1010 Amplifier (P/N AM-0007)

Low Noise Amplifier

Technical Description:

The Model 1010 amplifier is a DC coupled amplifier that is compact, rugged and battery powered. The amplifier circuit and batteries are housed in a die casted aluminum case. The micro powered circuit design gives a **continuous operating life of more than one year** from the two internal batteries (included). BNC connectors are used for signal input and output connections.

The very low voltage noise and current noise in the critical low frequency region of 0.1 Hz to 10 Hz makes the Model 1010 ideal for use with thermopile detectors. To prevent accidental damage to the input transistors the input is diode protected.

1010 Amplifier

Not Currently RoHS Compliant

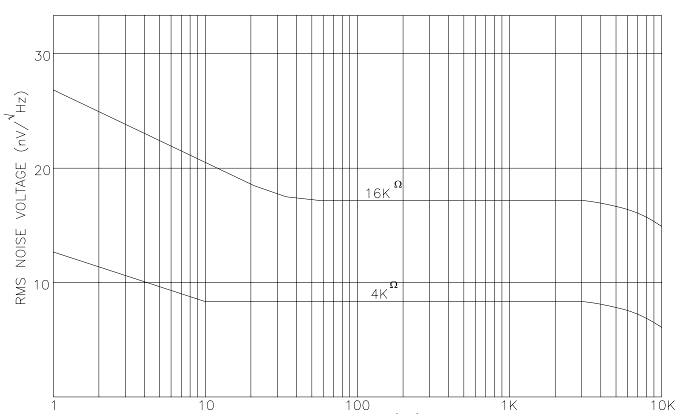
Features

- DC Coupled
- Low Noise
- DC offset Adjustment
- Micro Power
- 100% Electrostatic Shielding
- Battery Powered
- Gain of 1000

Technical Specifications

Specifications apply at 23°C

Parameter	Specification	Units	Comments
Gain	1000	V/V	60dB
Bandwidth (-3dB)	≤1	$mV_{peak\ to\ peak}$	DC input to 10KHz
	8	$mV_{peak\ to\ peak}$	DC input to 3KHz
	15	$mV_{peak\ to\ peak}$	DC input to 1.7KHz
Noise (.1Hz to 10Hz)	250	$nV_{peak\ to\ peak}$	
Maximum Output	±7.0	V	
Input Impedance	1	MΩ	
Output Impedance	300	Ω	
Output Load Minimum	10	kΩ	
Operating Temperature	0-70	°C	
Power Requirements	25	µA	From 2 internal 9V batteries
Package Size	1.4 x 2.5 x 3.9	inches	



AMPLIFIER INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY
4KΩ &16KΩ SOURCE IMPEDANCE SHOWN

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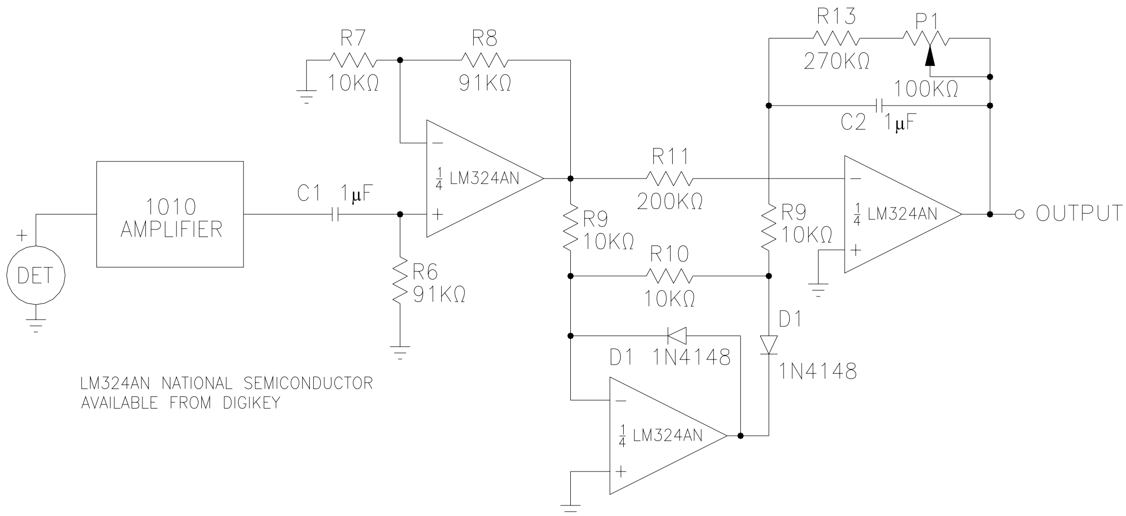
1010 Amplifier (P/N AM-0007)



TYPICAL MODULATED SIGNAL RECTIFIER FOR 10 Hz (Full Wave) USING 1010 AMPLIFIER

Adjust RC circuit (C1 & R6) for modulation frequency

Operating Instructions:

INPUT CONNECTOR: A shorting type BNC cap is used to protect the amplifier input. When the amplifier is not connected to an input source this cap should be reconnected to prevent draining the batteries.

OFFSET ADJUSTMENT: The amplifier DC offset can be adjusted with a small screwdriver through an access hole in the side of the housing. This adjustment is by means of a 22 turn cermet potentiometer. Adjust offset with detector connected. Blinded detector should be at thermal equilibrium for at least 15 minutes. Then adjust offset to your reference voltage (zero in most cases).

BATTERY REPLACEMENT: Remove the top cover by loosening the four screws. These screws are held captive to the cover. Replace the batteries with 9-Volt alkaline batteries. Replace cover.

CAUTION: Do not allow inner flange of cover to pinch the battery wires or the batteries.

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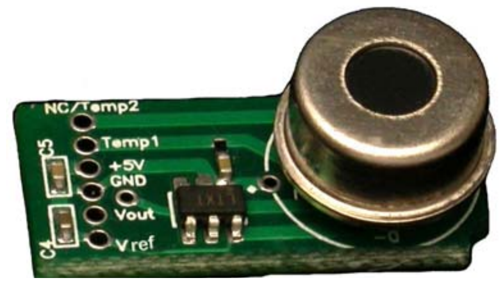
Miniature Amplifier PCB

Applications

Facilitates fast R&D startup time that can be integrated into your prototypes or final system design.

- Non-contact Temperature measurement
- Gas analysis
- Multiplexing of a number of thermopiles
- Reduction of noise on long cables



Miniature Amplifier PCB w/ optional ST60 (shown 3x actual size)

General Description

Available in three amplifier gains: 300, 500 and 1,000, this PCB includes a LM20 temperature sensor and 1.25V voltage reference. Although sized for single channel TO-5 packages, this amplifier is electrically compatible with all Dexter Research Center detectors, providing convenient buffering and pre-amplification of thermopile signal. The amplifier circuit board is impressively small (0.35” x 0.85”) and is designed around the AD8628 amplifier with ultra low offset (<1μV), low drift (<0.005μV/°C), and low bias current (100pA). The Mini Amp will operate on a 2.7V to 5.5V single supply, is chopper stabilized and has greatly reduced digital switching noise (0.5μV_{p-p} from 0Hz to 10Hz, input referred).

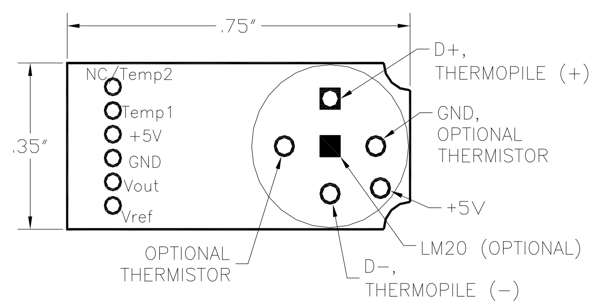
The LM20 temperature sensor (National Semiconductor) has precision analog output. The transfer function of LM20 is predominantly linear, yet has slight predictable parabolic curvature. The accuracy of the LM20 when specified to a parabolic transfer function is 1.5°C at room temperature. There is an option to connect any two terminal temperature sensor in place of LM20, for example a thermistor.

The LT1790 low drop out voltage reference combines high accuracy (0.05%) and low drift (10ppm/°C). The voltage reference has operational temperature range from –40°C to +85°C. The board may be used with an external voltage reference as well.

Highlights

- Auto-zeroing operational amplifier on-board
- Several standard gain options available
- Low noise
- Temperature sensor on board
- Single power supply (2.7V – 5.5V)
- Low Power (1mA @ 5V)
- Voltage reference on board

PCB Configuration



(DO NOT CONNECT THERMISTOR IF LM20 PRESENT, SEE SCHEMATIC)

Top View

Absolute Maximum Ratings

V_s to GND:…..………………..….…………….……….. 6V
Lead temperature soldering, 60 sec max:...... 300°C
Storage temperature:……...………. -65°C to 150°C
Operating temperature:..……....….. -40°C to +85°C

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Dexter Research Center, Inc.

Miniature Amplifier PCB

Typical Operating Characteristics

Technical Specifications: Specifications apply at 23°C

Parameter	Min.	Typ.	Max.	Symbol	Units	Comments
Supply Voltage	2.7		5.5	Vs	V	Single supply
Supply Current		1	1.2	I_{IN}	mA	
Amplifier Gain	1		1000	A_V	V/V	PCB available with standard gains of 300, 500, or 1,000
Bandwidth (-3dB)	DC to 15.9				Hz	For preset gain of 300, 500, or 1,000
Noise		0.5			µV	p-p from 0Hz to 10Hz
Offset			1		µV	
Drift			<.12		µV/°C	Below our measurement capability
LM20 Accuracy	1.5		5		°C	Min at 30°C; Max. at operating extremes (-55°C & 130°C)
LM20 Transfer Function	-11.77mV /°CxT + 1.86V			V_T	V	To give best accuracy, the LM20 must be calibrated

Part Number Selection

PCB P/N	GAIN	w/ LM20*
AM-0001	1000	No
AM-0002	1000	Yes
AM-0003	500	No
AM-0004	500	Yes
AM-0005	300	No
AM-0006	300	Yes

Please specify with or without LM20 and select gain of 300, 500, or 1,000 when ordering.
Pricing independent of LM20 option and standard gain selection. Lead-time 1-2 weeks.
* If a thermistor is to be attached to the Amplifier PCB, then the LM20 can't be mounted on the PCB

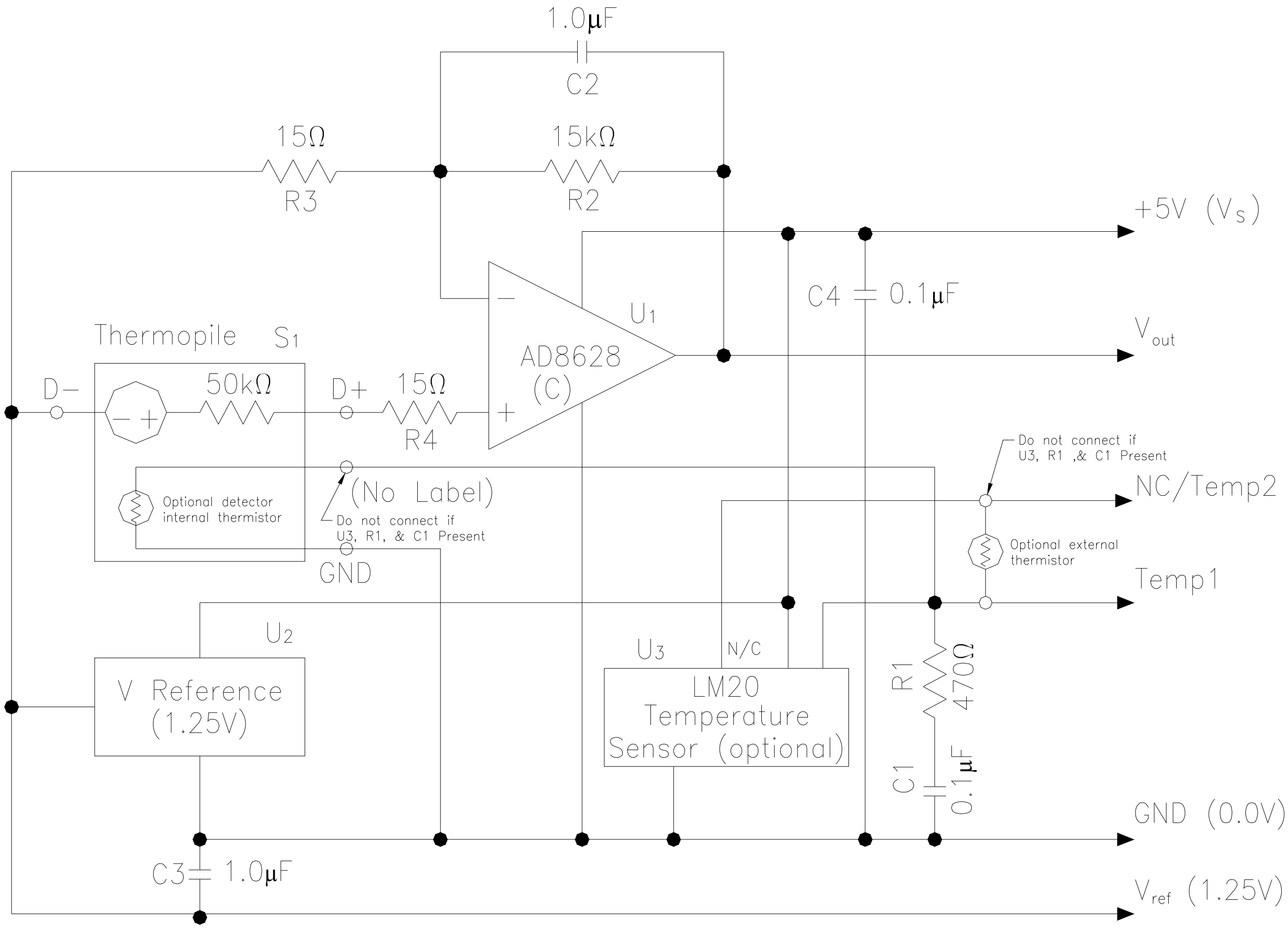
Dexter Research Center, Inc.

Miniature Amplifier PCB

Typical Application

The diagram in Figure 1 shows the schematic of the ST60 detector connected to the board. The schematic has four main sections: S_1: thermopile detector, U_1: amplifier, U_2: voltage reference, and U_3: LM20 temperature sensor.

Figure 1. Amplifier schematic with gain of 1000



Amplified detector output Voltage range

Between V_{out} and GND: 0 to V_S (when detector package is at thermal equilibrium with target, zero volts detector output will produce 1.25V PCB output)

Between V_{out} and V_{ref}: Minimum output: –1.25V, Maximum output: V_S – 1.25V (when detector package is at thermal equilibrium with target, zero volts detector output will produce 0.0V PCB output)

Detector Mounting Note: Use Thermal Epoxy or Thermally Conductive Paste between top of LM20 and detector header

LM20 versus Thermistor Note: U3, R1 & C1 removed if thermistor is connected.

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Miniature Dual Amplifier PCB

Not Currently RoHS Compliant

Applications

Facilitates fast R&D startup time that can be integrated into your prototypes or final system design.

- Non-contact Temperature measurement
- Gas analysis
- Human Presence Detection & Direction
- Multiplexing of a number of thermopiles
- Reduction of noise on long cables

Miniature Dual Amplifier PCB w/ optional ST60 Dual (shown 3x actual size)

General Description

Available in three amplifier gains: 300, 500 and 1,000, this PCB includes a LM20 temperature sensor and 1.25V voltage reference. Although sized for dual channel TO-5 packages, this amplifier is electrically compatible with all of Dexter Research Center detectors, providing convenient buffering and pre-amplification of thermopile signal. The amplifier circuit board is impressively small (0.36” x 1.17”) and is designed around the CS3012 amplifier with low offset (<10 μV), low drift (<0.05 μV/°C), and low bias current (50pA). The Mini Amp will operate on a 2.7V to 5.5V single supply.

The CS3012 dual amplifier is designed for precision amplification of low level signals and are ideally suited to applications that require very high closed-loop gains. These amplifiers achieve excellent offset stability, super-high open-loop gain, and low noise over time and temperature. The devices also exhibit excellent CMRR and PSRR. The common mode input range includes the negative supply rail.

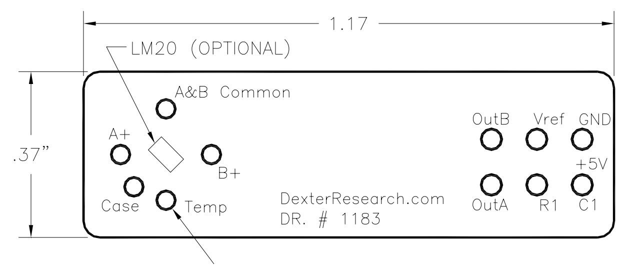
The LM20 temperature sensor (National Semiconductor) has precision analog output. The transfer function of LM20 is predominantly linear, yet has slight predictable parabolic curvature. The accuracy of the LM20 when specified to a parabolic transfer function is 1.5°C at room temperature. There is an option to connect any two terminal temperature sensor in place of LM20, for example a thermistor.

The LT 1790 low drop out voltage reference combines high accuracy (0.05%) and low drift (10ppm/°C). The voltage reference has operational temperature range from –40°C to +85°C. The board may be used with an external voltage reference as well.

Highlights

- Auto-zeroing operational amplifier on-board
- Several standard gain options available
- Low noise
- Temperature sensor on board
- Single power supply (2.7V – 5.5V)
- Low Power (1.8mA @ 5V)
- Voltage reference on board

PCB Configuration



(DO NOT CONNECT OPTIONAL THERMISTOR IF LM20 PRESENT)

Top View

Absolute Maximum Ratings

V_s to GND:……………….….……………………... 6V
Lead temperature soldering, 60 sec max:...... 300°C
Storage temperature:……..……..….. -65°C to 85°C
Operating temperature:..……....….. -40°C to +85°C

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Dexter Research Center, Inc.

Miniature Dual Amplifier PCB

Typical Operating Characteristics

Technical Specifications: Specifications apply at 23°C

Parameter	Min.	Typ.	Max.	Symbol	Units	Comments
Supply Voltage	2.7		5.5	Vs	V	Single supply
Supply Current		1.7	2	I_{IN}	mA	
Amplifier Gain	1		1000	V_O	V/V	PCB available with standard gains of 300, 500, or 1,000
Bandwidth (-3dB)	DC to 10.6				Hz	For preset gain of 300, 500, or 1,000
Noise		0.5			µV	p-p from 0Hz to 10Hz
Offset			1		µV	
Drift			<.12		µV/°C	Below our measurement capability
LM20 Accuracy	1.5		5		°C	Min at 30°C; Max. at operating extremes (-55°C & 130°C)
LM20 Transfer Function	-11.77mV /°CxT + 1.86V			V_T	V	To give best accuracy, the LM20 must be calibrated

Part Number Selection

PCB P/N	GAIN	w/ LM20*
AM-0013	1000	No
AM-0014	1000	Yes
AM-0009	500	No
AM-0010	500	Yes
AM-0011	300	No
AM-0012	300	Yes

Please specify with or without LM20 and select gain of 300, 500, or 1,000 when ordering.
* If a thermistor is to be attached to the Amplifier PCB, then the LM20 can’t be mounted on the PCB

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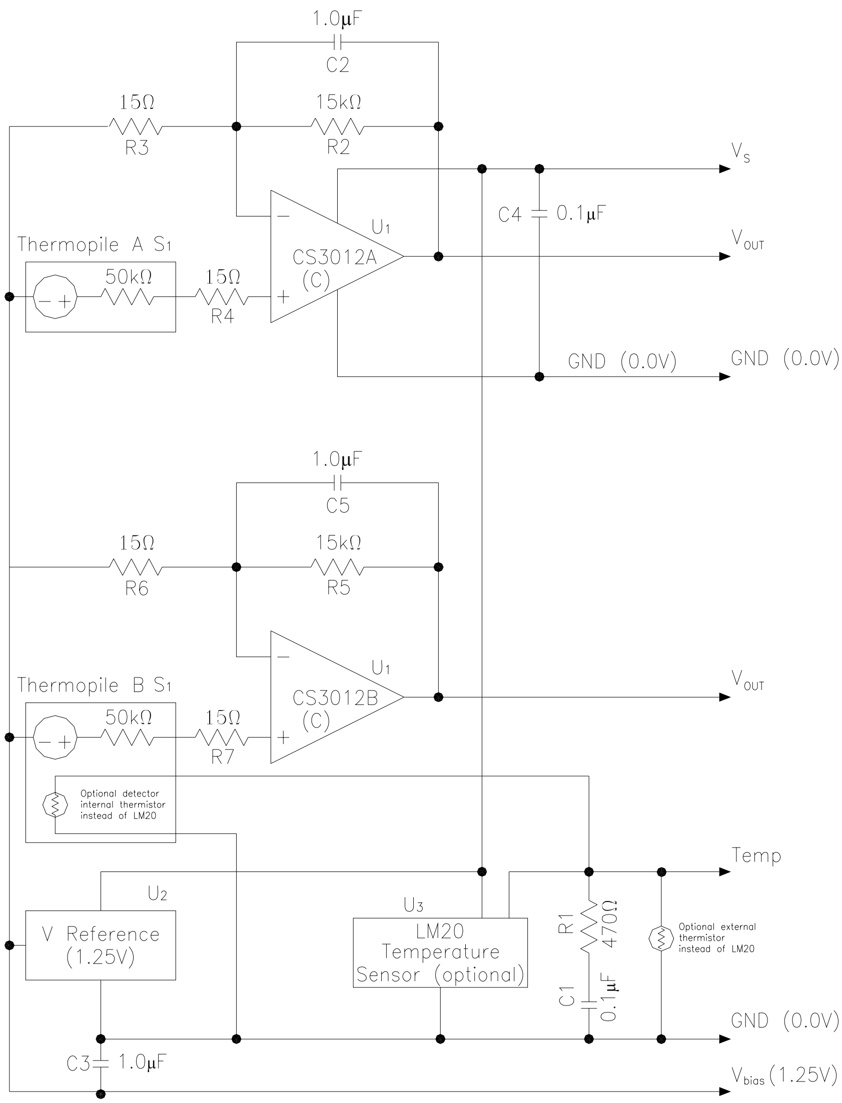
Miniature Dual Amplifier PCB

Typical Application

The diagram in Figure 1 shows the schematic of the ST60 Dual detector connected to the board. The schematic has four main sections: S_1: thermopile detector, U_1: amplifier, U_2: voltage reference, and U_3: LM20 temperature sensor.

Figure 1. Amplifier schematic with gain of 1000



<u>Amplified detector output Voltage range</u>

Between V_{OUT} and GND: 0 to V_S (when detector package is at thermal equilibrium with target, zero volts detector output will produce 1.25V PCB output)

Between V_{OUT} and V_{REF}: Minimum output: –1.25V, Maximum output: V_S – 1.25V (when detector package is at thermal equilibrium with target, zero volts detector output will produce 0.0V PCB output)

<u>Detector Mounting Notes:</u> Use Thermal Epoxy or Thermally Conductive Paste between top of LM20 and detector header

Standard Optical Filters: Wide Band & Uncoated

Window / Filter Description	Filter ID	Band Pass Wavelength	Typical Peak Trans-mission	Typical Average Trans-mission	Thick-ness (inches)	Window availability by package size					
						TO-18	TO-5	TO-8 ∅.250" hole ∅.280" hole	TO-8 ∅.437" hole	SLA32	SA32x 32
Sapphire	U1	0.1 - 7.0μm	90%	85%	.020 - .049	✔	✔	✔	✔		
UV Quartz	U2	0.15 - 2.6μm & 2.75 - 4.8μm	85%	70%	.039		✔	✔		✔	
B_aF_2 (Barium Fluoride)	U3	0.2 - 17.5μm	91%	91%	.039		✔	✔			
KBr (Potassium Bromide)	U4	0.2 - 30μm	90%	90%	~.040	✔	✔	✔			
ZnSe (Zinc Selenide)	U6	0.58 - 22μm	70%	68%	.039	✔	✔	✔			
KRS-5	U5	0.58 - 50μm	71%	68%	.039		✔	✔		✔	
IRTRAN-2 (Zinc Sulfide)	W2	1.0 - 15μm	75%	68%	.039		✔				
A-R coated Si (Anti-Reflection)	W4	1.1 - 20μm	92%	70%	.020	✔	✔	✔	✔		
Uncoated Si	U7	1.1 – 9.0μm 9.0 - 300μm	50% 20%	40% 10%	.020		✔	✔			
C_aF_2 (Calcium Fluoride)	U8	1.5 - 12.5μm	91%	91%	.020 (TO-18), .039	✔	✔	✔			
Uncoated Ge	U9	1.8 - 30μm	45%	45%	.039		✔	✔			
Diffractive Lens (DC-6132) 4.4μm F.L. A-R coated	A1	2.0 - 14μm	90%	See data sheet	.0265	✔	✔				
A-R coated Ge (Anti-Reflection)	W6	2.0 - 22μm	92%	69%	.039		✔			✔	
5μm cut-on LWP Si (Long Wave Pass Silicon)	L1	5.0 - 20μm	≥70%	60%	.020	✔	✔				
6.5μm cut-on LWP Si	L2	6.5 - 20μm	90%	70% 7.5-14μm	.020	✔	✔	✔		✔	✔
6.0μm LWP Ge	L3	6.0 - 30μm	94%	70%	.039		✔				
6.5μm LWP Ge	L4	6.5 - 30μm	94%	70%	.039		✔	✔			
8-14μm Si 1%	W1	8.0 - 14.0μm	90%	83%	.020		✔				
8-14μm Si 3%	W3	8.0 - 14.0μm	90%	≥75%	.020		✔				
8-14μm Si 5%	W5	8.0 - 14.0μm	90%	≥75%	.020	✔	✔	✔			
8-14μm Ge 2%	W7	8.0 - 14.0μm	92%	75%	.039		✔	✔			

Please call for specific needs if not listed. ✔ = Normally stocked, please call for availability.

Note: Typical Peak and Average Transmission shown are estimates, only to be used as an indication of relative performance.

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Gas Filter Detector Availability

Filter Description	Filter ID	Old P/N	Center Wave Length	HBW	Thick-ness (inches)	ST60 DUAL, ST60 QUAD, ST120 QUAD	TO-18	DR34	ST120 DUAL, ST150 DUAL, ST150 QUAD	DR46	TM34	T34 Compensated	2M QUAD, T0-5 w/ .125" hole	TO-5 Single Element w/.150" or .180" hole	10 CHANNEL
REF (Reference)	R3	F3000	3.000µm	.090µm	.020			✔			✔				
C_2H_2 (Acetylene)	M1	F3040	3.040µm	.087µm	.020							✔	✔		
CH_4 (Methane)	M2	F3357	3.357µm	.102µm	.020							✔	✔ [1]		
HC (Hydro Carbon)	H2		3.390µm	.190µm	.020	✔	✔ [1]		✔				✔	✔	
HC (Hydro Carbon)*	H1	FHC1	3.430µm	.200µm	.039	✔	✔ [1]		✔				✔		
HC (Hydro Carbon)	H3	F3455	3.455µm	.185µm	.039					✔				✔	
C_2H_6O (Ethanol)	M3	FETH	3.460µm	.175µm	.020			✔			✔	✔ [1,2]			
REF (Reference)*	R1	FREF1	3.875µm	.130µm	.039	✔	✔ [1]		✔				✔		
REF (Reference)	R2	FREF2	3.920µm	.110µm	.020	✔	✔ [1]		✔				✔	✔	
CO_2 (Carbon Dioxide)	D3	F426	4.260µm	.200µm	.020									✔	
CO_2 (Carbon Dioxide)	D2	FCO22	4.260µm	.180µm	.020	✔	✔ [1]		✔				✔	✔	
CO_2 (Carbon Dioxide)	D7	FCO2	4.262µm	.209µm	.020							✔			
CO_2 (Carbon Dioxide)	D4	F4270	4.270µm	.190µm	.039	✔	✔ [1]		✔	✔		✔ [1]		✔	
CO_2 (Carbon Dioxide)	D5	F4395	4.395µm	.050µm	.039				✔					✔	
CO_2 (Carbon Dioxide)*	D1	FCO21	4.415µm	.060µm	.039	✔	✔ [1]		✔				✔		
CO_2 (Carbon Dioxide)	D6		4.440µm	.100µm	.020	✔	✔ [1]		✔				✔	✔	
N_2O (Nitrous Oxide)	M4	FN2O	4.5527µm	.290µm	.020							✔	✔ [1]		
CO (Carbon Monoxide)*	C1	FCO1	4.650µm	.160µm	.039	✔	✔ [1]		✔				✔		
CO (Carbon Monoxide)	C2		4.650µm	.180µm	.020	✔	✔ [1]		✔				✔	✔	
CO (Carbon Monoxide)	C3	F4660	4.660µm	.220µm	.039					✔				✔	

Please call for other available filters. *Standard Automotive Gas Analysis Filters

1. Currently available for limited R&D samples. Additional fees may apply.
2. T34 Compensated channel C only

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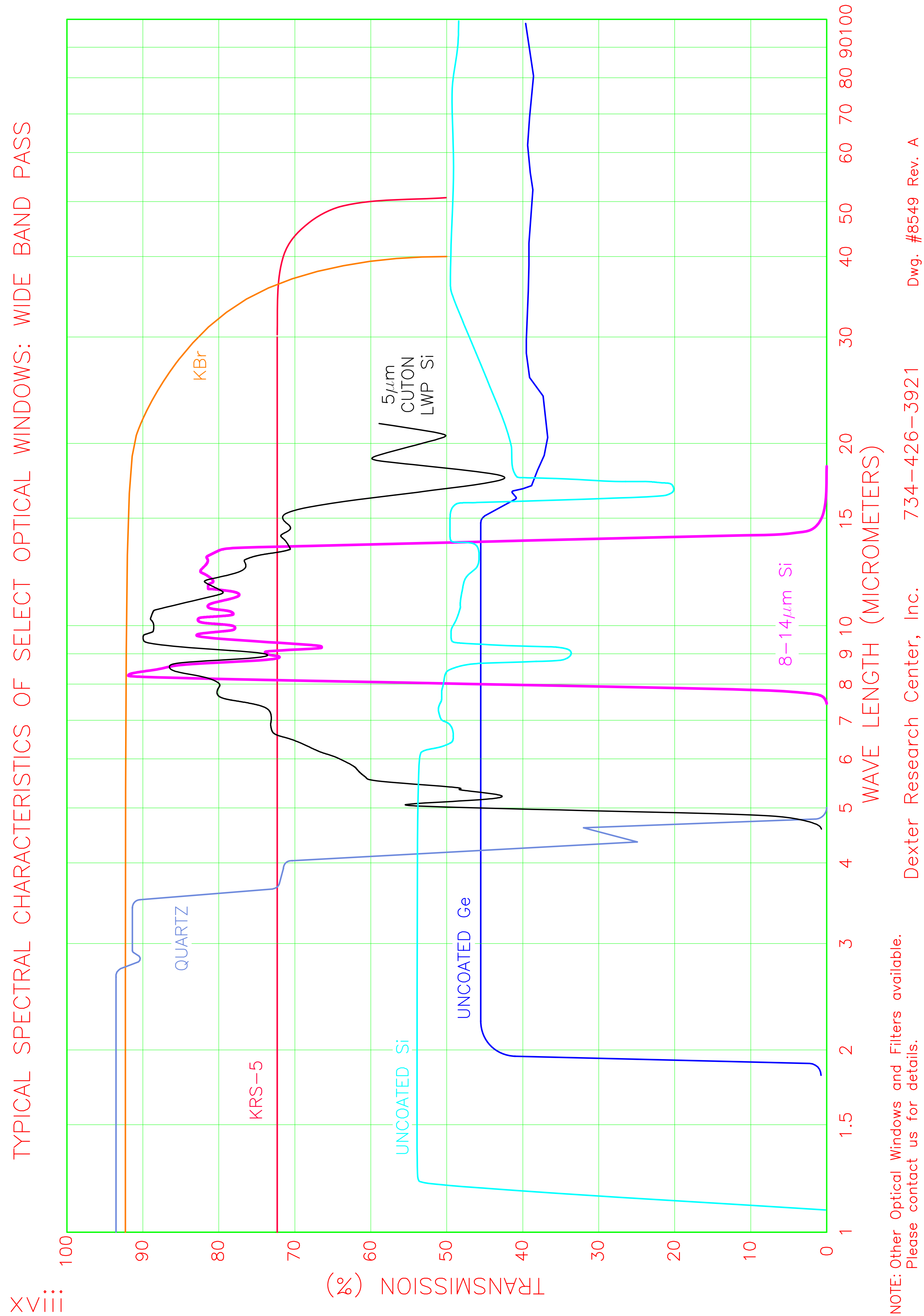

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Thermopile Comparison: Thin Film vs. Silicon

Benefits: Thin Film Based Thermopile Detectors

- Higher Output and Sensitivity
- Lower Noise
- Higher S/N Ratio
- Lower Resistance
- Larger Active Area Available
- Greater Flexibility in Responsivity and Time Constant by selecting Back-Fill gas. See Application Brief 7.
- Proven Technology – In Production Since 1977

Benefits: Silicon Based Thermopile Detectors

- Lower Temperature Coefficient of Responsivity
- Lower Cost (ST60 & ST150 models)
- Smaller Active Areas
- Faster Time Constant
- Response Linear for Higher Incident Power Levels (ST60 & ST150 models)
- Smaller Packages available
- Customizable Multi-Channel Configurations (ST60 & ST150 models)
- Adjustable Responsivity and Time Constant by selecting Back-Fill Gas.
- Proven Technology – In Production Since 1990

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Effects of Back-fill Gas on Thermopile Detectors

The selection of back-fill gas in a thermopile detector package affects three important performance parameters: the output voltage, Responsivity, and time constant. Different gases have different molecular thermal conductivity. The molecular thermal conductivity affects the thermal resistance of the detector and package, thereby affecting the output voltage, Responsivity, and time constant. Please note that there are other factors that affect these parameters such as: amount of black absorber, use of optional internal heat sink, type of package (cold weld vs. resistance weld), and thermopile model. The effect of the back-fill gas on these three parameters is less with Silicon Based Thermopiles than Thin Film Based Thermopile Detectors.

The specifications shown on the Dexter Research Center data sheets are for Argon or Nitrogen depending on detector model (see individual data sheets for gas specified, ST60/R (all models), ST150 (all models), SLA32, and SA32x32 data sheets are with N_2, all others are with Ar). These parameters change by the same percentage, approximated by the Multipliers shown in Tables 1, 2, and 3, for Thin Film Based, "S" type Silicon Based, and "ST" type Silicon Based thermopiles respectively. For example, when a detector package is back-filled with Xenon instead of Argon, the output voltage, Responsivity, and time constant will increase by 2.4 times for Thin Film Based Thermopiles (see Table 1 below). Where as these parameters would increase 2.1 times for "S" type Silicon Based Thermopiles (see Table 2 below). See Table 4 for the backfill gas calculations for all of our detector models.

Dexter Research Center (DRC) offers four standard back-fill gas options: Ar, N_2, Xe, and Ne. The effect varies for each gas depending on whether it is in a Thin Film, "S" type Silicon Based, or "ST" type Silicon Based Thermopile Detector. The tables below show a rough approximation of the back-fill gas factor (Multiplier) for these three groups of thermopile detectors. These tables are only intended to be a guide, the Multipliers below can vary by more than +/-25%. This variation is limited by the fact that if a Multiplier is greater than 1.0, then the multiplier can not go below 1.0 and if a Multiplier is less than 1.0, then the multiplier can not go above 1.0.

Thin Film Based Thermopile in Argon (Ar)	
Gas	Multiplier
Nitrogen (N_2)	.75
Xenon (Xe)	2.4
Neon (Ne)	.4

Table 1: Output voltage, Responsivity, and time constant Multipliers for Thin Film Based Thermopile detectors relative to Argon.

Two tables for Silicon Based Thermopiles are shown below: Table 2 is for "S" type Silicon Based models with data sheets using Argon (model S25, S60 and S707).

Table 3 is for “ST” type Silicon Based models with data sheets using Nitrogen (all ST60 and ST150 models including the multi-channel models). Currently, the model SLA32 and SA32x32 are only available with N_2 back-fill.

“S” type Silicon Based Thermopile in Argon (Ar)	
Gas	Multiplier
N_2	.87
Xe	~1.6
Ne	0.6

Table 2: Output voltage, Responsivity, and time constant Multipliers for “S” type Silicon Based Thermopile detectors relative to Argon.

“ST” type Silicon Based Thermopile in Nitrogen (N_2)	
Gas	Multiplier
Ar	1.1
Xe	1.55
Ne	0.9

Table 3: Output voltage, Responsivity, and time constant Multipliers for “ST” type Silicon Based Thermopile detectors relative to Nitrogen.

2M Time Constant Example

As an example of how the above back-fill gas Multipliers work, take the DRC model 2M. From the DRC data sheet for the 2M, the time constant is 85ms when back-filled with Argon.

To calculate the approximate time constant in Xenon, multiply the Argon time constant of 85ms by the Ar to Xe Multiplier of 2.4 (see Table 1) which gives 85ms x 2.4 = 204ms.

Therefore, by back-filling the model 2M with Xe, the time constant is approximately 204ms instead of 85ms when filled with Ar.

2M Output Voltage Example

The same holds true for the output voltage. From the DRC data sheet for the model 2M, the output voltage is 250µV when exposed to 330µW/cm^2 radiation and back-filled with Argon.

To calculate the approximate test stand output voltage for the 2M back-filled with Xenon, multiply the voltage of 250µV by the Ar to Xe Multiplier of 2.4 (see Table 1) which gives 250µV x 2.4 = 600µV.

Therefore, by back-filling the model 2M with Xe, the test stand output voltage is approximately 600µV instead of 250µV when back-filled with Ar. Table 4 below, shows the back fill gas calculations for all of our thermopile detector models.

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Estimated Effects of Back-fill Gas

Single-channel Thermopile Detectors

Gas	Thermopile Model	M14	M5	1M	1SC	2M	2MC Au	2MC Sb	3M	6M	S25	S60M	S707	ST60/R*	ST150*	Units
Ar	**Output Voltage**	**20**	**35**	**60**	**48**	**250**	**130**	**180**	**440**	**370**	**40**	**120**	**25**	**68.2**	**253**	µV
	Responsivity	16.5	54.1	23.5	14.5	18.9	9.8	13.6	14.8	4.0	193.9	101.0	144.3	55.6	34.1	V/W
	Time Constant	14	28	32	48	85	85	85	100	221	12	12	12	19.8	41.8	ms
N2	**Output Voltage**	**15**	**26.3**	**45**	**36**	**187.5**	**97.5**	**135**	**330**	**277.5**	**34.8**	**104.4**	**21.75**	**62**	**230**	µV
	Responsivity	12.4	40.6	17.6	10.9	14.2	7.4	10.2	11.1	3.0	168.7	87.9	125.5	50.5	31.0	V/W
	Time Constant	10.5	21.0	24.0	36.0	63.8	63.8	63.8	75.0	165.8	10.4	10.4	10.4	18	38	ms
Xe	**Output Voltage**	**48**	**84**	**144**	**115.2**	**600**	**312**	**432**	**1056**	**888**	**64**	**192**	**40**	**96.1**	**356.5**	µV
	Responsivity	39.6	129.8	56.4	34.8	45.4	23.5	32.6	35.5	9.6	310.2	161.6	230.9	78.3	48.1	V/W
	Time Constant	33.6	67.2	76.8	115.2	204.0	204.0	204.0	240.0	530.4	19.2	19.2	19.2	27.9	58.9	ms
Ne	**Output Voltage**	**8**	**14**	**24**	**19.2**	**100**	**52**	**72**	**176**	**148**	**24**	**72**	**15**	**55.8**	**207.0**	µV
	Responsivity	6.6	21.6	9.4	5.8	7.6	3.9	5.4	5.9	1.6	116.3	60.6	86.6	45.5	27.9	V/W
	Time Constant	5.6	11.2	12.8	19.2	34	34	34	40	88.4	7.2	7.2	7.2	16.2	34.2	ms

Multi-channel Thermopile Detectors

Gas	Thermopile Model	DR26	DR34	TM34	T34	DR46	2M Quad	10 Channel	ST60R Dual*	ST60R Quad*	ST150 Dual*	ST150 Quad*	SLA32*	SA32x32*	Units
Ar	**Output Voltage**	**54**	**115**	**115**	**115**	**210**	**250**	**115**	**68.2**	**68.2**	**253**	**253**	NA	NA	µV
	Responsivity	13.6	27.6	27.6	27.6	26.5	18.9	27.6	55.6	55.6	34.1	34.1			V/W
	Time Constant	38	38	38	38	40	85	38	19.8	19.8	41.8	41.8			ms
N2	**Output Voltage**	**40.5**	**86.3**	**86.3**	**86.3**	**157.5**	**187.5**	**86.3**	**62**	**62**	**230**	**230**	**14.8**	**27**	µV
	Responsivity	10.2	20.7	20.7	20.7	19.9	14.2	20.7	50.5	50.5	31.0	31.0	138.0	90.0	V/W
	Time Constant	28.5	28.5	28.5	28.5	30.0	63.8	28.5	18	18	38	38	7	6	ms
Xe	**Output Voltage**	**129.6**	**276**	**276**	**276**	**504**	**600**	**276**	**96.1**	**96.1**	**356.5**	**356.5**	NA	NA	µV
	Responsivity	32.6	66.2	66.2	66.2	63.6	45.4	66.2	78.3	78.3	48.1	48.1			V/W
	Time Constant	91.2	91.2	91.2	91.2	96.0	204.0	91.2	27.9	27.9	58.9	58.9			ms
Ne	**Output Voltage**	**21.6**	**46**	**46**	**46**	**84**	**100**	**46**	**55.8**	**55.8**	**207**	**207**	NA	NA	µV
	Responsivity	5.4	11.0	11.0	11.0	10.6	7.6	11.0	45.5	45.5	27.9	27.9			V/W
	Time Constant	15.2	15.2	15.2	15.2	16.0	34.0	15.2	16.2	16.2	34.2	34.2			ms

Detector starting specifications as noted in Data Sheets are for **Ar** except for models denoted with *, for these detectors starting specifications are for **N2**.

The above calculations are summarized in Application brief 7.

NA = Package not available with other back-fill gases.

DEXTER RESEARCH CENTER, INC.

Thermopile Time Constant Determination

The time constant of thermopile detectors can be determined by several methods depending on the specific waveform of the radiation used to excite the detector. If the detector is subject to a step function of radiation, its response follows the function $V_t = V_{max}(1-e^{-t/\tau})$, where V_t is the detector output at any time t. The time constant (τ) of the system is defined as the time when V_t is 63.2% of its maximum static value $V_{max.}$

If the detector is subjected to sinusoidally modulated radiation, its frequency response follows the function $V_d = V_s[1+(2\pi\tau/T)^2]^{-1/2}$, where V_d is the dynamic amplitude of the detector output voltage at any wave period T, and V_s is the static amplitude of the output voltage generated by un-modulated radiation. The period $T_{o,}$ at which the output amplitude V_d, falls off by 3dB (.707 V_s) from the static value, relates to the detector time constant by the expression $\tau = T_o/k\pi$, where k = 2 for sinusoidally modulated signals.

The waveform of chopper-modulated radiation corresponds closely to a square wave, and in this case the coefficient k = 1.124. The same relationship between the time constant and sine or square wave modulated radiation was found by Jones (see reference below).

A Red LED may be used with either method if the thermopile window/filter transmits in the visible spectrum. The appropriate coefficient should be applied depending upon the waveform used. At Dexter Research Center (DRC), the time constant is determined using two methods. 1) If the thermopile window/filter transmits in the visible spectrum then DRC uses a square wave modulated Red LED. 2) If the thermopile window/filter does not transmit in the visible spectrum, then DRC uses a chopped blackbody.

Direct measurement of the approximate time constant with a modulated signal is relatively simple and quick. Adjust the peak-to-peak trace of the detector's DC output to seven divisions on an oscilloscope using a very slow modulation frequency. Increase the frequency until the peak-to-peak trace spans five divisions (.707 x 7div. = 4.95div.). This is approximately –3 dB of $V_{max.}$ The time constant can then be determined from the frequency or from the wave period, again using the appropriate coefficient for the waveform utilized.

Infrared Detectors: Eds. Hudson & Hudson; Benchmark Papers in Optics, V.2; Dowden, Hutchinson, & Ross, Inc.; Stoudsburg, PA; J. Wiley & Sons, 1975. Page 324.

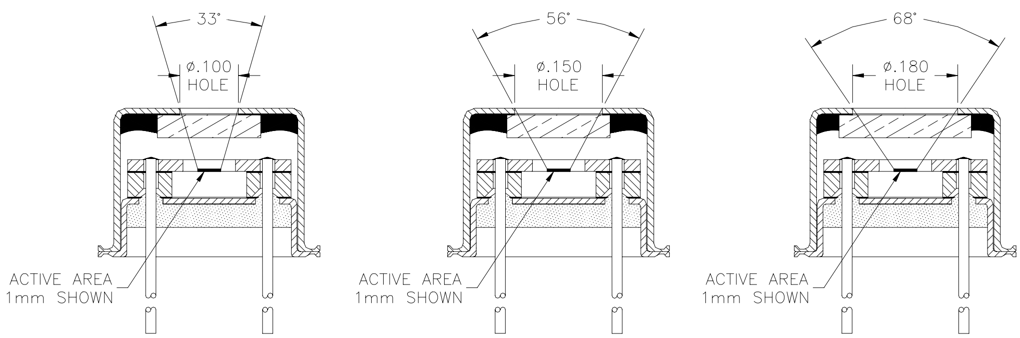
Dexter Research Center, Inc.

Package Hole Size and Aperture Options

Dexter Research offers a wide variety of package hole sizes and internal apertures which can be used to modify the Field of View (FOV) of single element detectors or minimize cross talk in multi-channel detectors.

Package Hole Size

Package hole size can be customized to modify detector Field of View (FOV) of TO-5 packages. Hole size also defines the amount of energy coming into the package and subsequently falling on the detector active area. Package (cover) hole sizes available (inches): .100”, .125”, .150”, .180”, .202” dia.



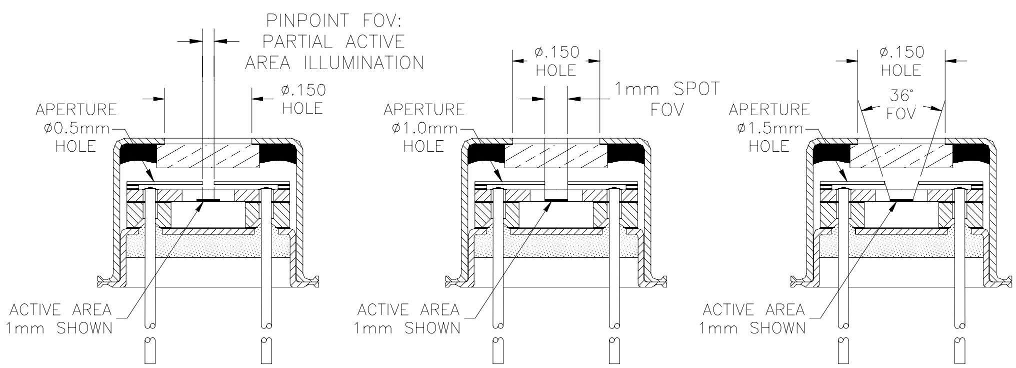
FOV effects of cover hole size on single element detector (model 1M used for example).

Internal Aperture

Internal apertures can be used to modify the FOV of our single element detectors in TO-5 packages.

Internal aperture sizes available (mm): .25mm, .5mm, .6mm, .75mm, 1.0mm, 1.5mm, 2mm dia.

Internal apertures for limiting cross talk in multi-element detectors are available for the following models: DR34, TM34, T34, DR46, 2M Quad, 10 channel. The aperture hole sizes are generally the same size as the detector active area.



FOV effects of internal aperture on single element detector (model 1M used for example).

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