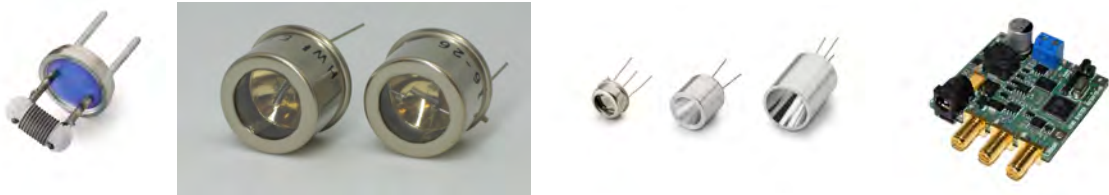


# Miniature Infrared Sources & Driver



Visit our web store to purchase or speak with our application specialists.

See our separate catalogs for other sources:

**Mid-IR LEDs:** 1.9 to 7.0  $\mu\text{m}$

**Quantum Cascade Lasers:** spectroscopic grade QCLs

**Calibration Grade Blackbodies:** NIST traceable



 **Boston**Electronics

91 Boylston Street, Brookline, MA 02445  
tel: (617)566-3821 fax: (617)731-0935  
www.boselec.com boselec@boselec.com



## Thermal Emitter Temperature and Color Correlation

| Centigrade | Fahrenheit | Color ( Apparent )            |
|------------|------------|-------------------------------|
| 400        | 752        | Red heat visible in the dark  |
| 474        | 885        | Red heat visible in twilight  |
| 525        | 977        | Red heat visible in daylight  |
| 581        | 1078       | Red heat visible in sunlight  |
| 700        | 1292       | Dark red                      |
| 800        | 1472       | Dull cherry red               |
| 900        | 1652       | Cherry red                    |
| 1000       | 1832       | Bright cherry red             |
| 1100       | 2012       | Orange red                    |
| 1200       | 2192       | Orange yellow                 |
| 1300       | 2372       | Yellow white                  |
| 1400       | 2552       | White welding heat            |
| 1500       | 2732       | Bright white                  |
| 1600       | 2912       | Dazzling white (bluish white) |

Boston Electronics offers a range of infrared radiation sources, both modulated and unmodulated. Please ask for details.



### Features

- \* Easy to use
- \* Low cost
- \* Simple, flexible control using dedicated software
- \* Adjustable voltage driving the source
- \* CW or pulsed operation—MHz to DC
- \* Nanosecond to seconds repetition rate
- \* Current and voltage monitor
- \* powered from USB (<0.5A) or DC supply

## UPS Driver™

# Universal Photon Source (UPS) Driver Board

The Boston Electronics Universal Photon Source (UPS) Driver delivers! It is a flexible, compact, low cost, configurable board, including power supply, that drives a wide range of light sources. The driver can control pulsed and CW sources, which makes it suitable for driving **ultraviolet (UV), visible and infrared (IR) sources, light emitting diodes (LEDs) and lasers over a frequency range of MHz to DC.**

Control is provided by easy to use PC software. The last used drive parameters are stored in the non-volatile EEPROM memory; thus, the configuration is remembered. The UPS Driver is equipped with voltage and current monitors, trigger output, power and communication inputs and anode/cathode connections for the sources.

**The UPS Driver is compatible with UV, visible and IR sources, LEDs and lasers.**





# UPS Driver Specifications

Developed with, and  
manufactured by:



## Electrical parameters:

- ◆ Power supply: - USB from computer or +5 ... +6 V, connected to the DC Jack connector
- ◆ Average power sources
  - ◇ max. 1.5W, for the power supply from USB
  - ◇ max. 10W, for the power supply connected to the DC Jack connector
- ◆ Adjustable voltage supply, in the range 0.5 – 25V, 4095 steps
- ◆ Maximum current: 10 A (tested with QCL at 20 V and 100 ns pulse width)
- ◆ Monitor for the supply voltage source (ADC)
- ◆ Master clock period / frequency:
- ◆ main clock period / frequency                      output signal max. period / min. frequency

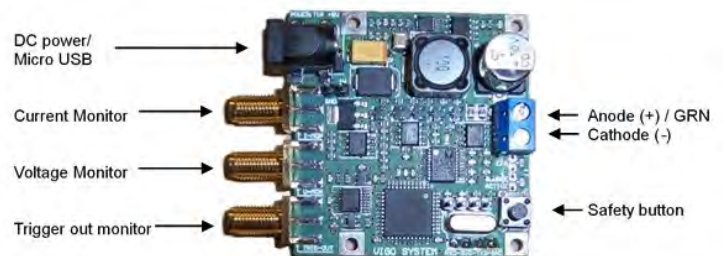
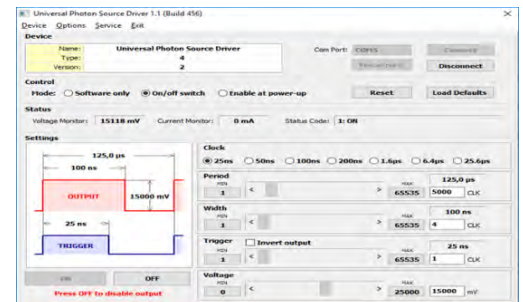
|                       |                    |
|-----------------------|--------------------|
| 25 ns / 40 MHz        | 1.638 ms / 610 Hz  |
| 50 ns / 20 MHz        | 3.27 ms / 305 Hz   |
| 100 ns / 10 MHz       | 6.55 ms / 152 Hz   |
| 200 ns / 5 MHz        | 13.1 ms / 76.3 Hz  |
| 1600 ns / 0,625 MHz   | 104 ms / 9.54 Hz   |
| 6.4 μs / 156,25 kHz   | 420 ms / 2.38 Hz   |
| 25.6 μs / 39,0625 kHz | 1.677 s / 0.594 Hz |
- ◆ Pulse repetition period - adjustable in the range 1 ... 65535 times the period of the master clock
- ◆ Pulse duration - adjustable in the range 1 ... 65535 times the period of the master clock
  - ◇ if pulse duration is higher than the period, source stays on – CW operation
- ◆ Driving signal rise / fall times < 3 ns.
- ◆ Pulse jitter : 6 ns pp
- ◆ Trigger output starts 50 ns before the IR pulse
  - ◇ adjustable duration time in the range 1 ... 65535 times the period of the master clock
- ◆ Power supply monitor
- ◆ Source average current monitor - time constant 100 ms
- ◆ All parameters have their equivalent – minimum/maximum to provide for safe operation
- ◆ Anode of the source is connected to ground, cathode below ground potential

## Software

- ◆ The UPS Driver is configured using PC software, or text protocols.

## Connections:

- ◆ trigger output—SMA connector
  - ◇ output impedance 50 Ω
  - ◇ standard LVTTTL: logic 0 - 0 V, logic 1 – 3,3 V @ Hi-imp, 1.65 V @ 50 Ω
- ◆ output current monitor—SMA connector
  - ◇ DC offset ~ 100 mV @ 50 Ω
  - ◇ current sensitivity 0.1 V/A @ 50 Ω / can be modified
  - ◇ 100 MHz BW
- ◆ output voltage monitor—SMA connector
  - ◇ DC offset ~ 100 mV @ 50 Ω
  - ◇ voltage sensitivity 50mV/V @ 50 Ω / can be modified
  - ◇ 100 MHz bandwidth
- ◆ micro-USB connector
  - ◇ communication with PC, virtual COM port
  - ◇ power supply, if current consumption of the driver does not exceed 0.5 A (USB 2.0 standard)
- ◆ DC power jack 2.5/5.5
  - ◇ power supply, if driver requires more than 0.5A (USB 2.0 standard), or If the PC is not used (configuration is restored from the memory)



## Size:

- ◆ PCB dimensions 60x50x15mm (width×height×depth), including connectors



"Out Shines All Others"

## PULSABLE IR SOURCE Model EVF-555X

**NEW  
PRODUCT!**

HelioWorks, Inc. offers a unique pulsable black body infrared emitter in an industry standard TO-39 package with 1.6 Watts input power at a peak temperature of 700°C (973°K). The radiating element is vertically oriented and centered in a parabolic reflector so that radiation from both sides of the element is captured. Window options (X) include: 0 = no window, 1 = sapphire, 2 = Calcium Fluoride, 3 = Zinc Selenide.



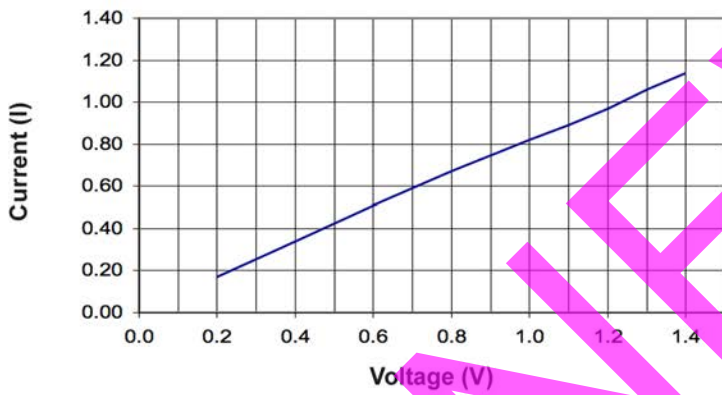
### Key features include:

- NiCr Filament with emissivity = 0.88
- 1.6 Watts peak input power at 700°C(973°K)
- Operates in pulsed or steady state mode
- Industry standard TO-39 package
- Window options (X) include:
  - 0 = No Window
  - 1 = Sapphire
  - 2 = Calcium Fluoride
  - 3 = Zinc Selenide

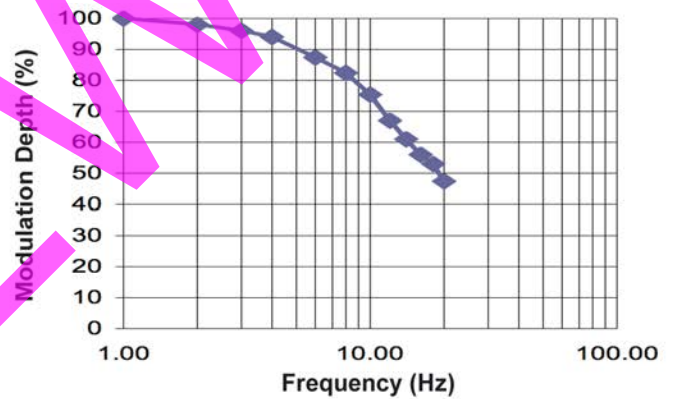
### Electrical Specifications:

Peak Voltage = 1.40 Volts MAXIMUM  
Peak Current = 1.14 Amps MAXIMUM  
Peak Power = 1.6 Watts

**Current vs. Voltage**

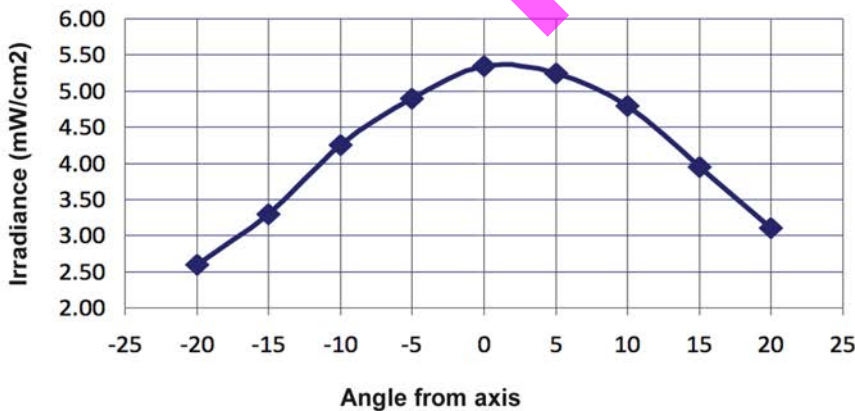


**Modulation (%) vs. Frequency (Hz)**  
(50% Duty Cycle)



**Irradiance vs. Angle From Axis**

Volts = 1.3, Distance = 2 in from face of cap



| Angle from axis (degrees) | Irradiance (mW/cm2) |
|---------------------------|---------------------|
| -20                       | 2.60                |
| -15                       | 3.30                |
| -10                       | 4.25                |
| -5                        | 4.90                |
| 0                         | 5.35                |
| 5                         | 5.25                |
| 10                        | 4.80                |
| 15                        | 3.95                |
| 20                        | 3.10                |

HelioWorks, Inc. 1275 4<sup>th</sup> Street, Santa Rosa, CA 95404 USA

Tel: (707) 578-7200 Fax: (707) 578-7200 [www.helioworks.com](http://www.helioworks.com) info@helioworks.com

## Helioworks - Pulsable and Steady State Infrared Sources

Helioworks, Inc. has a broad capability in the design and manufacture (including coil winding) of steady state and pulsable infrared sources utilizing Tungsten, NiCr, and Kanthal filaments. If our standard models do not meet your needs, please let us know your requirements.

### Pulsable & Steady State EP Series – Tungsten Filament

Tungsten achieves the highest temperature and power of any practical material and is therefore a valuable source of infrared emission. However, to make a source of intense infrared emission using tungsten, another protective window must be used. State-of-the-art, patented incandescent IR sources developed by Helioworks utilize sapphire because of its high transmission in the near infrared. The uniqueness of our product is the integration of the sapphire window with the tungsten filament. This allows high power transmission in the near infrared.



#### Key Features:

- Pulse or steady state
- Long term stability
- Desirable signal-to-noise ratio
- Large temperature modulation in pulse mode at elevated frequency
- Latest technology in packaging and window options

Tungsten filaments are provided in a variety of sizes to accommodate various frequency and modulation requirements. Operating temperatures up to 1900°K are standard with the EP-series source.

In the Steady State version tungsten filaments are wire wound in the form of right cylindrical coils of various diameters and length and operate with constant low voltage DC input for long life. All include gold plated parabolic reflectors and an inert gas backfill.

| TO-8 Package |          |                |              |          |
|--------------|----------|----------------|--------------|----------|
| Model        | Pk Volts | Pk Current (A) | Pk Power (W) | Window   |
| EP-3872      | 2.20     | 1.10           | 2.40         | Sapphire |
| EP-3962      | 2.60     | 1.05           | 2.70         | Sapphire |
| EP-3963      | 3.00     | 1.00           | 3.00         | Sapphire |
| EP-3964      | 3.50     | 1.00           | 3.50         | Sapphire |
| EP-3965      | 3.50     | 2.00           | 7.20         | Sapphire |
| EP-4317      | 5.00     | 2.10           | 10.50        | Sapphire |

## Pulsable IR Sources

### EF Series – NiCr Filament

Nichrome (NiCr) filaments are made from ultra-thin metallic strips. The metallic strips have a very high surface to volume ratio and thus a very short thermal time constant. They heat up and cool down or modulate very rapidly. The elements are typically attached in a series configuration to increase the overall resistance of the emitter (EF-series).



**Window options denoted by X include:** No Window (X=0), Sapphire (X=1), CaF2 (X=2), ZnSe (X=3)

#### Key Features:

- NiCr filament with emissivity of 0.88
- Uniform emitting area and temperature
- NiCr filaments operate at peak temperature of 700°C (973°K)

| <b>TO-8 Package</b> |                 |                       |                     |                            |
|---------------------|-----------------|-----------------------|---------------------|----------------------------|
| <b>Model</b>        | <b>Pk Volts</b> | <b>Pk Current (A)</b> | <b>Pk Power (W)</b> | <b>Window</b>              |
| EF-852XR            | 2.00            | 1.30                  | 2.60                | X= 0, 1, 2, 3<br>see above |
| EF-853XR            | 3.00            | 1.30                  | 4.40                | X= 0, 1, 2, 3<br>see above |

Note: Delete the "R" to exclude a reflector

## Steady State Infrared Sources

### EK Series – Kanthal Filament

Kanthal filaments are wire wound in the form of right cylindrical coils of various diameters and length. All the Kanthal based lamps (EK-series) operate in steady state with constant low voltage DC input for long life.



Window options denoted by X include: No Window (X=0), Sapphire (X=1), CaF2 (X=2), ZnSe (X=3)

**Key Features Include:**

- Kanthal filament with emissivity of 0.7
- Window options including no window, CaF<sub>2</sub>, ZnSe
- Internal gold plated parabolic reflector
- Industry standard TO-3, TO-5, or TO-8 packages
- Inert gas backfill

| <b>TO-8 Package</b> |                 |                       |                     |                            |
|---------------------|-----------------|-----------------------|---------------------|----------------------------|
| <b>Model</b>        | <b>Pk Volts</b> | <b>Pk Current (A)</b> | <b>Pk Power (W)</b> | <b>Window</b>              |
| EK-827X             | 1.20            | 1.08                  | 1.30                | X= 0, 1, 2, 3<br>see above |
| EK-837X             | 1.40            | 1.75                  | 2.45                | X= 0, 1, 2, 3<br>see above |
| EK-852X             | 3.00            | 1.48                  | 4.40                | X= 0, 1, 2, 3<br>see above |
| EK-862X             | 3.50            | 2.40                  | 8.40                | X= 0, 1, 2, 3<br>see above |
| <b>TO-3 Package</b> |                 |                       |                     |                            |
| <b>Model</b>        | <b>Pk Volts</b> | <b>Pk Current (A)</b> | <b>Pk Power (W)</b> | <b>Window</b>              |
| EK-343X             | 4.00            | 2.96                  | 11.84               | none (x=0)                 |
| <b>TO-5 Package</b> |                 |                       |                     |                            |
| <b>Model</b>        | <b>Pk Volts</b> | <b>Pk Current (A)</b> | <b>Pk Power (W)</b> | <b>Window</b>              |
| EK-527X             | 1.20            | 1.08                  | 1.30                | X= 0, 1, 2<br>see above    |
| EK-537X             | 1.40            | 1.75                  | 2.45                | X= 0, 1, 2<br>see above    |





"Out Shines All Others"

## STEADY STATE IR SOURCE Model EK-3430

**NEW  
PRODUCT!**

HelioWorks, Inc. offers a unique steady state black body infrared emitter in an industry standard TO-3 package with nearly 12 Watts input power at up to 950°C (1223°K). It has no window and therefore emits the full unattenuated blackbody spectrum. Other window options are available.

### Key features include:

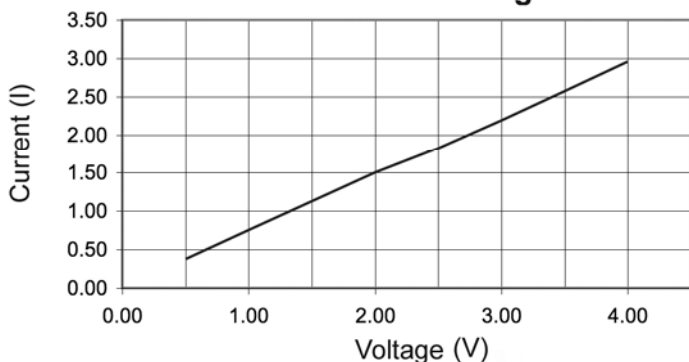
- Kanthal Filament with Emissivity = 0.7
- Approximately 12 Watts input at 950°C (1223°K)
- Emits full BB spectrum with No Window
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-3 Package
- Clear aperture = 0.540 inches



### Electrical Specifications:

Peak Voltage = 4.0 Volts MAXIMUM  
Peak Current = 2.96 Amps  
Peak Power = 11.84 Watts

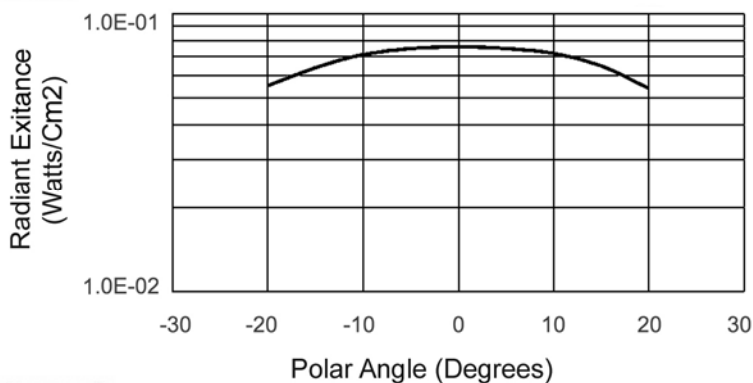
### Current vs Voltage



| Volts | I(Amps) | V/I (Ohms) | V*I (W) |
|-------|---------|------------|---------|
| 0.50  | 0.38    | 1.32       | 0.19    |
| 1.00  | 0.75    | 1.33       | 0.75    |
| 1.50  | 1.13    | 1.33       | 1.70    |
| 2.00  | 1.50    | 1.33       | 3.00    |
| 2.50  | 1.82    | 1.37       | 4.55    |
| 3.00  | 2.19    | 1.37       | 6.57    |
| 3.50  | 2.57    | 1.36       | 9.00    |
| 4.00  | 2.96    | 1.35       | 11.84   |

### Radiant Exitance (Watts/Cm2)

Volts = 4.0, Distance = 3.0 inches from source



| Polar Angle | Average (W/Cm2) |
|-------------|-----------------|
| -20         | 5.50E-02        |
| -15         | 6.40E-02        |
| -10         | 7.10E-02        |
| -5          | 7.50E-02        |
| 0           | 7.60E-02        |
| 5           | 7.50E-02        |
| 10          | 7.20E-02        |
| 15          | 6.50E-02        |
| 20          | 5.40E-02        |





*"Out Shines All Others"*

## PULSABLE IR SOURCE Model EP-3872\*

Helioworks, Inc. offers a unique pulsable infrared emitter with a tungsten filament that provides mid IR radiation to over 5 microns. It operates in pulsed or steady state mode at temperatures in excess of 1900° K in an industry standard TO-8 package.



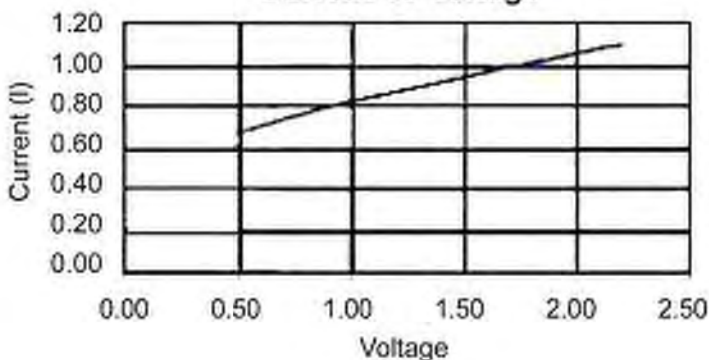
### Key Features Include:

- Tungsten Filament
- Can Be Operated in Pulsed or Steady State Mode
- Internal Gold Plated Parabolic Reflector
- Sapphire Window
- Standard TO-8 Package

### Electrical Specifications:

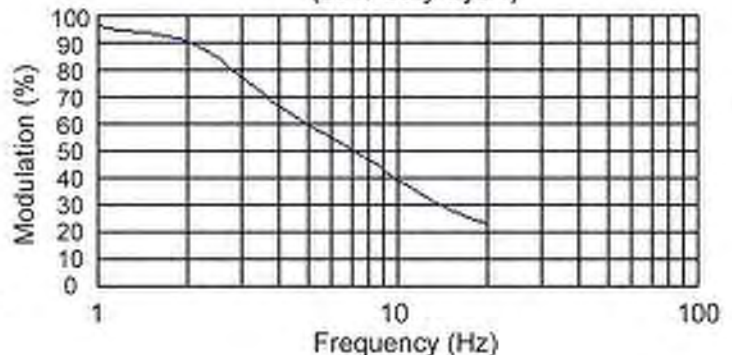
Peak Voltage = 2.2 Volts DC MAXIMUM  
 Peak Current = 1.1 Amps  
 Peak Power = 2.4 Watts

### Current vs Voltage



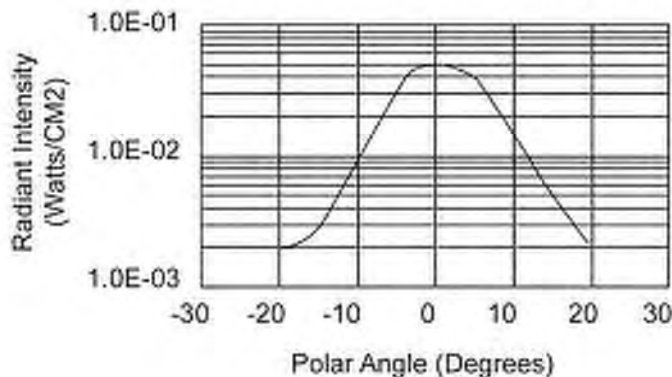
### Modulation vs. Frequency

(50% Duty Cycle)



### Average Radiant Intensity (Watts/CM2):

Volts = 2.20 Distance = 3.0 inches from source



| Polar Angle | Average (W/CM2) |
|-------------|-----------------|
| -20         | 2.00E-03        |
| -15         | 2.80E-03        |
| -10         | 8.00E-03        |
| -5          | 3.10E-02        |
| 0           | 4.75E-02        |
| 5           | 3.90E-02        |
| 10          | 1.50E-02        |
| 15          | 4.50E-03        |
| 20          | 2.10E-03        |

\*Patented





## PULSABLE IR SOURCE Model EP-3962\*

Helioworks offers a unique state-of-art black body infrared emitter with a tungsten filament and sapphire window. It can operate in pulsed or steady state mode at temperatures in excess of 1900° K in an industry standard TO-8 package.

### Key features include:

- Tungsten Filament
- Can be operated in pulsed or steady state mode
- Internal Gold Plated Parabolic Reflector
- Sapphire Window
- Standard TO-8 package
- 3 Year Lifetime

### Electrical Specifications:

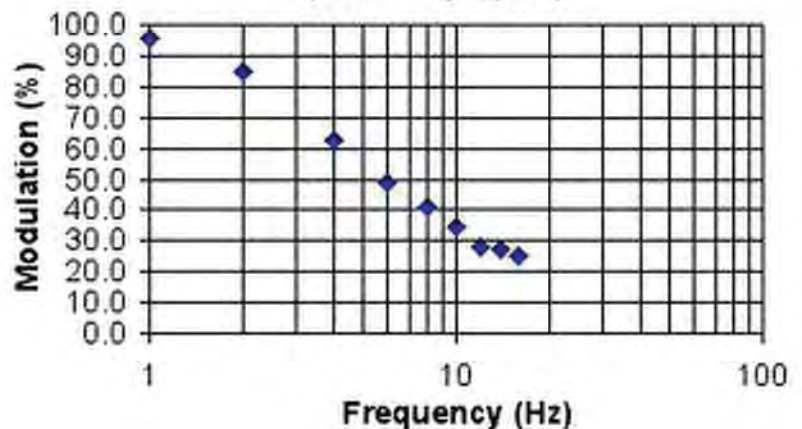
Peak Voltage = 2.6 Volts  
Peak Current = 1.05 Amps  
Peak Power = 2.7 Watts

1. Tungsten filament
2. Can be operated in pulsed or steady state mode (2.6 Watts DC)
3. Operating voltage must not exceed 2.6 Volts MAXIMUM
4. Voltage measured at base of header
5. Package temperature must not exceed 100 degrees C
6. Industry standard TO-8 package with sapphire window
7. Internal Gold plated parabolic reflector

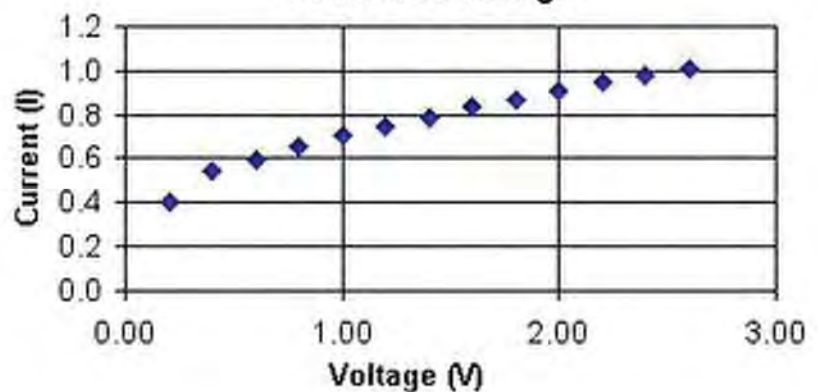
\*Patent Pending



**Modulation vs Frequency  
(50% Duty Cycle)**



**Current vs Voltage**







"Out Shines All Others"

### PULSABLE IR SOURCE Model EP-3963\*

Helioworks, Inc. offers a unique pulsable infrared emitter with a tungsten filament that provides mid IR radiation to over 5 microns. It operates in pulsed or steady state mode at temperatures in excess of 1900° K in an industry standard TO-8 package.



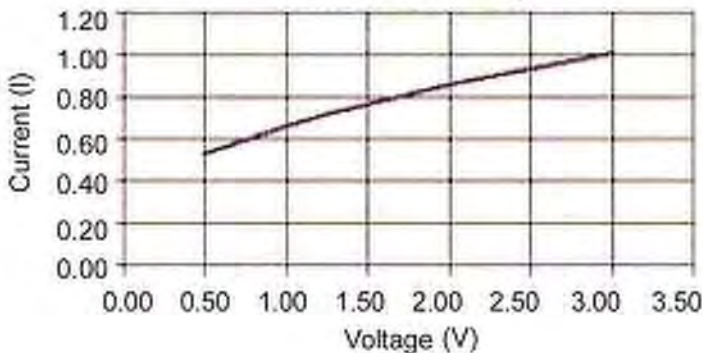
#### Key Features Include:

- Tungsten Filament
- Can Be Operated in Pulsed or Steady State Mode
- Internal Gold Plated Parabolic Reflector
- Sapphire Window
- Standard TO-8 Package

#### Electrical Specifications:

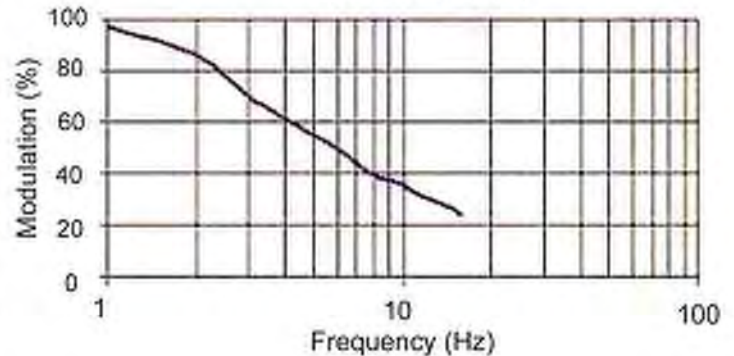
Peak Voltage = 3.0 Volts DC Maximum  
 Peak Current = 1.0 Amp  
 Peak Power = 3.0 Watts

#### Current vs Voltage



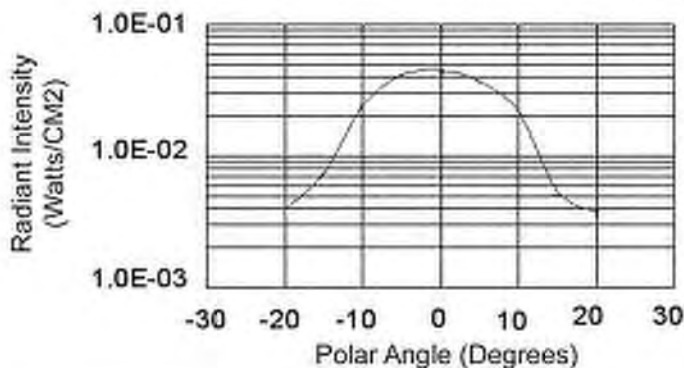
#### Modulation vs. Frequency

(50% Duty Cycle)



#### Average Radiant Intensity (Watts/CM2):

Volts = 3.0, Distance = 3.0 inches from source



| Polar Angle | Average (W/CM2) |
|-------------|-----------------|
| -20         | 4.00E-03        |
| -15         | 7.40E-03        |
| -10         | 2.40E-02        |
| -5          | 4.15E-02        |
| 0           | 4.55E-02        |
| 5           | 3.75E-02        |
| 10          | 2.15E-02        |
| 15          | 5.40E-03        |
| 20          | 3.70E-03        |



"Out Shines All Others"

### PULSABLE IR SOURCE Model EP-3964\*

Helioworks, Inc. offers a unique Pulsable infrared emitter with a tungsten filament that provides mid IR radiation to over 5 microns. It can operate in pulsed or steady state mode at temperatures in excess of 1900° K in an industry standard TO-8 package.



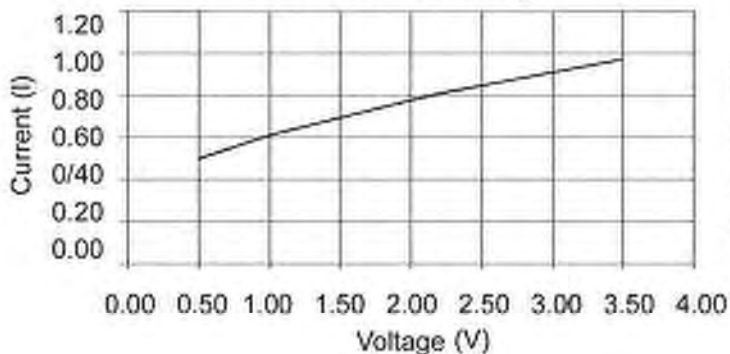
#### Key Features Include:

- Tungsten Filament
- Can Be Operated in Pulsed or Steady State Mode
- Internal Gold Plated Parabolic Reflector
- Sapphire Window
- Standard TO-8 Package

#### Electrical Specifications:

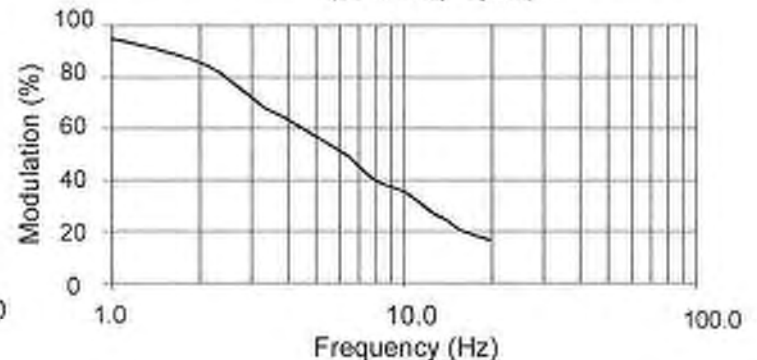
Peak Voltage = 3.5 Volts DC MAXIMUM  
 Peak Current = 1.0 Amp  
 Peak Power = 3.5 Watts

#### Current vs Voltage



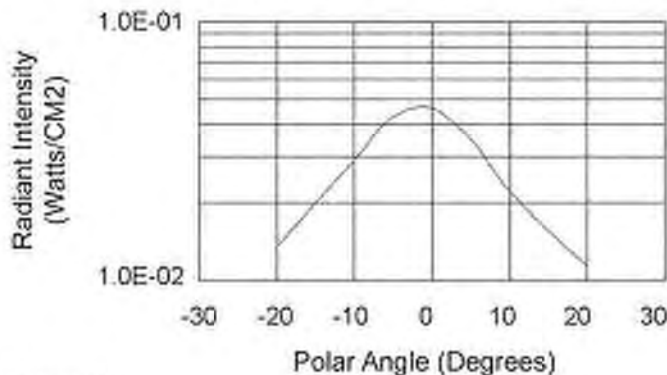
#### Modulation vs. Frequency

(50% Duty Cycle)



#### Average Radiant Intensity (Watts/CM2):

Volts = 3.5, Distance = 3.0 inches from source



| Polar Angle | Average (W/CM2) |
|-------------|-----------------|
| -20         | 1.35E-02        |
| -15         | 2.00E-02        |
| -10         | 2.90E-02        |
| -5          | 4.30E-02        |
| 0           | 4.65E-02        |
| 5           | 3.50E-02        |
| 10          | 2.20E-02        |
| 15          | 1.55E-02        |
| 20          | 1.15E-02        |

\* Patented





*"Out Shines All Others"*

## PULSABLE IR SOURCE Model EP-3965\*

Helioworks, Inc. offers a unique pulsable infrared emitter with a tungsten filament and sapphire window that provides spectral transmission to over 5 microns. It can operate in pulsed or steady state mode at temperatures in excess of 1900° K in an industry standard TO-8 package.



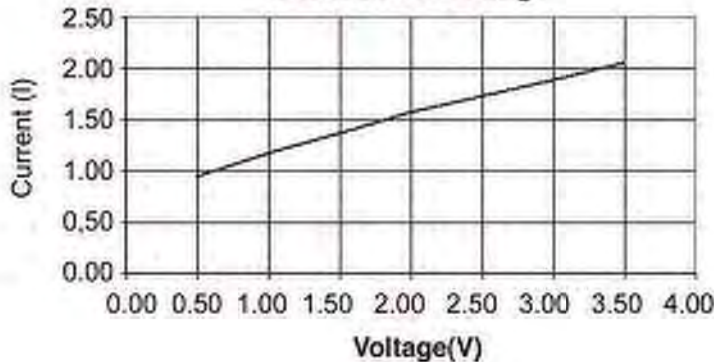
### Key features include:

- Tungsten Filament
- Operates in Pulsed or Steady State Mode
- Internal Gold Plated Parabolic Reflector
- Sapphire Window
- Standard TO-8 Package

### Electrical Specifications:

Peak Voltage = 3.5 Volts DC MAXIMUM  
 Peak Current = 2.0 Amps  
 Peak Power = 7.2 Watts

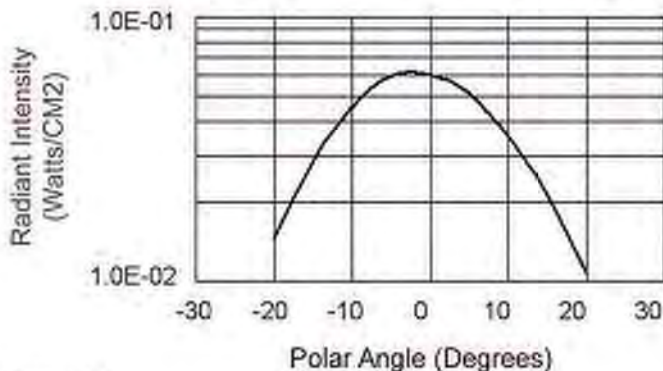
**Current vs Voltage**



| V    | I    | W=V*I | R=V/I |
|------|------|-------|-------|
| 0.50 | 0.94 | 0.47  | 0.53  |
| 1.00 | 1.17 | 1.17  | 0.85  |
| 1.50 | 1.37 | 2.06  | 1.09  |
| 2.00 | 1.57 | 3.14  | 1.27  |
| 2.50 | 1.73 | 4.33  | 1.45  |
| 3.00 | 1.89 | 5.67  | 1.59  |
| 3.50 | 2.05 | 7.18  | 1.71  |

### Average Radiant Intensity (Watts/CM2):

Volts = 3.5, Distance = 3.0 inches from source



| Polar Angle | Average Intensity (Watts/Cm2) |
|-------------|-------------------------------|
|             | 1.44E-02                      |
| -20         | 2.79E-02                      |
| -15         | 4.52E-02                      |
| -10         | 5.95E-02                      |
| -5          | 6.02E-02                      |
| 0           | 5.12E-02                      |
| 5           | 3.54E-02                      |
| 10          | 2.11E-02                      |
| 15          | 1.06E-02                      |
| 20          | 1.06E-02                      |

\* Patented



"Out Shines All Others"

**PULSABLE IR SOURCE  
Model EP-4317\***

**NEW  
PRODUCT!**

Helioworks, Inc. offers a unique Pulsable infrared emitter with a tungsten filament that provides mid IR radiation to over 5 microns. It can operate in pulsed or steady state mode at temperatures in excess of 2000°K in an industry standard TO-8 package.

Key features include:

- Tungsten filament
- Can be operated in pulsed or steady state mode
- Internal gold plated parabolic reflector
- Sapphire window
- Standard TO-8 package



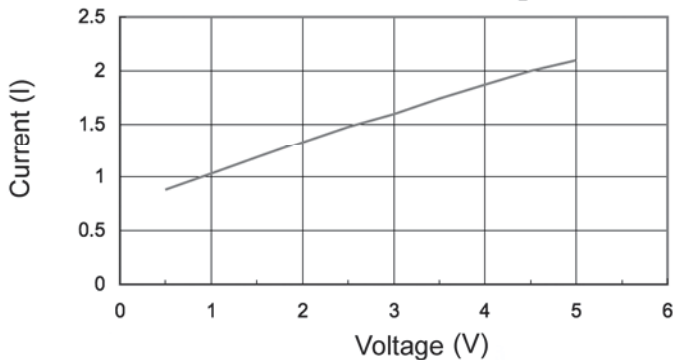
Electrical Specifications:

Peak Voltage = 5.0 Volts DC MAXIMUM

Peak Current = 2.1 Amps

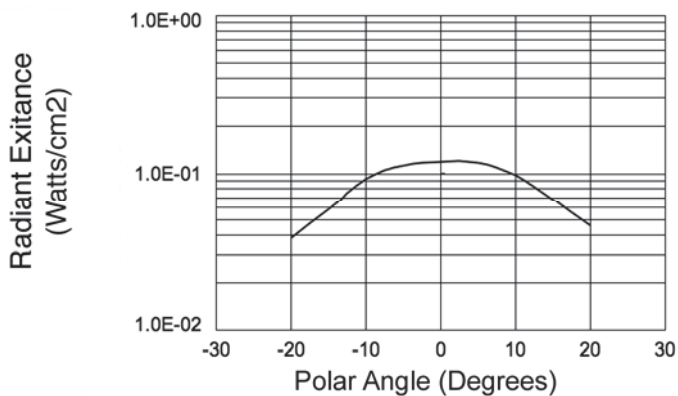
Peak Power = 10.5 Watts

**Current vs Voltage**



| Volts | I(Amps) | V/I (Ohms) | V*I (W) |
|-------|---------|------------|---------|
| 0.5   | 0.88    | 0.57       | 0.44    |
| 1.00  | 1.03    | 0.97       | 1.03    |
| 1.50  | 1.18    | 1.27       | 1.77    |
| 2.00  | 1.33    | 1.50       | 2.66    |
| 2.50  | 1.48    | 1.69       | 3.70    |
| 3.00  | 1.60    | 1.88       | 4.80    |
| 3.50  | 1.74    | 2.01       | 6.09    |
| 4.00  | 1.87    | 2.14       | 7.48    |
| 4.50  | 2.00    | 2.25       | 9.00    |
| 5.00  | 2.10    | 2.38       | 10.50   |

Radiant Exitance (Watts/cm<sup>2</sup>):  
Volts = 5.0, Distance = 3.0 inches from source



| Polar Angle | Average (W/cm <sup>2</sup> ) |
|-------------|------------------------------|
| -20         | 3.82E-02                     |
| -15         | 5.77E-02                     |
| -10         | 9.23E-02                     |
| -5          | 1.13E-01                     |
| 0           | 1.19E-01                     |
| 5           | 1.17E-01                     |
| 10          | 9.76E-02                     |
| 15          | 6.75E-02                     |
| 20          | 4.57E-02                     |

\*Patented





"Out Shines All Others"

## STEADY STATE IR SOURCE Model EK-527X

HelioWorks, Inc. offers a unique steady state black body Infrared emitter in an industry standard TO-5 package with approximately 1.3 Watts input power at up to 900°C (1173°K). Window options (X) include: 0 = no window, 1 = sapphire, 2 = Calcium Fluoride (CaF2)

### Key features include:

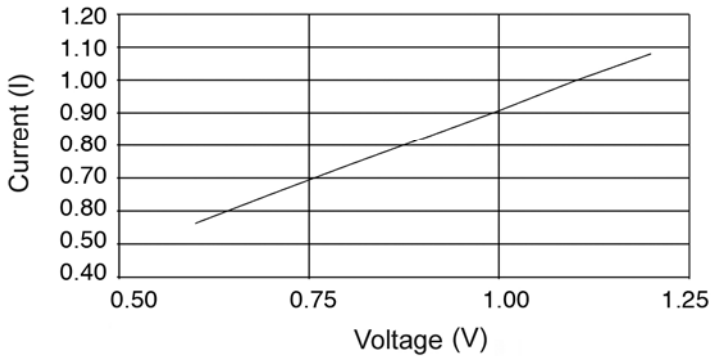
- Kanthal Filament with Emissivity = 0.7
- Approximately 1.30 Watts input at 900°C (1173°K)
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-5 Package
- Window Options (X) include:
  - 0 = No Window
  - 1 = Sapphire
  - 2 = Calcium Fluoride (CaF2)



### Electrical Specifications:

Peak Voltage = 1.2 Volts MAXIMUM  
Peak Current = 1.0 Amps  
Peak Power = 1.30 Watts

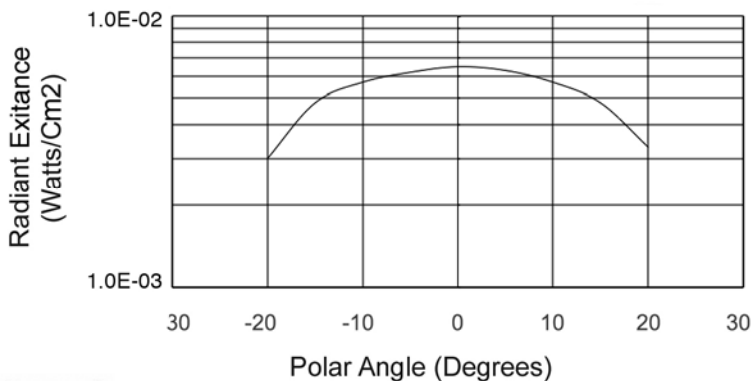
**Current vs Voltage**



| Volts | I(Amps) | V*I (W) | V/I (Ohms) |
|-------|---------|---------|------------|
| 0.50  | 0.48    | 0.24    | 1.05       |
| 0.60  | 0.56    | 0.34    | 1.07       |
| 0.70  | 0.65    | 0.46    | 1.07       |
| 0.80  | 0.74    | 0.59    | 1.08       |
| 0.90  | 0.82    | 0.74    | 1.09       |
| 1.00  | 0.91    | 0.91    | 1.10       |
| 1.10  | 1.00    | 1.10    | 1.10       |
| 1.20  | 1.08    | 1.30    | 1.11       |

### Radiant Exitance (Watts/Cm2):

Volts = 1.20, Distance = 3.0 inches from source



| Polar Angle | Average (W/Cm2) |
|-------------|-----------------|
| -20         | 3.00E-03        |
| -15         | 4.80E-03        |
| -10         | 5.70E-03        |
| -5          | 6.20E-03        |
| 0           | 6.50E-03        |
| 5           | 6.30E-03        |
| 10          | 5.70E-03        |
| 15          | 4.80E-03        |
| 20          | 3.30E-03        |







"Out Shines All Others"

## STEADY STATE IR SOURCE Model EK-537X

HelioWorks, Inc. offers a unique steady state black body Infrared emitter in an industry standard TO-5 package with approximately 2.4 Watts input power at up to 900°C (1173°K). Window options (X) include: 0 = no window, 1 = sapphire, 2 = Calcium Fluoride (CaF2)



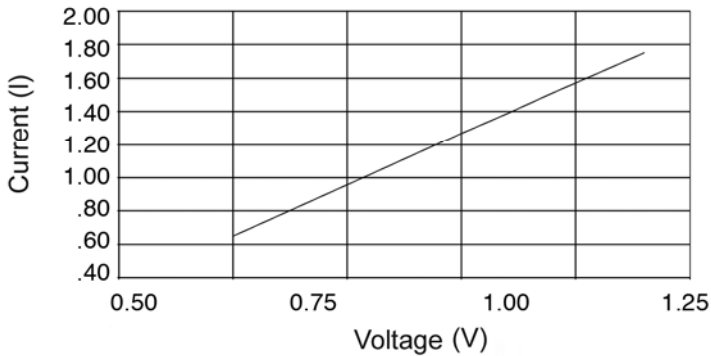
### Key features include:

- Kanthal Filament with Emissivity = 0.7
- Approximately 2.4 Watts input at 900°C (1173°K)
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-5 Package
- Window Options (X) include:
  - 0 = No Window
  - 1 = Sapphire
  - 2 = Calcium Fluoride (CaF2)

### Electrical Specifications:

Peak Voltage = 1.4 Volts MAXIMUM  
Peak Current = 1.75 Amps  
Peak Power = 2.45 Watts

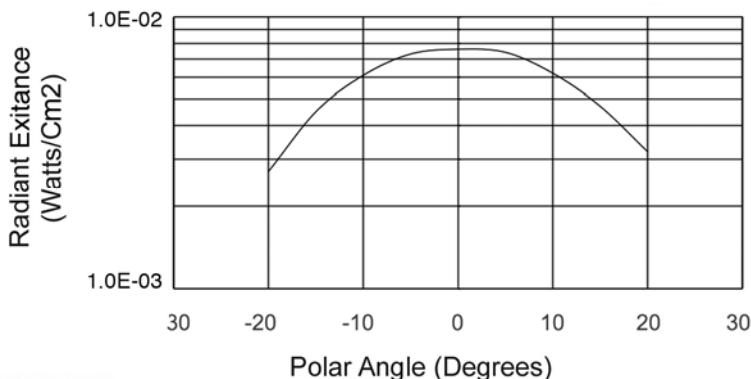
**Current vs Voltage**



| Volts | I(Amps) | V*I (W) | V/I (Ohms) |
|-------|---------|---------|------------|
| 0.50  | 0.65    | 0.32    | 0.77       |
| 0.80  | 1.02    | 0.82    | 0.78       |
| 1.00  | 1.27    | 1.27    | 0.79       |
| 1.10  | 1.39    | 1.53    | 0.79       |
| 1.20  | 1.51    | 1.81    | 0.79       |
| 1.30  | 1.63    | 2.12    | 0.80       |
| 1.40  | 1.75    | 2.45    | 0.80       |

### Radiant Exitance (Watts/Cm2):

Volts = 1.40, Distance = 3.0 inches from source



| Polar Angle | Average (W/Cm2) |
|-------------|-----------------|
| -20         | 2.70E-03        |
| -15         | 4.50E-03        |
| -10         | 6.10E-03        |
| -5          | 7.30E-03        |
| 0           | 7.60E-03        |
| 5           | 7.40E-03        |
| 10          | 6.20E-03        |
| 15          | 4.70E-03        |
| 20          | 3.20E-03        |





## STEADY STATE IR SOURCE Model EK-8520

Helioworks, Inc. offers a unique steady state black body infrared emitter in an industry standard TO-8 package that operates at up to 950° Centigrade. It has no window and therefore emits the full unattenuated blackbody spectrum.



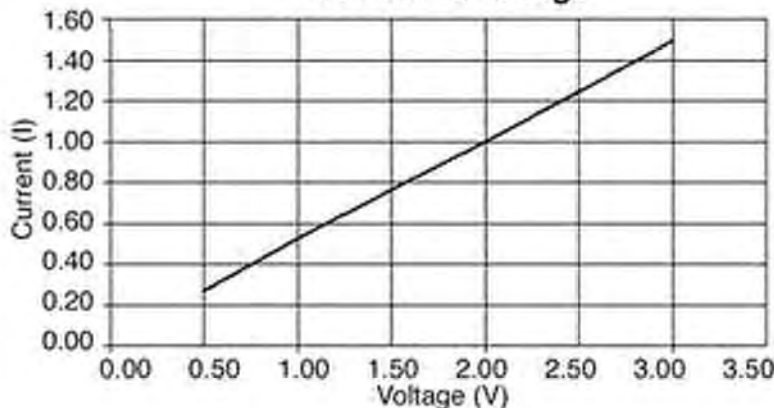
### Key Features Include:

- Kanthal Filament with Emissivity of 0.7
- No Window
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-8 Package
- Expected 3 year lifetime

### Electrical Specifications:

Peak Voltage = 3.0 Volts DC MAXIMUM  
Peak Current = 1.48 Amps  
Peak Power = 4.4 Watts

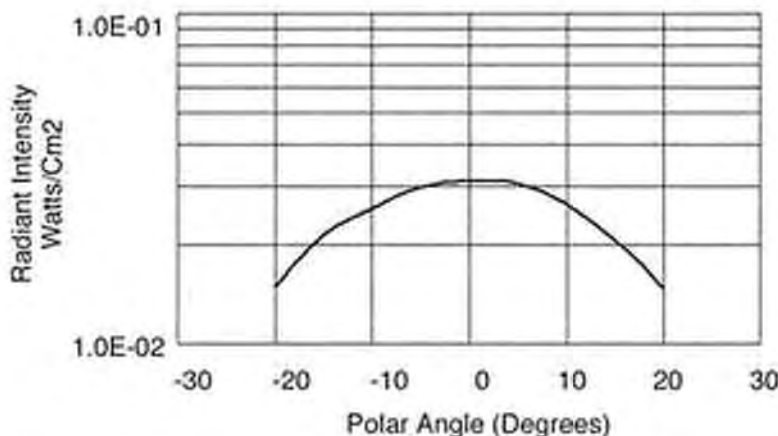
**Current vs Voltage**



| V    | I    | W=VI<br>(Watts) | R=V/I<br>(ohms) |
|------|------|-----------------|-----------------|
| 0.50 | 0.26 | 0.13            | 1.90            |
| 1.00 | 0.52 | 0.52            | 1.92            |
| 1.50 | 0.76 | 1.14            | 1.97            |
| 2.00 | 1.00 | 2.00            | 2.00            |
| 2.50 | 1.24 | 3.10            | 2.02            |
| 2.80 | 1.39 | 3.89            | 2.01            |
| 3.00 | 1.49 | 4.47            | 2.01            |

Approximate 950° C

**Radiant Intensity (Watts/Cm2):**  
Volts = 3.0, Distance = 3.0 inches from source



| Polar Angle | Average Intensity<br>(Watts/Cm2) |
|-------------|----------------------------------|
| -20         | 1.49E-02                         |
| -15         | 2.13E-02                         |
| -10         | 2.55E-02                         |
| -5          | 2.97E-02                         |
| 0           | 3.10E-02                         |
| 5           | 3.04E-02                         |
| 10          | 2.66E-02                         |
| 15          | 2.08E-02                         |
| 20          | 1.48E-02                         |





## STEADY STATE IR SOURCE Model EK-8521

Helioworks, Inc. offers a unique steady state black body infrared emitter in an industry standard TO-8 package that operates at up to 950° Centigrade. A Sapphire window provides spectral transmission to over 5 microns.

### Key Features include:

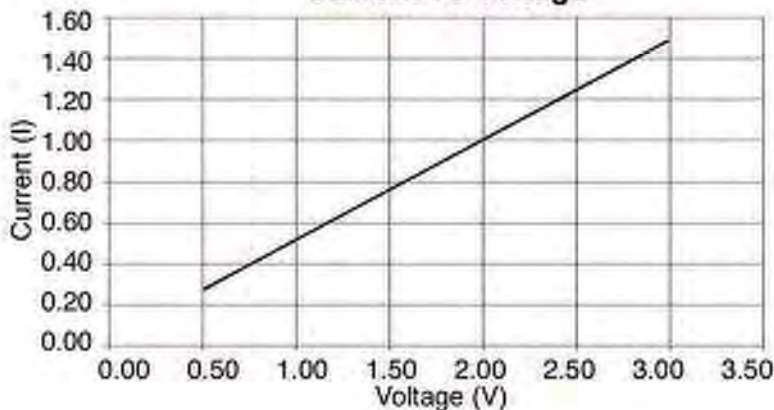
- Kanthal Filament with Emissivity of 0.7
- Sapphire Window
- Internal Gold Plated Parabolic Reflector
- Standard TO-8 Package
- Inert Gas Backfill
- Expected 3 Year Lifetime



### Electrical Specifications:

Peak Voltage = 3.0 Volts DC MAXIMUM  
Peak Current = 1.48 Amps  
Peak Power = 4.4 Watts

**Current vs Voltage**

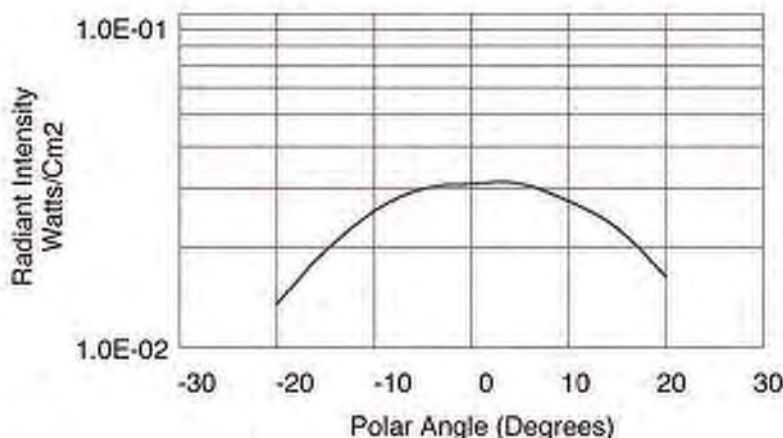


| V    | I    | W=VI<br>(Watts) | R=V/I<br>(ohms) |
|------|------|-----------------|-----------------|
| 0.50 | 0.26 | 0.13            | 1.90            |
| 1.00 | 0.52 | 0.52            | 1.92            |
| 1.50 | 0.75 | 1.13            | 2.00            |
| 2.00 | 0.99 | 1.99            | 2.01            |
| 2.50 | 1.23 | 3.08            | 2.03            |
| 2.80 | 1.38 | 3.87            | 2.03            |
| 3.00 | 1.48 | 4.43            | 2.03            |

Approximate 950° C

### Radiant Intensity (Watts/Cm2):

Volts = 3.0, Distance = 3.0 inches from source



| Polar Angle | Average Intensity<br>(Watts/Cm2) |
|-------------|----------------------------------|
| -20         | 1.35E-02                         |
| -15         | 1.95E-02                         |
| -10         | 2.58E-02                         |
| -5          | 2.98E-02                         |
| 0           | 3.10E-02                         |
| 5           | 3.09E-02                         |
| 10          | 2.75E-02                         |
| 15          | 2.28E-02                         |
| 20          | 1.63E-02                         |





"Out Shines All Others"

### STEADY STATE IR SOURCE

### Model EK-8522

Helioworks offers a unique steady state infrared emitter for the mid IR spectrum that operates at up to 950° Centigrade in an industry standard TO-8 package. A Calcium Fluoride (CaF<sub>2</sub>) window provides spectral transmission to over 9 microns.

#### Key Features Include:

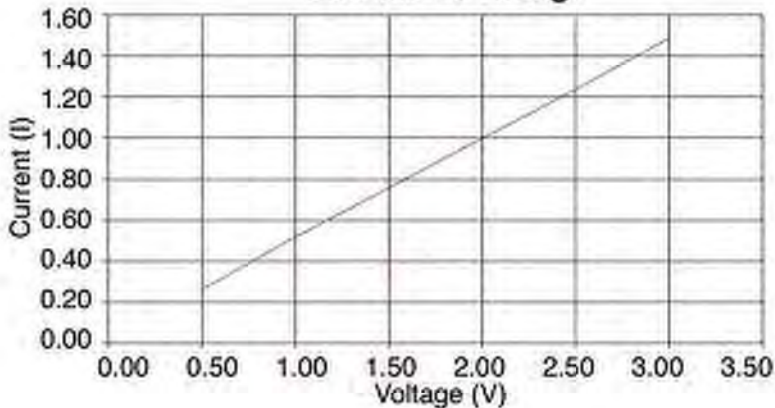
- Kanthal Filament with Emissivity of 0.7
- Calcium Fluoride (CaF<sub>2</sub>) Window
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-8 Package
- Inert Gas Backfill
- Expected 3 Year Lifetime



#### Electrical Specification:

Peak voltage = 3.0 Volts MAXIMUM  
 Peak Current = 1.48 Amps  
 Peak Power = 4.4 Watts

#### Current vs Voltage

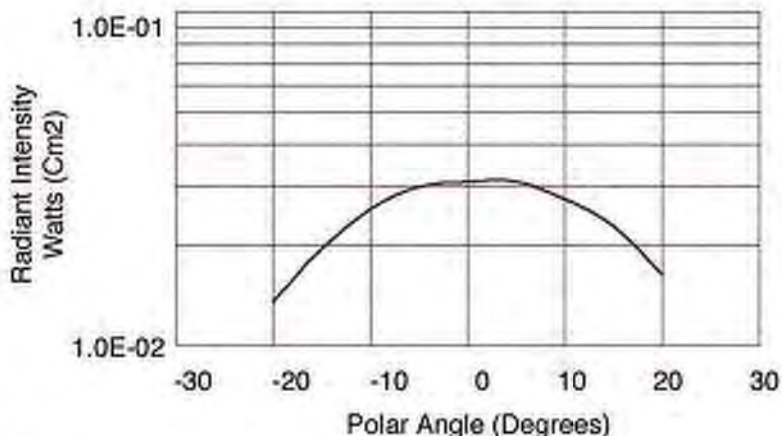


| V    | I    | W=VI | R=V/I |
|------|------|------|-------|
| 0.50 | 0.26 | 0.13 | 1.90  |
| 1.00 | 0.52 | 0.52 | 1.92  |
| 1.50 | 0.75 | 1.13 | 2.00  |
| 2.00 | 0.99 | 1.99 | 2.01  |
| 2.50 | 1.23 | 3.08 | 2.03  |
| 2.80 | 1.38 | 3.87 | 2.03  |
| 3.00 | 1.48 | 4.43 | 2.03  |

Approximate 950° C

#### Radiant Intensity (Watts/Cm2):

Volts = 3.0, Distance - 3.0 inches from source



| Polar Angle | Average Intensity (Watts/Cm2) |
|-------------|-------------------------------|
| -20         | 1.35E-02                      |
| -15         | 1.95E-02                      |
| -10         | 2.58E-02                      |
| -5          | 2.98E-02                      |
| 0           | 3.10E-02                      |
| 5           | 3.09E-02                      |
| 10          | 2.75E-02                      |
| 15          | 2.28E-02                      |
| 20          | 1.63E-02                      |



*"Out Shines All Others"*

## STEADY STATE IR SOURCE Model EK-8523

Helioworks offers a unique steady state infrared emitter for the mid IR spectrum that operates at up to 950° Centigrade in an industry standard TO-8 package. A Zinc Selenide (ZnSe) window provides spectral transmission to over 14 microns.



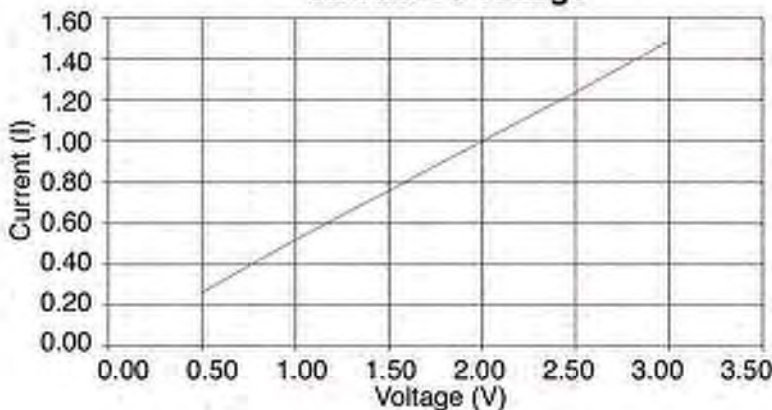
### Key Features Include:

- Kanthal Filament with Emissivity of 0.7
- Zinc Selenide (ZnSe) Window
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-8 Package
- Expected 3 Year Lifetime

### Electrical Specifications:

- Peak Voltage = 3.0 Volts MAXIMUM
- Peak Current = 1.48 Amps
- Peak Power = 4.4 Watts

**Current vs Voltage**

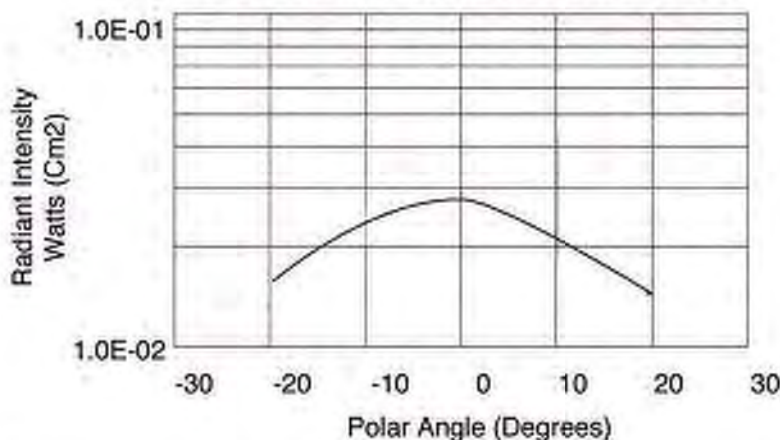


| V    | I    | W=VI | R=V/I |
|------|------|------|-------|
| 0.50 | 0.26 | 0.13 | 1.90  |
| 1.00 | 0.52 | 0.52 | 1.92  |
| 1.50 | 0.75 | 1.13 | 2.00  |
| 2.00 | 0.99 | 1.99 | 2.01  |
| 2.50 | 1.23 | 3.08 | 2.03  |
| 2.80 | 1.38 | 3.87 | 2.03  |
| 3.00 | 1.48 | 4.43 | 2.03  |

Approximate 950° C

**Radiant Intensity (Watts/Cm2):**

Volts = 3.0, Distance - 3.0 inches from source



| Polar Angle | Average Intensity<br>(Watts/Cm2) |
|-------------|----------------------------------|
| -20         | 1.60E-02                         |
| -15         | 2.00E-02                         |
| -10         | 2.37E-02                         |
| -5          | 2.60E-02                         |
| 0           | 2.65E-02                         |
| 5           | 2.45E-02                         |
| 10          | 2.10E-02                         |
| 15          | 1.75E-02                         |
| 20          | 1.40E-02                         |



## PULSABLE IR SOURCE Model EF-8530

HelioWorks, Inc. offers a unique pulsable infrared emitter with three (3) radiating elements that can be addressed individually (4 lead package), or in total (2 lead package). It can operate in pulsed or steady state mode at a peak temperature of 700°C (973°K) in an industry standard TO-8 package with no window. Specify either 2 lead (EF-8530-2) or 4 lead (EF-8530-4) version. Photo shows 4 lead version.



### Key Features Include:

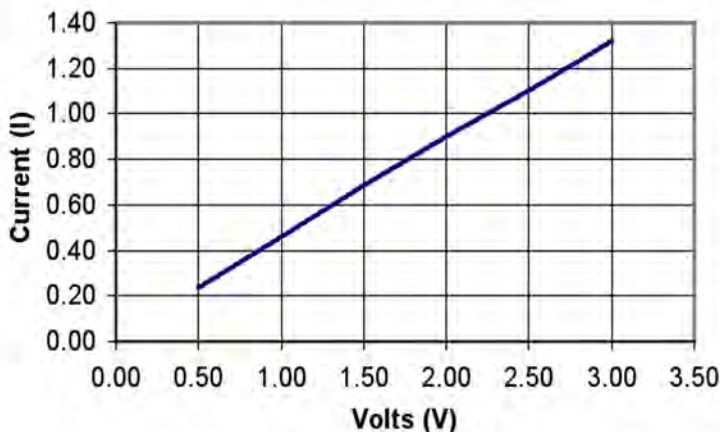
- Filament has uniform emitting area
- Emissivity is 0.88
- No window
- Operates in pulsed or steady state mode
- Industry standard TO-8 package
- Operates at peak temperature of 700°C (973°K)
- Large temperature change,  $\Delta T$ , during pulsing

Add suffix R for  
optional reflector in  
package

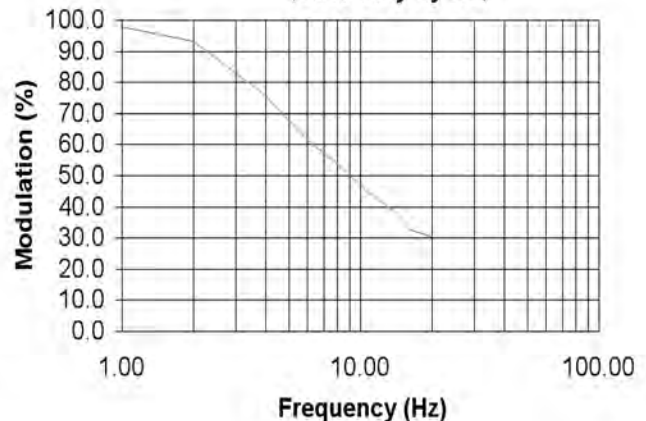
### Electrical Specifications (2 lead package):

Peak Voltage = 3.00 Volts DC MAXIMUM  
Peak Current = 1.34 Amps  
Peak Power = 4.0 Watts

Current vs Voltage

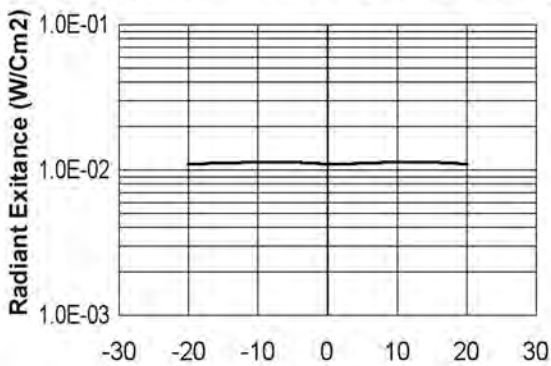


Modulation (%) Vs. Frequency (Hz)  
(50% duty cycle)



### Radiant Exitance

(V = 3.0, Distance = 2 inches from face)



| Polar Angle | Average<br>(Watts/Cm2) |
|-------------|------------------------|
| -20         | 1.10E-02               |
| -15         | 1.12E-02               |
| -10         | 1.14E-02               |
| -5          | 1.13E-02               |
| 0           | 1.10E-02               |
| 5           | 1.11E-02               |
| 10          | 1.13E-02               |
| 15          | 1.13E-02               |
| 20          | 1.10E-02               |

Polar Angle (Degrees)





## PULSABLE IR SOURCE Model EF-8531



HelioWorks, Inc. offers a unique pulsable infrared emitter with three (3) radiating elements that can be addressed individually (4 lead package), or in total (2 lead package). It can operate in pulsed or steady state mode at a peak temperature of 700°C (973°K) in an industry standard TO-8 package with a Sapphire window. Specify either 2 lead EF-8531-2) or 4 lead (EF-8531-4) version.

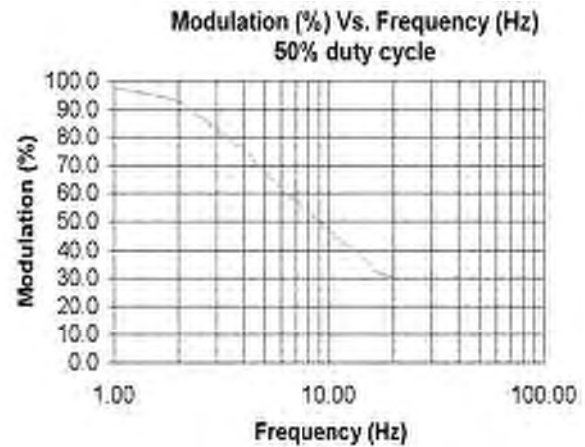
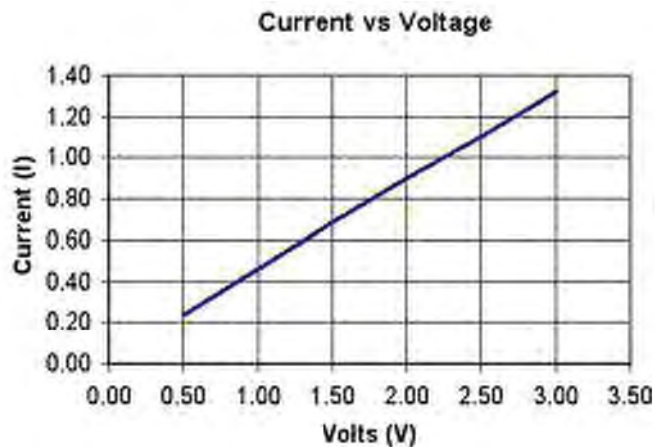
Photo shows 4 lead version.

Key features include:

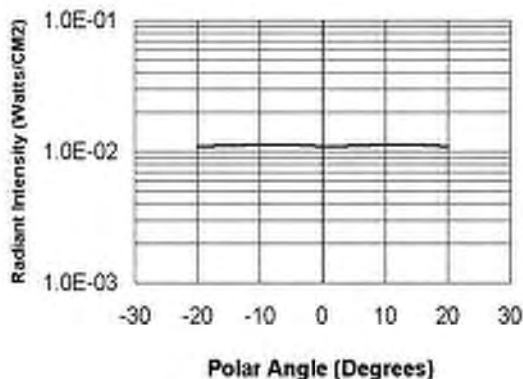
- Filament has uniform emitting area
- Emissivity is 0.88
- Sapphire window
- Operates in pulsed or steady state mode
- Industry standard TO-8 package
- Operates at peak temperature of 700°C (973°K)
- Large temperature change  $\Delta T$ , during pulsing

Electrical Specifications (2 lead package):

- Peak Voltage = 3.00 Volts DC MAXIMUM
- Peak Current = 1.34 Amps
- Peak Power = 4.0 Watts



Polar Intensity  
(V = 3.0, Distance = 2 inches from face)



| Polar Angle | Average (Watts/Cm) |
|-------------|--------------------|
| -20         | 1.10E-02           |
| -15         | 1.12E-02           |
| -10         | 1.14E-02           |
| -5          | 1.13E-02           |
| 0           | 1.10E-02           |
| 5           | 1.11E-02           |
| 10          | 1.13E-02           |
| 15          | 1.13E-02           |
| 20          | 1.10E-02           |







## PULSABLE IR SOURCE Model EF-8532



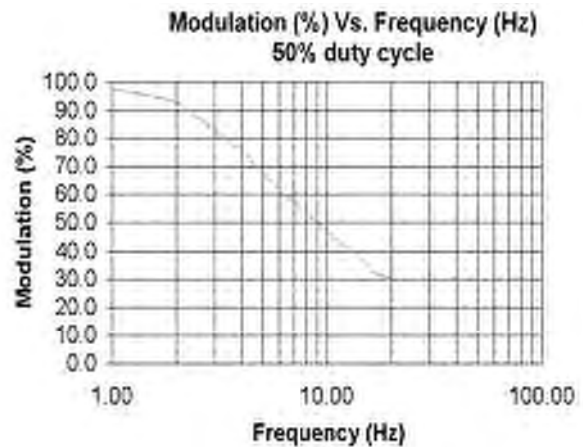
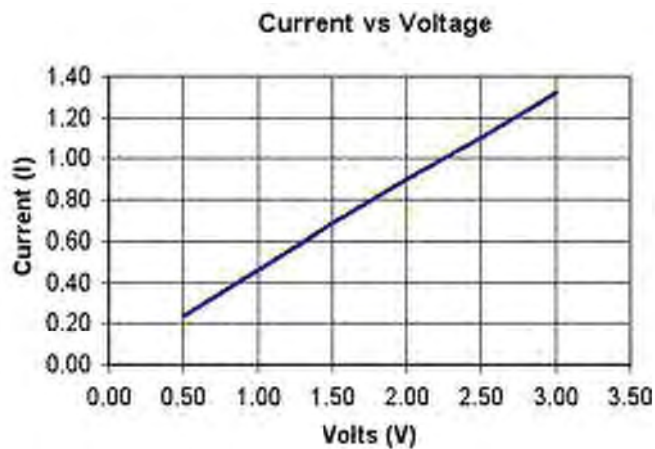
HelioWorks, Inc. offers a unique pulsable infrared emitter with three (3) radiating elements that can be addressed individually (4 lead package), or in total (2 lead package). It can operate in pulsed or steady state mode at a peak temperature of 700°C (973°K) in an industry standard TO-8 package with a Calcium Fluoride window. Specify either 2 lead (EF-8532-2) or 4 lead (EF-8532-4) versions. Photo shows 4 lead version.

Key features include:

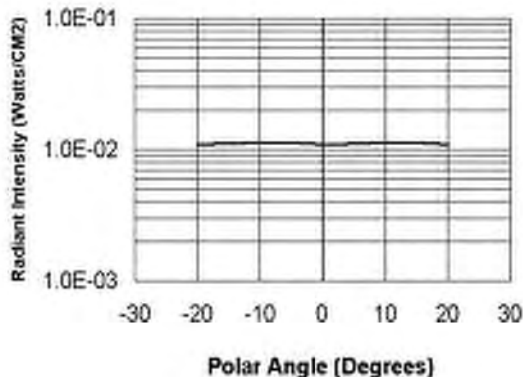
- Filament has uniform emitting area
- Emissivity is 0.88
- Calcium Fluoride window
- Operates in pulsed or steady state mode
- Industry standard TO-8 package
- Operates at peak temperature of 700°C (973°K)
- Large temperature change,  $\Delta T$ , during pulsing

Electrical Specifications (2 lead package):

- Peak Voltage = 3.00 Volts DC MAXIMUM
- Peak Current = 1.34 Amps
- Peak Power = 4.0 Watts



Polar Intensity  
(V = 3.0, Distance = 2 inches from face)



| Polar Angle | Average (Watts/Cm) |
|-------------|--------------------|
| -20         | 1.10E-02           |
| -15         | 1.12E-02           |
| -10         | 1.14E-02           |
| -5          | 1.13E-02           |
| 0           | 1.10E-02           |
| 5           | 1.11E-02           |
| 10          | 1.13E-02           |
| 15          | 1.13E-02           |
| 20          | 1.10E-02           |





## PULSABLE IR SOURCE Model EF-8533



HelioWorks, Inc. offers a unique pulsable infrared emitter with three (3) radiating elements that can be addressed individually (4 lead package), or in total (2 lead package). It can operate in pulsed or steady state mode at a peak temperature of 700°C (973°K) in an industry standard TO-8 package with a Zinc Selenide (ZnSe) window. Specify either 2 lead (EF-8532-2) or 4 lead (EF-8532-4) versions. Photo shows 2 lead version.

Key features include:

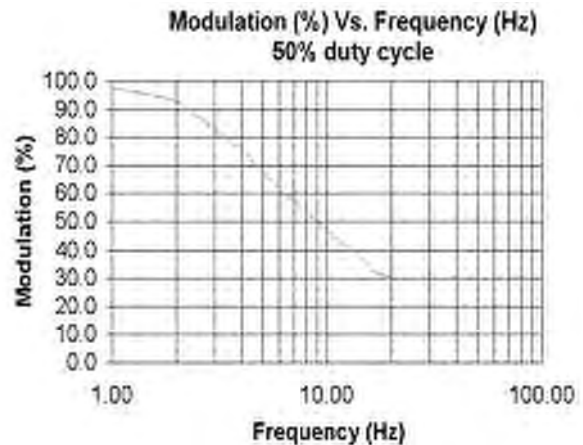
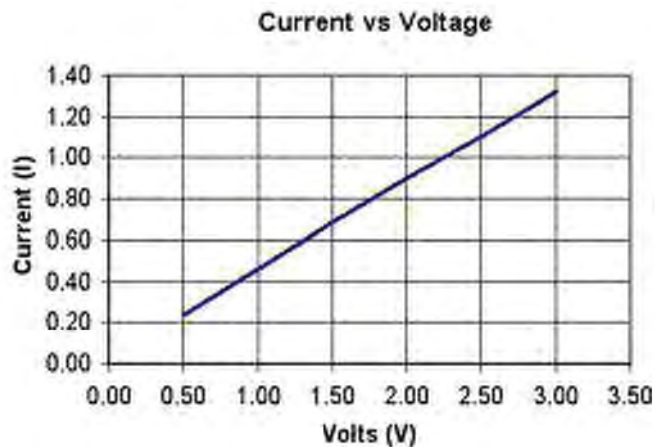
- Filament has uniform emitting area
- Emissivity is 0.88
- Zinc Selenide (ZnSe) window
- Operates in pulsed or steady state mode
- Industry standard TO-8 package
- Operates at peak temperature of 700°C (973°K)
- Large temperature change,  $\Delta T$ , during pulsing

Electrical Specifications:

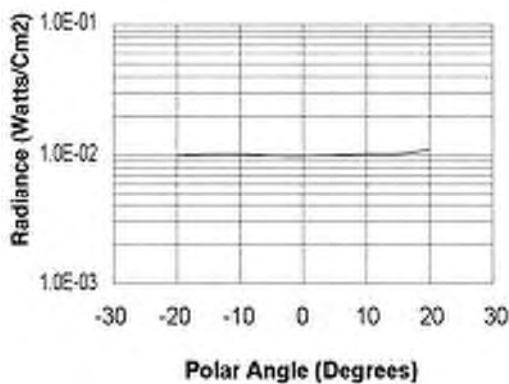
Peak Voltage = 3.00 Volts DC MAXIMUM

Peak Current = 1.34 Amps

Peak Power = 4.0 Watts



Polar Intensity  
(V = 3.0, Distance = 2 inches from face)



| Polar Angle | Average (Watts/Cm2) |
|-------------|---------------------|
| -20         | 1.00E-02            |
| -15         | 1.03E-02            |
| -10         | 1.03E-02            |
| -5          | 1.00E-02            |
| 0           | 9.80E-03            |
| 5           | 1.01E-02            |
| 10          | 1.03E-02            |
| 15          | 1.03E-02            |
| 20          | 1.10E-02            |





"Out Shines All Others"

## STEADY STATE IR SOURCE Model EK-3430

**NEW  
PRODUCT!**

HelioWorks, Inc. offers a unique steady state black body infrared emitter in an industry standard TO-3 package with nearly 12 Watts input power at up to 950°C (1223°K). It has no window and therefore emits the full unattenuated blackbody spectrum. Other window options are available.

### Key features include:

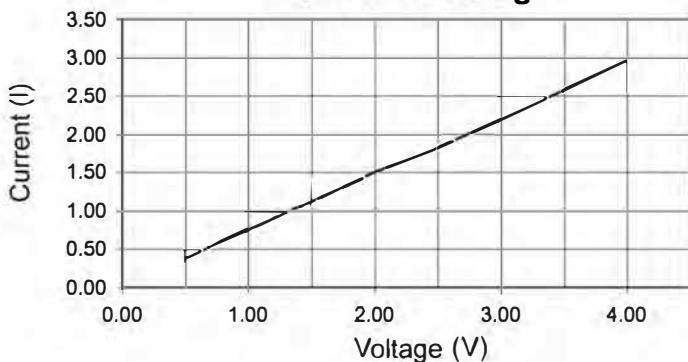
- Kanthal Filament with Emissivity = 0.7
- Approximately 12 Watts input at 950°C (1223°K)
- Emits full BB spectrum with No Window
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-3 Package
- Clear aperture = 0.540 inches



### Electrical Specifications:

Peak Voltage = 4.0 Volts MAXIMUM  
Peak Current = 2.96 Amps  
Peak Power = 11.84 Watts

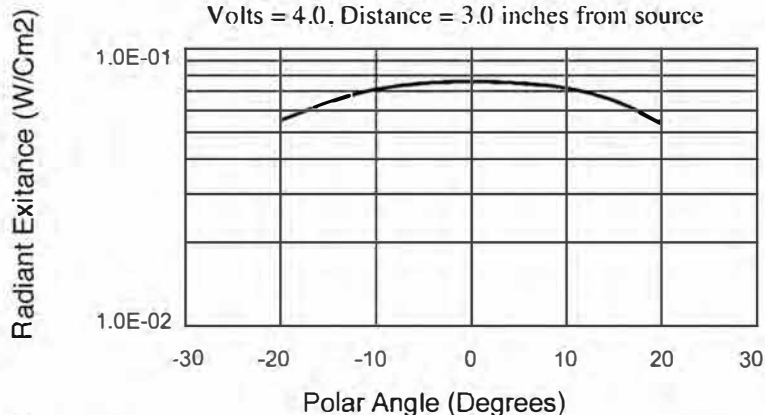
**Current vs Voltage**



| Volts | I(Amps) | V/I (Ohms) | V*I (W) |
|-------|---------|------------|---------|
| 0.50  | 0.38    | 1.32       | 0.19    |
| 1.00  | 0.75    | 1.33       | 0.75    |
| 1.50  | 1.13    | 1.33       | 1.70    |
| 2.00  | 1.50    | 1.33       | 3.00    |
| 2.50  | 1.82    | 1.37       | 4.55    |
| 3.00  | 2.19    | 1.37       | 6.57    |
| 3.50  | 2.57    | 1.36       | 9.00    |
| 4.00  | 2.96    | 1.35       | 11.84   |

**Radiant Exitance (Watts/Cm2)**

Volts = 4.0, Distance = 3.0 inches from source



| Polar Angle | Average (W/Cm2) |
|-------------|-----------------|
| -20         | 5.50E-02        |
| -15         | 6.40E-02        |
| -10         | 7.10E-02        |
| -5          | 7.50E-02        |
| 0           | 7.60E-02        |
| 5           | 7.50E-02        |
| 10          | 7.20E-02        |
| 15          | 6.50E-02        |
| 20          | 5.40E-02        |





"Out Shines All Others"

## STEADY STATE IR SOURCE Model EK-8620

HelioWorks, Inc. offers a unique steady state black body Infrared emitter in an industry standard TO-8 package. It has no window and therefore emits the full black body (BB) spectrum. Input power is up to 8 Watts at up to 1050° C (1323° K)\*

### Key features include:

- Kanthal Filament with Emissivity = 0.7
- Up to 8 Watts input power at 1050° C (1323° K)
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-8 Package
- No window\*

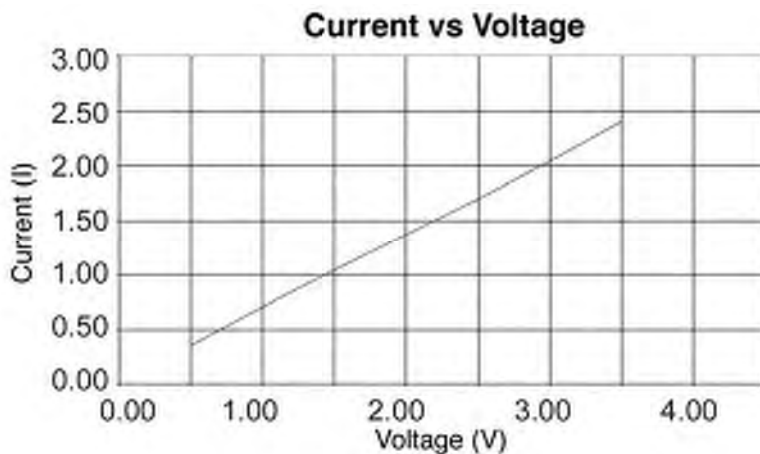


### Electrical Specifications:

Peak Voltage = 3.5 Volts MAXIMUM

Peak Current = 2.40 Amps

Peak Power = 8.40 Watts

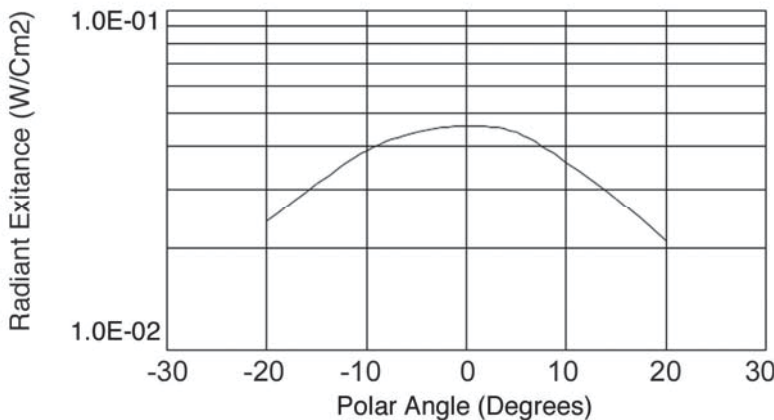


| V    | I    | W=VI | R=V/I |
|------|------|------|-------|
| 0.50 | 0.35 | 0.18 | 1.42  |
| 1.00 | 0.70 | 0.70 | 1.42  |
| 1.50 | 1.04 | 1.56 | 1.44  |
| 2.00 | 1.37 | 2.74 | 1.46  |
| 2.50 | 1.70 | 4.25 | 1.47  |
| 3.00 | 2.04 | 6.12 | 1.47  |
| 3.50 | 2.40 | 8.40 | 1.46  |

Approximate 1050° C (1323° K)

### Radiant Exitance (Watts/cm<sup>2</sup>):

Volts = 3.5, Distance = 3.0 inches from source



| Polar Angle | Average Intensity<br>(Watts/Cm2) |
|-------------|----------------------------------|
| -20         | 2.40E-02                         |
| -15         | 3.10E-02                         |
| -10         | 3.90E-02                         |
| -5          | 4.40E-02                         |
| 0           | 4.60E-02                         |
| 5           | 4.40E-02                         |
| 10          | 3.60E-02                         |
| 15          | 2.80E-02                         |
| 20          | 2.10E-02                         |







"Out Shines All Others"

## STEADY STATE IR SOURCE Model EK-8621

HelioWorks, Inc. offers a unique steady state black body Infrared emitter in an industry standard TO-8 package. It has a sapphire window and emits radiation to somewhat over 5 microns. Input power is approx 8 Watts at 1050° C (1323° K)\*

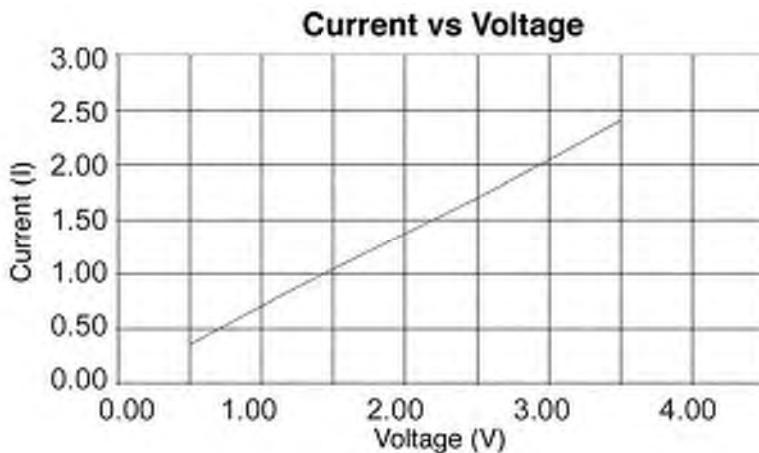
### Key features include:

- Kanthal Filament with Emissivity = 0.7
- Up to 8 Watts input power at 1050° C (1323° K)
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-8 Package
- Sapphire Window



### Electrical Specifications:

Peak Voltage = 3.5 Volts MAXIMUM  
Peak Current = 2.40 Amps  
Peak Power = 8.40 Watts

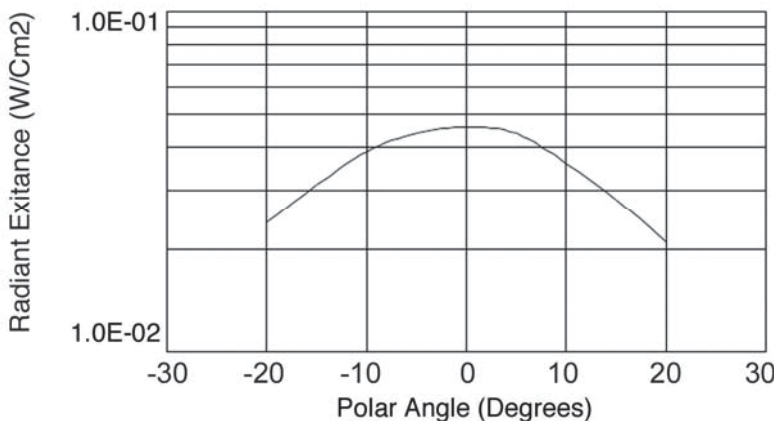


| V    | I    | W=VI | R=V/I |
|------|------|------|-------|
| 0.50 | 0.35 | 0.18 | 1.42  |
| 1.00 | 0.70 | 0.70 | 1.42  |
| 1.50 | 1.04 | 1.56 | 1.44  |
| 2.00 | 1.37 | 2.74 | 1.46  |
| 2.50 | 1.70 | 4.25 | 1.47  |
| 3.00 | 2.04 | 6.12 | 1.47  |
| 3.50 | 2.40 | 8.40 | 1.46  |

Approximate 1050° C (1323° K)

### Radiant Exitance (Watts/Cm2):

Volts = 3.5, Distance = 3.0 inches from source



| Polar Angle | Average Intensity<br>(Watts/Cm2) |
|-------------|----------------------------------|
| -20         | 2.40E-02                         |
| -15         | 3.10E-02                         |
| -10         | 3.90E-02                         |
| -5          | 4.40E-02                         |
| 0           | 4.60E-02                         |
| 5           | 4.40E-02                         |
| 10          | 3.60E-02                         |
| 15          | 2.80E-02                         |
| 20          | 2.10E-02                         |

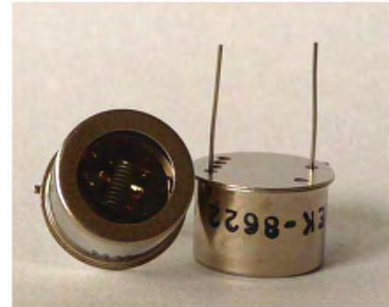




"Out Shines All Others"

**STEADY STATE IR SOURCE**  
**Model EK-8622**

HelioWorks, Inc. offers a unique steady state black body infrared emitter in an industry standard TO-8 package with Calcium Fluoride (CaF<sub>2</sub>) window that provides transmission to over 9 microns. Input power is approximately 8 Watts at up to 1050° C (1323° K).



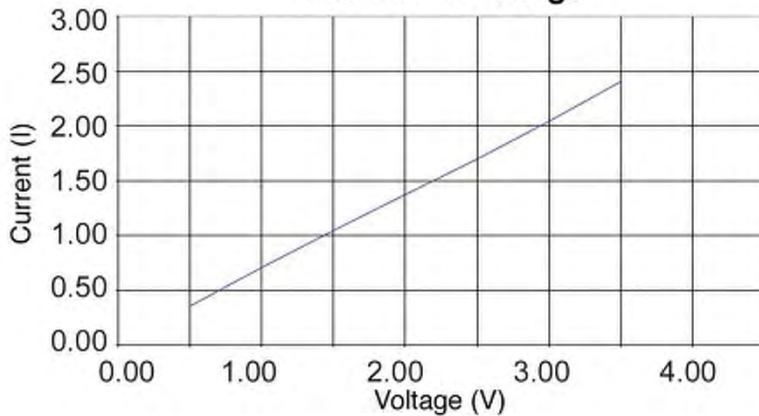
**Key features include:**

- Kanthal Filament with Emissivity = 0.7
- Over 8 Watts input power at 1050° C (1323° K)
- Internal Gold Plated Parabolic Reflector
- Industry Standard TO-8 Package
- Calcium Fluoride (CaF<sub>2</sub>) window

**Electrical Specifications:**

Peak Voltage = 3.5 Volts MAX  
Peak Current = 2.40 Amps MAX  
Peak Power = 8.40 Watts

**Current vs Voltage**

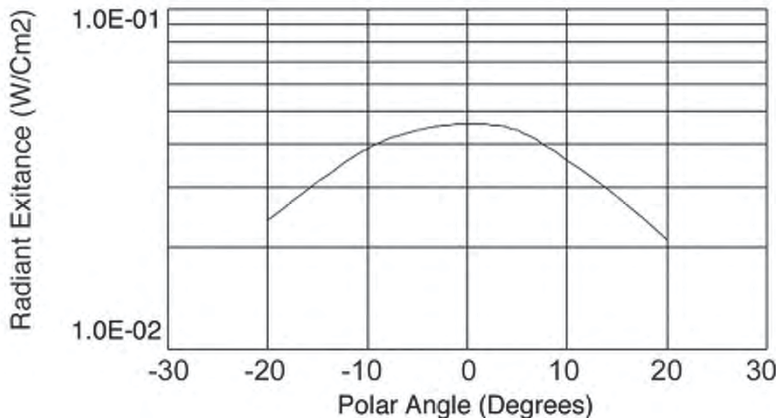


| V    | I    | W=VI | R=V/I |
|------|------|------|-------|
| 0.50 | 0.35 | 0.18 | 1.42  |
| 1.00 | 0.70 | 0.70 | 1.42  |
| 1.50 | 1.04 | 1.56 | 1.44  |
| 2.00 | 1.37 | 2.74 | 1.46  |
| 2.50 | 1.70 | 4.25 | 1.47  |
| 3.00 | 2.04 | 6.12 | 1.47  |
| 3.50 | 2.40 | 8.40 | 1.46  |

Approximate 1050° C (1323° K)

**Radiant Exitance (Watts/Cm<sup>2</sup>):**

Volts = 3.5, Distance = 3.0 inches from source



| Polar Angle | Average Intensity<br>(Watts/Cm <sup>2</sup> ) |
|-------------|---|
| -20         | 2.40E-02                                      |
| -15         | 3.10E-02                                      |
| -10         | 3.90E-02                                      |
| -5          | 4.40E-02                                      |
| 0           | 4.60E-02                                      |
| 5           | 4.40E-02                                      |
| 10          | 3.60E-02                                      |
| 15          | 2.80E-02                                      |
| 20          | 2.10E-02                                      |





"Out Shines All Others"

## PULSABLE IR SOURCE Model EVF-555X

**NEW  
PRODUCT!**

HelioWorks, Inc. offers a unique pulsable black body infrared emitter in an industry standard TO-39 package with 1.6 Watts input power at a peak temperature of 700°C (973°K). The radiating element is vertically oriented and centered in a parabolic reflector so that radiation from both sides of the element is captured. Window options (X) include: 0 = no window, 1 = sapphire, 2 = Calcium Fluoride, 3 = Zinc Selenide.



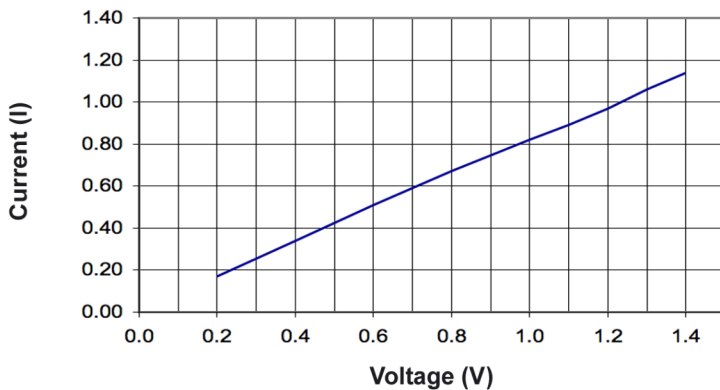
### Key features include:

- NiCr Filament with emissivity = 0.88
- 1.6 Watts peak input power at 700°C(973°K)
- Operates in pulsed or steady state mode
- Industry standard TO-39 package
- Window options (X) include:
  - 0 = No Window
  - 1 = Sapphire
  - 2 = Calcium Fluoride
  - 3 = Zinc Selenide

### Electrical Specifications:

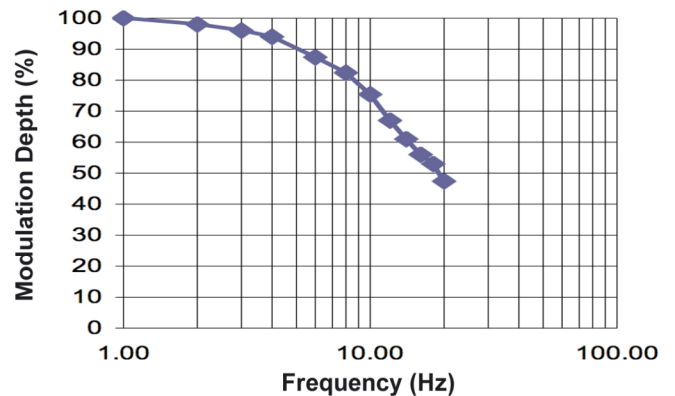
Peak Voltage = 1.40 Volts MAXIMUM  
Peak Current = 1.14 Amps MAXIMUM  
Peak Power = 1.6 Watts

**Current vs. Voltage**



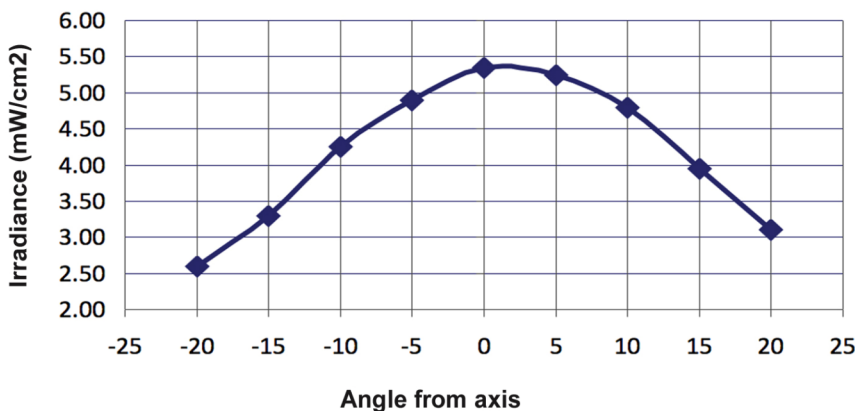
**Modulation (%) vs. Frequency (Hz)**

(50% Duty Cycle)



**Irradiance vs Angle From Axis**

Volts = 1.3, Distance = 2 in from face of cap



| Angle from axis (degrees) | Irradiance (mW/cm2) |
|---------------------------|---------------------|
| -20                       | 2.60                |
| -15                       | 3.30                |
| -10                       | 4.25                |
| -5                        | 4.90                |
| 0                         | 5.35                |
| 5                         | 5.25                |
| 10                        | 4.80                |
| 15                        | 3.95                |
| 20                        | 3.10                |

## HawkEye IR Source Selection

- The HawkEye line of IR Sources includes Pulsable and Steady State emitters and optional Parabolic and elliptical reflectors

### PULSABLE SOURCES SUMMARY

- High modulation depth / high pulse rate
- High efficiency - low power consumption
- Long life - > 3 years when used as recommended

#### TYPICAL SPECIFICATIONS:

| Products | Power, W | Voltage, V | Resistance, Ohms | Radiating Area, mm | Temperature, °C | Reflector                    | Source Material | Package |
|----------|----------|------------|------------------|--------------------|-----------------|------------------------------|-----------------|---------|
| IR-50    | 0.69     | 5.9        | 50               | 1.7 x 1.7          | 650             | 0.5," 1.0" and 2.0 available | thin film       | TO-39   |
| IR-70    | 0.65     | 5.1        | 40               | 2.2-2.2            | 700             |                              | thin film       | TO-39   |

### STEADY STATE SOURCES SUMMARY

- Input power range from low of 1.3W to high of 70 W
- Temperature to 1385° C
- Rugged and Reliable with proven long-life performance
- Material: thin film, filament (NiCr, Kanthal), Silicon Nitride, Silicon Carbide

#### TYPICAL SPECIFICATIONS:

| Product       | Power, W | Voltage, V | Radiating Area, mm | Temperature, °C | Reflector                   | Source Material |
|---------------|----------|------------|--------------------|-----------------|-----------------------------|-----------------|
| IR-12K        | 11       | 6          | 3.5 x 3.5          | 975             | 1.0", 2.0" available        | Kanthal         |
| IR-12         | 10       | 5          | 3.5 x 3.5          | 900             |                             | NiCr            |
| IR-30K        | 4.2      | 2.5        | 1.8 x 1.8          | 950             | 0.5:", 1.0", 2.0" available | Kanthal         |
| IR-30         | 4.2      | 2.75       | 1.8 x 1.8          | 925             |                             | NiCr            |
| IR-21/IR-21V  | 4        | 5          | 1.5 x 3.5          | 800             | 1.0", 2.0" available        | NiCr            |
| IR-22/IR-22V  | 4        | 5          | 1.5 x 3.5          | 900             | not available               | NiCr            |
| IR-40 / IR-41 | 2.5      | 26         | 4 x 3.5            | 500             | 41 – 0.5" Available         | thin film       |
| IR-43         | 1.3      | 14         | 1.5 x 1.5          | 600             | 0.5" Available              | thin film       |

| <b>Product</b>  | <b>Power,<br/>W</b> | <b>Voltage,<br/>V</b> | <b>Radiating Area,<br/>mm</b> | <b>Temperature,<br/>°C</b> | <b>Reflector</b>        | <b>Source<br/>Material</b> |
|-----------------|---------------------|-----------------------|-------------------------------|----------------------------|-------------------------|----------------------------|
| <b>IR-Si207</b> | 24                  | 12                    | 3 x 4.4                       | 1375                       | 1.0" Available          | Silicon Carbide            |
| <b>IR-Si217</b> | 37                  | 24                    | 6 x 4.4                       | 1385                       | 1.0" Available          | Silicon Carbide            |
| <b>IR-Si253</b> | 20                  | 12                    | 2 x 5                         | 1170                       | 0.5", 1.0"<br>Available | Silicon Nitride            |
| <b>IR-Si272</b> | 30                  | 6                     | 2.8 x 5                       | 1160                       | 1.0" Available          | Silicon Nitride            |
| <b>IR-Si295</b> | 40                  | 12                    | 3.5 x 12                      | 1200                       | 2.0" Available          | Silicon Nitride            |
| <b>IR-Si311</b> | 70                  | 12                    | 4.5 x 17                      | 1025                       | 2.0", 3.0"<br>Available | Silicon Nitride            |

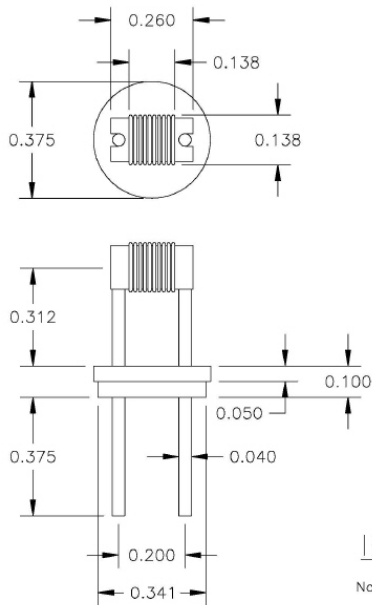


# IR-12 Series Miniature 8 to 11 Watt Infrared Emitter



91 Boylston St, Brookline MA 02446  
www.boselec.com irsource@boselec.com,  
(617)566-3821

This IR source is a thermal emitter with emissivity ~0.8. It is appropriate for use in lab or field instrumentation due to its long life and stable properties.



IR-12 Emitter

Note: all dimensions in inches.

The coiled resistance wire filament IR-12 operates at 825°C (1100K) when powered with 4.5 volts @ 1.8 amps (8 watts). The IR-12K takes higher electrical power and runs hotter. Emissivity is ~80% in the IR. The coil is wound on a cylindrical alumina substrate. Generally the IR-12K is recommended for maximum versatility. Operation in a controlled or sealed atmosphere is not required for either device.

The emitter coil is mounted horizontally on an 8.5 mm dia.

base. The emitter support pins also are the power leads and are sealed in glass. Active (coil) area is 3.5 mm dia x 3.5 mm tall.

The Series IR-12 is offered as follows:

| Part # | Description  | For Long Service Life<br>(Temp @ Volts, Amps) | Recommended<br>Upper Limit |
|--------|--|---|----------------------------|
| IR-12  | Standard unit – power approx 8 watts at 825C                                 | 825C @ ~4.5V, 1.8 A<br>Lifetime > 3 years     | 1025C at ~6V, 2.4 A        |
| IR-12K | Mechanically identical to standard unit but capable of higher temp operation | 975C @ ~6.0V, 1.8 A<br>Lifetime > 3 years     | 1125C at ~7V, 2.2 A        |

Parabolic and elliptical aluminum reflectors are available to collimate or focus the output of these devices. Boston Electronics can also supply custom designed miniature IR blackbody sources. Please inquire.



HawkEye Technologies, LLC  
Your **Source** for **Infrared**

www.hawkeyetechnologies.com

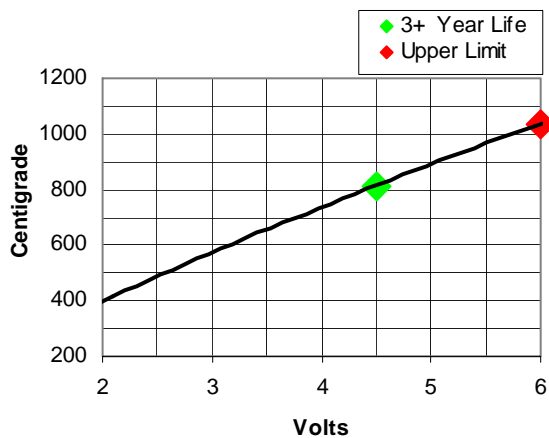


91 Boylston St, Brookline MA 02446  
www.boselec.com irsource@boselec.com,  
(617)566-3821

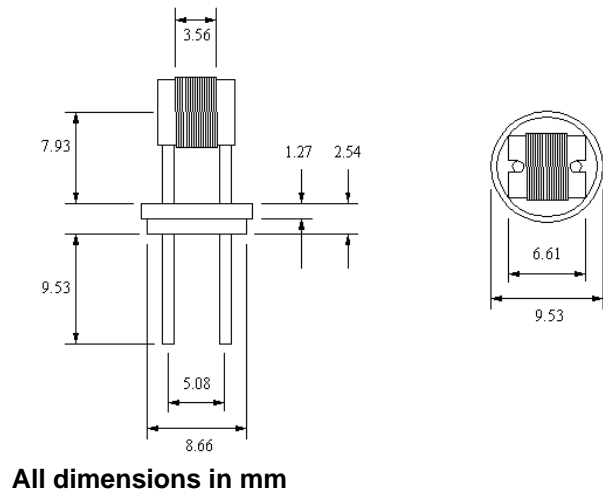
## IR-12 Steady State Infrared Emitter

### ENGINEERING DATA

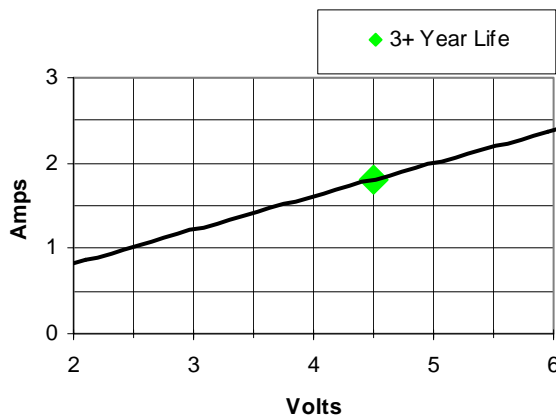
#### Temperature vs Voltage



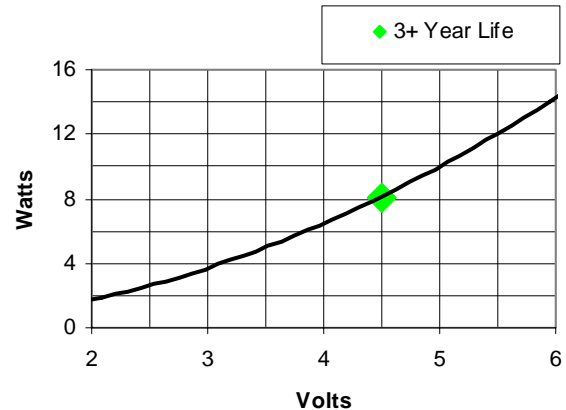
#### Dimensions



#### Current vs Voltage



#### Power vs Voltage



HawkEye Technologies LLC is a custom fabricator of IR sources. We will customize our existing products to your design specifications. We would be pleased to quote a new custom IR source, including engineering, that will meet your requirements.



HawkEye Technologies, LLC  
Your **Source** for **Infrared**

www.hawkeyetechnologies.com

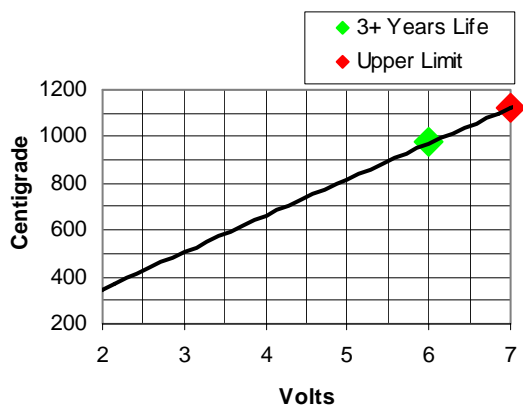


91 Boylston St, Brookline MA 02446  
www.boselec.com irsource@boselec.com  
(617)566-3821

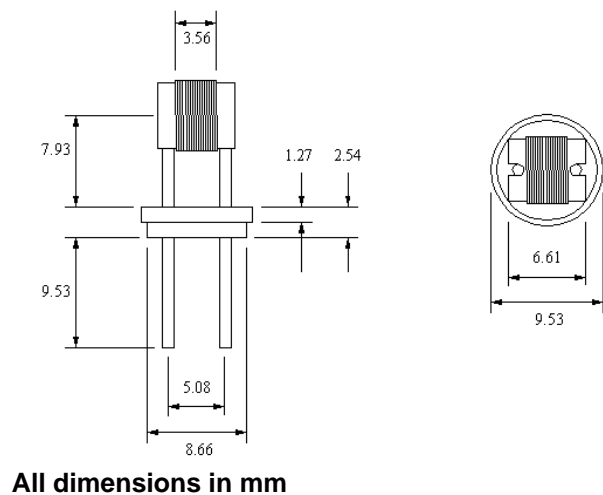
## IR-12K Steady State Infrared Emitter

### ENGINEERING DATA

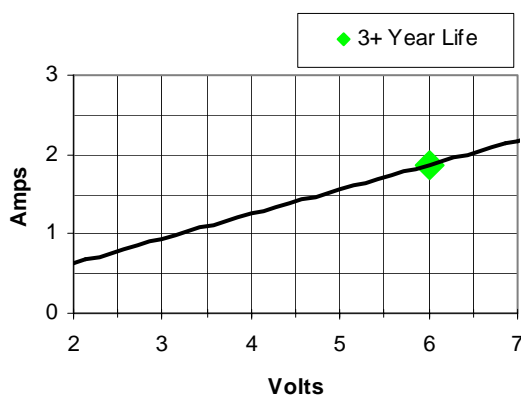
#### Temperature vs Voltage



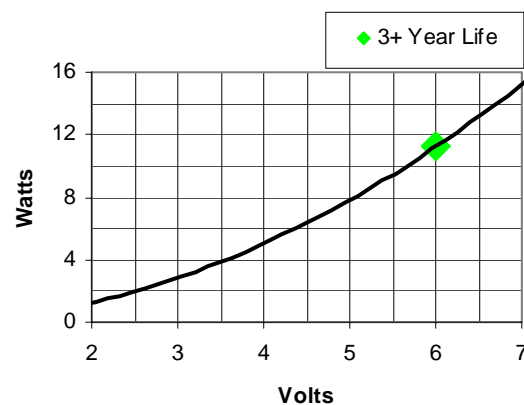
#### Dimensions



#### Current vs Voltage



#### Power vs Voltage



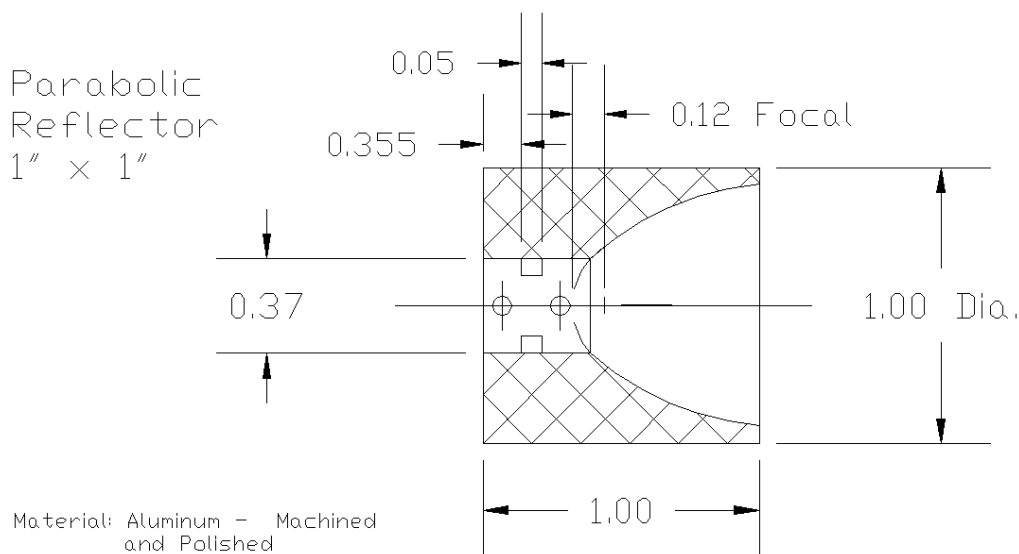
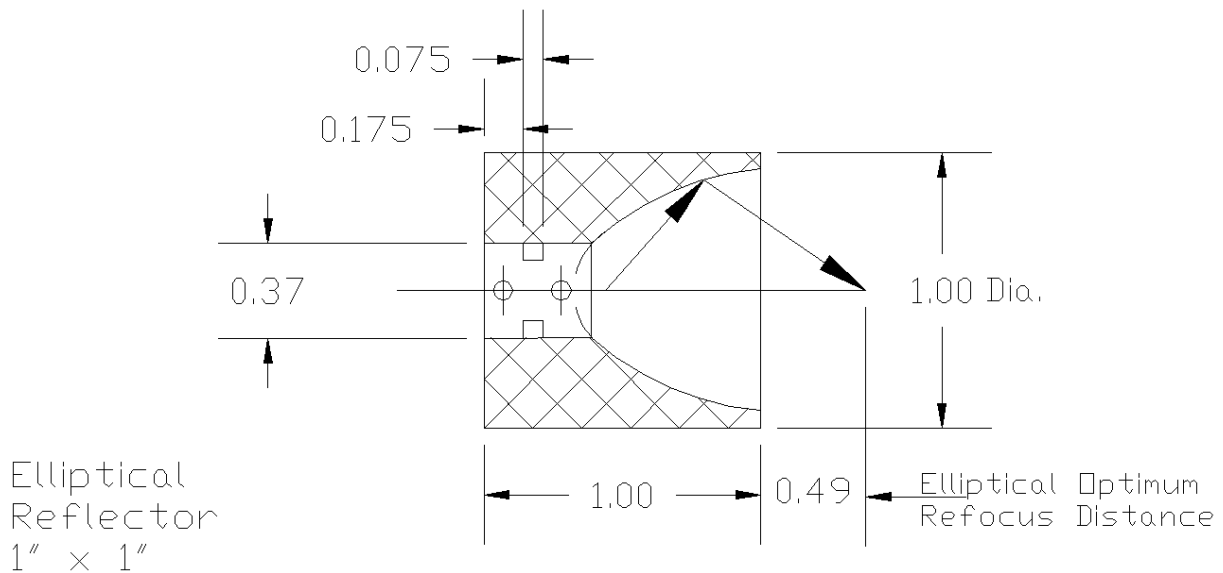
HawkEye Technologies LLC is a custom fabricator of IR sources. We will customize our existing products to your design specifications. We would be pleased to quote a new custom IR source, including engineering, that will meet your requirements.



## Parabolic and Elliptical Reflectors For IR-12 and IR-2x series

p/n MC-233 is Elliptical (focused)

p/n MC-234 is Parabolic (collimated)



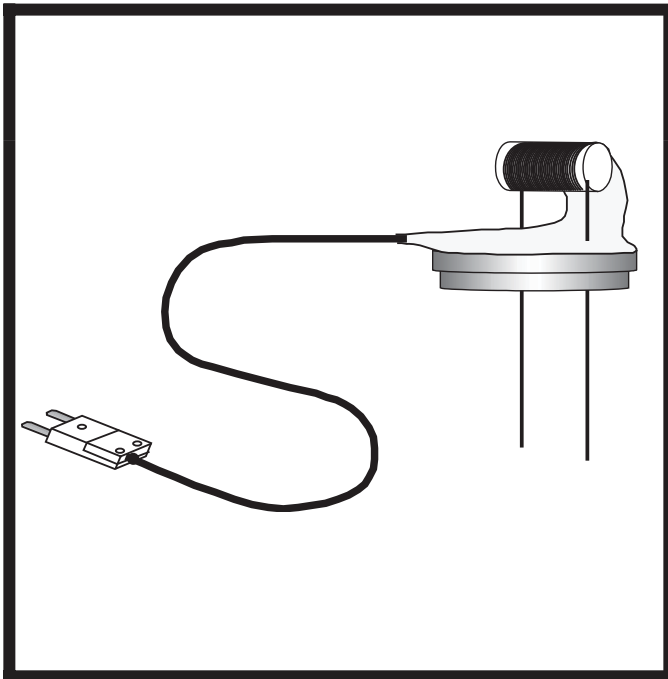
# IR-12 with Thermocouple Monitored, Stabilizable IR Source

## INFRARED SYSTEM

This Infrared System consists of our standard 800C Series 12 Infrared Light Source, a Type-K Thermocouple and optional digital thermometer.

This unit is intended as a low cost standard unit for general use. These units have been used as checks on Infrared Instruments such as thermometers and cameras. Emissivity value is not guaranteed but fairly constant. Temperature can be monitored quite precisely with this unit and can be maintained constant with feedback to your power source.

When power is applied to the Infrared Light Source the unit heats and the thermometer generates a digital read out of the surface temperature. The thermocouple output can also be used as an input to the [user supplied] power supply system to control the source temperature. Nominal source power requirement is 1.8 amps at 5 volts to maintain 825C [1100K]. The unit can be operated up to 1100K for long [3+ years] duration or at higher temperatures to 1400K for shorter durations. Temperatures from 300K up are easily achievable and operation cooler than 1100K extends lifetime rapidly.



**Construction:** The Type-K Thermocouple sensor is fabricated using special limit error thermocouple wire. This wire is rated at +/- 1.1° C. The sensor is applied directly to the coil of the Infrared Light Source. High temperature, low expansion, material is used to apply the sensor to the source. The thermocouple is terminated with a standard Type-K miniature plug. Other thermocouple types can be supplied on request.

**Optional Digital Thermometer:** The sensor output probe can be plugged directly into this unit. The meter accepts all type K thermocouple probes with ANSI mini connectors. Meter features: HOLD button to freezes reading, switch for readouts in °F and °C. The display has large ½" digital features. Meter comes with 9 volt battery.

We will customize our existing products to your design specifications. We would be pleased to quote a new custom IR source, including engineering, which will meet your requirements.





HawkEye Technologies, LLC  
Your **Source** for **Infrared**

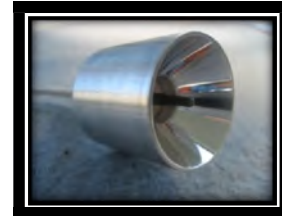
[www.hawkeyetechnologies.com](http://www.hawkeyetechnologies.com)



91 Boylston St, Brookline MA 02446  
[www.boselec.com](http://www.boselec.com) [irsource@boselec.com](mailto:irsource@boselec.com),  
(617)566-3821

## Infrared Sources IR-Si253-P-1 or -E-1 (formerly IR-18/19)

- Silicon Nitride Emitter mounted in a Parabolic or Elliptical Reflector
- Robust and Efficient
- 1150°C High Output Design



IR-18



IR-19

The IR-Si253 Series is designed for those customers who require higher temperatures and greater output from their infrared source. These emitters are manufactured using a patented silicon nitride material. The advanced ceramic technology ensures a very stable product. Their robust design ensures intrinsic physical and thermal strength. When operated at 12 volts/18 watts the IR-Si253 reaches 1150°C.

The IR-Si253-P-1 emitters are mounted in a 1 inch parabolic reflector for extremely efficient collimation of energy. The IR-Si253-E-1 emitters are mounted in a 1 inch elliptical reflector with an external focal point that is 1/2 inch in front of the clear aperture.

### Typical Operating Parameters

|                | IR-Si253                    |
|----------------|-----------------------------|
| Voltage        | 12.0 Volts (AC or DC)       |
| Temp           | 1150° C                     |
| Current        | 1.5 Amperes                 |
| Power          | 18.0 watts                  |
| Emissivity     | 0.75                        |
| Radiating Area | 1.5 mm dia. x 4.1 mm length |
| Lifetime       | 5000+ hours at 12 Volts     |



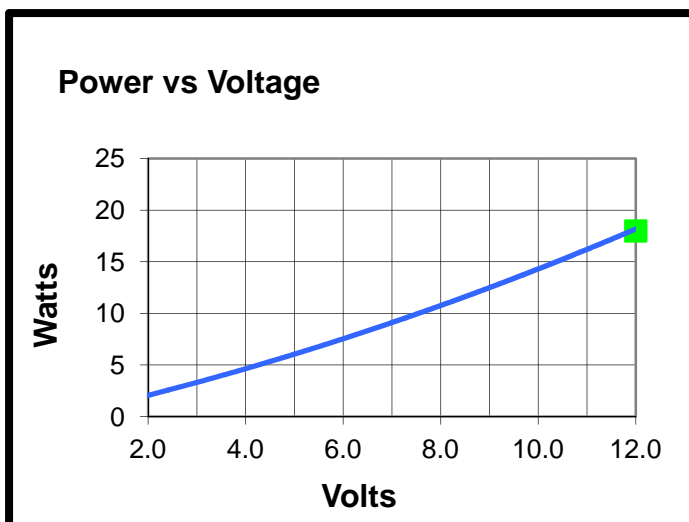
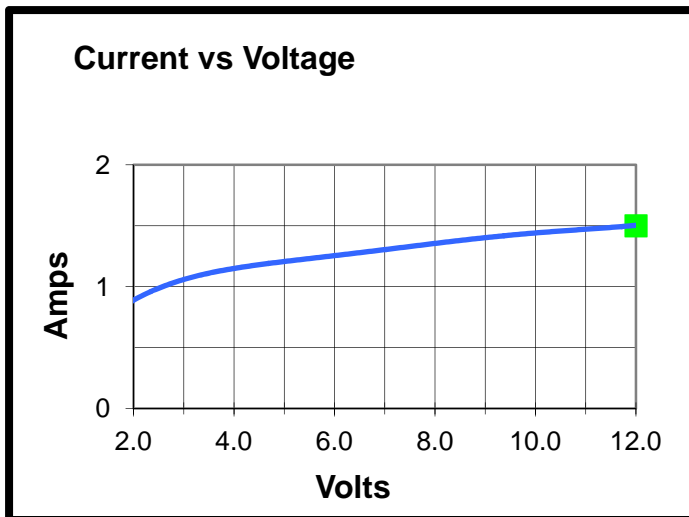
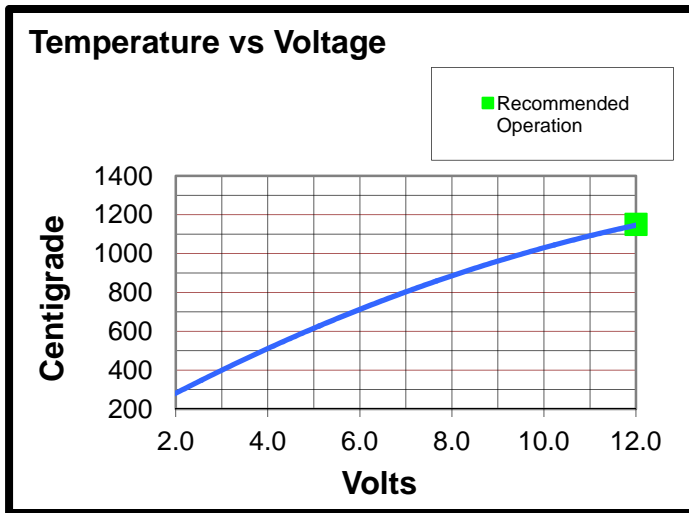
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## HawkEye IR-Si253 Engineering Data Charts



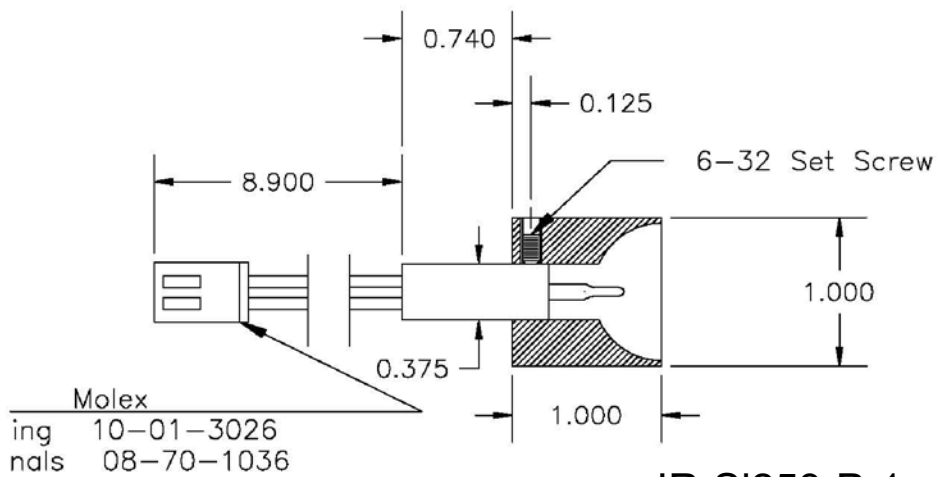


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IR-Si253-P-1 was  
IR-18 Emitter

Note: all dimensions in inches



## Infrared Source Series 2x

- Supported, Coil Wound
- Available mounted vertically or horizontally
- Available on large or small base



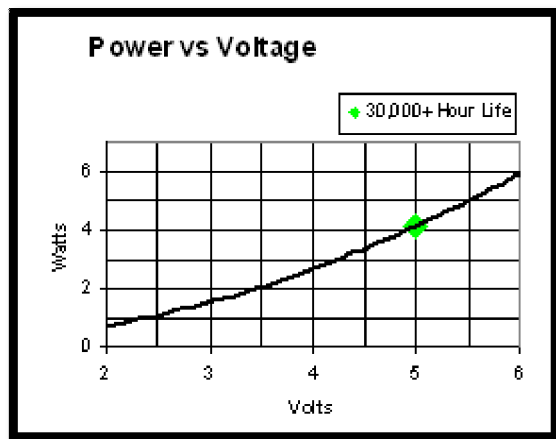
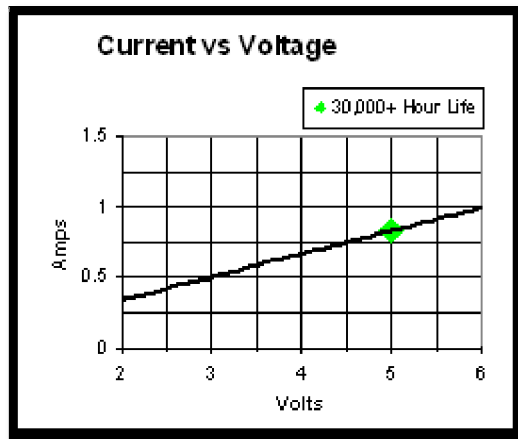
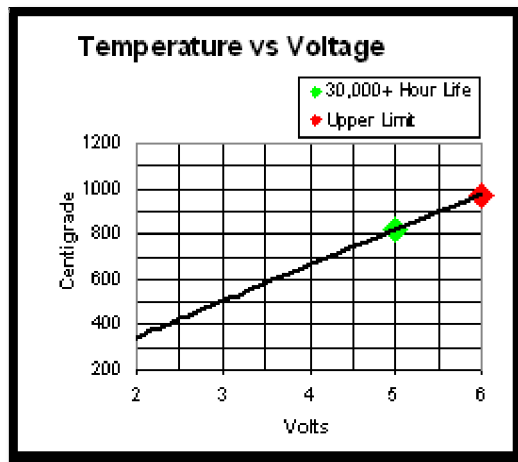
The coiled filament operates at approximately 800°C when powered with 4 watts. The radiating element is a coil of resistance wire which has a high emissivity in the Infrared spectral region. The coil is supported on a cylindrical substrate of alumina. Due to the reduced mass of this unit it can be pulsed at 1 hertz with a resultant temperature variation that can be detected. The unit does not require operation in a sealed atmosphere.

The Header body is available in two sizes. The larger, IR 21, has 0.200 inch center to center leads. The small, IR 22, has 0.100 inch center to center leads. The support pins are hermetically sealed in glass. The source can be mounted vertically or horizontally.

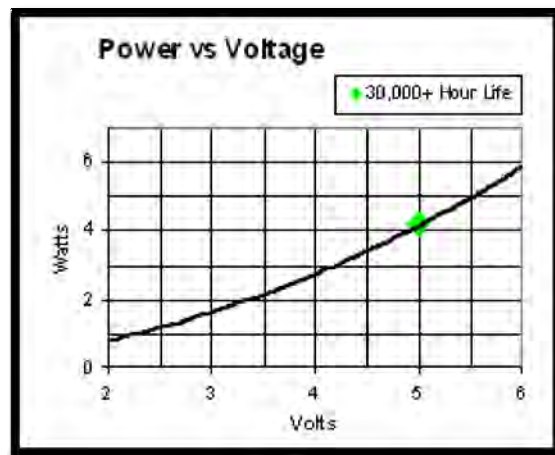
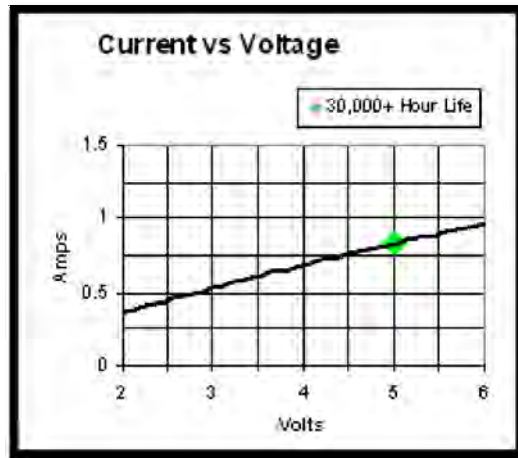
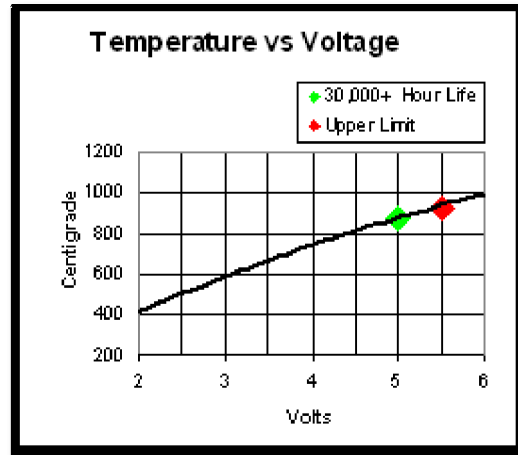
## Recommended Operating Parameters

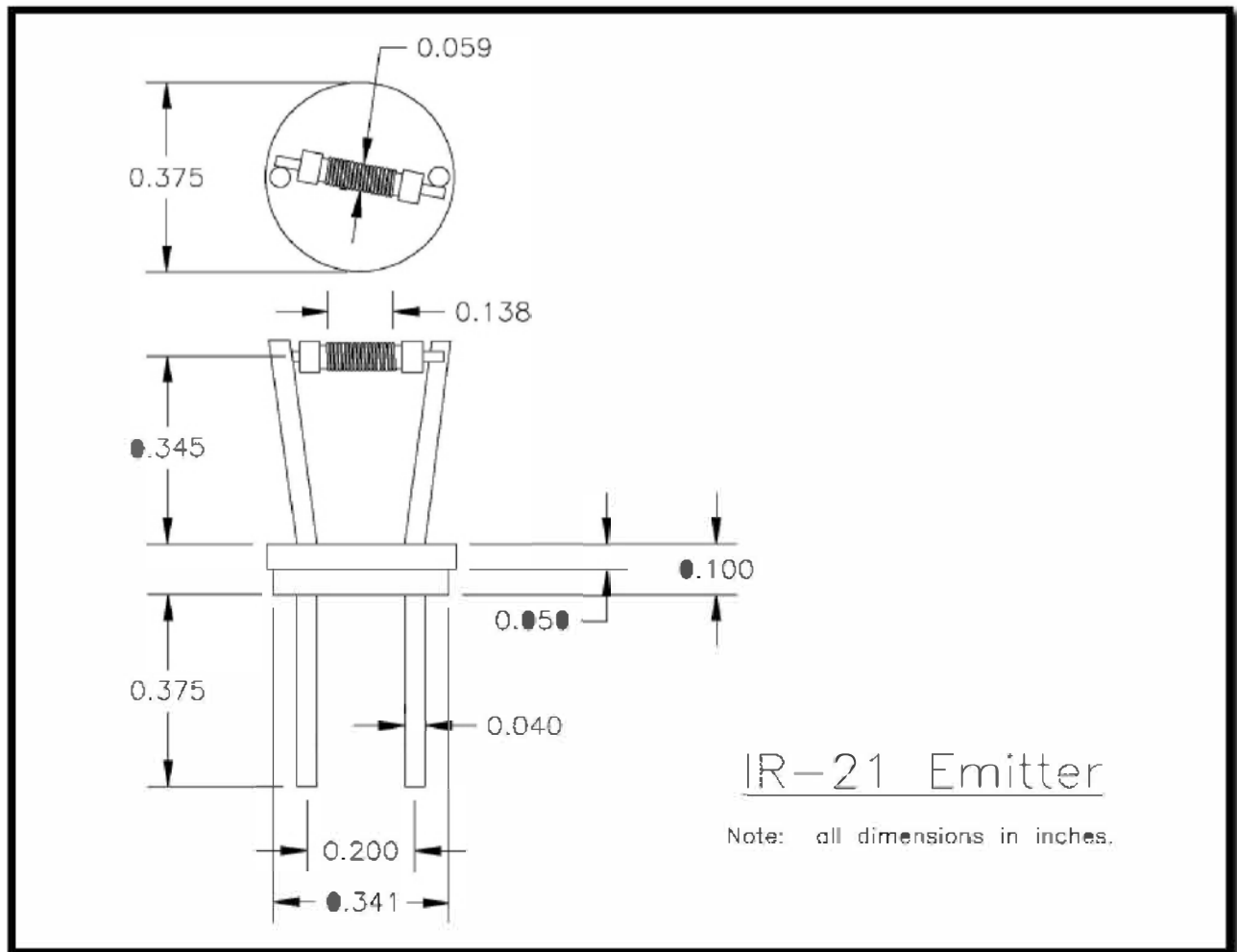
|                    | IR-21                   | IR-22                   |
|--------------------|-------------------------|-------------------------|
| <b>Voltage</b>     | 5.0 volts (AC or DC)    | 5.0 volts (AC or DC)    |
| <b>Temp</b>        | 800° C                  | 900°C                   |
| <b>Current</b>     | 0.8 Amperes             | 0.8 Amperes             |
| <b>Power</b>       | 4.0 watts               | 4.0 watts               |
| <b>Life</b>        | 30,000 Hours at 5 volts | 30,000 Hours at 5 volts |
| <b>Emissivity</b>  | 0.80                    | 0.80                    |
| <b>Active Area</b> | 1.5 mm X 3.5 mm         | 1.5 mm X 3.5 mm         |

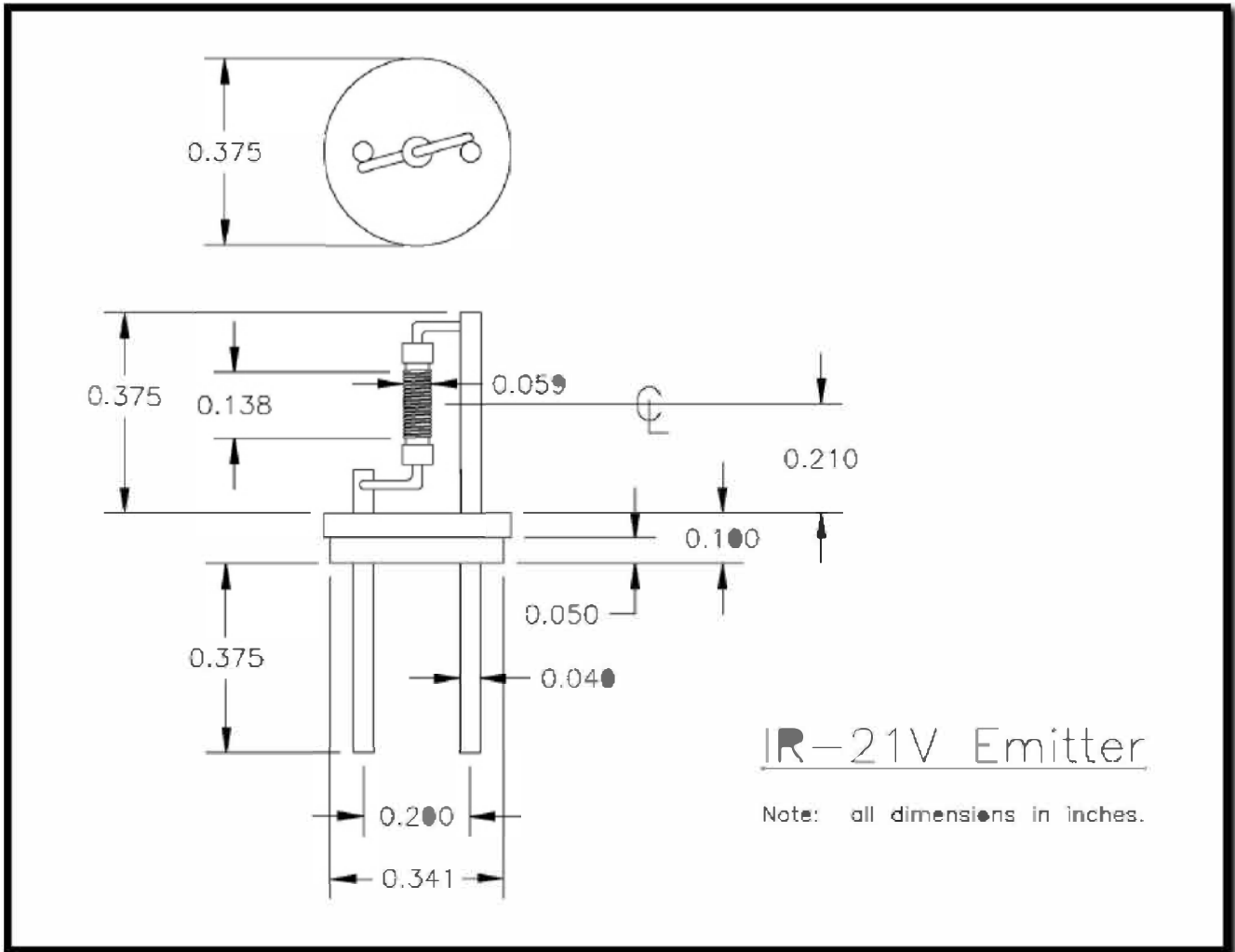
## HawkEye IR-21 Engineering Data Charts



## HawkEye IR-22 Engineering Data Charts







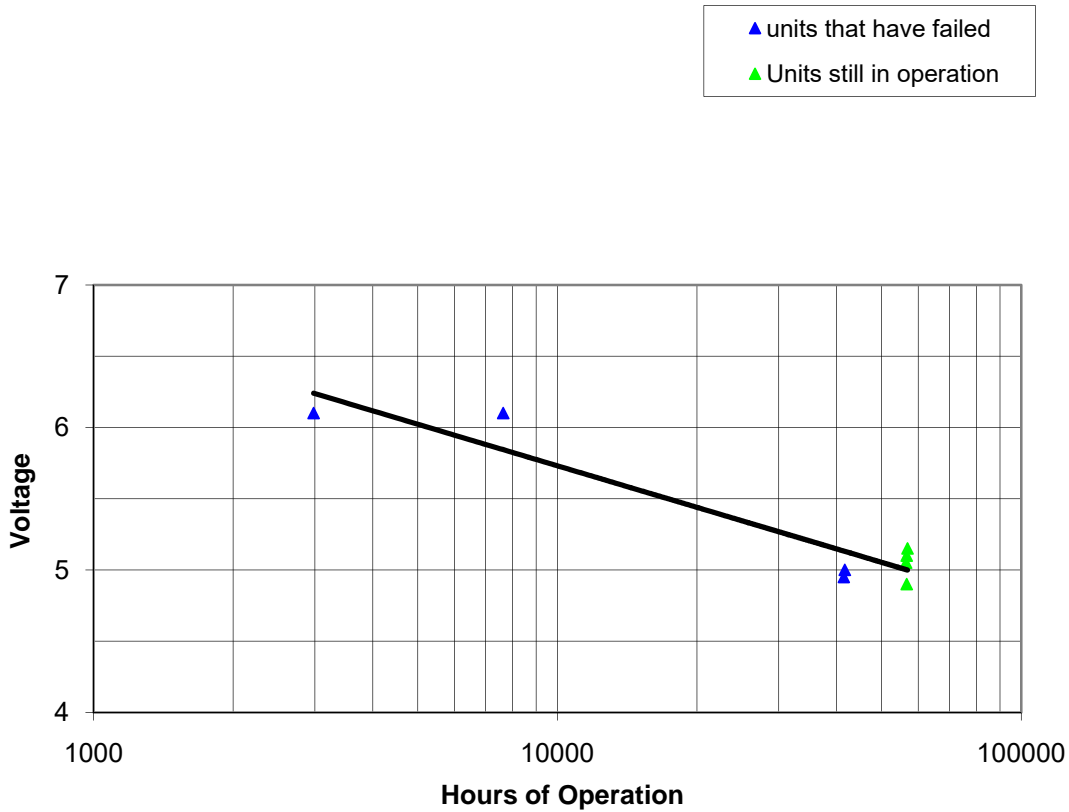




## HawkEye IR-2x Lifetime

### HawkEye Technologies IR-2x Series

Lifetime tests conducted 9/2002-9/2009



## Infrared Source IR-3x

- Supported, Coil Wound
- Operates at 950°C when powered with 4.2 watts
- Pulsable up to 1 Hz
- Available with a parabolic reflector to collimate energy (IR-35)

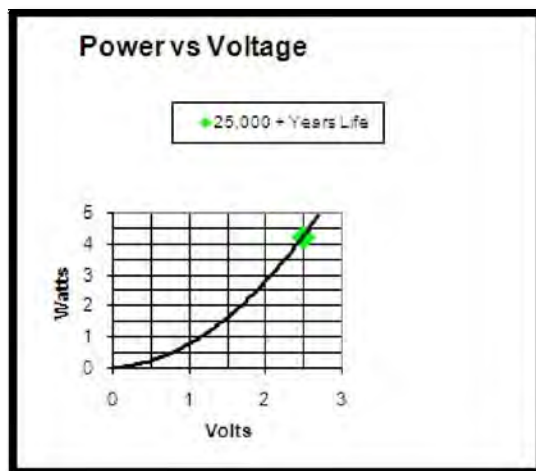
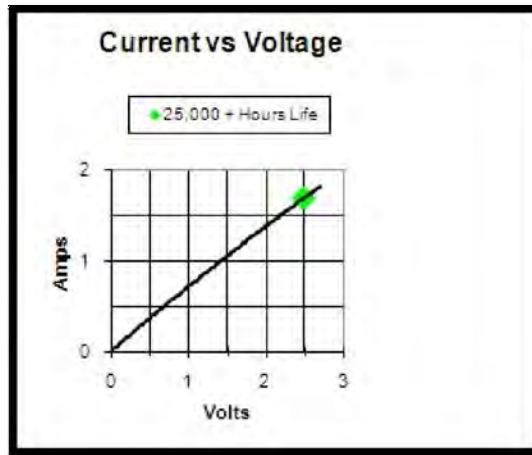
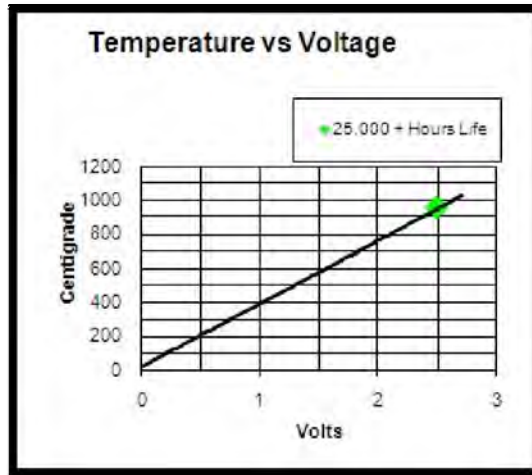


The IR-3x is a coil-wound, supported IR Source. At steady state, the coiled filament operates at approximately 950 degrees C when powered with 4.2 watts (2.5 volts, 1.7 amps). Expected life at this power level is 25,000 hours. This IR Source can be pulsed up to 1 hertz with a greater power input. For example, when operated at 1 hertz, 50% duty cycle with 3.5 volts and 7.1 watts, the output is a well defined saw tooth with approximately 32% modulation depth. This product is offered as an IR-30 which is mounted on a TO-5 header and also as an IR-35 in a 0.5 inch diameter parabolic reflector (for collimation of energy).

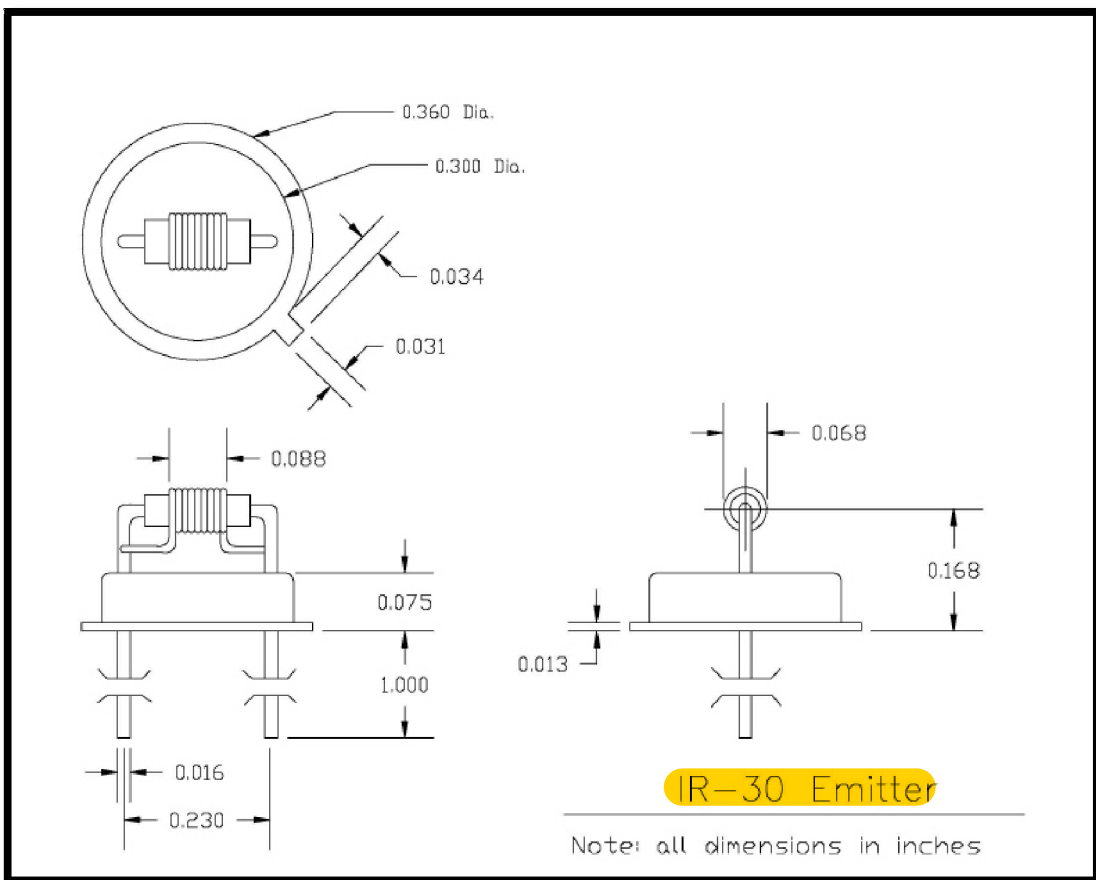
## Recommended Operating Parameters

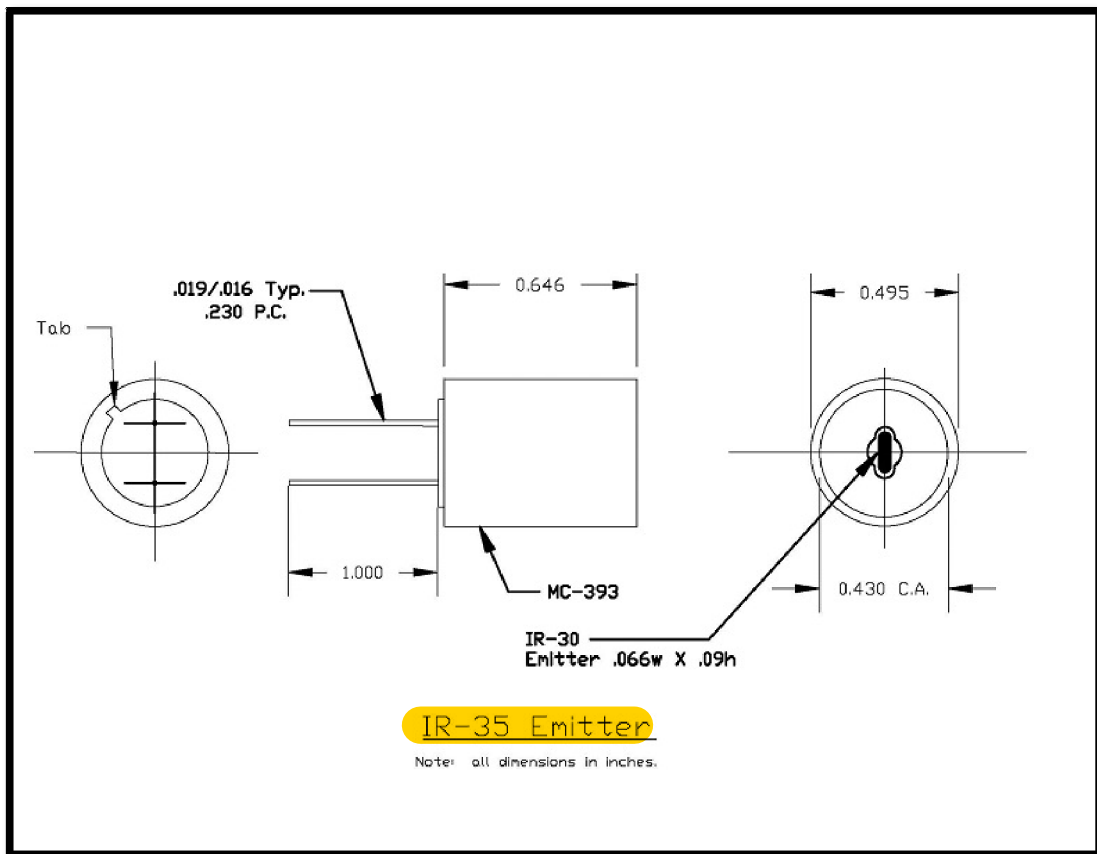
|                    |                           |
|--------------------|---------------------------|
|                    | <b>IR-3x</b>              |
| <b>Voltage</b>     | 2.5 volts (AC or DC)      |
| <b>Temp</b>        | 950° C                    |
| <b>Current</b>     | 1.7 Amperes               |
| <b>Power</b>       | 4.2 watts                 |
| <b>Life</b>        | 25,000 Hours at 2.5 volts |
| <b>Emissivity</b>  | 0.70                      |
| <b>Active Area</b> | 1.8 mm X 1.8 mm           |

## HawkEye IR-3x Engineering Data Charts











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## Infrared Source Series 4x

- Thin Film Laser Trimmed
- IR-43 operates at 600°C with 1.3 watts input
- IR-40 operates at 500°C with 2.5 watts input



IR-40NC



IR-43NC

The IR-4x radiating element is an approximately 1.5 micron thin film of precision laser trimmed resistance material which is permanently bonded to a flat substrate of alumina. This contributes to a uniform radiating source and a stable platform. The unit does not require operation in a sealed atmosphere. The thin film design results in a low mass of radiation material.

The IR-40 unit is attached to a TO-5 header with high temperature cement. This unit is also offered without a cap (as an IR-40NC) and with a cap and sapphire window (as an IR-40S). For alternative mounting, it is also offered attached to a flat, butterfly shaped, steel header (as an IR-42).

The IR-43 unit is free standing on a TO-5 header. It requires less power to achieve the same temperatures as the IR-40. Without a directly connected mass to draw off heat, it is more responsive.

## Maximum Operating Parameters

|                    | IR-40                      | IR-43                      |
|--------------------|----------------------------|----------------------------|
| <b>Voltage</b>     | 26.0 volts (AC or DC)      | 14.0 volts (AC or DC)      |
| <b>Temp</b>        | 500° C                     | 600°C                      |
| <b>Current</b>     | 0.10 Amperes               | 0.09 Amperes               |
| <b>Power</b>       | 2.5 watts                  | 1.3 watts                  |
| <b>Life</b>        | 3+ years at 500° C typical | 3+ years at 500° C typical |
| <b>Emissivity</b>  | 0.80                       | 0.80                       |
| <b>Active Area</b> | 3.5 mm X 2.5 mm            | 1.5 mm X 1.5 mm            |





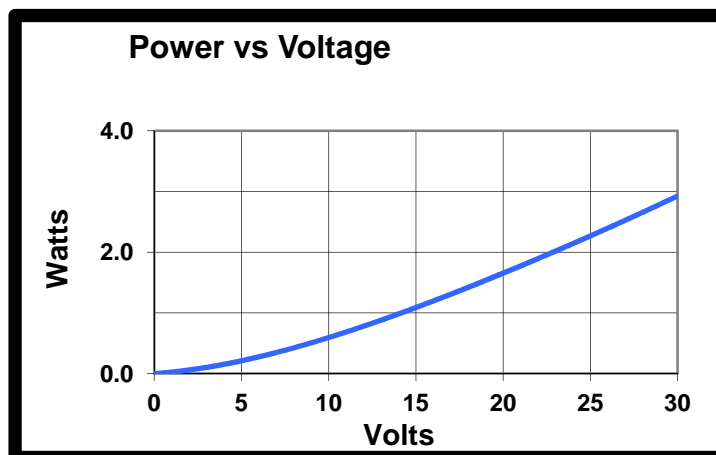
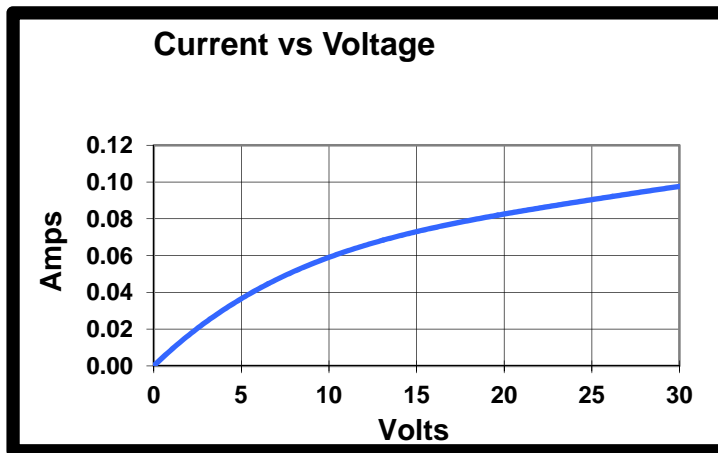
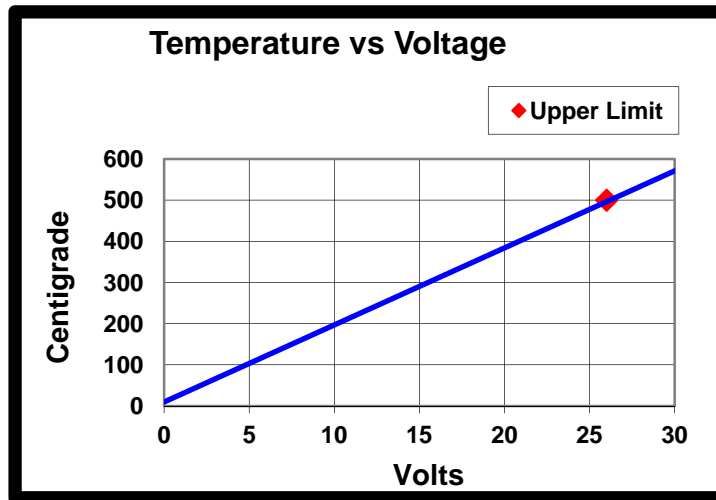
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## HawkEye IR-40 Engineering Data Charts





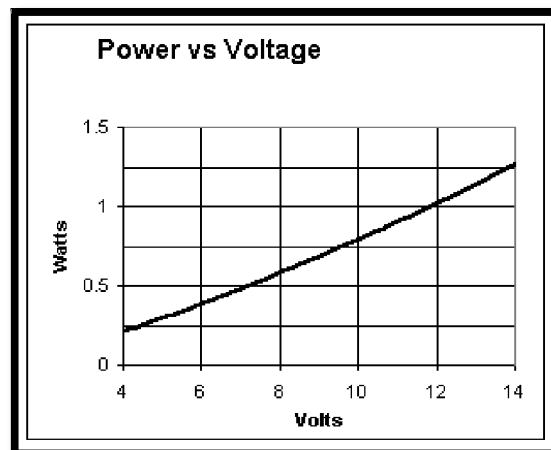
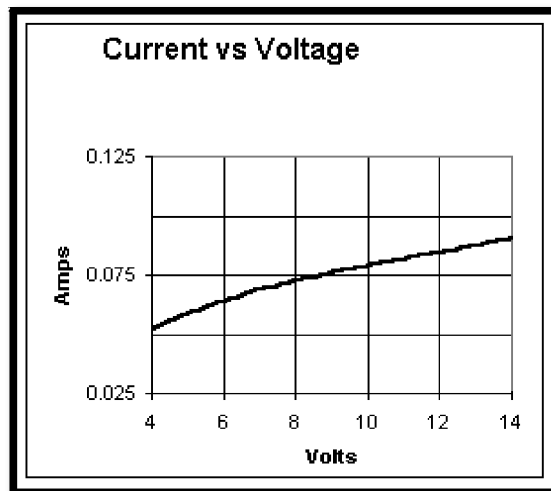
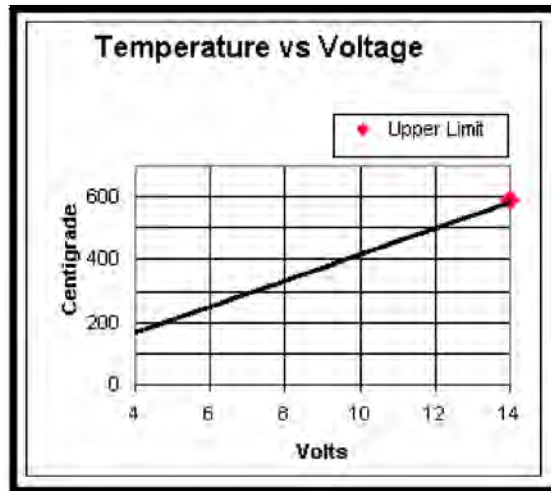
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## HawkEye IR-43 Engineering Data Charts



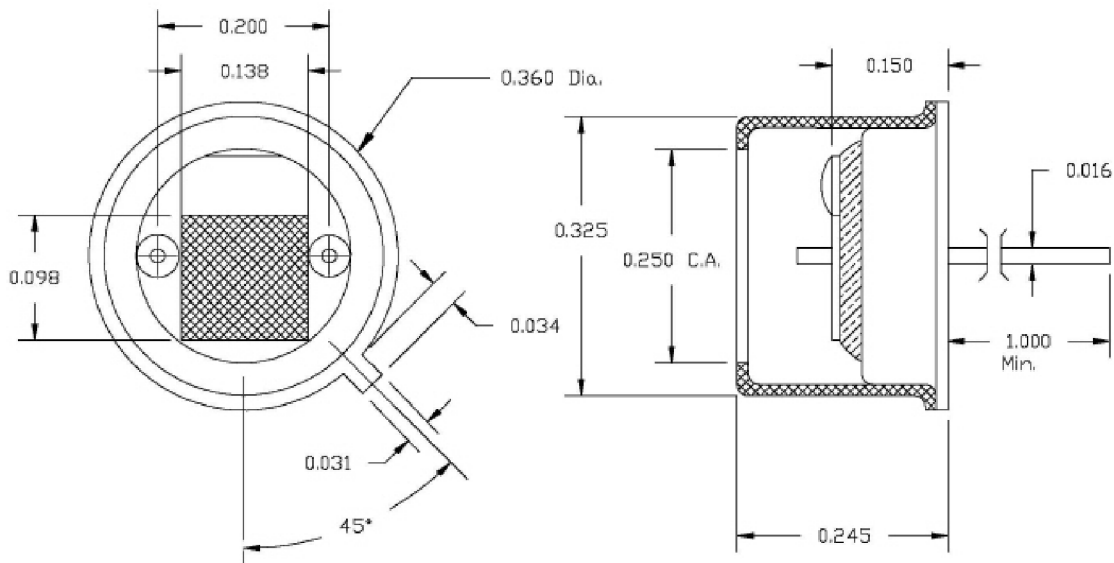


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IR-40 Emitter

Note: all dimensions in inches.

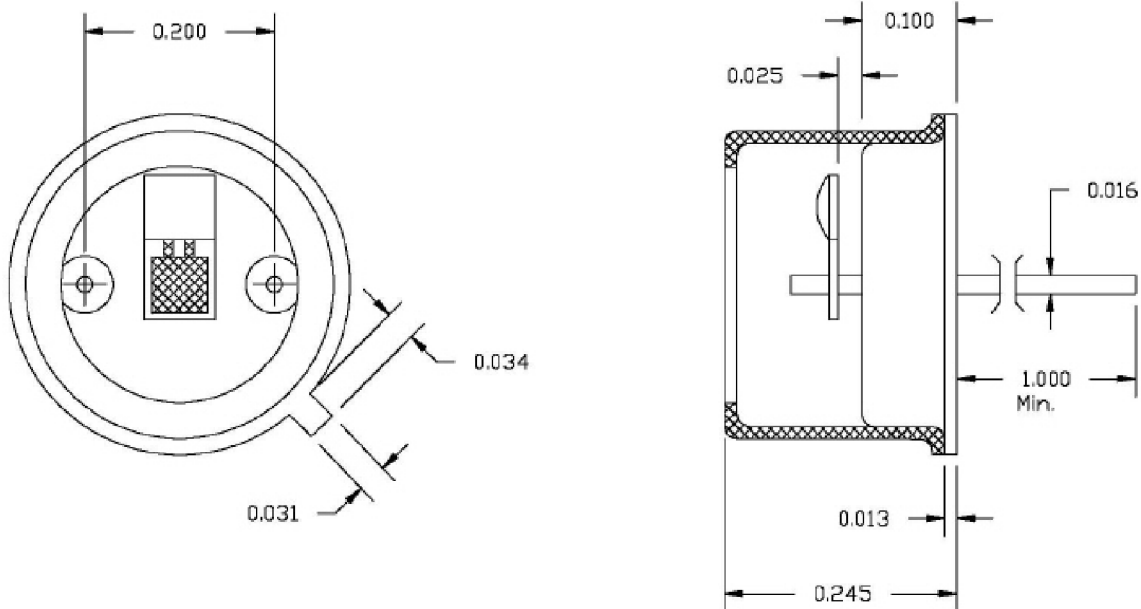


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IR-43 Emitter

Note: all dimensions in inches.





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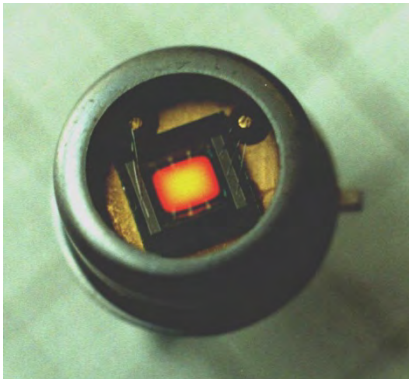
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## Infrared Source Series 5x

- Wide spectral output
- Fast response
- High pulse rate
- High modulation depth
- High efficiency – low power consumption
- Long life and cost effective
- Custom design – many package options

The HawkEye IR-5x Series is a MEMS technology pulsable infrared emitter. This source is based on patented technology, utilizing a thin film resistor of diamond-like nanostructured amorphous carbon. Due to its low thermal mass, the IR-5x Series can be pulsed at frequencies up to 100+ hertz with good modulation depth (contrast between the on and off states).



The HawkEye IR-50 pulsed infrared emitter in a TO5 header uses a micromachined source chip with a thin, high-emissivity membrane shown schematically below.





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## Operational Characteristics for the IR-5x Series

|   |                                       |
|---|---------------------------------------|
| <b>Active Area</b>  | 1.7 mm x 1.7 mm                       |
| <b>Resistance</b>   | 50 ohms (nominal) in the hot state    |
| <b>Typical Operating Temperature</b>                      | 450°C to 750°C                        |
| <b>Drive Voltage at 750°C</b>                             | 6.7 volts +/- 0.4 volts               |
| <b>Frequency at 50% Modulation Depth (25% Duty Cycle)</b> | 100 Hz                                |
| <b>Spectral Range</b>                                     | 1 to 20 microns                       |
| <b>Emissivity</b>   | 0.8 (in the range of 2 to 14 microns) |

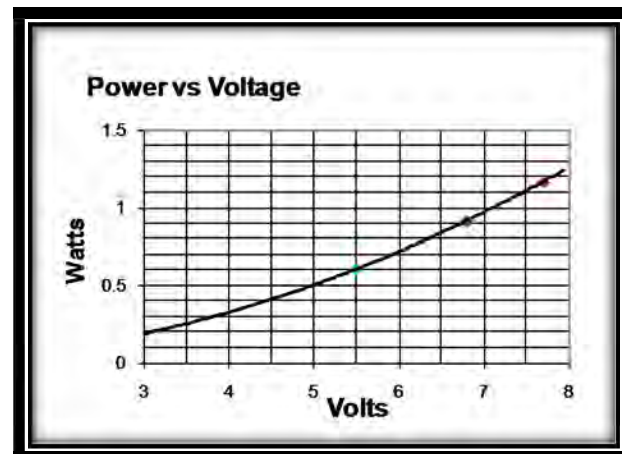
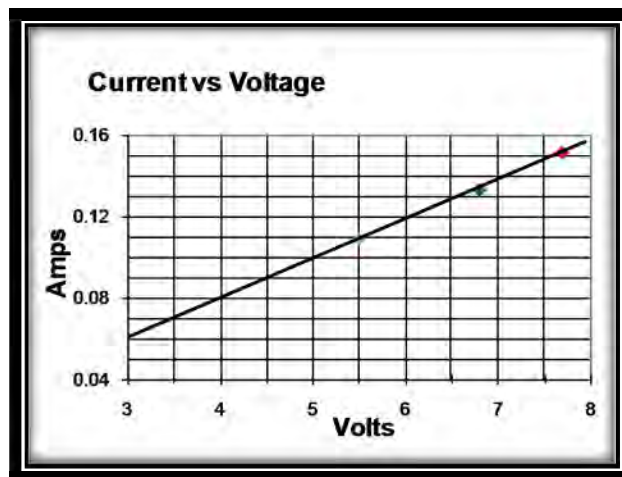
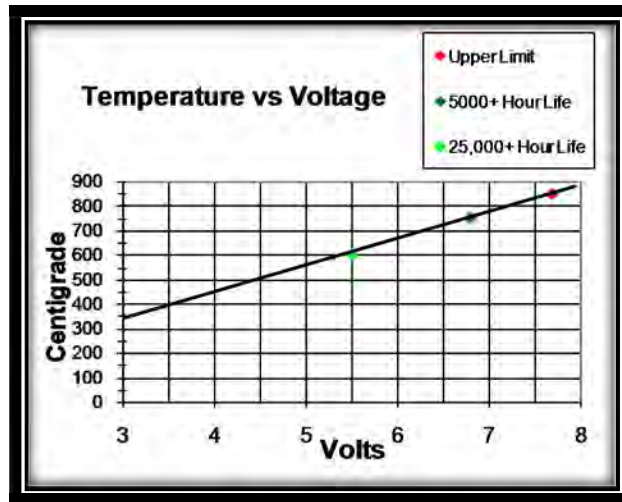


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## HawkEye IR-5x Engineering Data Charts





## Typical Operating Parameters




|                | Typical Levels |        |       |   |
|----------------|----------------|--------|-------|---|
| Temperature    | 450            | 600    | 750   | degrees centigrade                              |
| Voltage        | 4.0            | 5.5    | 6.7   | Volts (AC or DC)                                |
| Current        | 80             | 110    | 134   | mAmps   |
| Power Input    | 0.32           | 0.60   | 0.90  | Watts   |
| Estimated Life | 100,000        | 40,000 | 5,000 | hours of operation (10 hertz at 50% duty cycle) |

**Note:** The operating parameters assume an infrared source operating without a radiator and at ambient temperature and pressure. A rectangular voltage pulsed at a frequency of 10 hertz and with a duty cycle of 50% is used for heating. If a longer duty cycle (or steady-state operation) is used, lower power levels are recommended in order to achieve the desired temperature. Also, proportionately shorter lifetime would be expected.





## Comparison of IR-5x Series Models

|  | IR-50   | IR-55   | IR-56   | IR-57  | Units/Notes |
|--|---|---|---|--|-------------|
|  |  |  |  |  |             |
| <b>Length</b>                              | 0.170   | 0.646   | 0.360   | 1.000  | inches      |
| <b>Diameter</b>                            | 0.360   | 0.495   | 0.400   | 1.000  | inches      |
| <b>Package</b>                             | TO-5 with Cap   | parabolic optic   | parabolic optic   | elliptical optic   |             |
| <b>Normalized On-Axis Output at 1 inch</b> | 1   | 15  | 11  | NA   |             |
| <b>Normalized Angular Output--FWHM</b>     | 100°  | 15°   | 20°   | NA   |             |



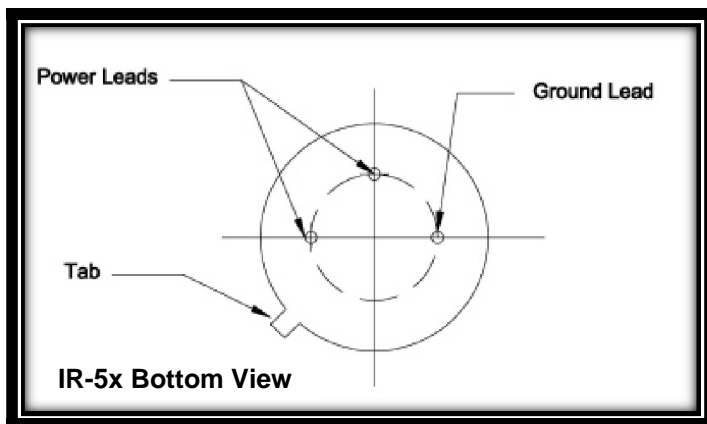
## Operational Guidelines - Infrared Source Series 5x

The HawkEye IR-5x Series utilizes a thin thermoresistive film of conducting amorphous (diamond-like) carbon. Infrared radiation is the result of heating this film by passing an electric current through it.

The maximum temperature of the film should not exceed 750°C in continuous operation. A faint red luminescence of the film is observed during operation at temperatures near 750°C. Short term heating up to 850°C is possible but will reduce the lifetime of the unit.

The operating parameters assume an infrared source operating without a radiator and at ambient temperature and pressure. A rectangular voltage pulsed at a frequency of 10 hertz and with a duty cycle of 50% is used for heating.

Two power leads and a ground are provided per the sketch below. The IR-50 emitter is to be powered through the two power leads. Bi-polar drive voltage may be used. The Case Ground Lead is not required under normal operation.





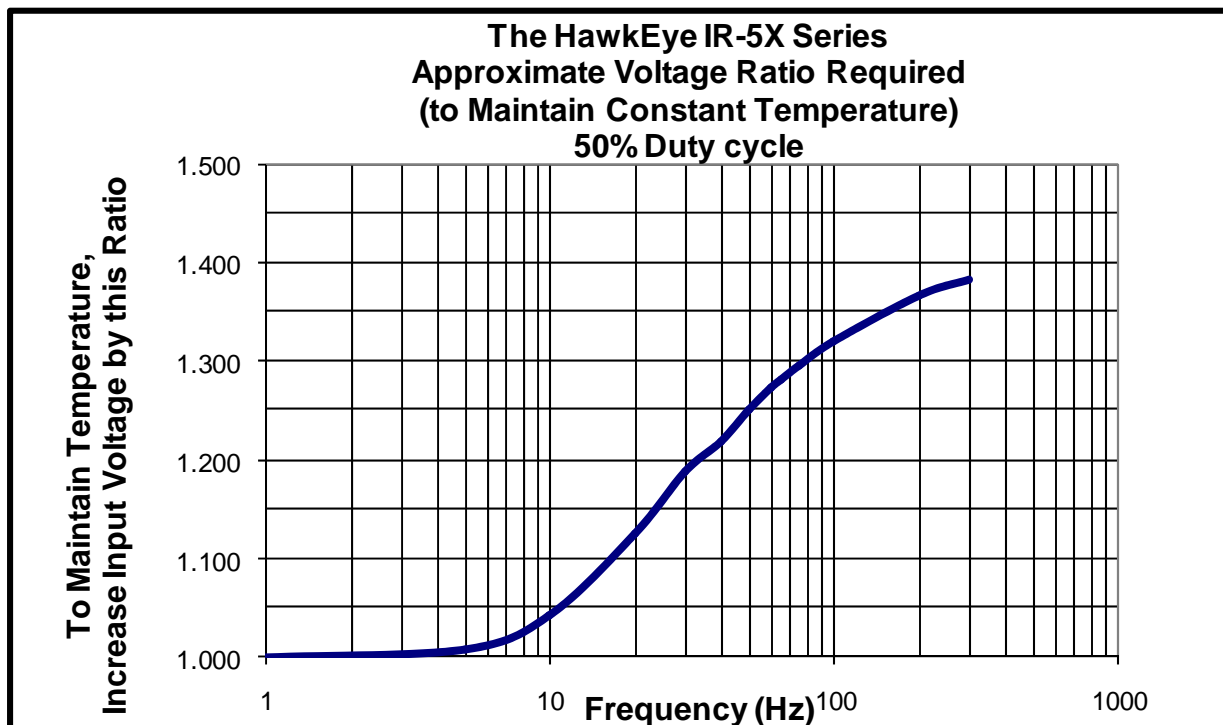
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The HawkEye IR-5x Series is the perfect solution for an application that requires fast electrical modulation. However, it can also be used in a steady state (dc) mode. In applications where steady state power is used (or if used with electrical modulation but with a duty cycle of greater than 50%), it is recommended that the nominal input power specifications be reduced in order to avoid overheating of the membrane.

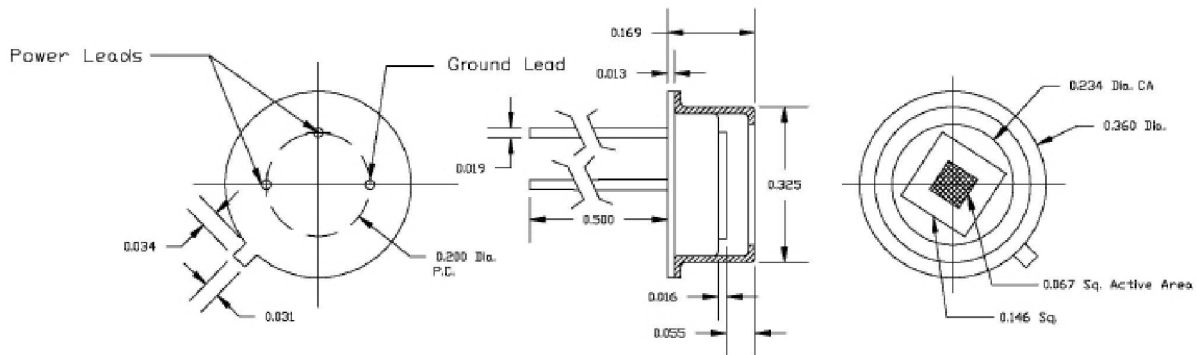
On the other hand, by reducing the length of the heating pulse or by increasing the frequency of modulation, the membrane will not have sufficient time to reach the desired temperature. In this case, the pulsed power can be increased to allow the temperature to be maintained. The chart below shows the factor by which the voltage can be increased as frequency is increased. This chart reflects a 50% duty cycle.





## HawkEye IR-50

The IR-50, mounted in a TO-5 base with a windowless cap provides the smallest package and gives the widest output energy beam. FWHM (full width at half max) for the IR-50 is 100°, as demonstrated in the Normalized Angular Output Chart on page 12.



IR-50 Emitter w/Cap

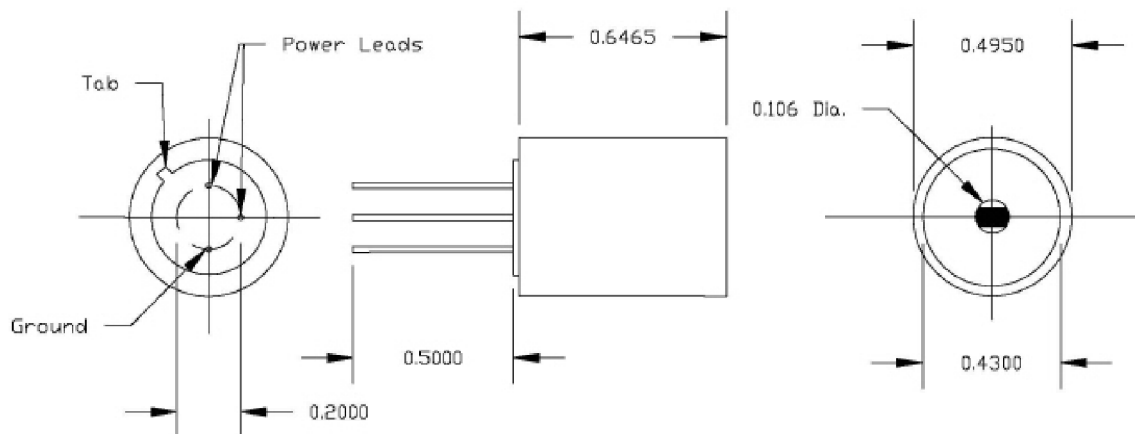
Note: all dimensions in inches.





## HawkEye IR-55

The IR-55 utilizes a collimated HawkEye Optic to provide more than 12x the on-axis output. The package is 0.5 inches in diameter and 0.65 inches long. FWHM (full width at half max) for the IR-55 is 15°. See the Normalized Angular Output Chart on page 12.



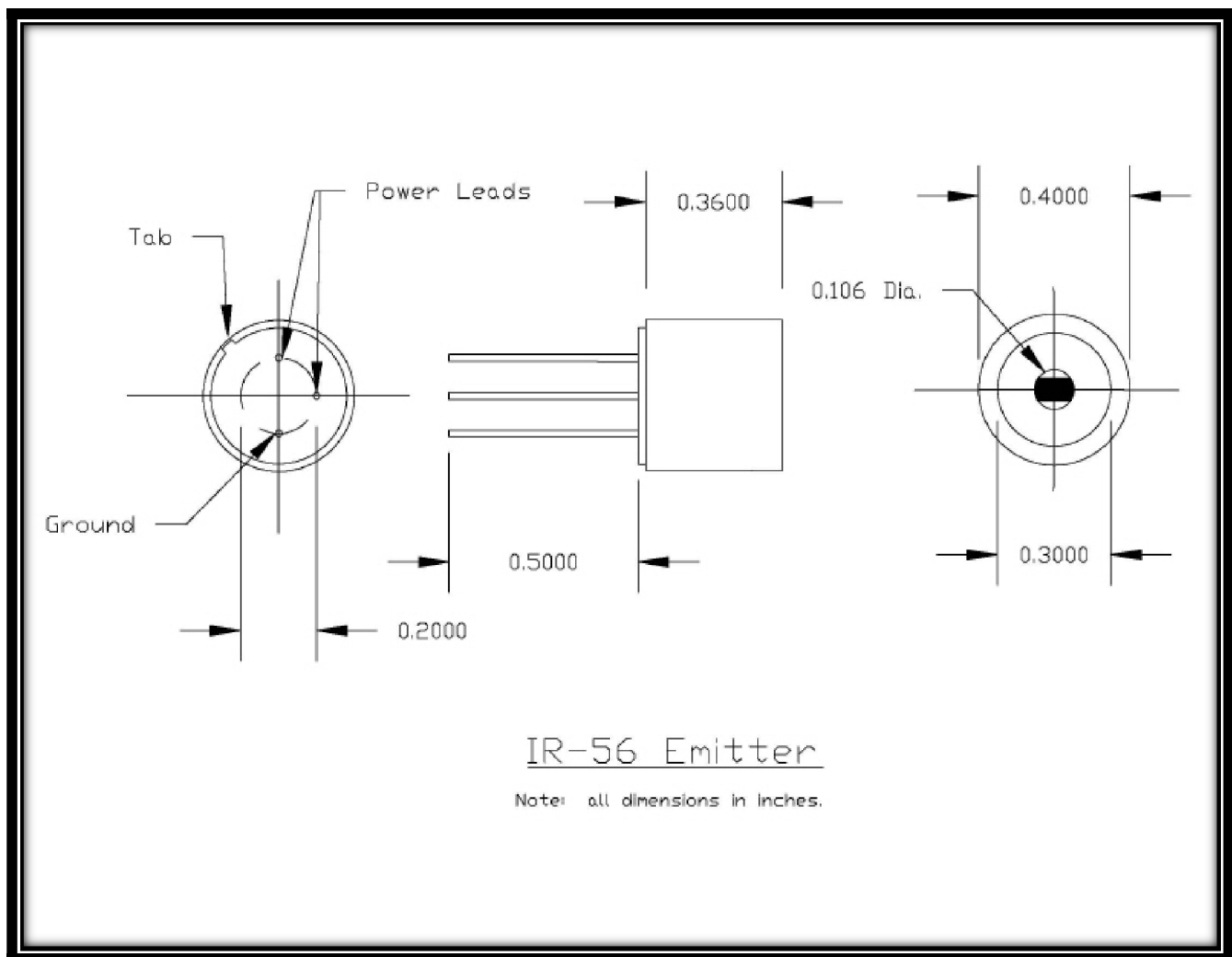
IR-55 Emitter

Note: all dimensions in inches.



## HawkEye IR-56

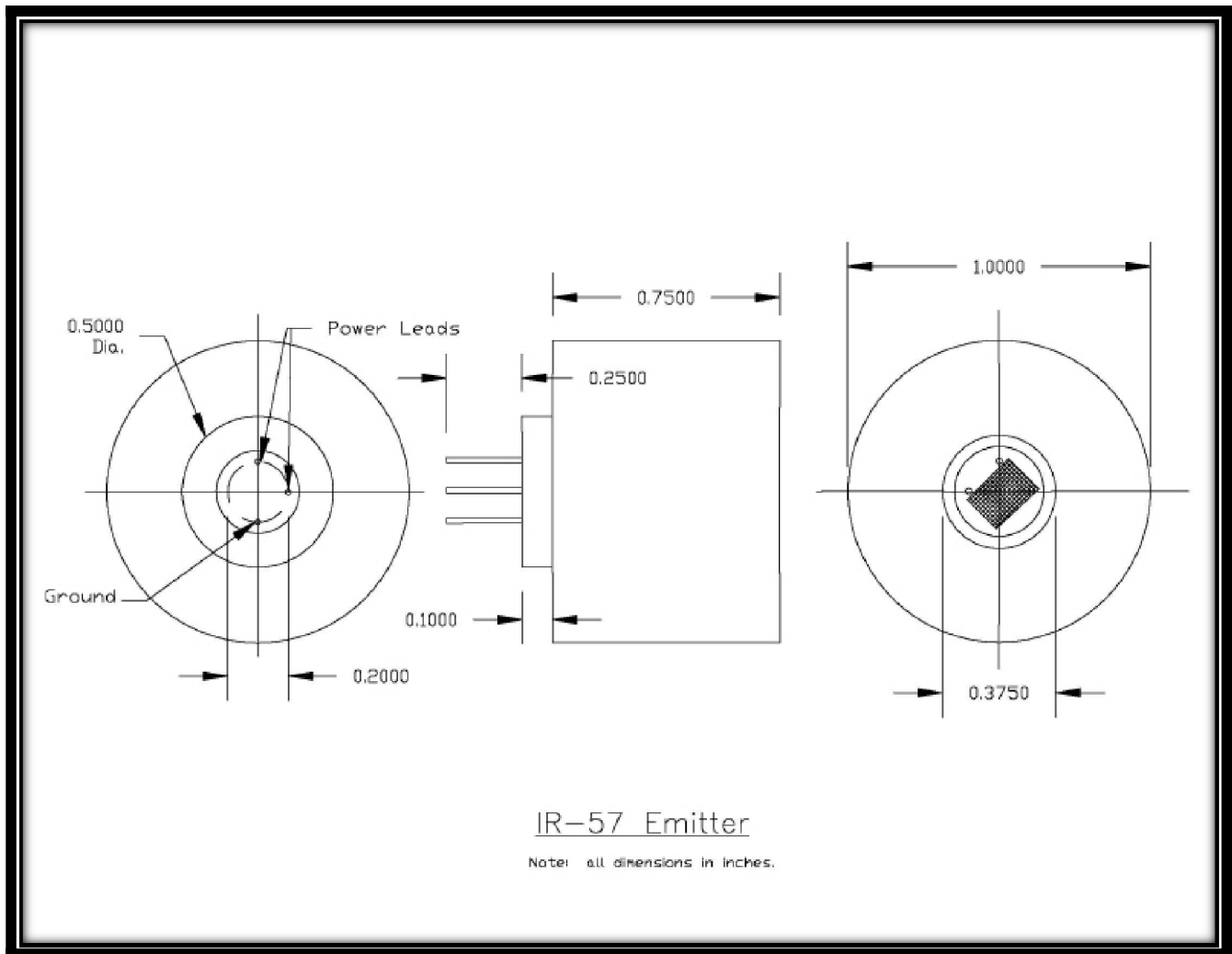
The IR-56 is built upon the same technology as the IR-55, but has just 36% of the IR-55 size. The package is 0.40 inches in diameter and 0.36 inches long. And yet it delivers 50% to 75% of the IR-55 on-axis output energy. FWHM (full width at half max) for the IR-56 is 20°. See the Normalized Angular Output Chart on page 12.





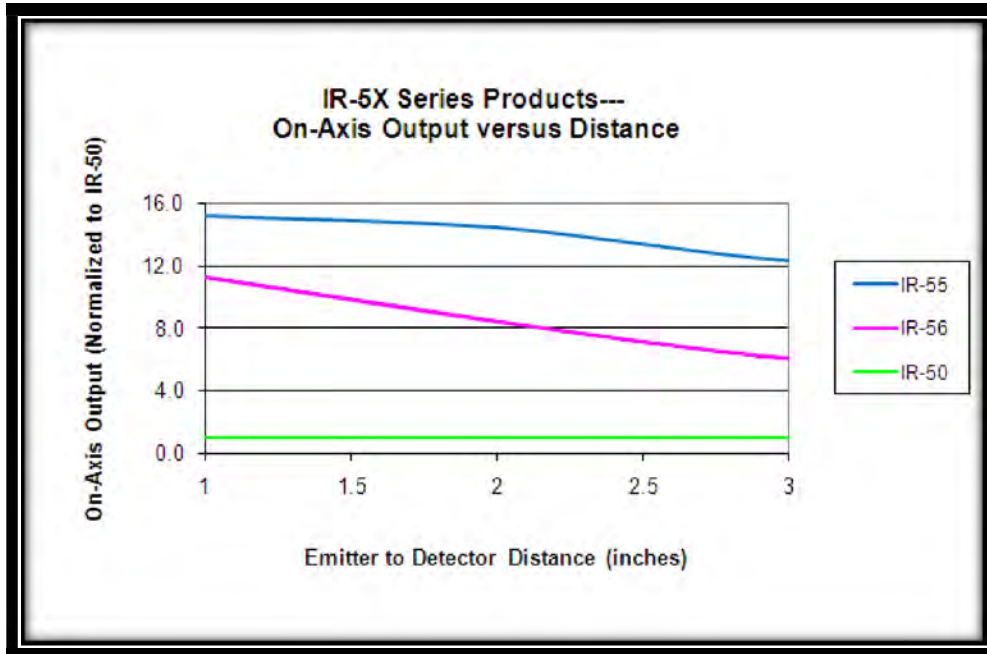
## HawkEye IR-57

The HawkEye Technologies IR-57 utilizes a highly efficient elliptical optic to capture and focus the energy of the HawkEye IR-50 Pulsable Emitter. The unit is one inch in diameter and has an external focal point that is  $\frac{1}{2}$  inch in front of the clear aperture.

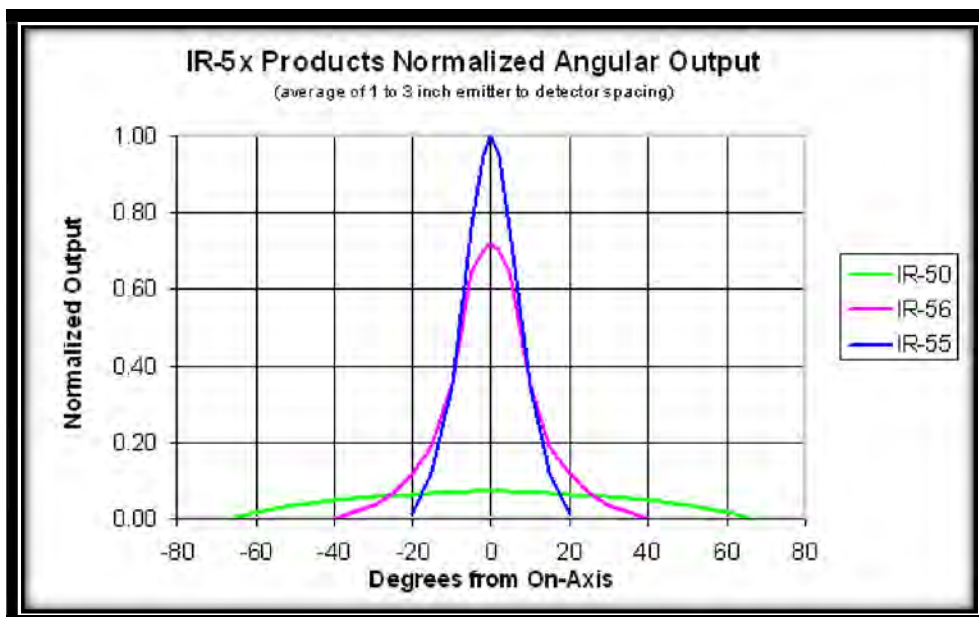




## Normalized On-Axis Output



## Normalized Angular Output







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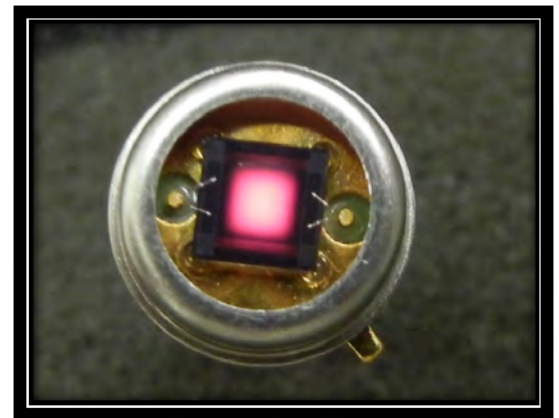
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## Infrared Source Series 7x

- More on-axis output
- Fast response
- High modulation depth
- Highest efficiency – low power consumption
- Most robust pulsable unit ever!

The HawkEye IR-7x Series is a MEMS technology pulsable infrared emitter. This source is based on patented technology, utilizing a thin film resistor of diamond-like nanostructured amorphous carbon. Due to its low thermal mass, the IR-7x Series can be pulsed at frequencies up to 70+ hertz with good modulation depth (contrast between the on and off states). This exciting new product produces more on-axis output and is more robust than the HawkEye IR-5x, the HawkEye IR-6x or any other pulsable product sold.

|  |                                       |
|--|---------------------------------------|
| Active Area  | 2.2 mm x 2.4 mm                       |
| Resistance   | 40 ohms (nominal) in the hot state    |
| Typical Operating Temperature                      | 450°C to 750°C                        |
| Drive Voltage at 750°C                             | 6.0 volts +/- 0.4 volts               |
| Frequency at 50% Modulation Depth (25% Duty Cycle) | 70 Hz                                 |
| Spectral Range                                     | 1 to 20 microns                       |
| Emissivity   | 0.8 (in the range of 2 to 14 microns) |
| Output   | Over 20% greater than the IR-60       |



The HawkEye IR-70 pulsed infrared emitter in a TO-39 header uses a micromachined source chip with a thin, high-emissivity membrane assembled using isolation pads for high efficiency and fast response



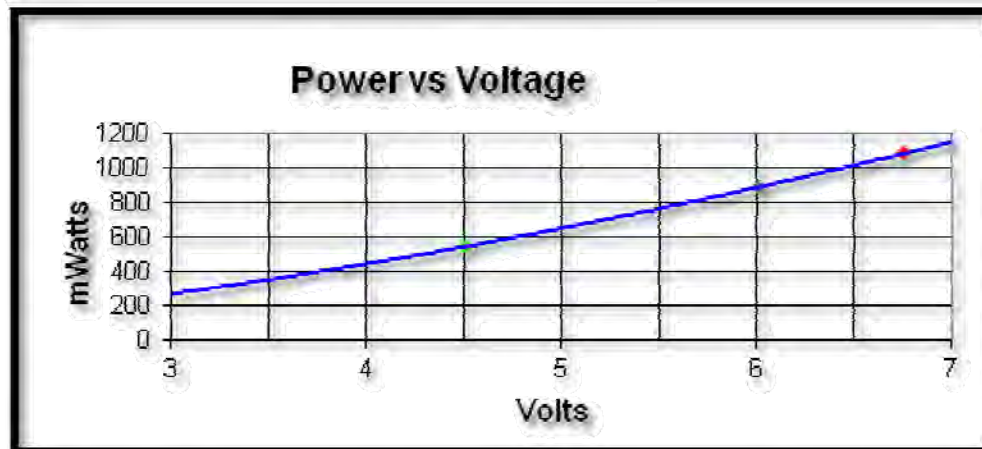
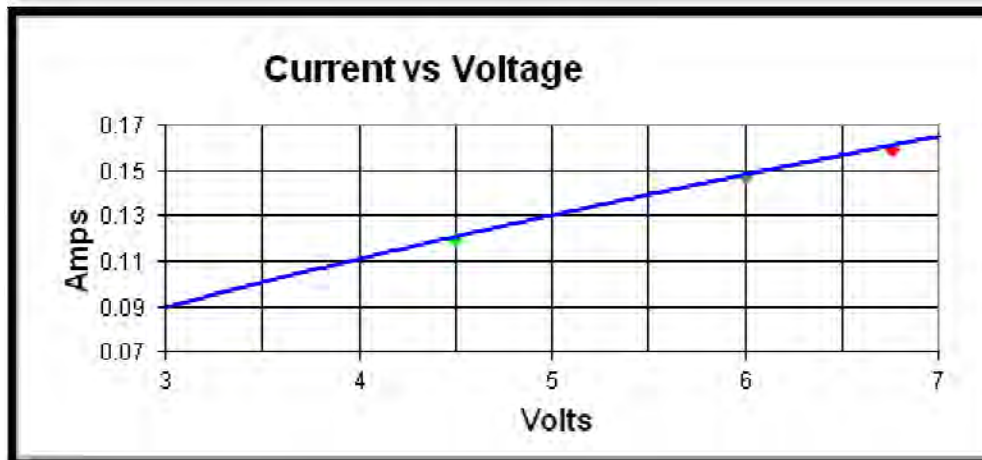
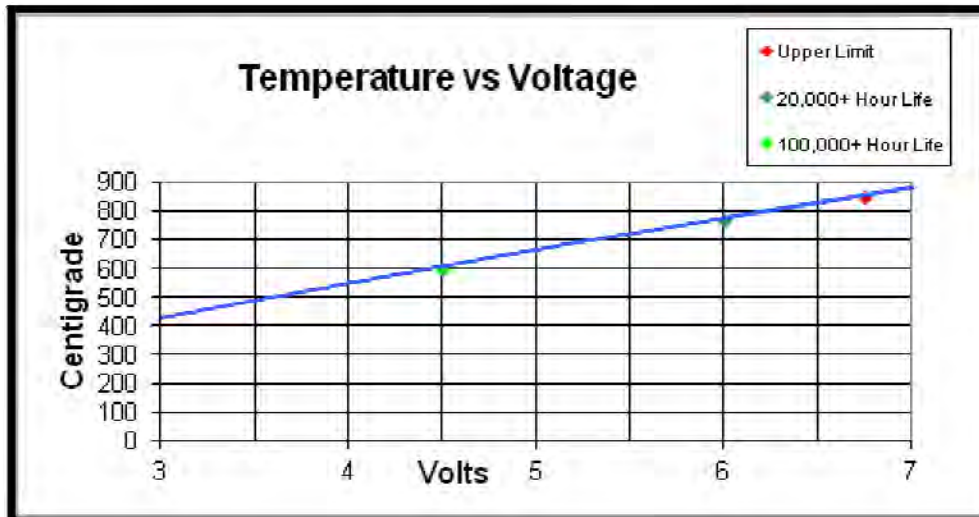
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(617)566-3821

## HawkEye IR-7x Engineering Data Charts



Typical



**Hawkeye Technologies, LLC**  
 Your **Source** for **Infrared**

www.hawkeyetechnologies.com



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 www.boselec.com irsource@boselec.com,  
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## Operating Parameters

| Typical Levels |         |         |        |   |
|----------------|---------|---------|--------|---|
| Temperature    | 450     | 600     | 750    | degrees centigrade                              |
| Voltage        | 3.0     | 4.5     | 6.0    | Volts (AC or DC)                                |
| Current        | 90      | 122     | 150    | mAmps   |
| Power Input    | 270     | 550     | 900    | mWatts  |
| Estimated Life | 150,000 | 100,000 | 20,000 | hours of operation (10 hertz at 50% duty cycle) |

**Note:** The operating parameters assume an infrared source operating without a heat sink and at ambient temperature and pressure. A rectangular voltage pulsed at a frequency of 10 hertz and with a duty cycle of 50% is used for heating. If a longer duty cycle (or steady-state operation) is used, lower power levels are recommended in order to achieve the desired temperature. Also, proportionately shorter lifetime would be expected.

|                          |   |  |                  |
|--------------------------|---|--|------------------|
|                          |  |  |                  |
|                          | IR-70   | IR-75  |                  |
| Length                   | 0.170   | 0.629  | inches           |
| Diameter                 | 0.360   | 0.495  | inches           |
| Package                  | TO-39 with Cap  | parabolic optic  |                  |
| On-Axis Output at 1 inch | 1.6X  | 23.4X  | Indexed to IR-50 |
| Angular Output--FWHM     | 100°  | 15°  | degrees          |



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## Operational Guidelines - Infrared Source Series 7x

The HawkEye IR-7x Series utilizes a thin thermoresistive film of conducting amorphous (diamond-like) carbon. Infrared radiation is the result of heating this film by passing an electric current through it.

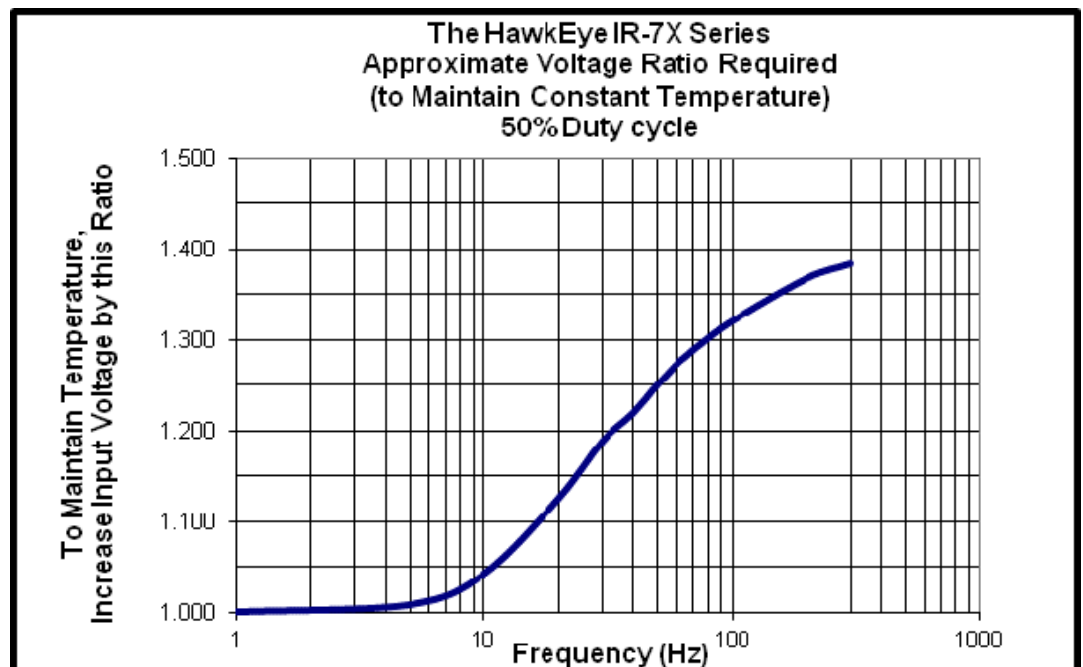
The maximum temperature of the film should not exceed 750°C in continuous operation. A faint red luminescence of the film is observed during operation at temperatures near 750°C. Short term heating up to 850°C is possible but will reduce the lifetime of the unit.

The operating parameters assume an infrared source operating without a radiator and at ambient temperature and pressure. A rectangular voltage pulsed at a frequency of 10 hertz and with a duty cycle of 50% is used for heating.

Two power leads and a ground are provided per the sketch below. The IR-70 emitter is to be powered through the two power leads. Bi-polar drive voltage may be used. The Case Ground Lead is not required under normal operation.

The HawkEye IR-7x Series is the perfect solution for an application that requires fast electrical modulation. However, it can also be used in a steady state (DC or CW) mode. In applications where steady state power is used (or if used with electrical modulation but with a duty cycle of greater than 50%), it is recommended that the nominal input power specifications be reduced in order to avoid overheating of the membrane.

On the other hand, by reducing the length of the heating pulse or by increasing the frequency of modulation, the membrane will not have sufficient time to







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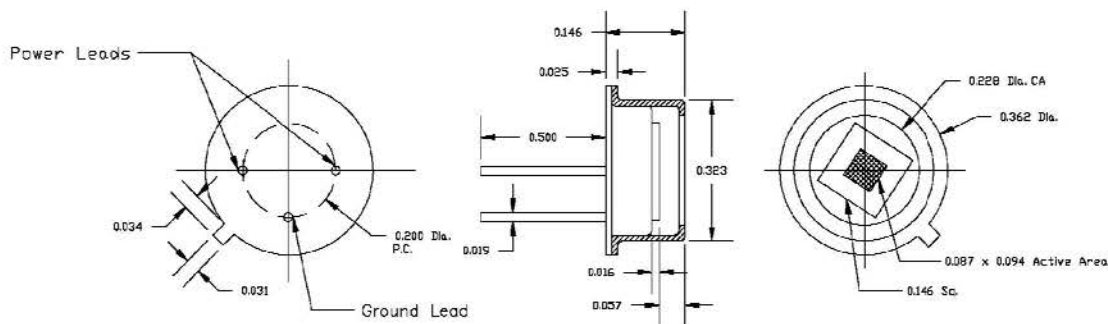


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reach the desired temperature. In this case, the pulsed power can be increased to allow the temperature to be maintained. The chart below shows the factor by which the voltage can be increased as frequency is increased. The next chart reflects a 50% duty cycle.

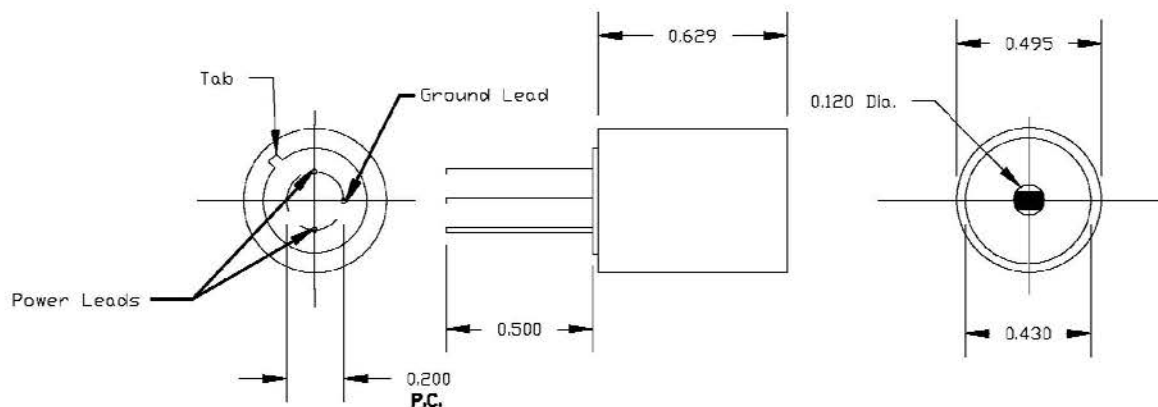
## HawkEye IR-70

The IR-70, mounted in a TO-39 header with a windowless cap provides the smallest package and gives the widest output energy beam. FWHM (full width at half max) for the IR-70 is 100°.



## HawkEye IR-75

The IR-75 utilizes a collimated HawkEye Optic to provide approximately 15x the on-axis output. The package is 0.5 inches in diameter and 0.63 inches long. FWHM (full width at half max) for the IR-75 is 15°. The combination of fast electrical modulation, low input power requirements and great on-axis output places this unit clearly in a class of its own!



IR-75 Emitter

Note: all dimensions in inches.



## HSL Series

## IR-Lamps

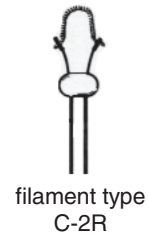
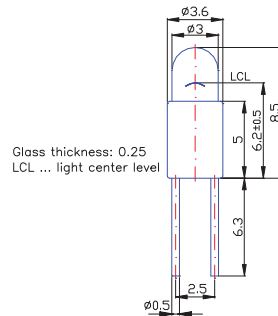
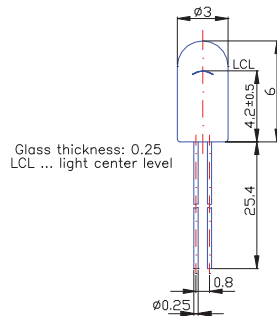
The lamps HSL 5/115 or HSL5/115-S are low cost and reliable IR sources for nondispersive infrared (NDIR) gas detection by IR light absorption, e.g. for gases like CO<sub>2</sub> and hydrocarbons. The IR lamp combines a small design, good processability and has a long lifetime. The lamps meet the requirements of the European Union RoHS (Regulation of Hazardous Substances) directive.

| Parameter             | HSL 5-115<br>HSL 5-115-S | HSL-5-60 | Tolerances | Unit  | Conditions    |
|-----------------------|--------------------------|----------|------------|-------|---------------|
| supply voltage        | 5                        | 5        |            | Volt  |               |
| current               | 115                      | 60       | ± 10%      | mA    |               |
| brightness            | 0,15                     | 0,05     | ± 25%      | MSCP  | visible light |
| filament              | C-2R                     | C-2R     |            |       |               |
| operating temperature | -20..100                 | -20..100 |            | °C    |               |
| average lifetime      | 40000                    | 100000   |            | hours | 5V, AC        |

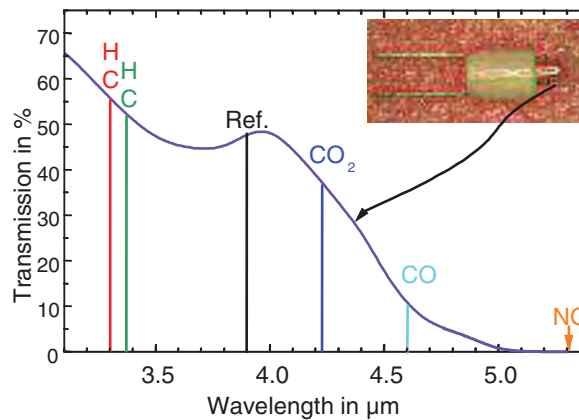
### Ordering Information:

HSL / supply voltage /  
typical current – socket or  
non-socket-type

e.g.: HSL 5/115-S



### Spectral Transmission



Modifications reserved Rev.01 / 06.04.2008



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## Match the Emitter to the Task

BRIAN ELIAS, CAL SENSORS INC.

Often a scientist or engineer is tasked with developing a spectroscopic system for which he must choose a source. He may know exactly which architecture, dispersive element, slit size and sensor the application requires, but he may be left to the mercy of marketing propaganda when it comes to the selection of the infrared source. Should he depend on the old reliable technology or venture into a new and innovative source – and what are the benefits? Maybe a lightbulb would work.

The easy way is reviewing the technologies of each emitter type and selecting a specific spectroscopic application.

The use of infrared is expanding as applications that address cost, quality or security issues are developed. Some applications rely on the generation of IR energy from the object itself, but these are rare. Most spectroscopic measurements rely on reflection from, or transmission through, a sample, with the resultant absorbance spectra measurement being made on the transmitted energy. These require sources of IR energy that have characteristics based on the application, on the spectrometer design or on the detector used.

### Two choices

Infrared sources or emitters can be broken down into two general technologies: quantum and thermal emitters.

Thermal emitters generate photons by heating material. They are, by nature, broadband emitters whose output characteristic is determined primarily by the temperature of the element as described by Planck's law. Characterized by high output power, they have long been the standard source for IR spectroscopy. Thermal emitters can be pulsed but require careful design to overcome the intrinsic thermal mass of the heated filament.

Quantum emitters – laser diodes, IR LEDs, etc. – offer good efficiency and can output well into the IR region. They are useful in spectroscopic applications where a monochromatic source is sufficient or preferred. They offer long lifetimes and high pulse rates in modulated applications.

To determine adequacy for a particular application, each of these technologies can be evaluated by the following parameters: size, efficiency, output power, drive requirements, stability over time, cost, lifetime and pulse rate (for modulated applications).

In addition, some detector technologies dictate the type of source used in a system based on their characteristics; for example, because pyroelectric detectors have slow response to incident radiation, a fast-pulsing source would not be appropriate.

Thermal emitters, also called incandescent emitters, heat material to a point where photons are emitted. Modern thermal emitters have their basis in blackbody radiation and typically are characterized by their emissivity ( $\epsilon$ ), which is defined as the ratio of the radiant emittance of a source to the radiant emittance of a perfect blackbody at the same temperature. Although metals commonly are used as source elements for thermal emitters, they typically have very low emissivity values in the range of 5 percent. A relatively simple process of oxidization can increase their emissivity to more than 80 percent, at which point they have sufficient emissivity to be used as thermal radiators.

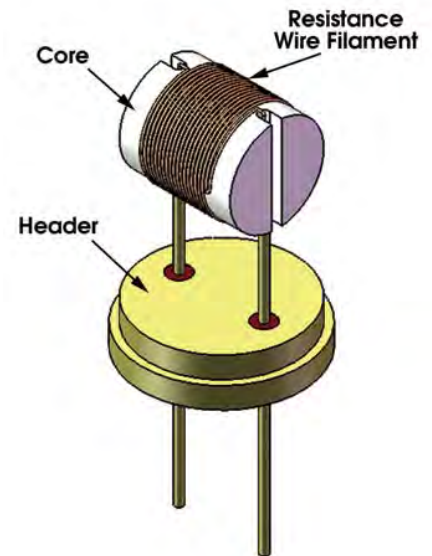
Thermal emitters have the advantage of broadband emission and the disadvantages of slow speed – for pulsed applications – and of high drive-power requirements. Some applications rely on a simple tungsten bulb for a source, but the glass or quartz bulb material used often does not transmit the longer wavelengths; for example, quartz

transmits only 50 percent of its peak value at 4.3  $\mu\text{m}$ . Recent advances in several areas have brought improvements in dedicated thermal emitters that enhance their use in a variety of broadband applications. MEMS technologies now can produce both spectral and blackbody emitters with very small size and fast pulsing – thanks to the low mass of the emitter – with a resultant limitation of low output power. Deposited film emitters offer a compromise between fast pulsing rates and high power output. In addition, advances in filament emitters have resulted in high pulsing speeds with high output power and long lifetimes.

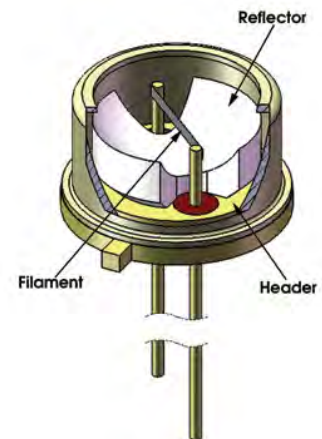
Several filament configurations for thermal emitters, each with their advantages and disadvantages, direct the designer of spectroscopic systems to choose one over the other.

*Wound Filament:* These emitters provide high power output with relatively low cost and high reliability. They can have a solid or air core, with the former material typically ceramic. In its basic form, the air core wound filament emitter is similar to a lightbulb. The dedicated IR emitter's advantage is that it can generate IR photons, so all of the materials are designed with that in mind. A ceramic core often is added to produce a more uniform output because the filament heats the core, thus radiating photons. In some multielement detector systems, air core wound emitters can be problematic because the filament coils are imaged on the detector and produce a nonhomogeneous flux field.

The filament material is a resistance wire, often NiCr, or a variety of wires produced by Kanthal AB that are FeCrAl alloys and that offer high-temperature operation (1350 °C for Kanthal A) and long life. Because of the large mass of the source, wound filament emitters do not lend themselves to modulated applications. Any modulation would require mechanical means, such as an optical chopper.



*Ribbon Filament:* The pulsing speed of an incandescent filament depends on the rate at which the filament can be heated and at which the heat can be removed. Addressing this problem involves the analysis of all aspects of the energy cycle, including filament mass, photon direction, filament “heat sinking” and power-drive design. Ribbon filament emitters are mechanically simple devices, making them cost-effective and reliable. Although tungsten often is used as the filament material, it has very low emissivity, particularly in the infrared, so surface treatments must be applied to enhance the emissivity, and the atmosphere must be carefully controlled to eliminate further emissivity changes resulting from atmospheric interaction. Hermetic sealing with a thermally conductive backfill gas ensures filament emissivity stability as well as a maximum cooling rate during the cooling cycle of the pulsed operation.



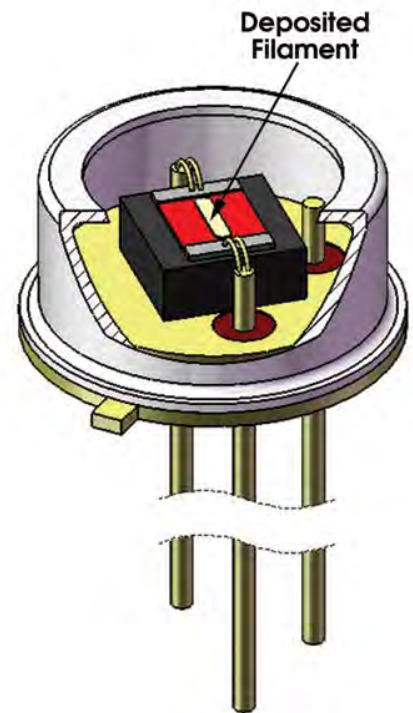
Reflectors often are used – as with the wound filament emitters – to direct all possible radiation out of the package, particularly in vertically oriented filaments.

During the “On” part of the pulsed cycle, it is important to impart as much power to the filament as possible without overstressing it from film evaporation at localized heating points. Careful design of the drive wave form and backfill environment can enhance the pulse rate and modulation depth significantly. Careful control of these parameters has produced emitters with pulse rates of nearly 200 Hz at a modulation depth of 50 percent. The emitters also can be operated as steady-state sources and do not have the coil imaging problems associated with wound filament sources.

*Deposited Filament:* Further reduction in filament mass for a high pulsing rate can be achieved through deposition methods. By their nature, deposited film emitters require a substrate to be the mechanical support mechanism, unlike the ribbon filament, which is self-supporting. The deposited filament emitter consists of a film of electrically resistive material deposited onto a substrate of thermally resistive material. The deposited film can be any material that is compatible with film deposition techniques and that has sufficient resistance and emissivity. It also must withstand the high temperatures associated with incandescent photon emission.

Metals such as tungsten have been used, as have various configurations of silicon, where the resistivity is controlled by doping. Doped polysilicon filaments present some problems with dopant migration and often cannot operate at temperatures sufficient for near-IR spectroscopy. A nonmetallic filament's advantages are that the materials can have higher resistivity and that the drive current requirement is correspondingly lower.

The advantages of the deposited filament source are fast pulse rate and a relatively low cost, depending on the material used. High-volume substrate processing can produce high volumes at relatively low cost. The disadvantage is that the small filament size results in low output power, and for pulsing applications, the thermal mass of the substrate reduces the pulsing speed.



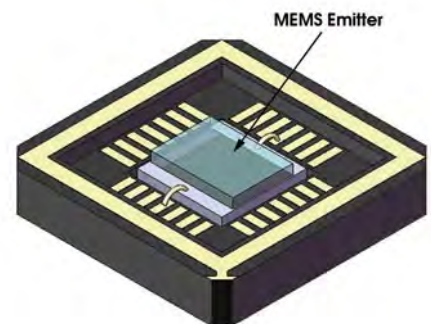
### **Incandescent emitter failure**

A major failure mechanism in incandescent filament emitters is evaporation of the filament, which has two effects that decrease emitter lifetime. As the filament evaporates, it becomes thin, often nonuniformly, because of localized heating resulting from the increased spot resistance. In addition, the evaporated filament deposits onto the window material, decreasing the optical output and increasing the internal temperature of the emitter. Operating these emitters at lower temperatures greatly increases their lifetime. For pulsing emitters, the trade-off always is between low-mass filaments for rapid modulation and sufficient lifetime.

### **Microelectromechanical systems**

*Microelectromechanical systems (MEMS)* techniques are being used in a wide array of applications, including IR emitters, to enhance performance using micromachining methods previously not possible. MEMS devices targeted at specific wavelengths or wavelength ranges are available in both thermal (blackbody) and spectral emitter configurations.

A typical thermal MEMS emitter is like the deposited filament emitter, with the added benefit that the substrate on which the filament is deposited can be made into a very thin member. This greatly reduces the thermal mass of the system and enhances the modulated performance.



Many filament materials have been used, including traditional metals and polysilicon. MEMS techniques have produced single-crystal silicon filament sources that can operate at 1200 K with 10.7 mW of total radiated power from a 1-mm<sup>2</sup> emitter. Other filament materials used are diamondlike carbon or diamondlike nanocomposites, which are durable and have widely variable electrical conductance properties.

MEMS techniques also have produced spectral emitters with methods using, for example, photonic crystals. Although spectrally limited emitters are not appropriate for broadband spectroscopy, they can be advantageous in



spectral analysis of fixed compounds, eliminating the need for band-limiting optical filters.

## Quantum emitters

Whereas thermal emitters generate photons by heating a filament material, quantum emitters generate them by the recombination of electrons and holes across a semiconductor bandgap. The energy of the photon emitted is equal to the difference between the recombined electron-hole pair; thus its wavelength is determined by the host semiconductor material. The bandwidth can vary from fairly wide in the case of pumped infrared LEDs to very narrow in the case of a laser diode. This can be advantageous to some spectroscopic systems, eliminating the need for optical filters to differentiate wavelengths of interest. These devices are not practical in systems that require wideband, high-power infrared radiation.

*IR LEDs:* These components have been developed with wavelengths well into the near-IR spectrum, with continuous power outputs of approximately 1 mW and pulsed power in the tens of milliwatts for wavelengths to 2.2  $\mu\text{m}$ . Higher-wavelength LEDs are available, but the power output is in the microwatt range.

To extend the wavelength range and increase the power output, pumping techniques are used whereby a lower-wavelength source (LED or semiconductor laser) is used to excite a material with a bandgap in the wavelength of interest. The excited material then emits photons at a longer wavelength. This technique can increase the output power 20 times over that of standard LEDs at wavelengths greater than 3  $\mu\text{m}$ .

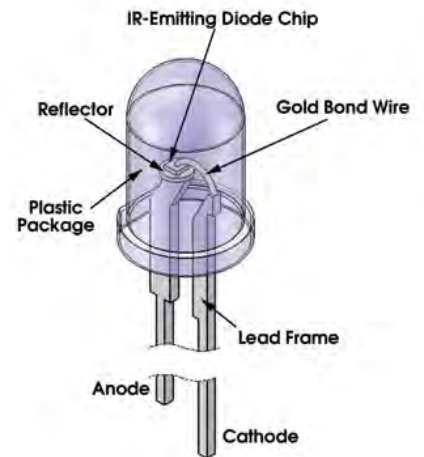
*Laser Diodes:* Because of the process of stimulated emission of photons, a laser diode has an even narrower bandwidth than a conventional LED. In addition, laser diodes can have power outputs in the milliwatt range, making them appropriate for applications that require a high-power, narrowband source. Quantum cascade lasers can produce tens or hundreds of milliwatts in pulsed mode into the far-IR.

Quantum emitters offer high speed and efficiency but are not suited for broadband spectroscopic applications. Thermal emitters are well-suited spectrally for broadband applications, with outputs closely approximating Planck's blackbody curve. Advances in technologies such as micromachining and in applications of existing physics have led to thermal radiators that have a long lifetime as well as relatively high pulsing speeds with high modulation depth.

In addition, cost is always a criterion for any practical system, and solutions that are more exotic are more expensive, but prices will decrease as technology advances. All of these developments improve the quality of spectroscopic systems but require the designer to carefully consider the trade-offs when selecting a specific emitter technology.

## Meet the author

Brian Elias is director of engineering at Cal Sensors Inc. in Santa Rosa, Calif.; e-mail: [brian@calsensors.com](mailto:brian@calsensors.com).



## History

In 1860, Gustav Kirchhoff used the term “blackbody” to refer to an object that perfectly absorbs and thereby perfectly emits energy. In 1894, Wilhelm Wien developed his displacement law, which provided the general form of the equation for the spectral distribution of the radiation from a blackbody. Unfortunately, it agreed only with the experimental data at short wavelengths. In 1900, Lord Rayleigh derived an expression that fit the experimental data

for long wavelengths, but his expression predicted that energy would increase without limit as the wavelength decreases, earning it the dubious distinction as the “ultraviolet catastrophe.” Max Planck interpolated between Wien and Rayleigh to provide a radiation formula that was valid at all wavelengths. He presented his paper to the German Physical Society on Oct. 19, 1900. This introduced the concept of quantum physics.

---



### Features

- \* Easy to use
- \* Low cost
- \* Simple, flexible control using dedicated software
- \* Adjustable voltage driving the source
- \* CW or pulsed operation—MHz to DC
- \* Nanosecond to seconds repetition rate
- \* Current and voltage monitor
- \* powered from USB (<0.5A) or DC supply

## UPS Driver™

# Universal Photon Source (UPS) Driver Board

The Boston Electronics Universal Photon Source (UPS) Driver delivers! It is a flexible, compact, low cost, configurable board, including power supply, that drives a wide range of light sources. The driver can control pulsed and CW sources, which makes it suitable for driving **ultraviolet (UV), visible and infrared (IR) sources, light emitting diodes (LEDs) and lasers over a frequency range of MHz to DC.**

Control is provided by easy to use PC software. The last used drive parameters are stored in the non-volatile EEPROM memory; thus, the configuration is remembered. The UPS Driver is equipped with voltage and current monitors, trigger output, power and communication inputs and anode/cathode connections for the sources.

**The UPS Driver is compatible with UV, visible and IR sources, LEDs and lasers.**



# UPS Driver Specifications

Developed with, and  
manufactured by:



## Electrical parameters:

- ◆ Power supply: - USB from computer or +5 ... +6 V, connected to the DC Jack connector
- ◆ Average power sources
  - ◇ max. 1.5W, for the power supply from USB
  - ◇ max. 10W, for the power supply connected to the DC Jack connector
- ◆ Adjustable voltage supply, in the range 0.5 – 25V, 4095 steps
- ◆ Maximum current: 10 A (tested with QCL at 20 V and 100 ns pulse width)
- ◆ Monitor for the supply voltage source (ADC)
- ◆ Master clock period / frequency:
- ◆ main clock period / frequency                      output signal max. period / min. frequency

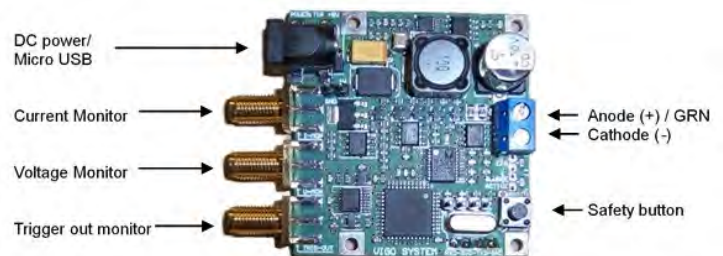
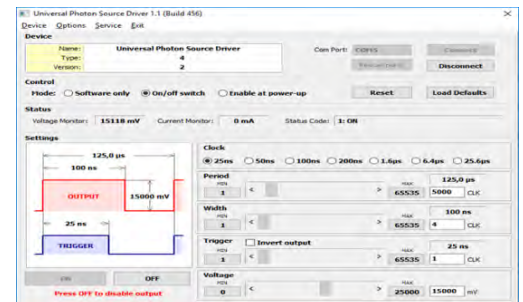
|                       |                    |
|-----------------------|--------------------|
| 25 ns / 40 MHz        | 1.638 ms / 610 Hz  |
| 50 ns / 20 MHz        | 3.27 ms / 305 Hz   |
| 100 ns / 10 MHz       | 6.55 ms / 152 Hz   |
| 200 ns / 5 MHz        | 13.1 ms / 76.3 Hz  |
| 1600 ns / 0,625 MHz   | 104 ms / 9.54 Hz   |
| 6.4 μs / 156,25 kHz   | 420 ms / 2.38 Hz   |
| 25.6 μs / 39,0625 kHz | 1.677 s / 0.594 Hz |
- ◆ Pulse repetition period - adjustable in the range 1 ... 65535 times the period of the master clock
- ◆ Pulse duration - adjustable in the range 1 ... 65535 times the period of the master clock
  - ◇ if pulse duration is higher than the period, source stays on – CW operation
- ◆ Driving signal rise / fall times < 3 ns.
- ◆ Pulse jitter : 6 ns pp
- ◆ Trigger output starts 50 ns before the IR pulse
  - ◇ adjustable duration time in the range 1 ... 65535 times the period of the master clock
- ◆ Power supply monitor
- ◆ Source average current monitor - time constant 100 ms
- ◆ All parameters have their equivalent – minimum/maximum to provide for safe operation
- ◆ Anode of the source is connected to ground, cathode below ground potential

## Software

- ◆ The UPS Driver is configured using PC software, or text protocols.

## Connections:

- ◆ trigger output—SMA connector
  - ◇ output impedance 50 Ω
  - ◇ standard LVTTTL: logic 0 - 0 V, logic 1 – 3,3 V @ Hi-imp, 1.65 V @ 50 Ω
- ◆ output current monitor—SMA connector
  - ◇ DC offset ~ 100 mV @ 50 Ω
  - ◇ current sensitivity 0.1 V/A @ 50 Ω / can be modified
  - ◇ 100 MHz BW
- ◆ output voltage monitor—SMA connector
  - ◇ DC offset ~ 100 mV @ 50 Ω
  - ◇ voltage sensitivity 50mV/V @ 50 Ω / can be modified
  - ◇ 100 MHz bandwidth
- ◆ micro-USB connector
  - ◇ communication with PC, virtual COM port
  - ◇ power supply, if current consumption of the driver does not exceed 0.5 A (USB 2.0 standard)
- ◆ DC power jack 2.5/5.5
  - ◇ power supply, if driver requires more than 0.5A (USB 2.0 standard), or If the PC is not used (configuration is restored from the memory)



## Size:

- ◆ PCB dimensions 60x50x15mm (width×height×depth), including connectors



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 boselec@boselec.com www.boselec.com

1/7/2018 0:00

## IR SOURCES



| Qty            | P/N       | Description  | Unit \$ |
|----------------|-----------|--|---------|
| 10 (min order) | HSL-5-115 | LOW COST miniature infrared light source, in Glass envelope - useful at wavelengths shorter than about 4.5 microns. Average lifetime 40,000 hours. | \$4.70  |
| 50             |           |  | \$3.40  |
| 100            |           |  | \$2.90  |
| 1000           |           |  | \$2.21  |
| 10000          |           |  | \$1.62  |

Prices are FOB Brookline MA USA  
 Prices do NOT include shipping cost to customer  
 Payment terms are NET 30 days to customers whose credit we approve.  
 We accept credit cards.





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[boselec@boselec.com](mailto:boselec@boselec.com)

## HelioWorks - Infrared Sources Prices

### IO-8 PACKAGE

| Quantity | Steady State |            |        | Pulsable    |            |        |
|----------|--------------|------------|--------|-------------|------------|--------|
|          | (No Window)  | (Sapphire) | (CaF2) | (No Window) | (Sapphire) | (CaF2) |
| 1-9      | \$57         | \$89       | \$102  | \$135       | \$89       | \$102  |
| 10-24    | \$50         | \$76       | \$85   | \$112       | \$50       | \$85   |
| 25-99    | \$45         | \$63       | \$70   | \$93        | \$45       | \$70   |
| 100-249  | \$41         | \$54       | \$60   | \$93        | \$41       | \$60   |
| 250-499  | \$38         | \$48       | \$53   | \$93        | \$38       | \$53   |
| 500-999  | \$36         | \$43       | \$48   | \$93        | \$36       | \$48   |
| 1000 up  |              |            |        |             |            |        |

For EF-series emitters, add \$3.00 each for reflectors and add a suffix "R" to the model number

### IO-5 PACKAGE

| Quantity | Steady State |            |        | Pulsable    |            |        |
|----------|--------------|------------|--------|-------------|------------|--------|
|          | (No Window)  | (Sapphire) | (CaF2) | (No Window) | (Sapphire) | (CaF2) |
| 1-9      | \$45         | \$80       | \$90   | \$45        | \$60       | \$70   |
| 10-24    | \$38         | \$70       | \$78   | \$40        | \$50       | \$60   |
| 25-99    | \$35         | \$60       | \$60   | \$38        | \$43       | \$53   |
| 100-249  | \$32         | \$45       | \$55   | \$30        | \$35       | \$45   |
| 250-499  | \$29         | \$40       | \$46   | \$26        | \$30       | \$40   |
| 500-999  | \$27         | \$38       | \$44   | \$21        | \$25       | \$35   |
| 1000 up  |              |            |        |             |            |        |

### IO-3 PACKAGE

| Quantity | Steady State |            |        | Pulsable    |            |        |
|----------|--------------|------------|--------|-------------|------------|--------|
|          | (No Window)  | (Sapphire) | (CaF2) | (No Window) | (Sapphire) | (CaF2) |
| 1-9      | \$85         | \$110      | \$130  | \$85        | \$110      | \$130  |
| 10-24    | \$74         | \$100      | \$115  | \$74        | \$100      | \$115  |
| 25-99    | \$62         | \$90       | \$102  | \$62        | \$90       | \$102  |
| 100-249  | \$62         | \$85       | \$92   | \$62        | \$85       | \$92   |
| 250-499  | \$62         | \$80       | \$90   | \$62        | \$80       | \$90   |
| 500-999  | \$62         | \$75       | \$89   | \$62        | \$75       | \$89   |
| 1000 up  |              |            |        |             |            |        |

Universal Photon Drive Board \$395

**Note:**  
 All prices FOB Brookline, MA  
 Prices based on standard specifications  
 Prices subject to change without notice  
 For EF-series emitters, add \$3.00 each for reflectors and add a suffix "R" to the model number  
 Larger quantities than listed quoted upon request  
 21-Dec-18

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| <u>Part Number</u> | <u>Description</u> | <u>1 to 9</u> | <u>10 to 24</u> | <u>25 to 99</u> | <u>100 to 249</u> |
|--------------------|--------------------|---------------|-----------------|-----------------|-------------------|
|--------------------|--------------------|---------------|-----------------|-----------------|-------------------|

|  |  |          |          |          |          |
|--|--|----------|----------|----------|----------|
| <b>STEADY STATE SOURCES (Series 1X, 2X, SIX)</b> |  |          |          |          |          |
| IR-12  | IR-12 source (NiChrome)                                | \$70.00  | \$64.00  | \$58.00  | \$53.00  |
| IR-12K   | IR-12K source (Kanthal) <b>Recommended</b>             | \$70.00  | \$64.00  | \$58.00  | \$53.00  |
| IR-12/TC; IR-12K/TC                              | IR-12 / IR-12K with Thermocouple for Temp Ref          | \$160.00 | \$146.00 | \$133.00 | \$121.00 |
| IR-Si253-P-1 (was IR-18)                         | Silicon Nitride Source (12V, 20W) with 1 inch parabola | \$115.00 |          |          |          |
| IR-Si253-E-1 (was IR-19)                         | Silicon Nitride Source (12V, 20W) with 1 inch ellipse  | \$125.00 |          |          |          |
| IR-21  | IR-21 source   | \$61.00  | \$56.00  | \$51.00  | \$46.00  |
| IR-21V   | IR-21 source with a vertical coil                      | \$61.00  | \$56.00  | \$51.00  | \$46.00  |
| IR-Si207   | Silicon Carbide Source (12V, 24W)                      | \$75.00  | \$68.00  | \$62.00  | \$56.00  |
| IR-Si217   | Silicon Carbide Source (24V, 37W)                      | \$85.00  | \$77.00  | \$70.00  | \$64.00  |
| IR-Si253   | Silicon Nitride Source (12V, 20W)                      | \$75.00  | \$68.00  | \$62.00  | \$56.00  |
| IR-Si272   | Silicon Nitride Source (6V, 30W)                       | \$75.00  | \$68.00  | \$62.00  | \$56.00  |
| IR-Si295   | Silicon Nitride Source (12V, 40W)                      | \$85.00  | \$77.00  | \$70.00  | \$64.00  |
| IR-Si311 (was PL-311)                            | Silicon Nitride Source (12V, 70W)                      | \$95.00  | \$86.00  | \$78.00  | \$71.00  |

Reflectors available for IR-12, -12K, IR-2X, IR-Si2X (Add reflector price to the source price. Show in PO the complete part number. Example: IR-Si207-P-1)

|                      |                             |         |         |         |         |
|----------------------|-----------------------------|---------|---------|---------|---------|
| XXX-P-1 (was MC-234) | 1 inch Parabolic Reflector  | \$40.00 | \$36.00 | \$33.00 | \$30.00 |
| XXX-P-2              | 2 inch Parabolic Reflector  | \$65.00 | \$59.00 | \$54.00 | \$49.00 |
| XXX-P-3              | 3 inch Parabolic Reflector  | \$75.00 | \$68.00 | \$62.00 | \$56.00 |
| XXX-E-1 (was MC-233) | 1 inch Elliptical Reflector | \$50.00 | \$46.00 | \$42.00 | \$38.00 |
| XXX-E-2              | 2 inch Elliptical Reflector | \$75.00 | \$68.00 | \$62.00 | \$56.00 |
| XXX-E-3              | 3 inch Elliptical Reflector | \$85.00 | \$77.00 | \$70.00 | \$64.00 |

Windows available for IR-12, -12K, IR-2X, IR-SiX. Add window price to source+reflector price. Available with reflectors only. Show in PO the complete assembly. Example: IR-Si207-P-1-CaF2)

|              |  |         |         |         |         |
|--------------|--|---------|---------|---------|---------|
| XXX-X-1-S    | Source with 1 inch Parabolic/Elliptical Reflector and uncoated Sapphire Window | \$32.00 | \$29.00 | \$26.00 | \$24.00 |
| XXX-X-1-CaF2 | Source with 1 inch Parabolic/Elliptical Reflector and uncoated CaF2 Window     | \$48.00 | \$44.00 | \$40.00 | \$36.00 |

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| <u>Part Number</u>  | <u>Description</u>   | <u>1 to 9</u> | <u>10 to 24</u> | <u>25 to 99</u> | <u>100 to 249</u> |
|---|--|---------------|-----------------|-----------------|-------------------|
| <b>STEADY STATE SOURCES (Series 3X, 4X)</b>   |  |               |                 |                 |                   |
| IR-30/NC  | IR-30 source (NiChrome) no Cap                               | \$75.00       | \$68.00         | \$62.00         | \$56.00           |
| IR-30   | IR-30 source (NiChrome) with Cap                             | \$77.00       | \$70.00         | \$64.00         | \$58.00           |
| IR-30K/NC   | IR-30K source (Kanthal) no Cap                               | \$75.00       | \$68.00         | \$62.00         | \$56.00           |
| IR-30K  | IR-30K source (Kanthal) with Cap                             | \$77.00       | \$70.00         | \$64.00         | \$58.00           |
| IR-43/NC  | IR-43 source no Cap  | \$43.00       | \$39.00         | \$35.00         | \$32.00           |
| IR-43   | IR-43 source with Cap  | \$45.00       | \$41.00         | \$37.00         | \$34.00           |
| <b>Reflectors available for IR-3X, IR-4X (Add reflector price to the "NC" source price. Show in PO the complete package. Example: IR-30K-P-05)</b>                      |  |               |                 |                 |                   |
| XXX-P-05  | half inch Parabolic Reflector                                | \$23.00       | \$21.00         | \$19.00         | \$18.00           |
| XXX-E-05  | half inch Elliptical Reflector                               | \$23.00       | \$21.00         | \$19.00         | \$18.00           |
| <b>Windows available for IR-3X and IR-4X (Add window price to the "NC" or "NC" source+reflector price. Show in PO the complete assembly. Example: IR-30K-P-05-CaF2)</b> |  |               |                 |                 |                   |
| XXX-S   | Cap and Sapphire Window                                      | \$17.00       | \$15.00         | \$14.00         | \$13.00           |
| XXX-CaF2  | Cap and CaF2 Window  | \$42.00       | \$38.00         | \$35.00         | \$32.00           |
| XXX-X-05-S  | half inch Parabolic/Elliptical Reflector and Sapphire Window | \$17.00       | \$15.00         | \$14.00         | \$13.00           |
| XXX-X-05-CaF2   | half inch Parabolic/Elliptical Reflector and CaF2 Window     | \$42.00       | \$38.00         | \$35.00         | \$32.00           |

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| <u>Part Number</u>  | <u>Description</u>   | <u>1 to 9</u> | <u>10 to 24</u> | <u>25 to 99</u> | <u>100 to 249</u> |
|---|--|---------------|-----------------|-----------------|-------------------|
| <b>ELECTRICALLY MODULATED SOURCES and ACCESSORIES (Series 5X, 7X)</b> |  |               |                 |                 |                   |
| IR-50/NC (was PL-240)   | IR-50 source no Cap  | \$63.00       | \$57.00         | \$52.00         | \$47.00           |
| IR-50   | IR-50 source with Cap  | \$65.00       | \$59.00         | \$54.00         | \$49.00           |
| IR-50-S   | IR-50 source with Cap and Sapphire Window                      | \$80.00       | \$73.00         | \$66.00         | \$60.00           |
| IR-50-CaF2 (was PL-218)   | IR-50 source with Cap and CaF2 Window                          | \$105.00      | \$96.00         | \$87.00         | \$79.00           |
| IR-55   | IR-50 source with "Long" Parabolic Reflector                   | \$78.00       | \$71.00         | \$65.00         | \$59.00           |
| IR-55-S   | IR-50 source with "Long" Parabolic Reflector and Sapphire Win  | \$93.00       | \$85.00         | \$77.00         | \$70.00           |
| IR-55-CaF2  | IR-50 source with "Long" Parabolic Reflector and CaF2 Window   | \$120.00      | \$109.00        | \$99.00         | \$90.00           |
| IR-56   | IR-50 source with "Short" Parabolic Reflector                  | \$78.00       | \$71.00         | \$65.00         | \$59.00           |
| IR-56-S   | IR-50 source with "Short" Parabolic Reflector and Sapphire Win | \$98.00       | \$89.00         | \$81.00         | \$74.00           |
| IR-56-CaF2  | IR-50 source with "Short" Parabolic Reflector and CaF2 Window  | \$118.00      | \$107.00        | \$97.00         | \$88.00           |
| IR-70/NC  | IR-70 source no Cap  | \$73.00       | \$66.00         | \$60.00         | \$55.00           |
| IR-70   | IR-70 source with Cap  | \$75.00       | \$68.00         | \$62.00         | \$56.00           |
| IR-70-S   | IR-70 source with Cap and Sapphire Window                      | \$90.00       | \$82.00         | \$75.00         | \$68.00           |
| IR-70-CaF2  | IR-70 source with Cap and CaF2 Window                          | \$115.00      | \$105.00        | \$96.00         | \$87.00           |
| IR-75   | IR-70 source with "Long" Parabolic Reflector                   | \$88.00       | \$80.00         | \$73.00         | \$66.00           |
| IR-75-S   | IR-70 source with "Long" Parabolic Reflector and Sapphire Win  | \$103.00      | \$94.00         | \$86.00         | \$78.00           |
| IR-75-CaF2  | IR-70 source with "Long" Parabolic Reflector and CaF2 Window   | \$130.00      | \$118.00        | \$107.00        | \$97.00           |
| IR-76   | IR-70 source with "Short" Parabolic Reflector                  | \$88.00       | \$80.00         | \$73.00         | \$66.00           |
| IR-76-S   | IR-70 source with "Short" Parabolic Reflector and Sapphire Win | \$108.00      | \$98.00         | \$89.00         | \$81.00           |
| IR-76-CaF2  | IR-70 source with "Short" Parabolic Reflector and CaF2 Window  | \$128.00      | \$116.00        | \$106.00        | \$96.00           |

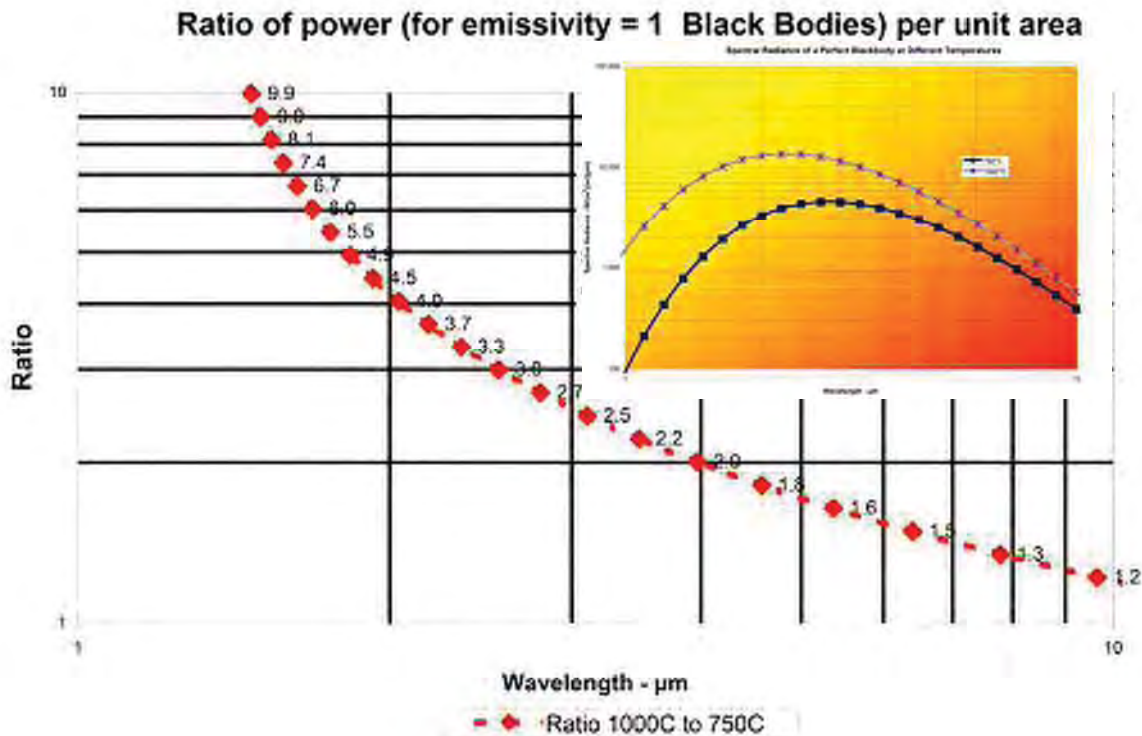
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## If I use a hotter source, how much more energy will I get from it?

The question above is a common one. Just how much additional energy do you get when you raise the temperature of an IR emitter?

To answer this, we have calculated the RATIO of the power (spectral radiance, watts per unit area per steradian) of a 1000C (1273K) blackbody to the power of a 750C (1023K) blackbody. The result is charted below:



We find that at 2 microns one gets about 4 times more power, but this falls to 2 times more at 4 microns and only 1.5 times more at 6 microns.

The bottom line: turning up the heat may get you less than you hoped for.