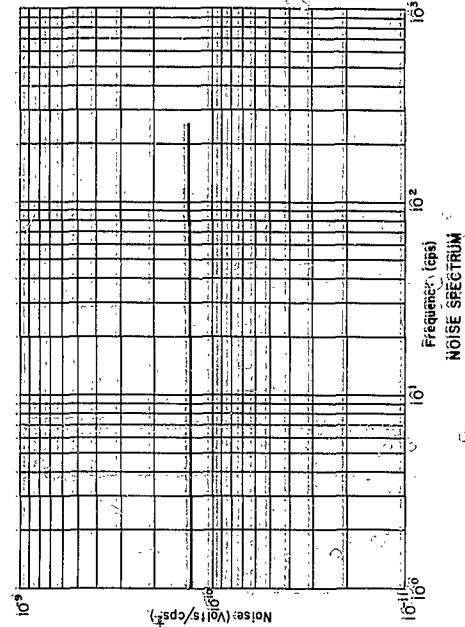
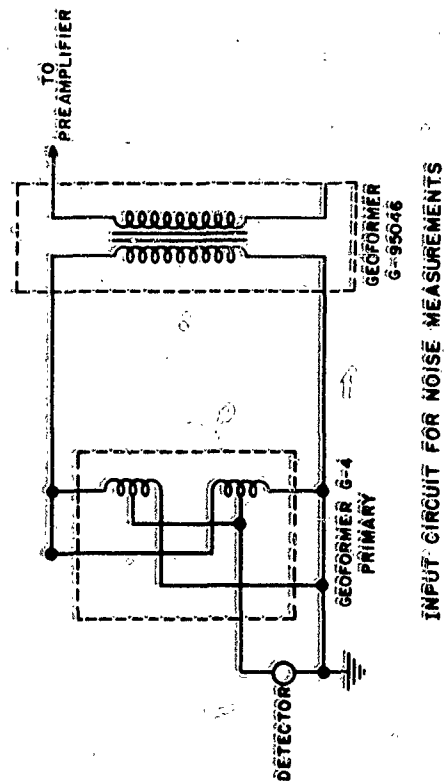
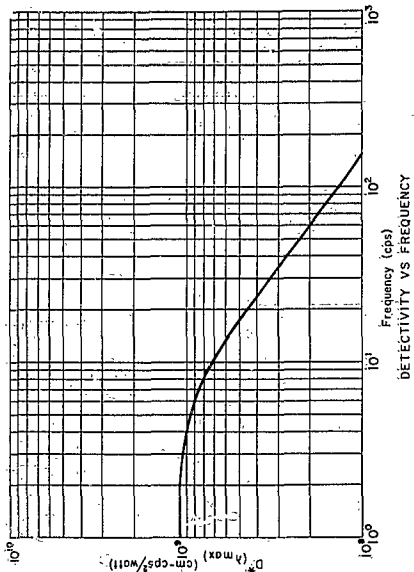
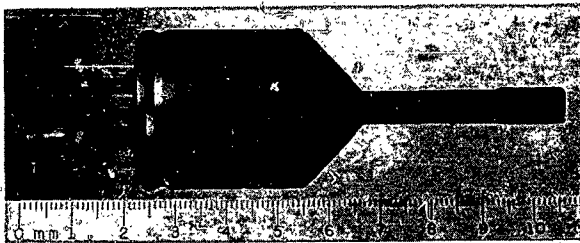
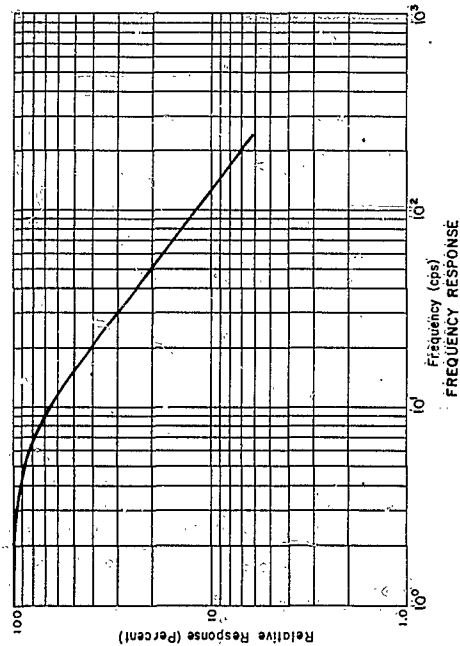


FIELD OF VIEW



SPECTRAL RESPONSE

Santa Barbara Research Center Cell 22-8, Ge
Data Sheet No. 800-B, April 1964



Beckman Instruments Cell 2352, Thermocouple
Data Sheet No. 801-A; December 1963

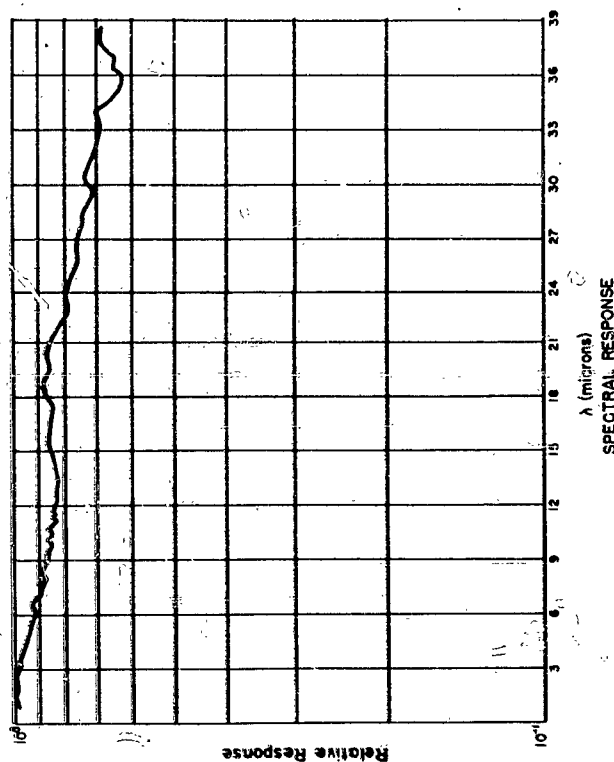
TEST RESULTS

CONDITIONS OF MEASUREMENT

R (volts/watt) (500, 10)	1.1	Blackbody temperature (°K)	500
H _N (watts/cm ² ·cm ²) (500, 10)	1.9×10^{-8}	Blackbody flux density (μwatts/cm ² , rms)	9.0
P _N (watts/cm ²) (500, 10)	1.3×10^{-10}	Chopping frequency (cps)	10
D* (cm·cps ^{1/2} /watt) (500, 10)	6.5×10^8	Noise bandwidth (cps)	0.3
Responsive time (constant (μsec))	1.9×10^4	Cell temperature (°K)	296
$\frac{R_{Nmax}}{R_{Nb}}$	1.1	Cell current for 10-cps data (μa)	---
Peak wavelength (μ)	1.8	Cell current for D* mm (μa)	---
Peak detective modulation frequency (cps)	< 2	Load resistance (ohms)	---
D* mm (cm·cps ^{1/2} /watt)	1.1×10^9	Transformer Geoformer G-4 and G95046	29
		Relative humidity (%)	---
		Responsive plane (from window)	---
		Ambient temperature (°C)	23
		Ambient radiation on detector	296°K only

CELL DESCRIPTION

Type	Thermocouple
Shape of sensitive area (cm)	0.033×0.208
Area (cm ²)	6.86×10^{-3}
Dark resistance (ohms)	---
Dynamic resistance (ohms)	1.0
Field of view	---
Window material	CsI



Beckman Instruments Cell 2352, Thermocouple
Data Sheet No. 801-B, December 1963

APPENDIX

DEFINITIONS OF SYMBOLS AND TERMS

A = adopted sensitive area of the detector in cm^2

f = modulation frequency of the radiation incident on the detector

Δf = frequency bandwidth of the electrical measuring system
in cps

J = rms value of the fundamental component of the radiant
energy flux density, in watts/cm^2

N = rms noise voltage

R_0 = maximum response

R_ω = response as a function of $\omega = 2\pi f$

$\frac{R_{\lambda \text{ max}}}{R_{\text{bb}}}$ = ratio of the responsivity at the peak wavelength to
the responsivity to blackbody radiation

V = rms value of the fundamental component of the signal voltage
as measured with the entire surface of the detector exposed

T , responsive time constant. When the photon-excited carriers in the semiconductor have a simple decay mechanism, the response to a sinusoidal varying signal may be given by

$$R_\omega / R_0 = (1 + \omega^2 T^2)^{-\frac{1}{2}}$$

The responsive time constant (T) is calculated from the frequency response. It will be noted that the load resistance used in each case is given on the frequency response curve.

R . The responsivity (R) is defined as the ratio of the rms value of the fundamental component of the signal voltage to the rms value of the fundamental component of the incident radiation power:

$$R = V/JA$$

The units of R are volts/watt.

H_N . The noise equivalent irradiance (H_N) is defined as the minimum radiant flux density necessary to give a signal-to-noise ratio of 1 when the noise is normalized to unit bandwidth:

$$H_N = JN/V \cdot \Delta f^{\frac{1}{2}}$$

The units of H_N are watts/cps $^{\frac{1}{2}}$ ·cm 2 .

P_N . The noise equivalent power (P_N) is defined as the minimum radiant flux necessary to give a signal-to-noise ratio of 1 when the noise is normalized to unit bandwidth:

$$P_N = JNA/V \cdot \Delta f^{\frac{1}{2}}$$

The units of P_N are watts/cps $^{\frac{1}{2}}$.

D^* . D-star is defined¹ as the detectivity normalized to unit area and unit bandwidth. Detectivity is the signal-to-noise ratio produced with unit radiant flux incident on the detector:

$$D^* = A^{\frac{1}{2}}/P_N$$

The units of D^* are cm·cps $^{\frac{1}{2}}$ /watt.

D^*_{mm} is defined as D-star at the peak wavelength, the optimum bias value, and the peak detective modulation frequency.

Calibration. The gain of the electrical system is calibrated by injecting a known voltage in series with the detector being tested. This is accomplished by means of a small resistor placed between the detector ground terminal and the system ground. Thus, the detector signal and noise voltages are referred to the detector terminals and to an infinite load impedance. The detector noise is corrected for amplifier noise.

¹R. Clark Jones, "Methods of Rating the Performance of Photoconductive Cells," Proceedings of IRIS, Vol. 2, No. 1, June 1957.

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