

Thermal Camera Control

Ramses Alcaide

John Thomson

Adrian Haruta

Team Lead

Electrical Lead

Mechanical Lead



Outline

- General Update
 - Schedule
 - Materials and Budget
- Thermal Update
 - Full Box Design
 - Thermal Dynamics
 - Thermal Performance
- Controller
 - Sensor Design and Performance
 - Control System and Performance



Schedule

Week	Goals
1	ID Challenges
2	Mech. Modeling
3	Elec. Modeling
4	Mech. Development
5	Integration/Testing
6	Design Changes
7	Redevelopment
8	Testing

INFRARED CAMERA PARTS

INSURANCE INFORMATION

Personnel Use	Last Name	First Name	Phone	Notes
Team Lead	Alcaide	Ramses		
Electrical Engineering Lead	Thomson	John		
Mechanical Engineering Lead	Haruta	Adrian		

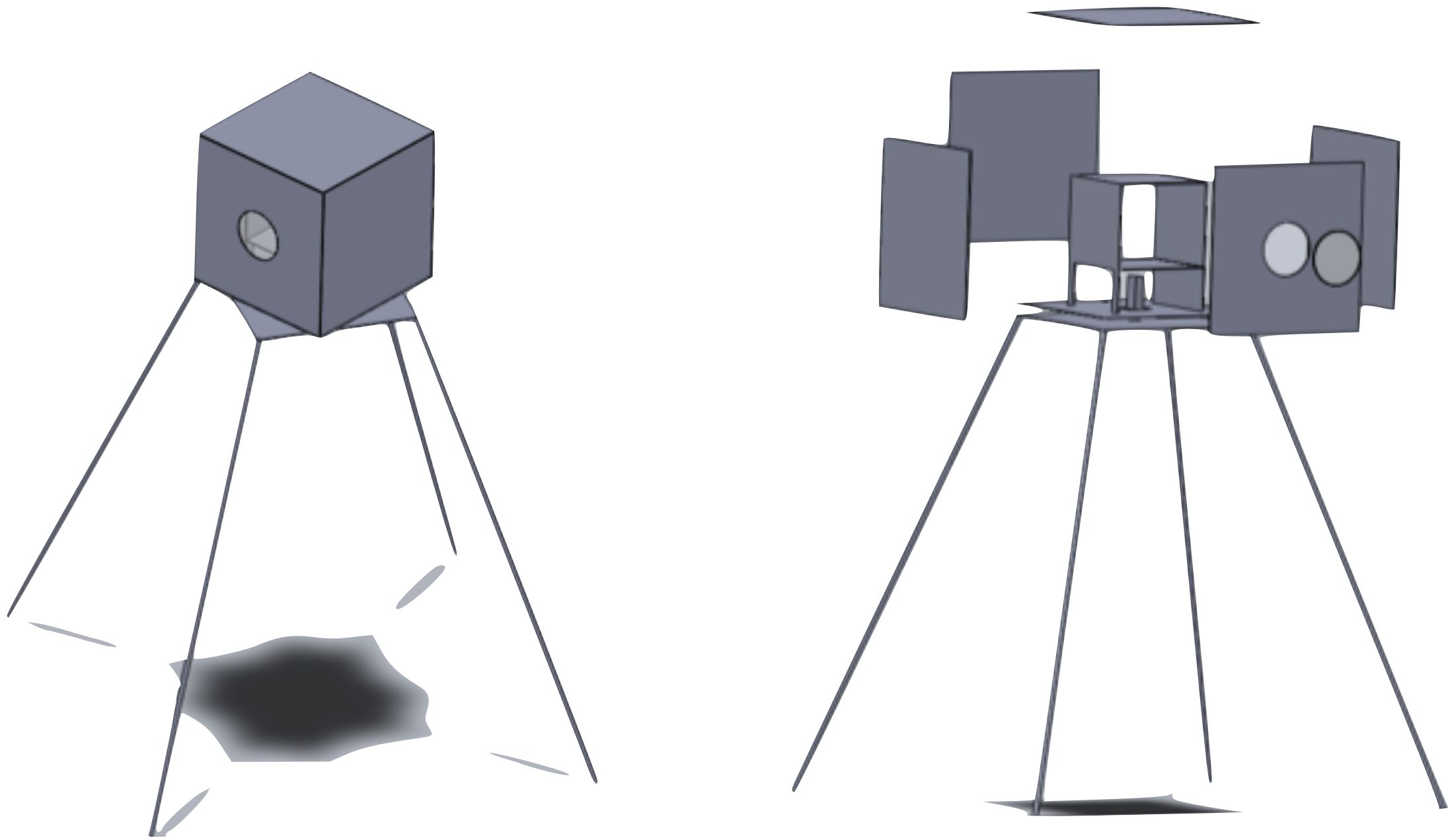
Item	Photo	Quantity	Purchase Date	Place of Purchase	Cost	Total W/O Tax	Description
▼ Electrical Components							
Atmega168		5	4/10/10	Digi-Key	\$4.32	\$21.60	\$45.30 including tax and shipping for above items
IC Driver Dual 15Multiwatt		4	4/10/10	Digi-Key	\$4.34	\$17.36	
PIR_D203S		8	4/10/10	Futurlec	\$1.90	\$15.20	
PIR_D203B		8	4/10/10	Futurlec	\$1.90	\$15.20	
PIR_D202X		8	4/10/10	Futurlec	\$1.90	\$15.20	\$67.60 including tax and shipping for above
Quad Encoder Motor		1	4/10/10	Robotkits	\$50.00	\$50.00	\$58.00 including tax and shipping
Zippy 100mAh 20C Single Cell		8	4/16/10	Hobby King	\$2.00	\$16.00	\$72.55 including tax and shipping
Zippy Flightmax 5800mAh 2S1P		1	4/16/10	Hobby King	\$36.18	\$36.18	
▼ Mechanical Components							
Haynes 214 Sheet		2246 in.^2	5/6/10	Haynes International	TBD	TBD	If possible 3 ft. x 3 ft. sheets, 1/8 in. thick.
Haynes 214 Billets		2 Cylinders 3 in. Diameter 4 in. Tall	5/6/10	Haynes International	TBD	TBD	6 ft. Long 1/2 in. Thick Please Call: 800-354-0806 To order. Ship as soon as possible.
Haynes 214 Bars		4 Bars	5/6/10	Haynes International	TBD	TBD	
Fiberfrax Blanket S		1536 in.^2	5/6/10	Fiberfrax	TBD	TBD	1 in. Thickness 8 lb/ft.^3 density Please Call: 716-278-3800 To order. Ship as soon as possible.
Solid/Solid PCMs		4 ft.^2 x 1in. Thickness	5/6/10	PCM	TBD	TBD	Please Call: +44(0)1733245511To order. Ship as soon as possible.
Sapphire Lens		2 lens	5/6/10	Redoptronics	\$600		3 inch Diameter, 2.5mm Thick, <3in parallelism

Thermal Dynamics

Adrian Haruta



Enclosure



Equations

Variables	
T	Temp
ρ	Density of wall
c	Specific Heat
t	Time
x	Length of Node
N	Number of Node
k	Thermal Conductivity
h	Thermal Convection

Energy balance on Hot face

$$\frac{\rho c \Delta x}{2} \times \frac{T_1^{n+1} - T_1^n}{\Delta t} = (T_{\infty}^{outside} - T_1) h_{outside} + \frac{(T_2 - T_1) k}{\Delta x}$$

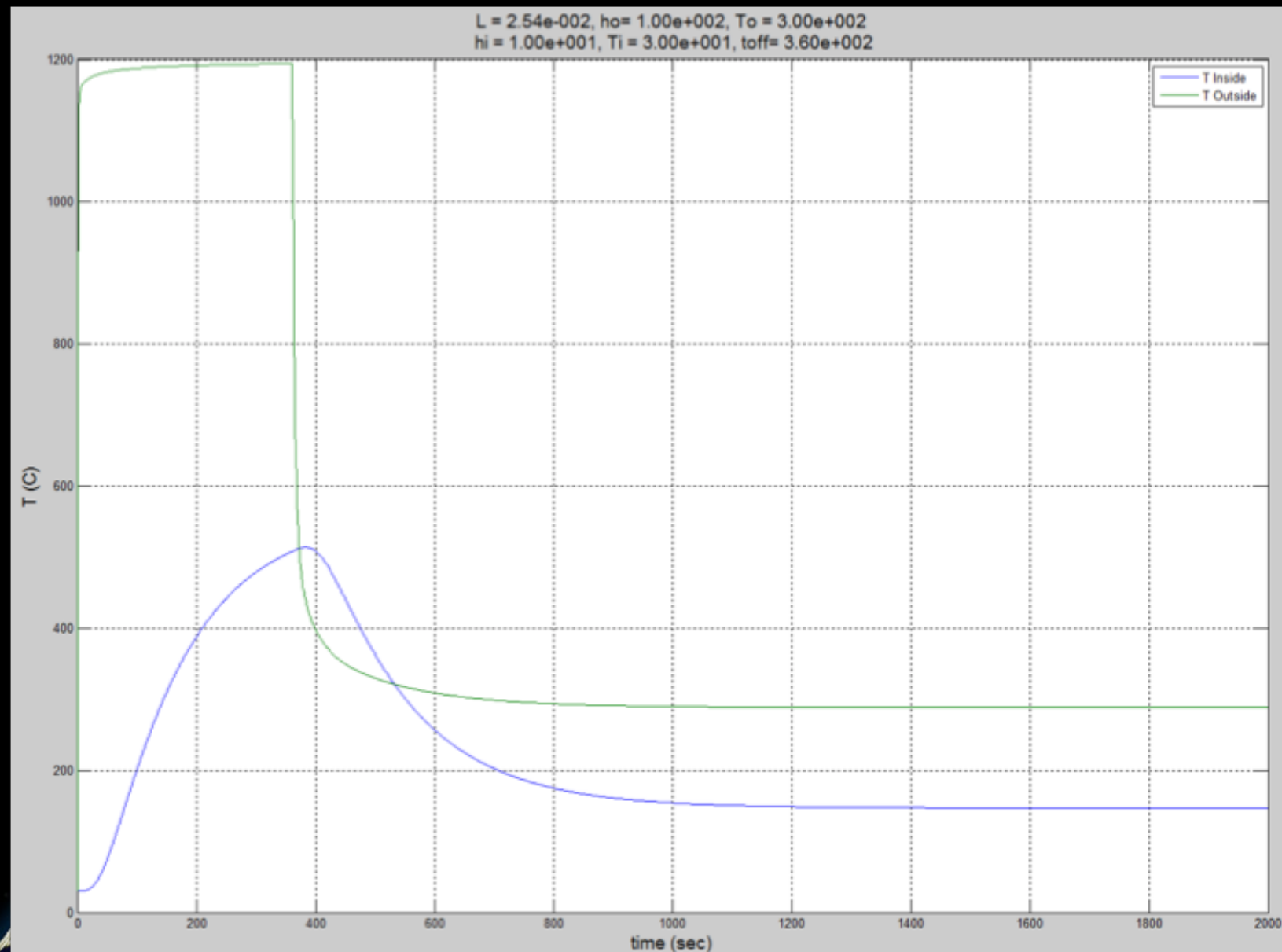
Energy balance in middle of insulation (General)

$$\frac{\rho c \Delta x}{2} \times \frac{T_1^{n+1} - T_1^n}{\Delta t} = \frac{(T_1 - T_2) k}{\Delta x} + \frac{(T_3 - T_2) k}{\Delta x}$$

Energy balance on Cold face

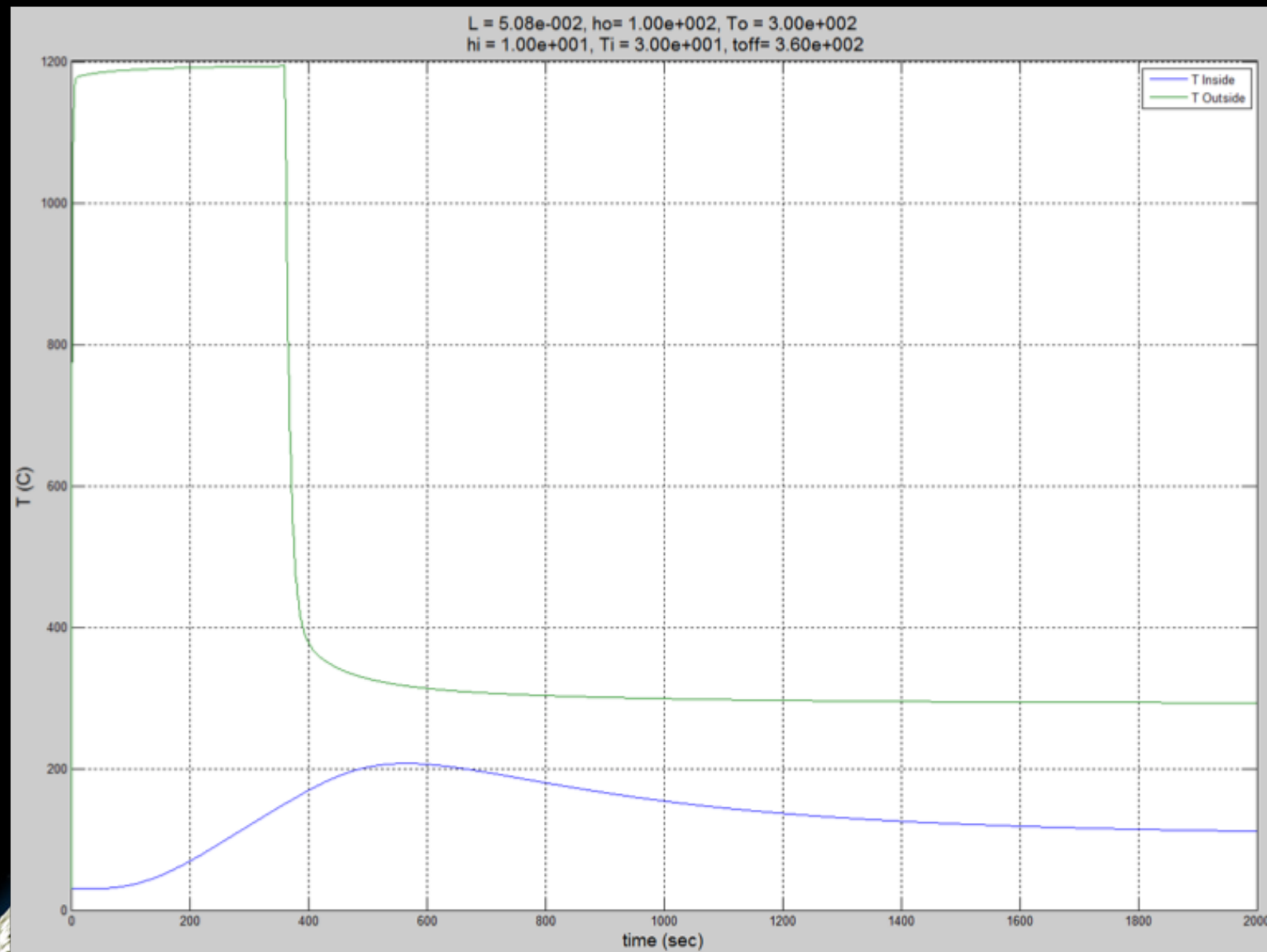
$$\frac{\rho c \Delta x}{2} \times \frac{T_N^{n+1} - T_N^n}{\Delta t} = (T_{\infty}^{inside} - T_N) h_{inside} + \frac{(T_{N-1} - T_N) k}{\Delta x}$$

Performance



Step Response 1 inch Thickness 1200C

Performance



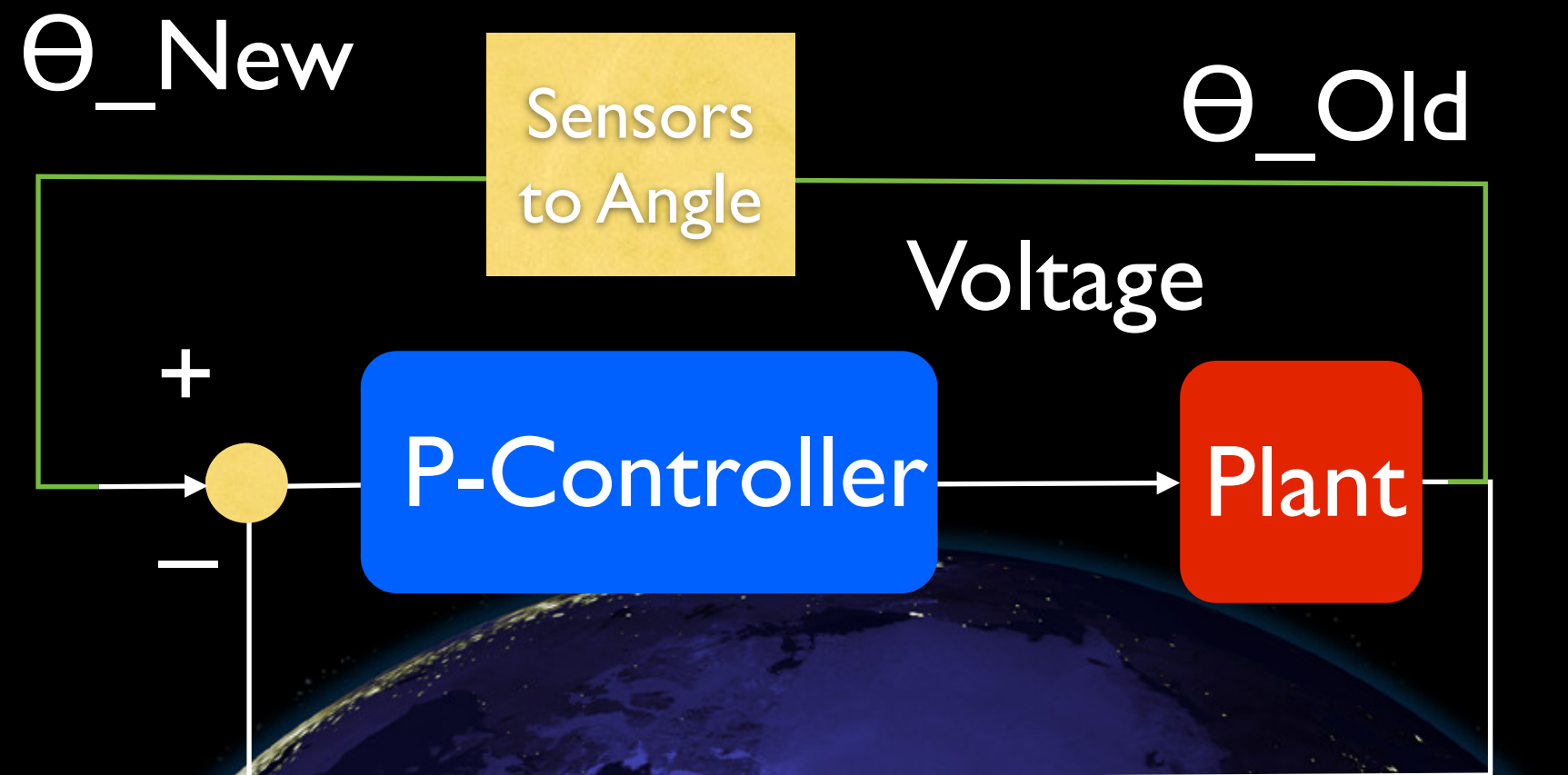
Step Response 2 inch Thickness 1200C

Controller

John Thomson



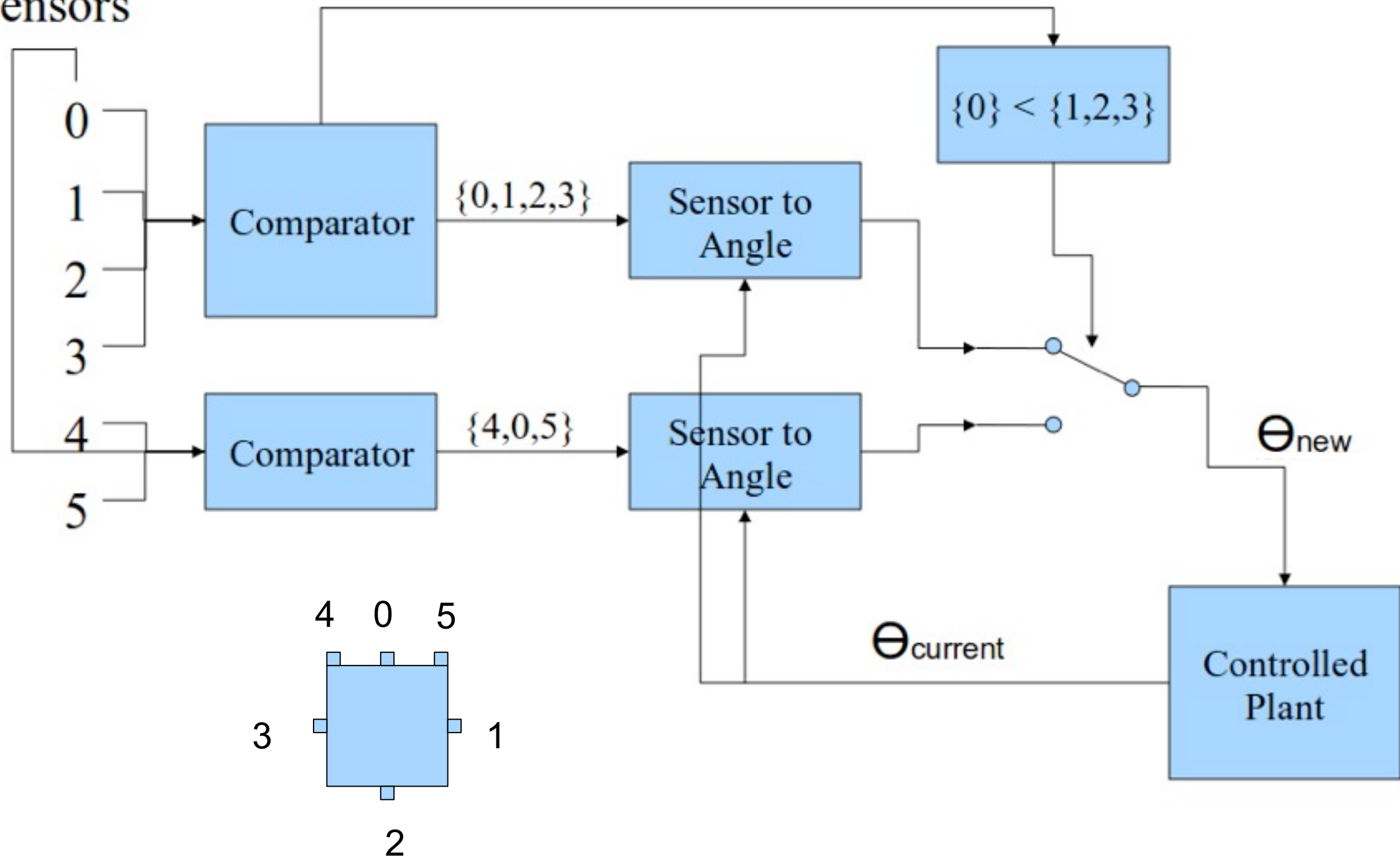
Thermal Camera System



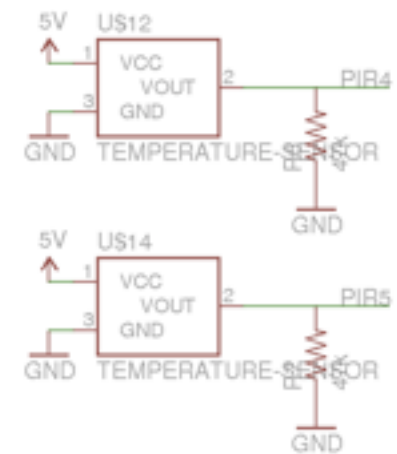
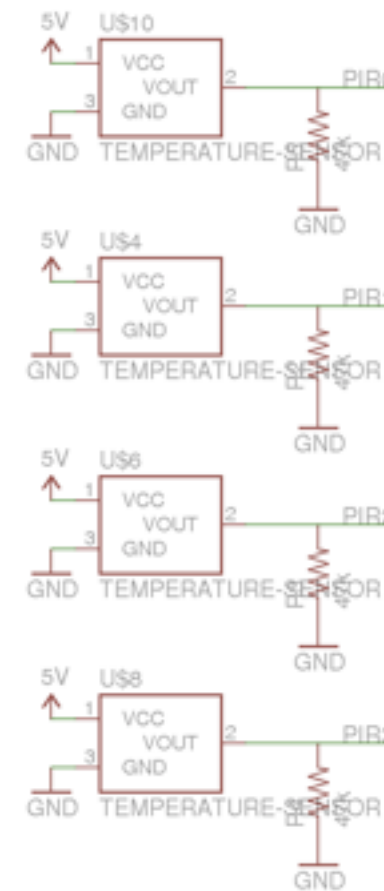
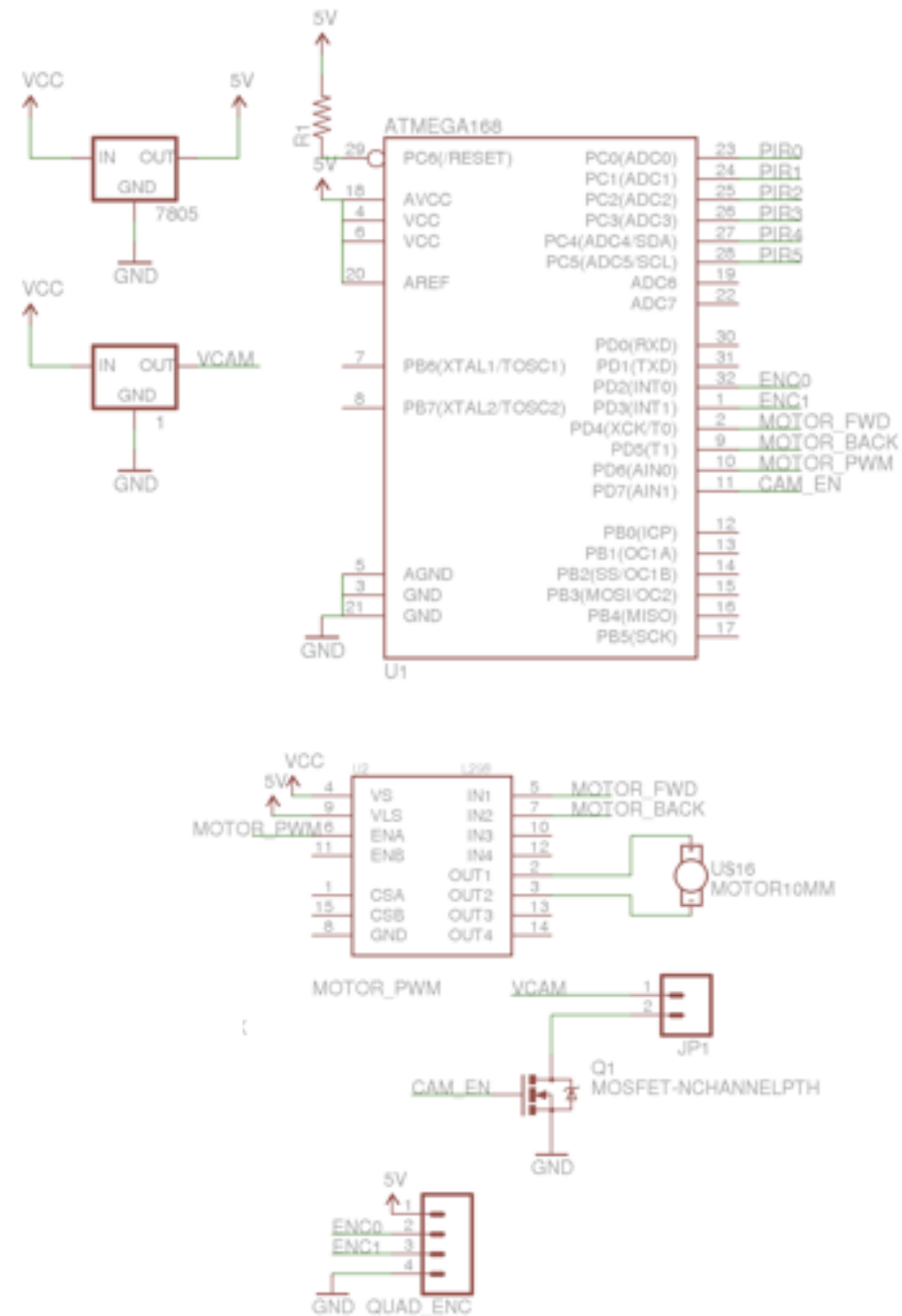
$$V_i = K(\theta_{\text{New}} - \theta_{\text{Old}})$$

Sensor Design

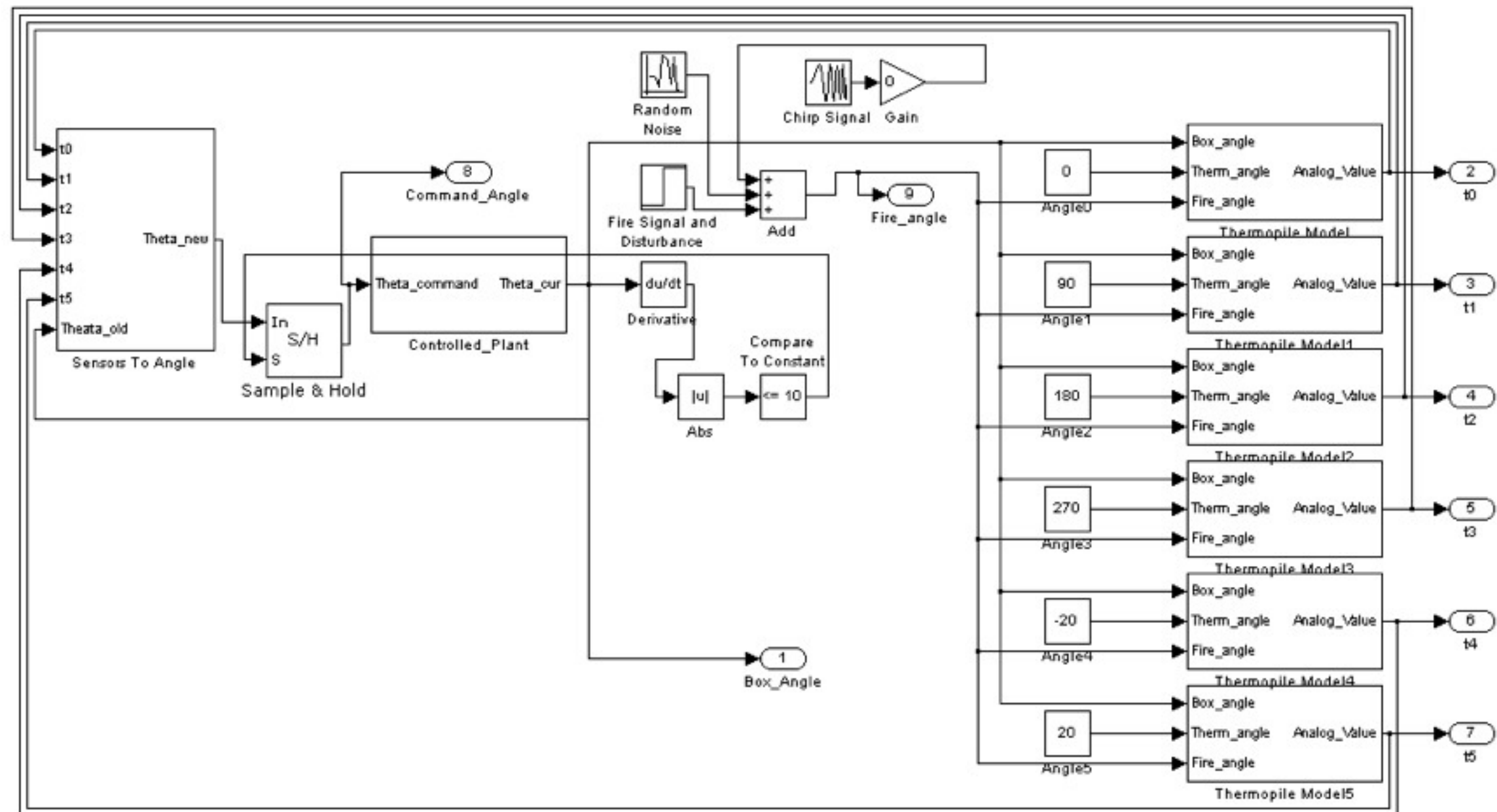
Raw PIR
Sensors



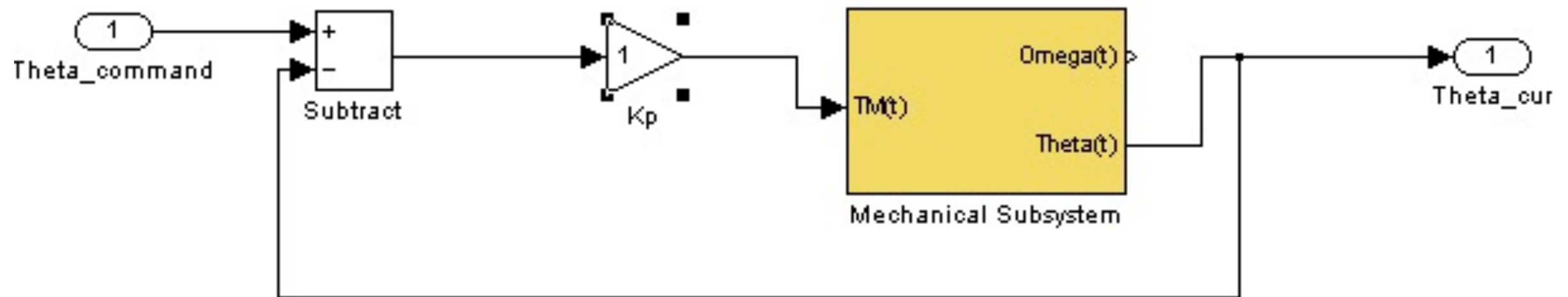
Sensor Design



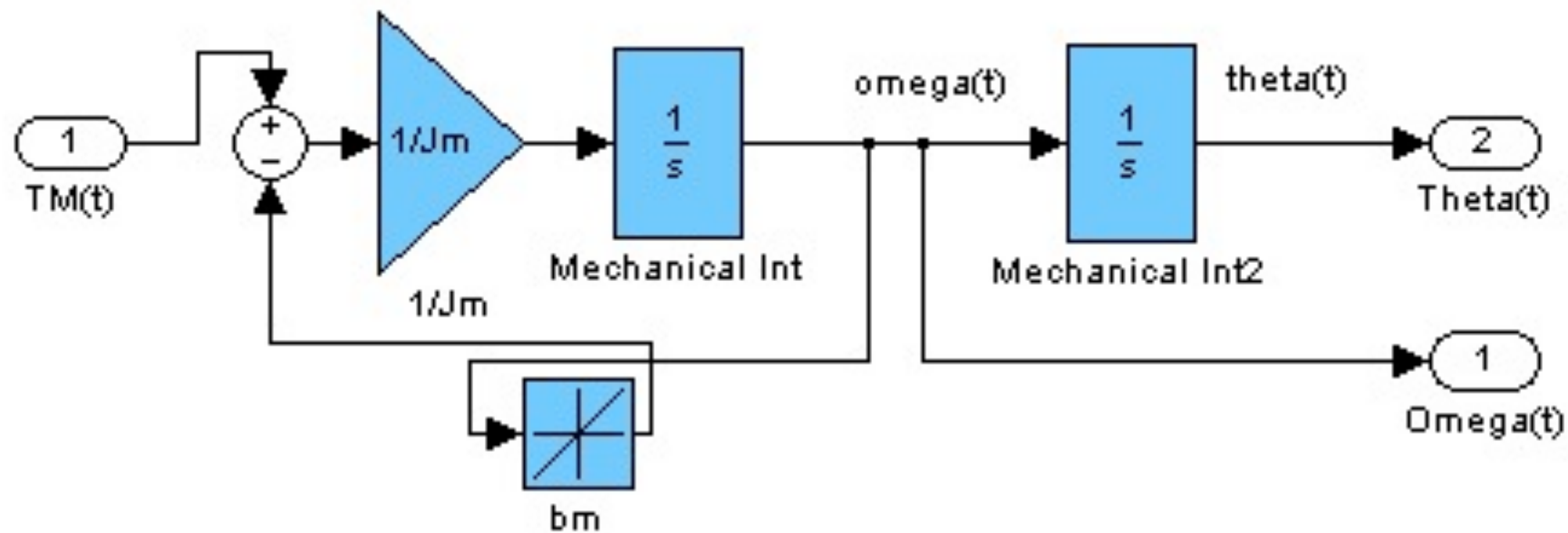
Control System



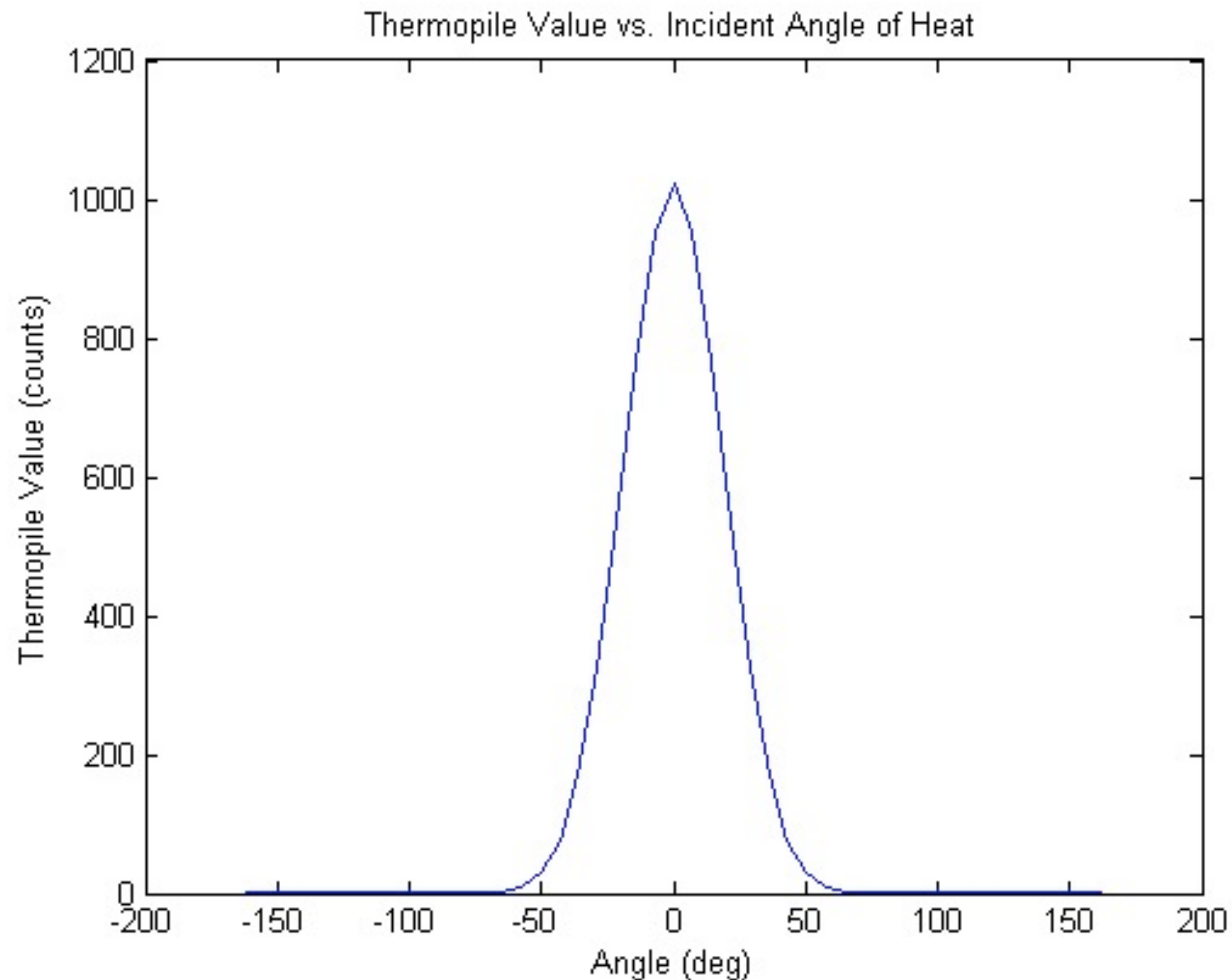
Control System



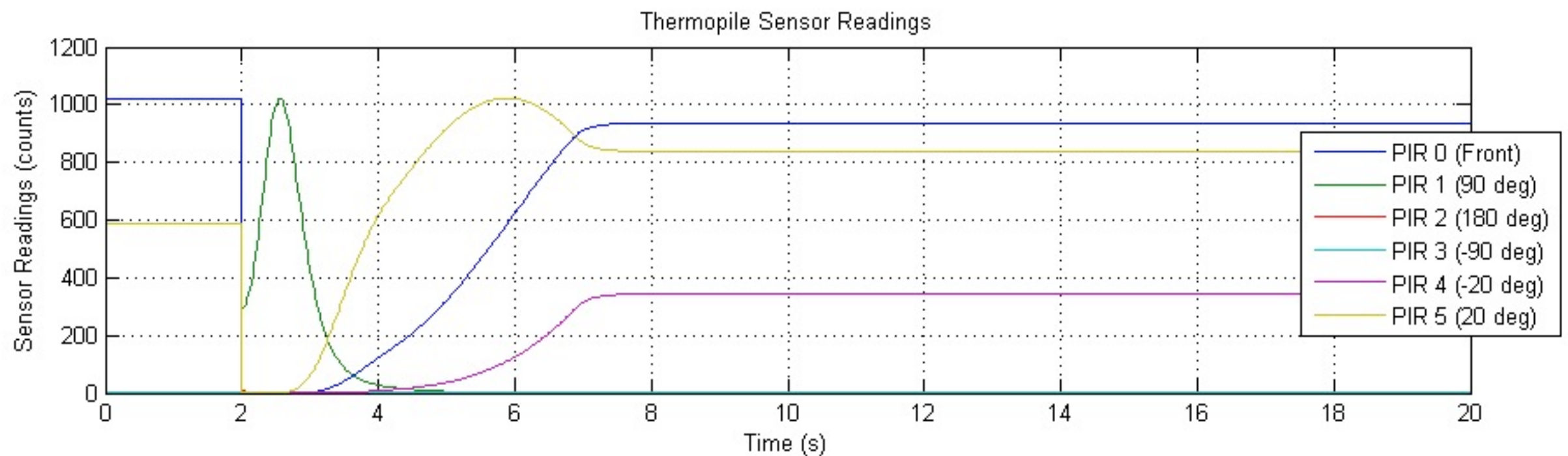
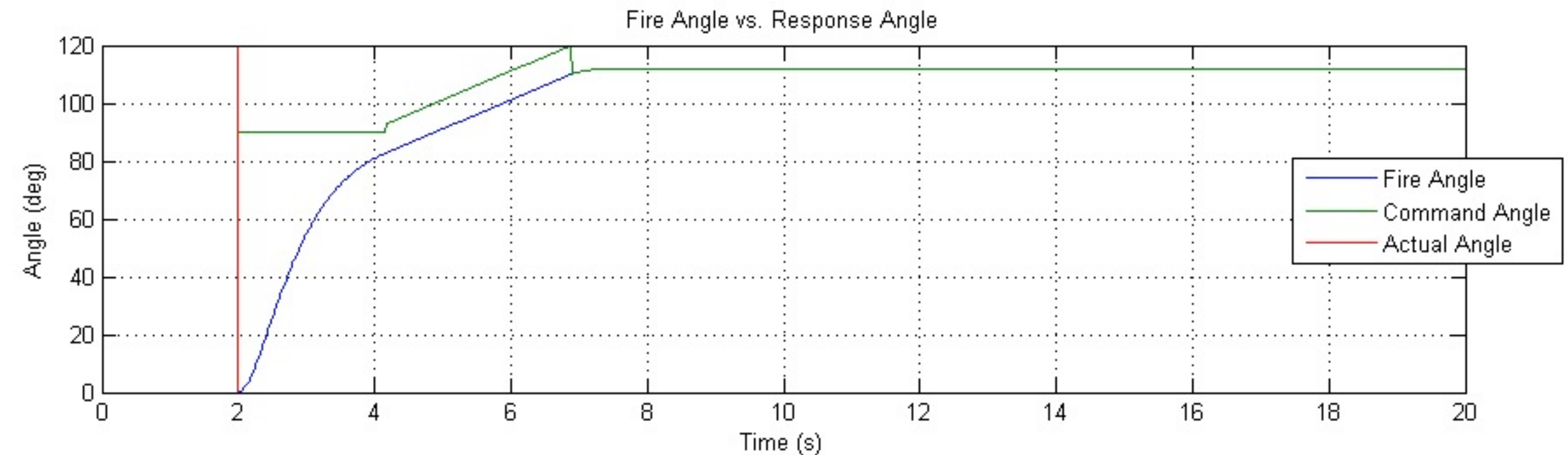
Control System



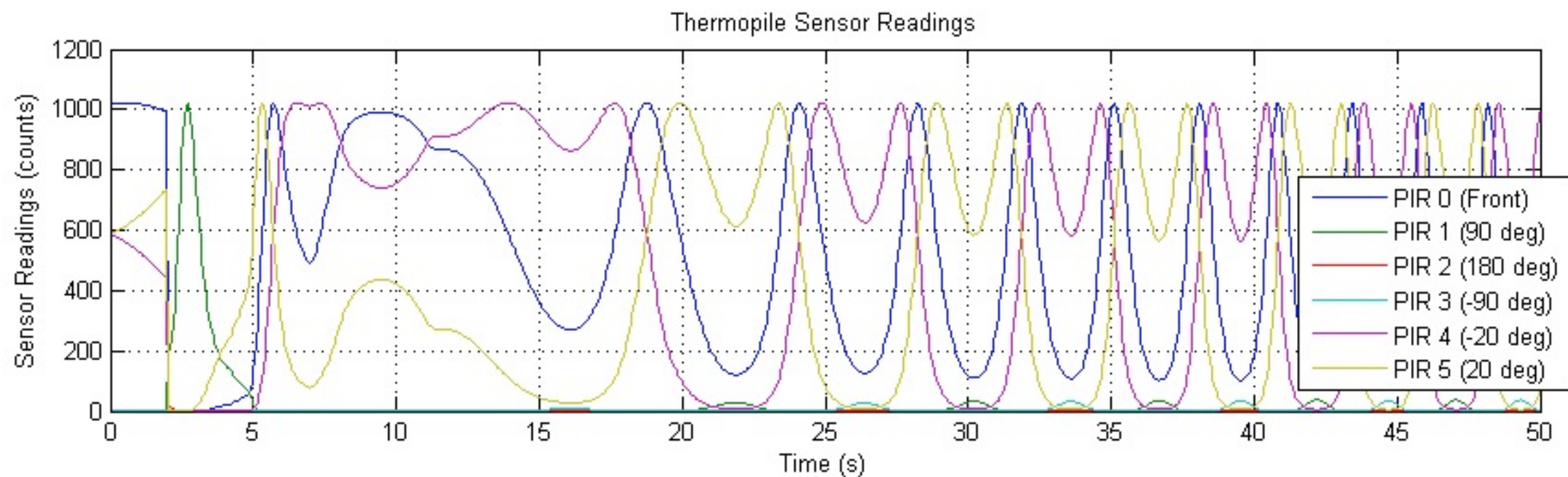
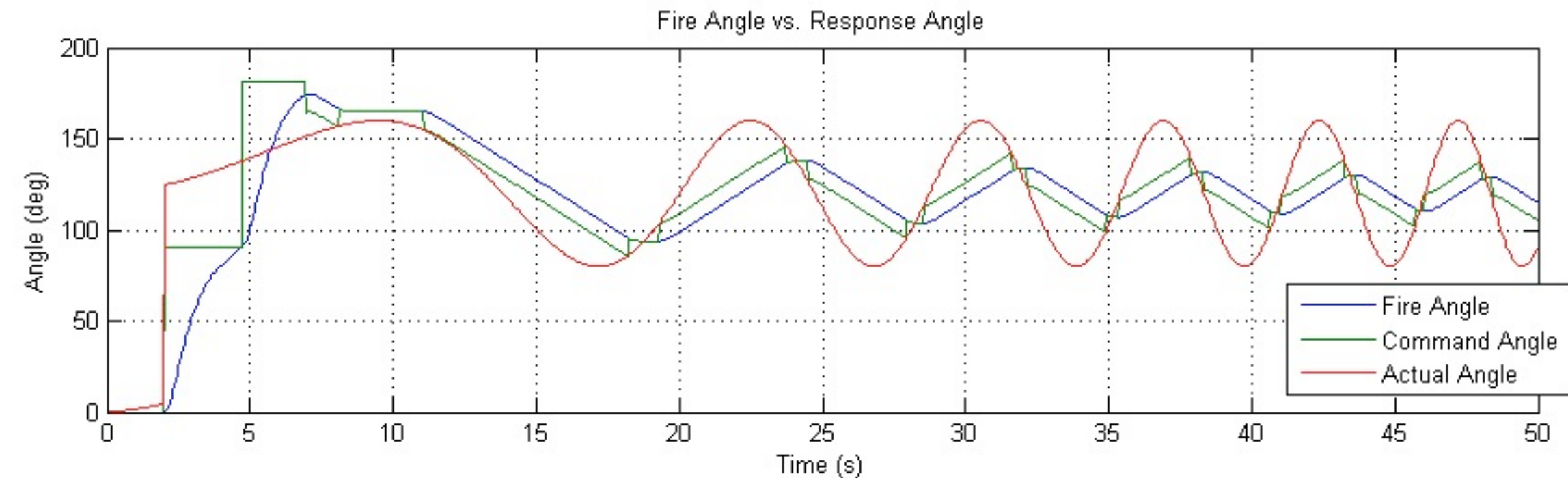
Control System



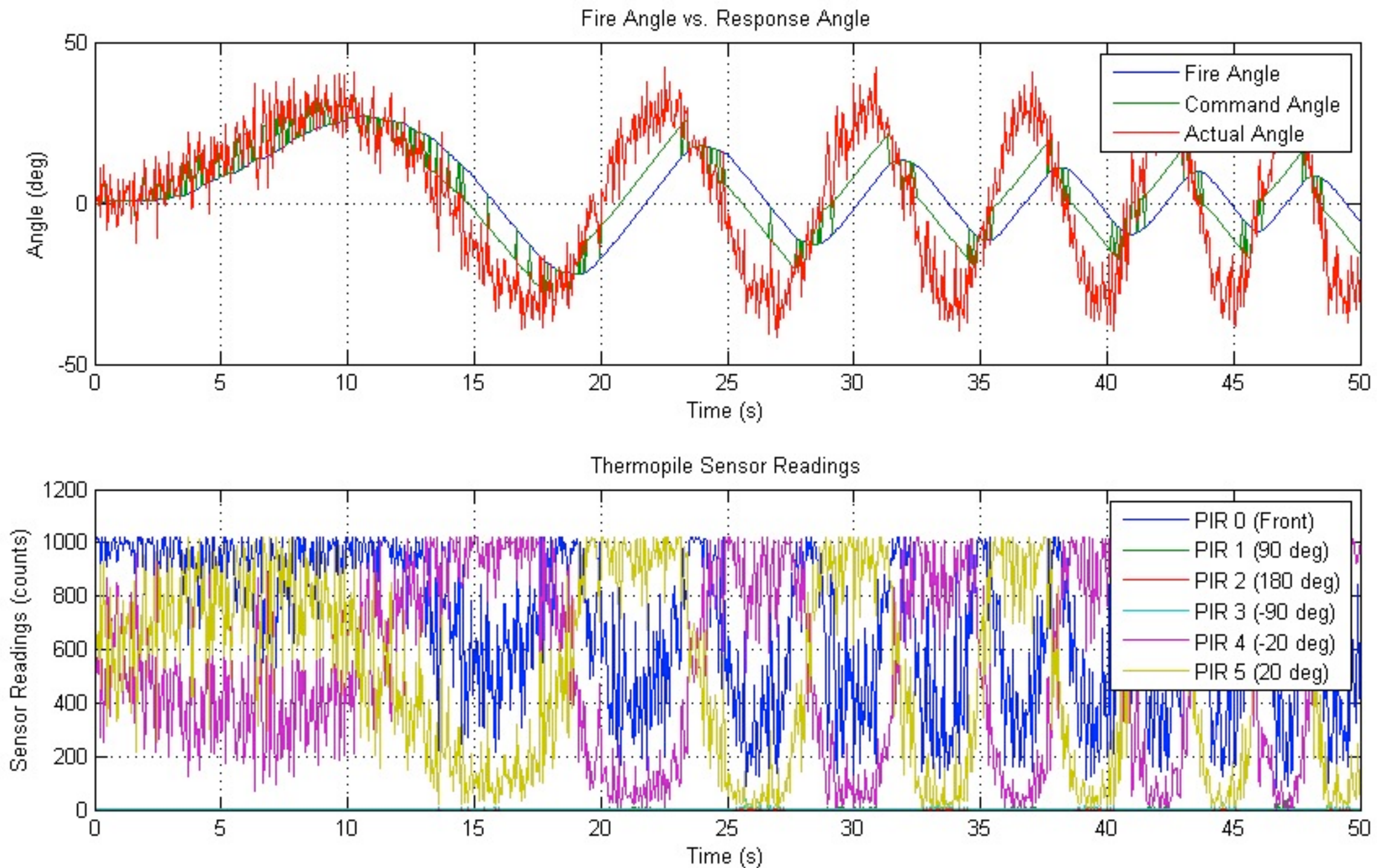
Controller Performance



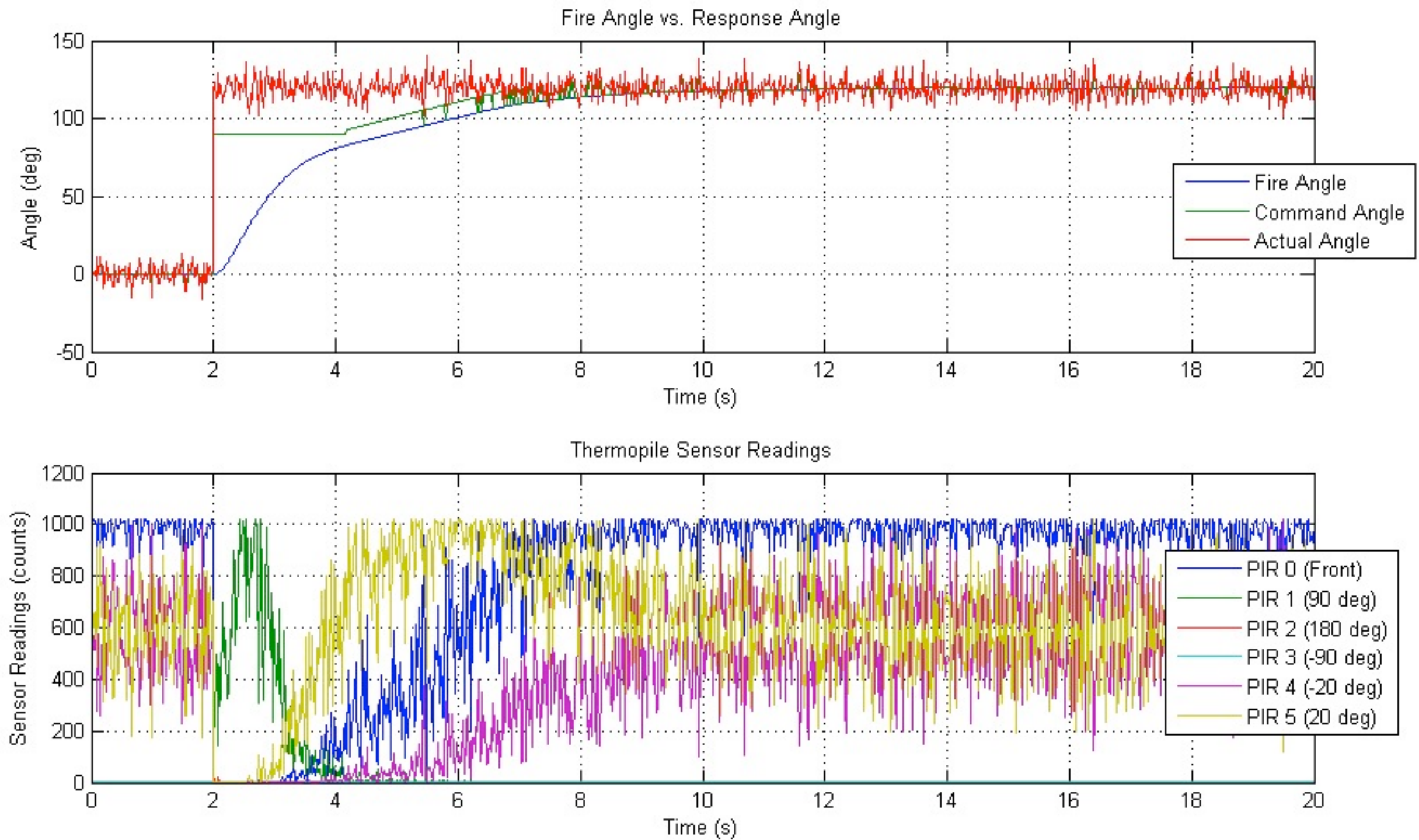
Controller Performance



Controller Performance



Controller Performance



References

Haynes 214

Haynes: H3008 PDF

www.haynesintl.com/pdf/h3008.pdf

PIR Sensor Characteristics

Futurlec: <http://www.futurlec.com>

FiberFrax Blanket S

FiberFrax: Form C-1462 Insulfrax S Blanket 12-08 PDF

<http://www.fiberfrax.com/>

Solid Solid Phase Change Material

Plus Ice: solid_solid_pcm_range PDF

http://www.pcmproducts.net/Solid_Solid_PCMs.htm

Sapphire Optics

Red Optronics: <http://www.redoptronics.com/sapphire-optical-material.html>

Circuit Diagram

Sparkfun Electronics: <http://www.sparkfun.com>

Digikey Corp.: <http://www.digikey.com>