# Control Circuit for Radiometer

```
clear; clc;
f = Func_lib;
```

## Stock Detector Specs

```
Detector = {1,.785,60,8571,23.2,3,-.36,-.2,7,.3,2.9,32,56,85,.284,.403};
Diam_d = Detector{1} / 10;%cm
A_j = Detector{2} / 100;%cm^2, area of detector
V_o_dm = Detector{3} / 10^6;%V
S_N_R = Detector{4};
Responsivity = Detector{5};
R_det = Detector{6};
TC_Res = Detector{7};
TC_R = Detector{8};
N_V = Detector{9};
N_EP = Detector{10};
Detectivity = Detector{11};
tau = Detector{12};
AFOV_1 = Detector{13};
AFOV_2 = Detector{14};
x1 = Detector{15}%cm
```

```
x1 = 0.2840
```

```
D_d = Detector{16} * 2.54%cm
```

```
D_d = 1.0236
```

## Package Hole Sizes:

```
hole_dia = .1*2.54%converted to cm
```

```
hole_dia = 0.2540
```

```
internal_aperture = false;
tube = true;
external_aperture = false;
```

### Location & FOV Info:

```
r_r = Diam_d / 2; %radius of receiving area,cm
if internal_aperture  == 0
    r_a = hole_dia / 2; %radius of aperture,cm
    if tube == 1
        x1 = 6.9;
        %{
        if external_aperture ==1
            d_a = 0.498;
            r_a = d_a / 2;
        else
            r_a = D_d/2;
        end
```

```
        %}
        r_a = D_d/2;
        AFOV = 2*atand(r_a/x1);
        rat = r_a/x1
    else

        r_a = hole_dia / 2; %radius of aperture,cm
    end
else
    ap_d = 1.5/10;
    x1 = .0769; %cm
    r_a = ap_d / 2 %cm
    AFOV = 2*atand(r_a/x1);
end
```

```
rat = 0.0742
```

```
if exist("AFOV")
    if AFOV_1<AFOV
        AFOV = AFOV_1;
    end
else
    AFOV = AFOV_1;
end

x2 = 9*2.54/2; %estimated distance from sample,cm

if r_a > r_r
    r_s = x2 * tand(AFOV/2) + r_r %radius of visible area, cm
    h_s = 15; %assuming centered on sample,half of height
    wid_s = 3.25; %assuming centered on sample,half of width

    R = sqrt((x2^2) + (r_r^2));
    sr = 1/(R^2);

    %{
    If r is greater than h_s  and wid_s, entire sample is in view.
    If r is greater than wid_s but not h_s, part of sample is in view.
    If r is less than h_s  and wid_s, all of view is an area of sample.
    %}
    if r_s > h_s
        A_i = 4 * h_s * wid_s;
    elseif r_s > wid_s
        theta = acosd(wid_s/r_s);
        a = (180 - theta)/2;
        w = sqrt((2*(r_s^2))*(1-cosd(a)));
        A_sec = theta*pi*(r_s^2)/360 - .5*w*wid_s;
        A_i = pi*(r_s^2) - 2*A_sec;
    else
        A_i = pi*(r_s^2);
    end
else
    A_i = pi * (r_a^2)
```

```
    A_j = A_i;
    R = sqrt((x2^2) + (r_a^2));
    sr = 1/(R^2);
end
```

```
r_s = 0.8978
```

## Basic IR Calcs

**Range of Temps:**

```
T_range = [273:1273];
```

**Range of Wavelengths:**

```
lambda_max = 2898 ./ T_range
```

```
lambda_max = 1×1001
   10.6154   10.5766   10.5382   10.5000   10.4621   10.4245   10.3871   10.3500 ⋯
```

## Optical Filter

```
Opt_filt = {[.2:.1:17.5],.91,.91,.039,[0,0,1,1,0,0,0]};
BP_wavelength = Opt_filt{1};
Peak_trans = Opt_filt{2};
Avg_trans = Opt_filt{3}
```

```
Avg_trans = 0.9100
```

```
Thickness_fil = Opt_filt{4};
Pac_avail = Opt_filt{5};
```

## Encapsulating Gas

```
det_type = [1,.75,2.4,.4]
```

```
det_type = 1×4
    1.0000    0.7500    2.4000    0.4000
```

```
mult_gas = det_type(2)
```

```
mult_gas = 0.7500
```

## Time Constant

*may not be necessary

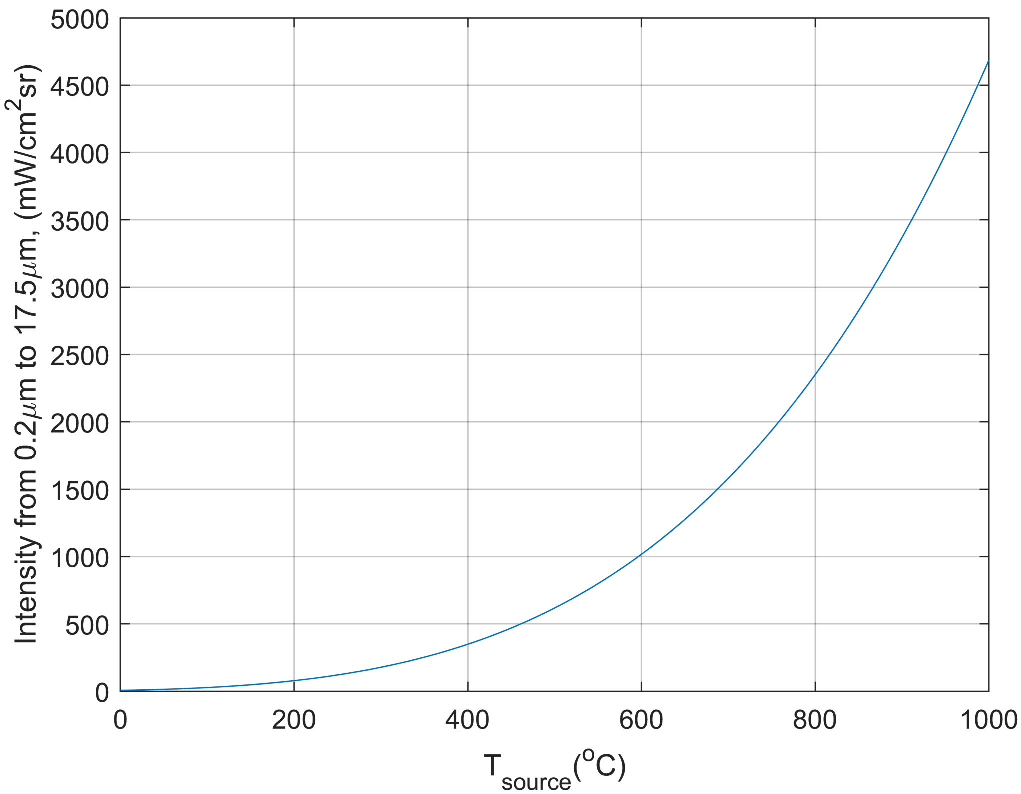
## Blackbody Radiance For Temperature & Wavelength Range:

```
L = f.Intensity2(T_range,BP_wavelength).*1000; %mW/cm^2sr
```

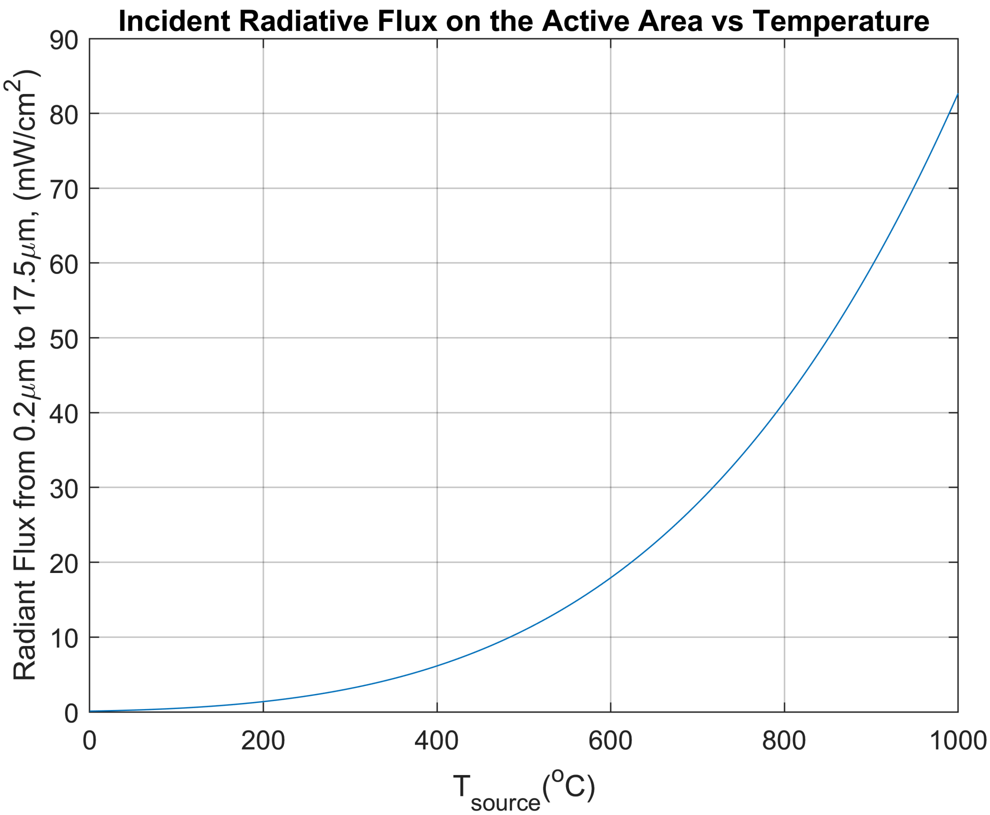
```
p = polyfit(T_range,L,3);
```

```
Warning: Polynomial is badly conditioned. Add points with distinct X values, reduce the degree of the
 polynomial, or try centering and scaling as described in HELP POLYFIT.
```

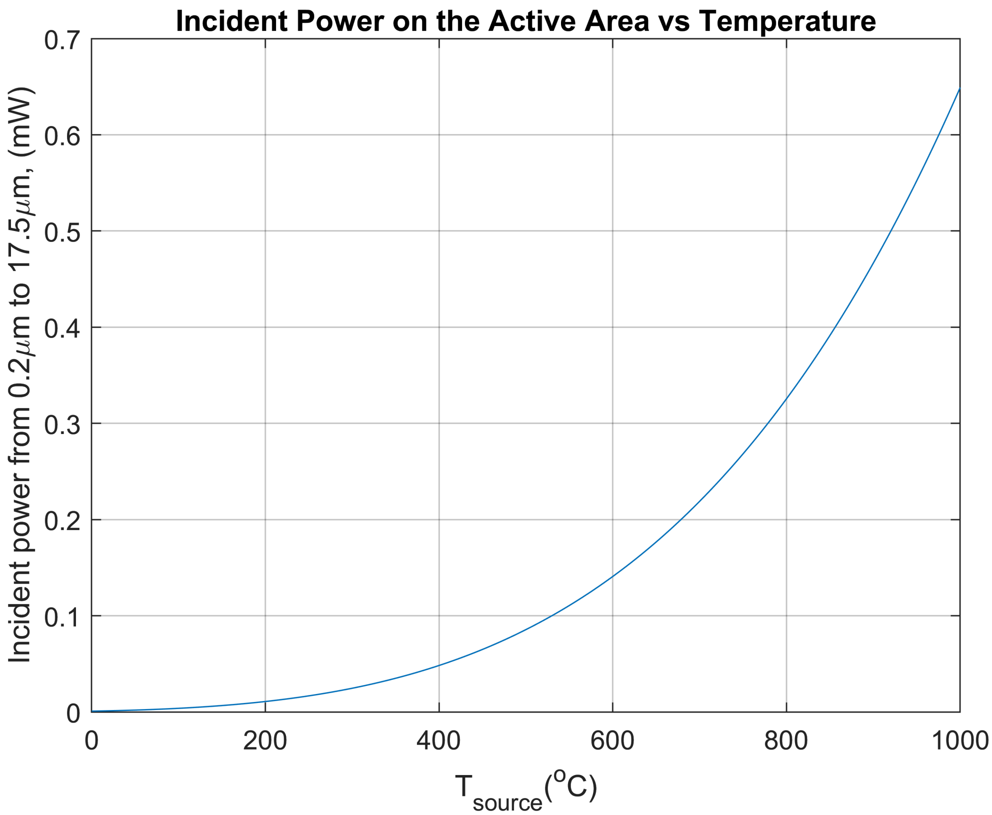
```
y1 = polyval(p,T_range);

plot(T_range-273,L)
ylabel(['Intensity from ',num2str(BP_wavelength(1)),'\mum to ',num2str(BP_wavelength(end)),'\mu
xlabel('T_{source}(^{o}C)')
grid on
```




```
Phi_uA = L * A_i * sr * Avg_trans;%mW/cm

plot(T_range-273,Phi_uA)
ylabel(['Radiant Flux from ',num2str(BP_wavelength(1)),'\mum to ',num2str(BP_wavelength(end)),'
xlabel('T_{source}(^{o}C)')
title('Incident Radiative Flux on the Active Area vs Temperature')
grid on
```



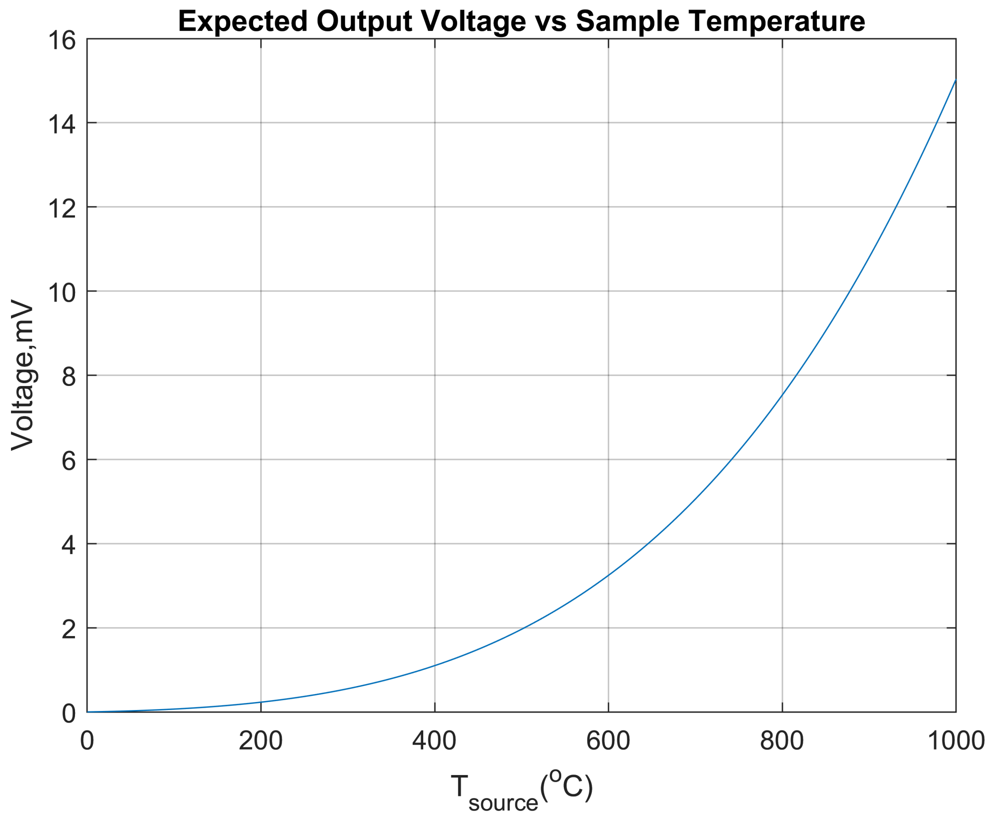

```
Phi = Phi_uA * A_j ;%mW

plot(T_range-273,Phi)
ylabel(['Incident power from ',num2str(BP_wavelength(1)),'\mum to ',num2str(BP_wavelength(end))
xlabel('T_{source}(^{o}C)')
title('Incident Power on the Active Area vs Temperature')
grid on
```



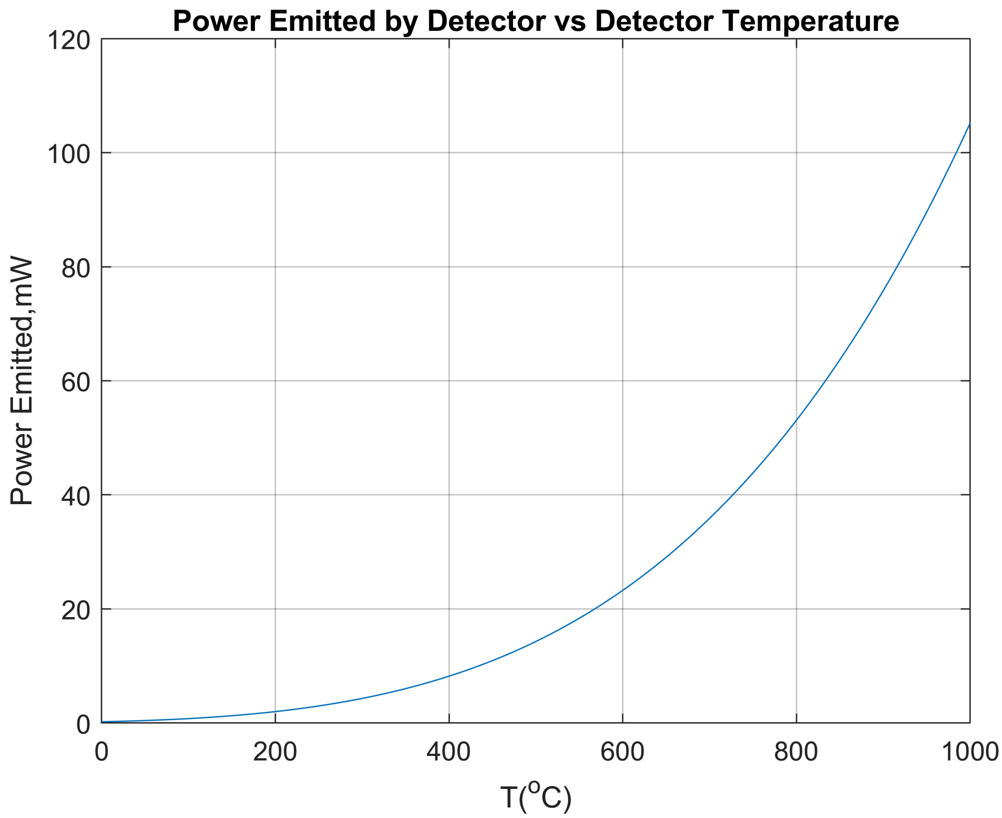

```
dV = (Phi - Phi(1)) .* Responsivity %mV
```

```
dV = 1×1001
        0    0.0004    0.0007    0.0011    0.0015    0.0019    0.0023    0.0027 ···
```

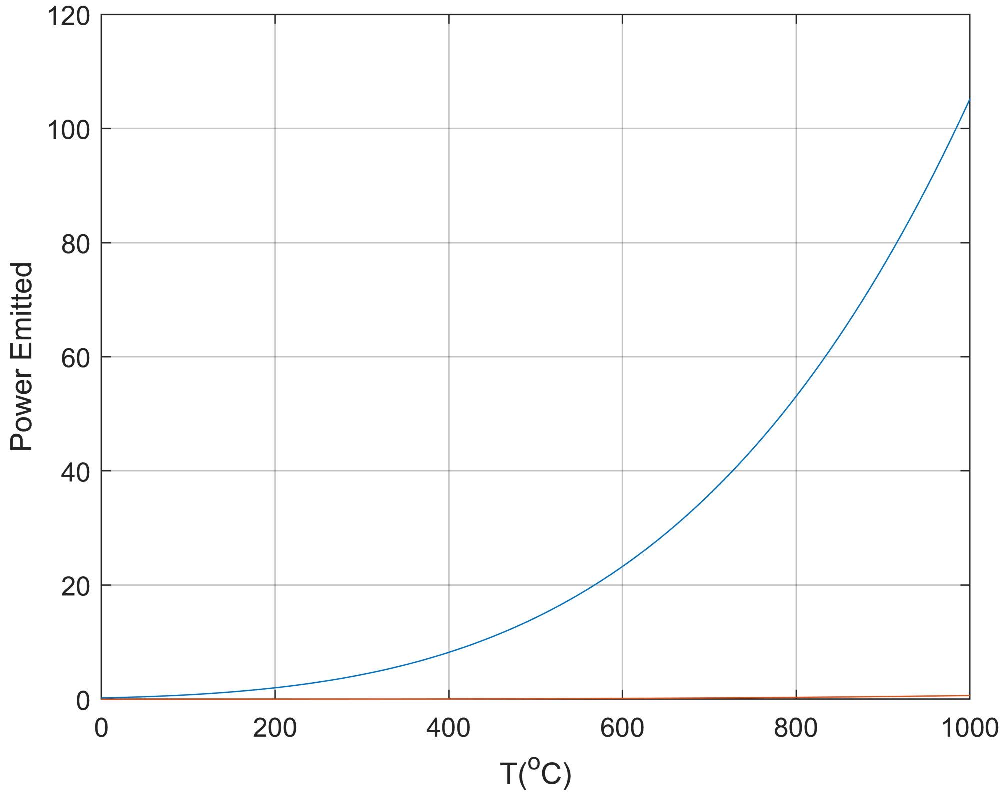
```
plot(T_range-273,dV)
title('Expected Output Voltage vs Sample Temperature')
ylabel('Voltage,mV')
xlabel('T_{source}(^{o}C)')
grid on
```




```
sigma = 5.6697*(10^-9);
epsilon = .9;

Phi_emitted = sigma * epsilon* (T_range.^4);
q_emitted = Phi_emitted * A_j;%mW

plot(T_range-273,q_emitted)
ylabel('Power Emitted,mW')
xlabel('T(^{o}C)')
title('Power Emitted by Detector vs Detector Temperature')
grid on
```

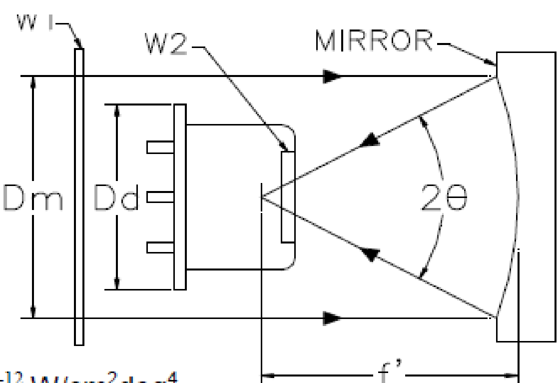



```
plot(T_range-273,q_emitted,T_range-273,Phi)
ylabel('Power Emitted')
xlabel('T(^{o}C)')
grid on
```




## If parabolic mirror is used:

# Detector Signal Calculation




**Power On Detector:** $\Delta\Phi = \tau_0 \tau_1 \tau_2 \rho(\Delta L)\pi \mathrm{SIN}^2\theta \mathrm{Ad}$ Watts

$$\theta \approx \mathrm{TAN}^{-1}\left(\frac{Dm}{2f'}\right); \qquad \Delta L = \frac{4\sigma T^3 \Delta T}{\pi}$$

**Where:**

$\tau_1 \tau_2$ = Transmission of Windows $W_1$ & $W_2$

$\tau_0 = 1 - \left(\frac{Dd}{Dm}\right)^2$

$\rho$ = Mirror Reflectance

$\sigma = 5.6686 \times 10^{-12}$ W/cm$^2$deg$^4$

T = 273 + °C (T in Kelvin)

Ad = Detector Area in cm$^2$

$\Re$ = Responsivity

**Voltage from Detector:** $\Delta V = \Re\, \Delta\Phi$ Volts

**May be necessary if maximum power on detector could exceed .1W/cm^2.**

```
a =0.3;
D_m = D_d + a
```

```
D_m = 1.3236
```

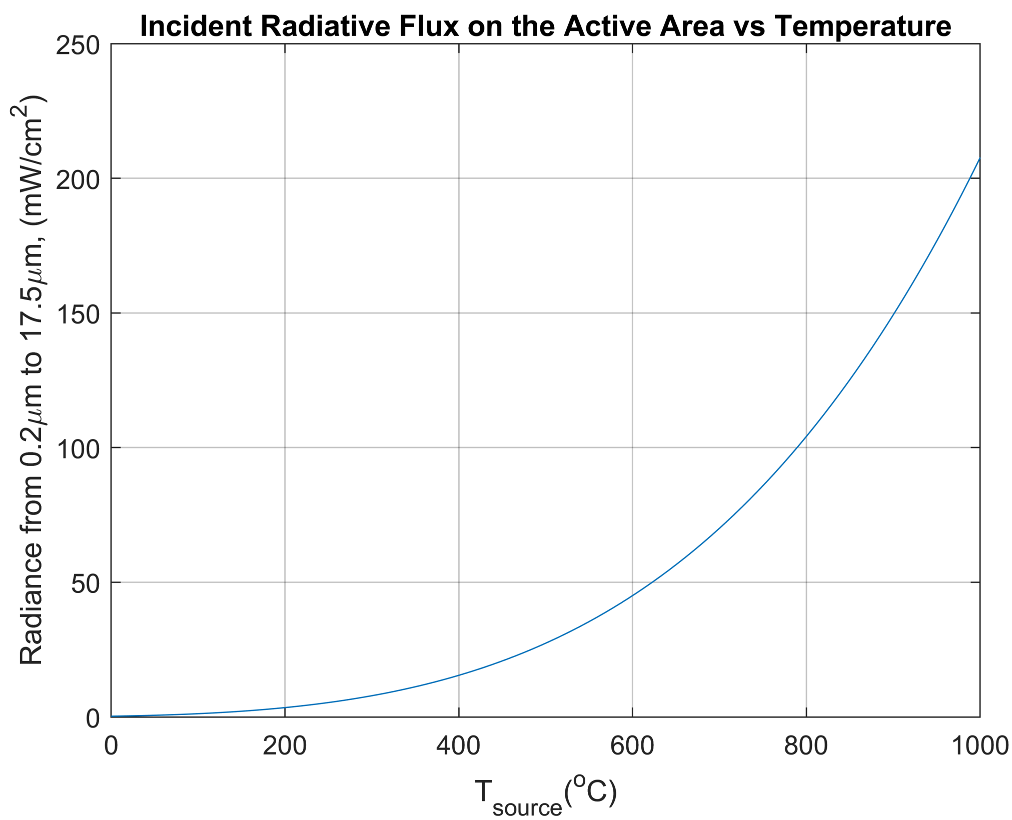
```
rho = .9;
foc = 5;
theta = atand(D_m./(2*foc));
tau_o = 1 - ((D_d./D_m).^2)
```

```
tau_o = 0.4019
```

```
Phi_uA2 = Avg_trans * rho * L * pi * (sind(theta)^2)
```

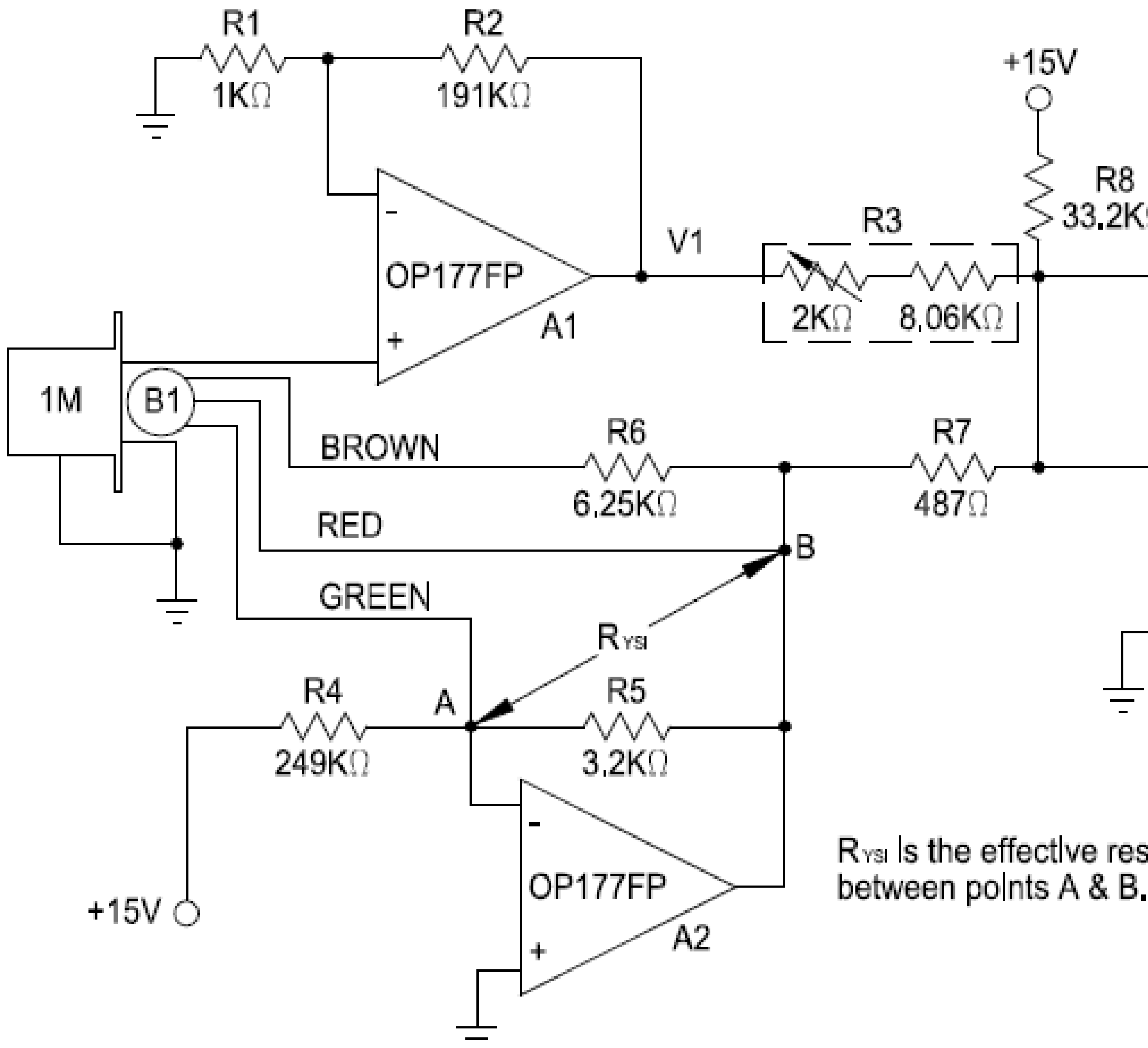
```
Phi_uA2 = 1×1001
    0.2684    0.2735    0.2786    0.2837    0.2890    0.2943    0.2996    0.3051 ···
```

```
plot(T_range-273,Phi_uA2)
ylabel(['Radiance from ',num2str(BP_wavelength(1)),'\mum to ',num2str(BP_wavelength(end)),'\mum
xlabel('T_{source}(^{o}C)')
title('Incident Radiative Flux on the Active Area vs Temperature')
grid on
```




## Thermistor Integration

*This is a recommended reference junction correction circuit from Dexter, but we are going to just do the calculations on the computer.




```
R1 = 1 * 1000;
R1 = 191 * 1000;
R3 =2.8 * 1000;
R4 = 249 * 1000;
R5 = 3.2 * 1000;
R6 = 6.25 * 1000;
R7 = 0.487 * 1000;
R8 = 33.2 * 1000;
R9 = 10 * 1000;
V_i = 15;
T_c = 0:50;

T_d = T_c;
```

```
110+273;
R_YSI = 2768.23 - 17.115.*T_c;
V_T = f.Inv_Amp(V_i,R4,R_YSI);
%Term_1 =
%Term_2 =
Term_3 = f.Inv_Amp(V_T,R7,R9);
Term_4 = f.Inv_Amp(V_i,R8,R9);

V_need = -(Term_3 + Term_4);

V_o_max = 10;
Max_T = 200 + 273;
Inst_Const = -V_o_max./(Max_T^4);


a = .0214*T_c + 1.08;
R9*V_i/R8;
R9*15/(R7*R4);

%R3_req =
b = -Inst_Const .* T_d.^4;
polyfit(T_c,V_need,2);

plot(T_c,V_need,T_c,a)
legend('V_{need}','a')
```