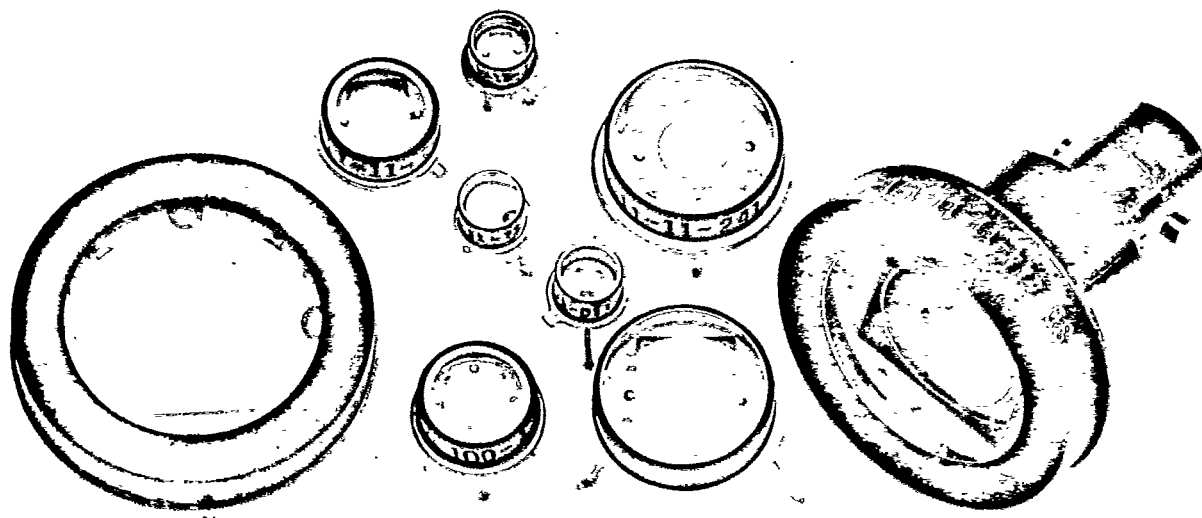




T-41-45

SILICON DETECTOR CORPORATION

1240 Avenida Acasco, Camarillo, California 93010, U.S.A., Phone: 805/484-2884, Fax: 805/484- 9935



GENERAL DESCRIPTION

SDC's General Purpose Detectors exemplify the current state-of-the-art in hi-rel planar technology and are offered in an extensive assortment of sizes. **Red/IR, Blue** and **UV** spectral options are available and each unit can be supplied with the detector isolated from its hermetic metal package. These devices are optimized for use with either of two basic circuit interfaces as described below.

The **PHOTOVOLTAIC GROUP** of General Purpose Detectors delivers unexcelled performance in low to medium frequency applications. The design of this group specifically optimizes signal-to-noise ratio and signal linearity when driving transimpedance preamplifiers (current-to-voltage amplifiers). Although no bias is usually applied to detectors in this circuit configuration, reverse bias may be used to improve frequency response and large signal linearity with extremely small resultant dark currents.

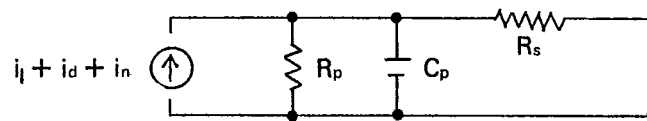
The **PHOTOCONDUCTIVE GROUP** is intended for high frequency applications. These detectors are normally reverse biased and have small junction capacitance. Low dark currents result in superior signal-to-noise characteristics and small d.c. offsets. Reverse biases of over 100 volts may be applied to most detectors of this group. A Photoconductive Detector can be used to drive a transimpedance amplifier or can be wired in series with a load resistor to drive a voltage amplifier in very high frequency applications.

APPLICATIONS

- Nephelometers and Turbidimeters
- Densitometers
- Photometers and Radiometers
- Colorimeters and Glossmeters
- Optical Communications and Facsimile Systems
- Laser Detection and Alignment
- High Frequency Isolators and Encoders

CHARACTERISTICS

- High Responsivity - .55A/W at Peak
- Extremely Low Dark Current -
100nA/cm² @ 50 Volts
- Very High Dynamic Junction Impedance -
1000M Ω (SD-041-11-11)
- No 1/f Noise - Photovoltaic Mode
- Excellent Output Linearity -
More than 11 Decades
- High Frequency Response -



i_l is the light current which is equal to the radiant power falling on the detector times the responsivity of the detector at the wavelength of the light (see page 3).

i_d is the dark current and is equal to zero in the photovoltaic mode. Under reverse biased conditions (photoconductive mode), an approximate expression which relates dark current to applied reverse voltage, V , below breakdown is:

$$i_d \propto \sqrt{V + 1}$$

i_n is the noise current generated by the photodetector and has a magnitude shown below over an electronic bandwidth, f :

$$i_n = \sqrt{[4kT/R_p + 2q(i_l + i_d)] \Delta f}$$

k = Boltzman's constant

T = absolute temperature in degrees Kelvin

q = magnitude of the charge of an electron.

Notice that the second term in this equation for i_n is usually insignificant in photovoltaic applications while the first term is usually insignificant in photoconductive applications.

i_n has an additional component at frequencies below about 100 Hz in the photoconductive mode. This noise component is referred to as $1/f$ noise and is not well characterized. This additional noise component **does not exist** in photovoltaic operation!

R_p is the dynamic junction resistance of the photodetector. Values are given on pages 4 through 7 for the zero biased condition (photovoltaic mode). The larger the value of R_p in the photovoltaic mode, the better the thermal stability of the detector/amplifier circuit becomes.

In the photoconductive mode R_p becomes very large and can be expressed as a function of reverse voltage, V , in the following approximate relationship:

$$R_p(V) = 2[V + 1]/i_d(V), \text{ for } V > .1 \text{ Volt.}$$

R_p does not usually play a significant role in photoconductive circuits.

C_p is the parallel junction capacitance of the photodetector. The primary effect of junction capacitance is to limit frequency response. SDC's photoconductive detectors are all manufactured using processes and materials which minimize capacitance per unit area and, consequently, will operate at very high frequencies. Capacitance can be reduced through application of a reverse bias, V , in accordance with the following relationship:

$$C_p(V) = C_p(0)/\sqrt{V + 1}$$

R_s is the Internal series resistance of the photodetector. R_s limits the maximum attainable output current under photovoltaic conditions and limits bandwidth in both the photovoltaic and photoconductive modes.

The equivalent circuit shown above does not apply to extremely high light level conditions because it does not account for the fact that the photodetector has a limited voltage driving capability. When the voltage across R_s in the photovoltaic mode becomes equal to the maximum open circuit voltage of the photodetector (about 0.6 volts), the photodetector can deliver no more current. The photovoltaic current saturates, therefore, at the following value:

$$i_l(\text{Sat}) \approx 0.6 \text{ Volts}/R_s \quad (\text{photovoltaic mode})$$

R_s has little effect on the maximum output current in the photoconductive mode as current is limited primarily by space charge effects.

The response time of a photovoltaic or photoconductive detector is inherently limited to the following value:

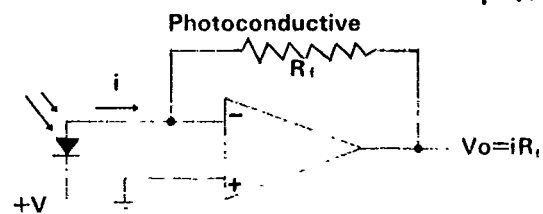
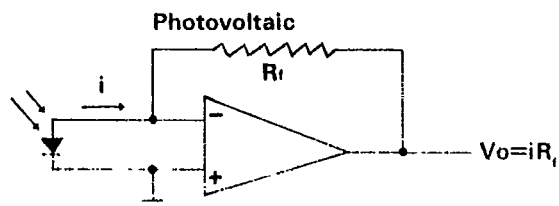
$$10\%-90\% \approx 2.2 R_s C_p$$

Other factors often cause system response times to exceed this value, but this sets a lower limit.

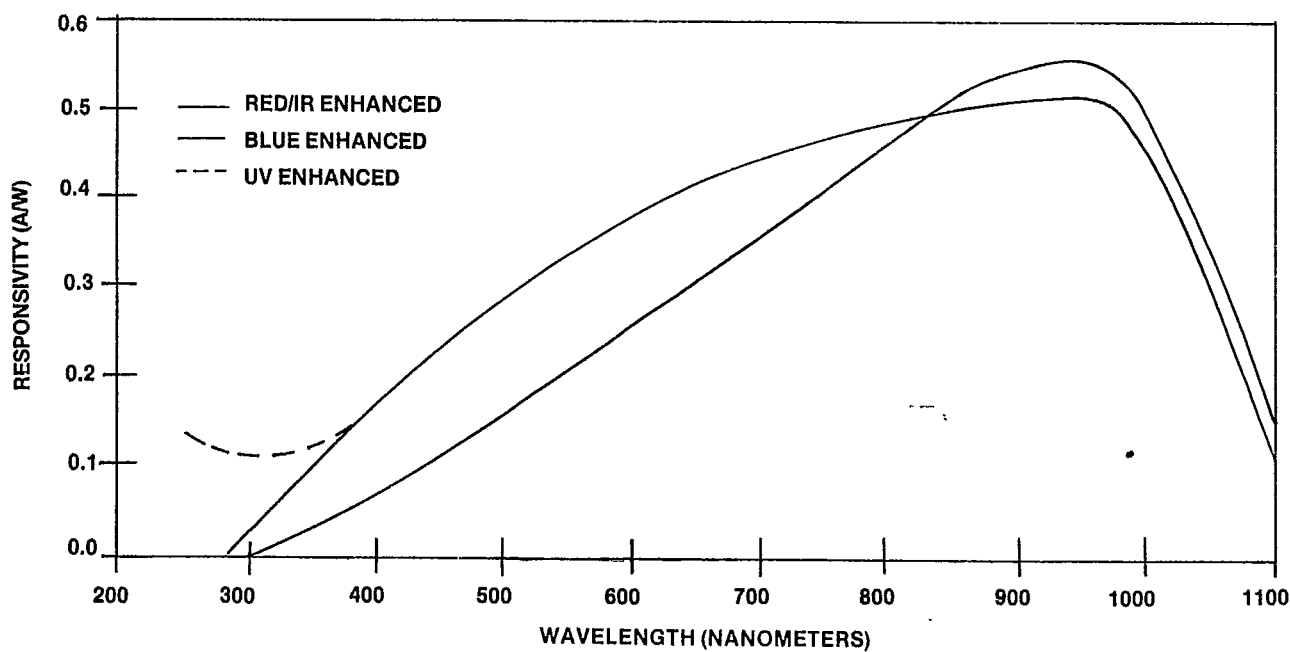
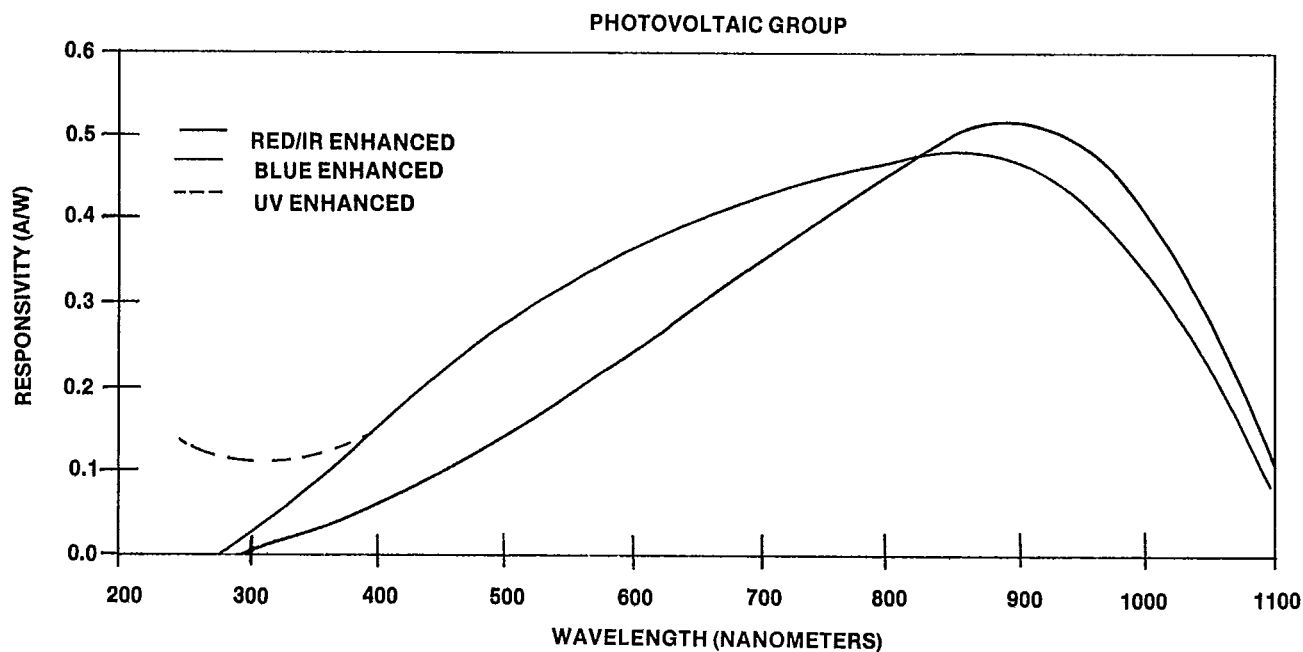
In the tabulation of Operating Specifications (pages 4 through 7), Max. Linear Output Currents and Response Times have been shown rather than R_s . These are felt to be the more significant parameters to the user.

TYPICAL CIRCUIT CONNECTION

T-41-45



SPECTRAL RESPONSIVITY



PHOTOVOLTAIC GROUP — ULTRA-LOW NOISE/MEDIUM FREQUENCY DETECTORS
OPERATING SPECIFICATIONS (23°C)

MODEL NUMBER	SPECTRAL ENHANCEMENT	ACTIVE SURFACE		TYP. (1) RESPONSIVITY AT SPECTRAL PEAK (A/W)	MIN. DYNAMIC RESISTANCE (2) 0Volts (MΩ)
		Area (mm ²)	Dimensions (in)		
SD-020-11-11-011 (ISOLATED)-211	RED/IR	0.20	0.020 (DIA)	.50	800
SD-020-12-12-011 (ISOLATED)-211	BLUE/VISIBLE	0.20	.020 (DIA)	.50	800
SD-041-11-11-011 (ISOLATED)-211	RED/IR	0.85	.040 x .033	.50	500
SD-041-12-12-011 (ISOLATED)-211	BLUE/VISIBLE	0.85	.040 x .033	.50	500
SD-076-11-11-011 (ISOLATED)-211	RED/IR	2.91	.105 x .043	.50	200
SD-076-12-12-011 (ISOLATED)-211	BLUE/VISIBLE	2.91	.105 x .043	.50	200
SD-100-11-11-021 (ISOLATED)-221	RED/IR	5.1	.100 (DIA)	.50	100
SD-100-12-12-021 (ISOLATED)-221	BLUE/VISIBLE	5.1	.100 (DIA)	.50	100
SD-100-13-13-022 (ISOLATED)-222	UV	5.1	.100 (DIA)	.50	100
SD-172-11-11-021 (ISOLATED)-221	RED/IR	15.0	.185 x .125	.50	70
SD-172-12-12-021 (ISOLATED)-221	BLUE/VISIBLE	15.0	.185 x .125	.50	70
SD-172-13-13-022 (ISOLATED)-222	UV	15.0	.185 x .125	.50	70
SD-200-11-11-041 (ISOLATED)-241	RED/IR	20.3	.200 (DIA)	.50	50
SD-200-12-12-041 (ISOLATED)-241	BLUE/VISIBLE	20.3	.200 (DIA)	.50	50
SD-200-13-13-042 (ISOLATED)-241	UV	20.3	.200 (DIA)	.50	50
SD-290-11-11-041 (ISOLATED)-241	RED/IR	42.6	.300 x .220	.50	20
SD-290-12-12-041 (ISOLATED)-241	BLUE/VISIBLE	42.6	.300 x .220	.50	20
SD-290-13-13-042 (ISOLATED)-242	UV	42.6	.300 x .220	.50	20
SD-444-11-11-171 (ISOLATED)-251	RED/IR	100	.444 (DIA)	.50	10
SD-444-12-12-171 (ISOLATED)-251	BLUE/VISIBLE	100	.444 (DIA)	.50	10
SD-444-13-13-172 (ISOLATED)-252	UV	100	.444 (DIA)	.50	10

(1) See Page 3 for complete spectral response.

(2) Typical values of Dynamic Resistance are 4x the minimum values shown here. Selection can be performed.

(3) This denotes the level above which the output current deviates more than 10 percent from the ideal linear relationship extrapolated from the low light level region. The short circuit current saturates at about 10x this value.

TYP. JUNCTION CAPACITANCE - C _p		TYP DARK CURRENT - I _d 5 Volts (nA)	TYP. RESPONSE TIME (10% - 90%)		TYP. NEP Spectral Peak 0 Volts 1 kHz (W/√Hz)	MAX (3) LINEAR OUTPUT CURRENT - I (mA)
0 Volts (pF)	5 Volts (pF)		0 Volts (ns)	5 Volts (ns)		
50	25	.10	12	7	5×10^{-15}	.040
50	25	.10	12	7	5×10^{-15}	.040
85	39	.13	9	4.1	7.3×10^{-15}	.085
85	39	.13	18	8	7.3×10^{-15}	.082
290	132	.45	16	7.3	1.2×10^{-14}	.30
290	132	.45	46	21	1.2×10^{-14}	.27
510	232	.75	23	10	1.7×10^{-14}	.50
510	232	.75	75	34	1.7×10^{-14}	.42
510	232	.75	75	34	1.7×10^{-14}	.42
1,500	682	2	56	25	1.9×10^{-14}	1.5
1,500	682	2	207	94	1.9×10^{-14}	.94
1,500	682	2	207	94	1.9×10^{-14}	.94
2,030	923	3	73	33	2.3×10^{-14}	2.0
2,030	923	3	280	128	2.3×10^{-14}	1.1
2,030	923	3	280	128	2.3×10^{-14}	1.1
4,260	1,936	7	147	67	3.6×10^{-14}	4.2
4,260	1,936	3 @ 1 V	475	216	3.6×10^{-14}	1.5
4,260	1,936	3 @ 1 V	475	216	3.6×10^{-14}	1.5
10,000	4,545	15	336	153	5.1×10^{-14}	10
10,000	4,545	7 @ 1 V	1100	510	5.1×10^{-14}	2.0
10,000	4,545	7 @ 1 V	1100	510	5.1×10^{-14}	2.0

PHOTOCONDUCTIVE GROUP — HIGH FREQUENCY DETECTORS

T-41-43

MODEL NUMBER	SPECTRAL ENHANCEMENT	ACTIVE SURFACE		TYP. (1) RESPONSIVITY AT SPECTRAL PEAK (A/W)	MAX DARK (2) CURRENT - I _d 50 Volts (nA)
		Area (mm ²)	Dimensions (in)		
SD-020-11-21-011 (ISOLATED)-211	RED/IR	0.20	.020 (DIA)	.55	2
SD-020-12-22-011 (ISOLATED)-211	BLUE/VISIBLE	0.20	.020 (DIA)	.55	2
SD-041-11-21-011 (ISOLATED)-211	RED/IR	0.85	.040 x .033	.55	6
SD-041-12-22-011 (ISOLATED)-211	BLUE/VISIBLE	0.85	.040 x .033	.55	6
SD-076-11-21-011 (ISOLATED)-211	RED/IR	2.91	.105 x .043	.55	20
SD-076-12-22-011 (ISOLATED)-211	BLUE/VISIBLE	2.91	.105 x .043	.55	20
SD-100-11-21-021 (ISOLATED)-221	RED/IR	5.1	.100 (DIA)	.55	35
SD-100-12-22-021 (ISOLATED)-221	BLUE/VISIBLE	5.1	.100 (DIA)	.55	35
SD-100-13-23-022 (ISOLATED)-222	UV	5.1	.100 (DIA)	.55	35
SD-172-11-21-021 (ISOLATED)-221	RED/IR	15.0	.185 x .125	.55	105
SD-172-12-22-021 (ISOLATED)-221	BLUE/VISIBLE	15.0	.185 x .125	.55	105
SD-172-13-23-022 (ISOLATED)-222	UV	15.0	.185 x .125	.55	105
SD-200-11-21-041 (ISOLATED)-241	RED/IR	20.3	.200 (DIA)	.55	140
SD-200-12-22-041 (ISOLATED)-241	BLUE/VISIBLE	20.3	.200 (DIA)	.55	140
SD-200-13-23-042 (ISOLATED)-241	UV	20.3	.200 (DIA)	.55	140
SD-290-11-21-041 (ISOLATED)-241	RED/IR	42.6	.300 x .220	.55	300
SD-290-12-22-041 (ISOLATED)-241	BLUE/VISIBLE	42.6	.300 x .220	.55	200 @ 10 V
SD-290-13-23-042 (ISOLATED)-251	UV	42.6	.300 x .220	.55	200 @ 10 V
SD-444-11-21-171 (ISOLATED)-251	RED/IR	100	.444 (DIA)	.55	700
SD-444-12-22-171 (ISOLATED)-251	BLUE/VISIBLE	100	.444 (DIA)	.55	500 @ 10 V
SD-444-13-23-172 (ISOLATED)-252	UV	100	.444 (DIA)	.55	500 @ 10 V
SD-1100-11-21-181	RED/IR	613	1.1 (DIA)	.55	6000 @ 10 V
SD1100-12-22-181	BLUE/VISIBLE	613	1.1 (DIA)	.55	6000 @ 10 V

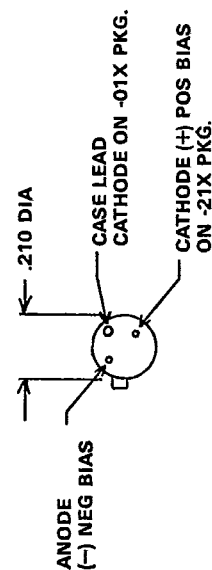
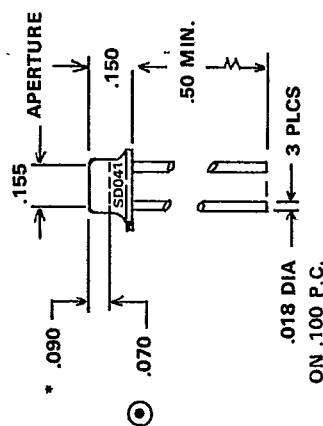
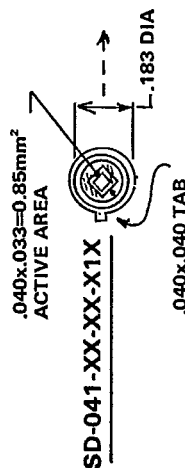
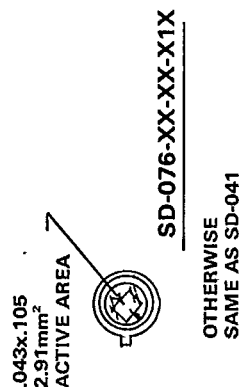
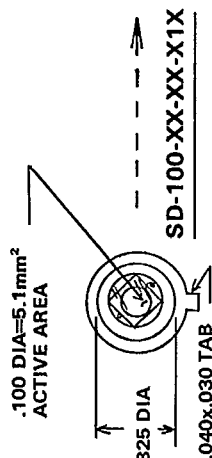
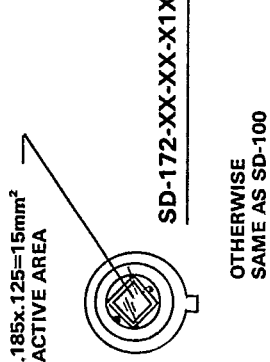
NOTE: All Photoconductive Detectors with the exception of Blue and UV Enhanced SD-290's and SD-444's have typical breakdown voltages exceeding 100 Volts.

(1) See Page 3 for complete spectral response.

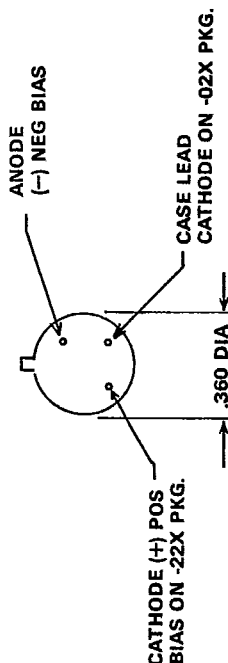
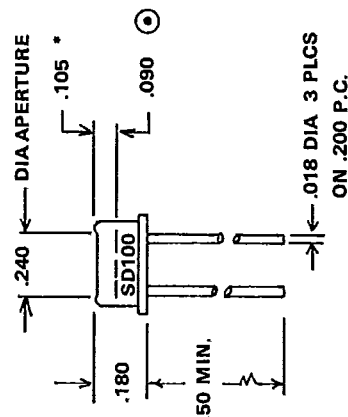
(2) Typical dark current values are 1/6 of the maximum values shown here. Selection can be performed.

(3) See Footnote (3) Page 4.

TYP. JUNCTION CAPACITANCE - C _p		TYP DYNAMIC RESISTANCE - R _p 0 Volts (M Ω)	TYP. RESPONSE TIME (10% - 90%)		TYP. NEP Spectral Peak 50 Volts 1 kHz (W/ $\sqrt{\text{Hz}}$)	MAX (3) LINEAR OUTPUT CURRENT - I ₁ (mA)
0 Volts (pF)	50 Volts (pF)		0 Volts (ns)	50 Volts (ns)		
7	1	600	37	3.5	4.0×10^{-14}	.02
7	1	600	37	3.5	4.0×10^{-14}	.02
13	2	300	38	3.7	5.7×10^{-14}	.04
13	2	300	43	4.5	5.7×10^{-14}	.04
45	6	130	39	3.8	1.0×10^{-13}	.12
45	6	130	57	6.3	1.0×10^{-13}	.12
75	11	70	39	4.6	1.4×10^{-13}	.20
75	11	70	69	8.6	1.4×10^{-13}	.18
75	11	70	69	8.6	1.4×10^{-13}	.18
225	33	50	44	4.9	2.4×10^{-13}	.60
225	33	50	135	18	2.4×10^{-13}	.50
225	33	50	135	18	2.4×10^{-13}	.50
305	44	30	46	5.3	2.7×10^{-13}	.80
305	44	30	170	23	2.7×10^{-13}	.60
305	44	30	170	23	2.7×10^{-13}	.60
640	91	13	57	6.8	4.0×10^{-13}	1.7
640	212 @ 10 V	13	318	103 @ 10 V	3.2×10^{-13} @ 10 V	1.1
640	212 @ 10 V	13	318	103 @ 10 V	3.2×10^{-13} @ 10 V	1.1
1500	214	7	86	11	6.2×10^{-13}	4.0
1500	500 @ 10 V	7	690	230	5.3×10^{-13} @ 10 V	2.0
1500	500 @ 10 V	7	690	230	5.3×10^{-13} @ 10 V	2.0
9060	3040	1		300 @ 10 V	1.0×10^{-12}	4.0
9060	3040	1		300 @ 10 V	1.0×10^{-12}	4.0



BOTTOM VIEW
JEDEC NO. TO-46



BOTTOM VIEW
JEDEC NO. TO-5

* DIMENSION FROM
OUTSIDE WINDOW
SURFACE TO ACTIVE
AREA ON 01X & 02X PKGS.

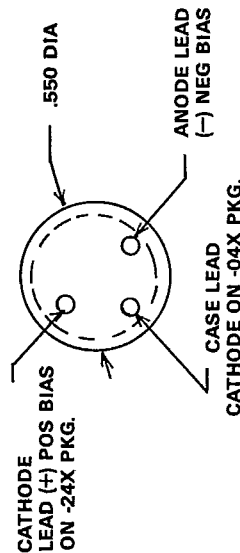
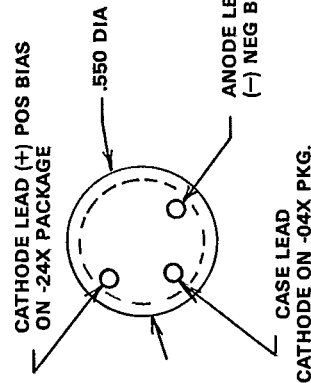
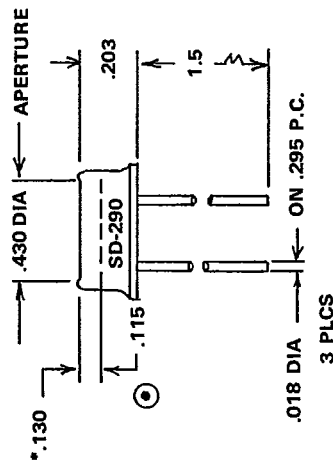
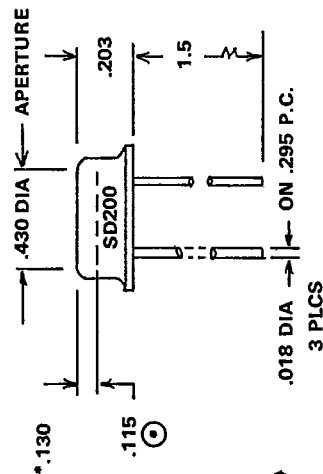
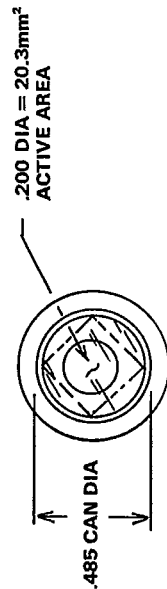
⊙ DIMENSION FROM
OUTSIDE WINDOW
SURFACE TO ACTIVE
AREA ON 21X & 22X PKGS.

T-41-45

SD-041-XX-XX-X1X & SD-076-XX-XX-X1X

SD-100-XX-XX-X2X & SD-172-XX-XX-X2X

 SILICON DETECTOR CORPORATION			
SCALE: FULL	APPROVED BY:	DRAWN BY T.M.	
DATE: 9-22-77	RMM/DLM	REVISED	
GENERAL PURPOSE DETECTOR DIMENSIONS			
B400-44-004 SHEET 1		DRAWING NUMBER	
		A	



BOTTOM VIEW
JEDEC NO. TO-8

SD-200-XX-XX-X4X

BOTTOM VIEW
JEDEC NO. TO-8

SD-290-XX-XX-X4X

*= DIMENSION FROM OUTSIDE WINDOW SURFACE TO ACTIVE AREA OF PHOTODIODE. (-04X PACKAGE)
⊙= DIMENSION FROM OUTSIDE WINDOW SURFACE TO ACTIVE AREA OF PHOTODIODE. (-24X PACKAGE)

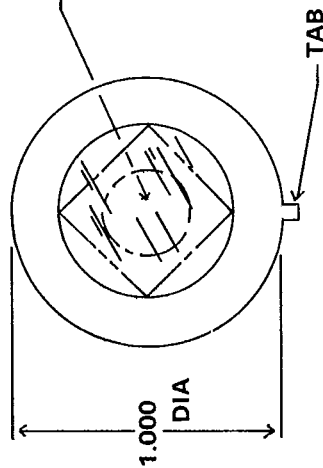
SILICON DETECTOR CORPORATION

SCALE: FULL	APPROVED BY:	DRAWN BY T.M.
DATE: 9-22-77	RMM/DLM	REVISED

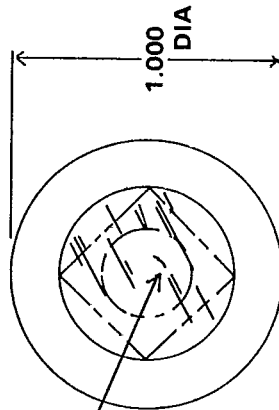
GENERAL PURPOSE DETECTOR DIMENSIONS

B-400-44-004	SHEET 2	DRAWING NUMBER
		A

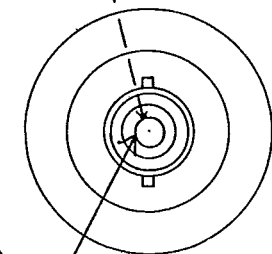
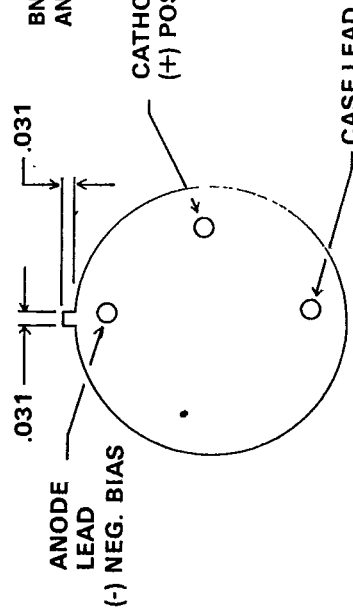
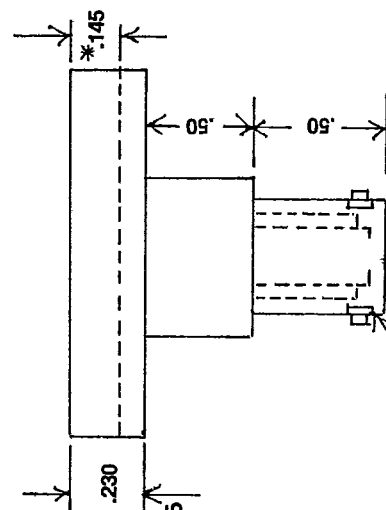
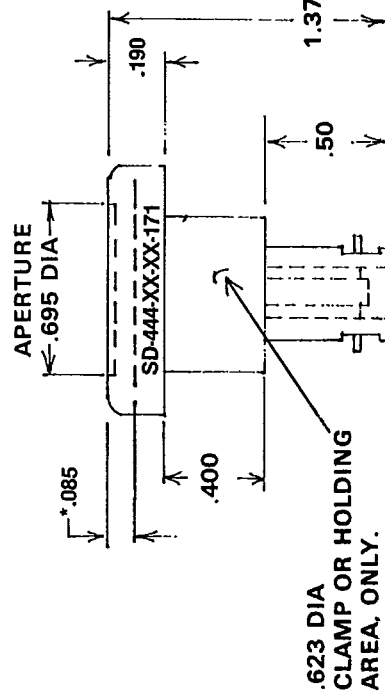
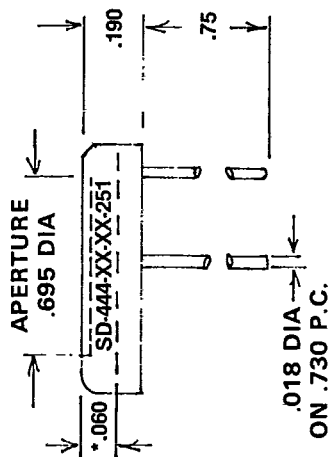
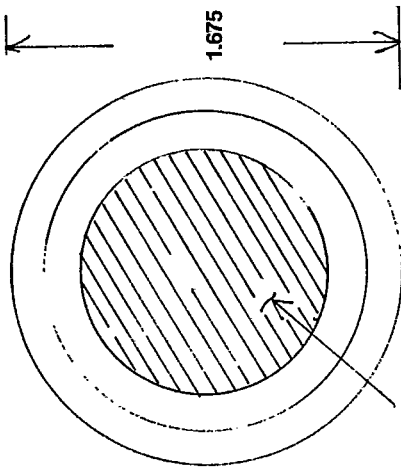
SD-444-XX-XX-25X



SD-444-XX-XX-17X



SD1100-XX-XX-181



BNC RECEPTACLE ANODE & CASE ARE COMMON

BNC RECEPTACLE ANODE & CASE ARE COMMON

DIMENSION FROM OUTSIDE OF WINDOW TO ACTIVE AREA OF PHOTODIODE

BOTTOM VIEW

*DIMENSION FROM OUTSIDE OF WINDOW TO ACTIVE AREA OF PHOTODIODE

 MILICON DETECTOR CORPORATION			
SCALE: FULL	APPROVED BY:	DRAWN BY T.M.	
DATE: 9-22-77	RMM/DLM	REVISED	
GENERAL PURPOSE DETECTOR DIMENSIONS			
B400-44-004 SHEET 3		DRAWING NUMBER A	

SD-444-XX-XX-25X

SD-444-XX-XX-17X