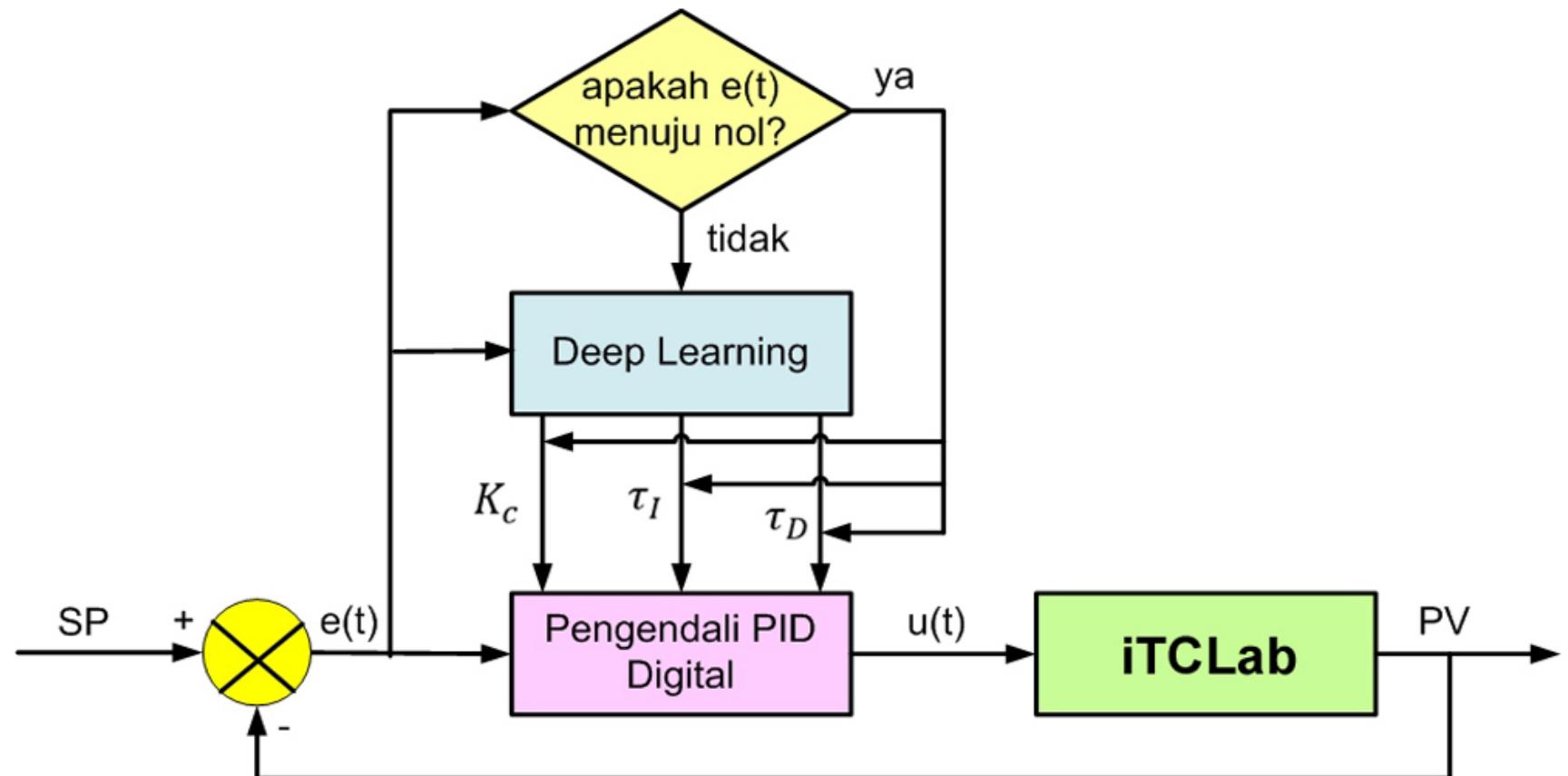


Penalaan Parameter PID Menggunakan Deep Learning pada Kit iTCLab

Oleh: Tim IO-T.NET (<https://io-t.net/itclab>)



Proses penalaan nilai K_c , τ_I dan τ_D pada pengendali PID menggunakan Deep Learning pada Kit iTCLab

```
In [18]: import itclab
import numpy as np
import time
import matplotlib.pyplot as plt
from scipy.integrate import odeint
import random
```

In [19]: # Machine Learning - Building Datasets and Model

```
# Impor `Sequential` dari `keras.models`
from keras.models import Sequential

# Impor `Dense` dari `keras.layers`
from keras.layers import Dense

# Inisialisasi konstruktor
model = Sequential()

# Tambahkan Lapisan masukan
model.add(Dense(2, activation='sigmoid', input_shape=(2,)))

# Tambahkan satu lapisan tersembunyi
model.add(Dense(3, activation='sigmoid'))

# Tambahkan Lapisan keluaran
model.add(Dense(3, activation='sigmoid'))

# Data Latih.
X = np.array([
    [1, 1],
    [0.4, 1.2],
    [1.2, 0.1],
    [1, 0.1]
])
# Label untuk Data Latih.
y = np.array([
    [0.25, 4.31, 0.20],
    [0.2, 4.1, 0.1],
    [0.1, 4.0, 0],
    [0.1, 4.0, 0]
])
# Bentuk keluaran model
model.output_shape

# Ringkasan model
model.summary()

# Konfigurasi model
```

```
model.get_config()  
  
# Buat daftar semua tensor bobot  
model.get_weights()
```

Model: "sequential_2"

Layer (type)	Output Shape	Param #
<hr/>		
dense_6 (Dense)	(None, 2)	6
dense_7 (Dense)	(None, 3)	9
dense_8 (Dense)	(None, 3)	12
<hr/>		
Total params: 27		
Trainable params: 27		
Non-trainable params: 0		

Out[19]: [array([[6.5393162e-01, 6.7713737e-02],
[5.0425529e-04, 1.0704283e+00]], dtype=float32),
array([0., 0.], dtype=float32),
array([[-0.93929756, 0.2688167 , 0.72485137],
[-0.11020211 -0.02721882 -0.9171271511], dtype=float32)]

```
In [20]: model.compile(loss='binary_crossentropy',
                      optimizer='adam',
                      metrics=['accuracy'])
```

```
model.fit(X, y, epochs=100, batch_size=1, verbose=1)
```

```
Epoch 1/100
4/4 [=====] - 0s 2ms/step - loss: 1.2397 - accuracy: 0.0000e+00
Epoch 2/100
4/4 [=====] - 0s 2ms/step - loss: 1.2222 - accuracy: 0.0000e+00
Epoch 3/100
4/4 [=====] - 0s 3ms/step - loss: 1.2049 - accuracy: 0.0000e+00
Epoch 4/100
4/4 [=====] - 0s 3ms/step - loss: 1.1876 - accuracy: 0.0000e+00
Epoch 5/100
4/4 [=====] - 0s 3ms/step - loss: 1.1704 - accuracy: 0.5000
Epoch 6/100
4/4 [=====] - 0s 3ms/step - loss: 1.1532 - accuracy: 0.7500
Epoch 7/100
4/4 [=====] - 0s 4ms/step - loss: 1.1362 - accuracy: 1.0000
Epoch 8/100
4/4 [=====] - 0s 4ms/step - loss: 1.1191 - accuracy: 1.0000
Epoch 9/100
4/4 [=====] - 0s 2ms/step - loss: 1.1021 - accuracy: 1.0000
Epoch 10/100
    0%|          | 0/100 [00:00 < 00:00]
```

In [21]:

```
#####
# Use this script for evaluating model predictions    #
# and PID controller performance for the iTCLab      #
# Adjust only PID and model sections                 #
#####

#####
# PID Controller                                     #
#####

# inputs -----
# sp = setpoint
# pv = current temperature
# pv_last = prior temperature
# ierr = integral error
# dt = time increment between measurements
# outputs -----
# op = output of the PID controller
# P = proportional contribution
# I = integral contribution
# D = derivative contribution
def pid(sp,pv,pv_last,ierr,dt):
    Kc    = 10.0 # K/%Heater
    tauI  = 50.0 # sec
    tauD  = 1.0  # sec
    # Parameters in terms of PID coefficients
    KP   = Kc
    KI   = Kc/tauI
    KD   = Kc*tauD
    # ubias for controller (initial heater)
    op0  = 0
    # upper and lower bounds on heater Level
    ophi = 100
    opl0 = 0
    # calculate the error
    error = sp-pv
    # calculate the integral error
    ierr = ierr + KI * error * dt
    # calculate the measurement derivative
    dpv = (pv - pv_last) / dt
    # calculate the PID output
    P = KP * error
    I = ierr
```

```
D = -KD * dpv
op = op0 + P + I + D
# implement anti-reset windup
if op < oplo or op > ophi:
    I = I - KI * error * dt
    # clip output
    op = max(oplo,min(ophi,op))
# return the controller output and PID terms
return [op,P,I,D]
```

In [22]:

```
#####
# PID Controller using Deep Learning          #
#####
# inputs -----
# sp = setpoint
# pv = current temperature
# pv_last = prior temperature
# ierr = integral error
# dt = time increment between measurements
# outputs -----
# op = output of the PID controller
# P = proportional contribution
# I = integral contribution
# D = derivative contribution

def pid_dl(sp,pv,pv_last,ierr,dt):

    # calculate the error
    error = sp-pv
    d_error = sp-pv_last
    delta_error = (error - d_error)

    outDL = model.predict(np.array([[error,delta_error]]))

    Kc = outDL[0,0]
    tauI = outDL[0,1]
    tauD = outDL[0,2]

    # Parameters in terms of PID coefficients
    KP = Kc
    KI = Kc/tauI
    KD = Kc*tauD
    # ubias for controller (initial heater)
    op0 = 0
    # upper and lower bounds on heater level
    ophi = 100
    oplo = 0

    # calculate the integral error
    ierr = ierr + KI * error * dt
    # calculate the measurement derivative
    dpv = (pv - pv_last) / dt
```

```
# calculate the PID output
P = KP * error
I = ierr
D = -KD * dpv
op = op0 + P + I + D
# implement anti-reset windup
if op < opl0 or op > ophi:
    I = I - KI * error * dt
    # clip output
    op = max(oplo,min(ophi,op))
# return the controller output and PID terms
return [op,P,I,D]
```

In [23]:

```
#####
# FOPDT model
#####
Kp = 0.5      # degC/%
tauP = 120.0   # seconds
thetaP = 10    # seconds (integer)
Tss = 23       # degC (ambient temperature)
Qss = 0        # % heater

#####
# Energy balance model
#####
def heat(x,t,Q):
    # Parameters
    Ta = 23 + 273.15    # K
    U = 10.0              # W/m^2-K
    m = 4.0/1000.0        # kg
    Cp = 0.5 * 1000.0     # J/kg-K
    A = 12.0 / 100.0**2 # Area in m^2
    alpha = 0.01           # W / % heater
    eps = 0.9              # Emissivity
    sigma = 5.67e-8        # Stefan-Boltzman

    # Temperature State
    T = x[0]

    # Nonlinear Energy Balance
    dTdt = (1.0/(m*Cp))*(U*A*(Ta-T) \
        + eps * sigma * A * (Ta**4 - T**4) \
        + alpha*Q)
    return dTdt
```

In [24]:

```
#####
# Do not adjust anything below this point      #
#####

# Connect to Arduino
a = itclab.iTCLab()
#a.encode('utf-8').strip()#modification error
# Turn LED on
print('LED On')
a.LED(100)

# Run time in minutes
run_time = 15.0

# Number of cycles
loops = int(60.0*run_time)
tm = np.zeros(loops)

# Temperature
# set point (degC)
Tsp1 = np.ones(loops) * 25.0
Tsp1[60:] = 45.0
Tsp1[360:] = 30.0
Tsp1[660:] = 35.0
T1 = np.ones(loops) * a.T1 # measured T (degC)
error_sp = np.zeros(loops)

Tsp2 = np.ones(loops) * 23.0 # set point (degC)
T2 = np.ones(loops) * a.T2 # measured T (degC)

# Predictions
Tp = np.ones(loops) * a.T1
error_eb = np.zeros(loops)
Tp1 = np.ones(loops) * a.T1
error_fopdt = np.zeros(loops)

# impulse tests (0 - 100%)
Q1 = np.ones(loops) * 0.0
Q2 = np.ones(loops) * 0.0

print('Running Main Loop. Ctrl-C to end.')
print(' Time      SP      PV      Q1    = P    + I    + D')
```

```

print('{{:6.1f} {:6.2f} {:6.2f} ' + \
      '{:6.2f} {:6.2f} {:6.2f} {:6.2f}}').format( \
      tm[0],Tsp1[0],T1[0], \
      Q1[0],0.0,0.0,0.0))

# Create plot
plt.figure(figsize=(10,7))
plt.ion()
plt.show()

# Main Loop
start_time = time.time()
prev_time = start_time
# Integral error
ierr = 0.0
try:
    for i in range(1,loops):
        # Sleep time
        sleep_max = 1.0
        sleep = sleep_max - (time.time() - prev_time)
        if sleep>=0.01:
            time.sleep(sleep-0.01)
        else:
            time.sleep(0.01)

        # Record time and change in time
        t = time.time()
        dt = t - prev_time
        prev_time = t
        tm[i] = t - start_time

        # Read temperatures in Kelvin
        T1[i] = a.T1
        T2[i] = a.T2

        # Simulate one time step with Energy Balance
        Tnext = odeint(heat,Tp[i-1]+273.15,[0,dt],args=(Q1[i-1],))
        Tp[i] = Tnext[1]-273.15

        # Simulate one time step with linear FOPDT model
        z = np.exp(-dt/tauP)
        Tpl[i] = (Tp[i-1]-Tss) * z \
                  + (Q1[max(0,i-int(thetaP))-1])-Qss)*(1-z)*Kp \

```

+ Tss

```

# Calculate PID Output (Choose one of them)
# 1. Manually Choose
# [Q1[i],P,ierr,D] = pid(Tsp1[i],T1[i],T1[i-1],ierr,dt)

# 2. Based on Deep Learning Result
[Q1[i],P,ierr,D] = pid_dl(Tsp1[i],T1[i],T1[i-1],ierr,dt)

# Start setpoint error accumulation after 1 minute (60 seconds)
if i>=60:
    error_eb[i] = error_eb[i-1] + abs(Tp[i]-T1[i])
    error_fopdt[i] = error_fopdt[i-1] + abs(Tpl[i]-T1[i])
    error_sp[i] = error_sp[i-1] + abs(Tsp1[i]-T1[i])

# Write output (0-100)
a.Q1(Q1[i])
a.Q2(0.0)

# Print line of data
print('{{:6.1f} {:6.2f} {:6.2f} ' + \
      '{:6.2f} {:6.2f} {:6.2f} {:6.2f}}'.format( \
          tm[i],Tsp1[i],T1[i], \
          Q1[i],P,ierr,D))

# Plot
plt.clf()
ax=plt.subplot(4,1,1)
ax.grid()
plt.plot(tm[0:i],T1[0:i],'r.',label=r'$T_1$ measured')
plt.plot(tm[0:i],Tsp1[0:i],'k--',label=r'$T_1$ set point')
plt.ylabel('Temperature (degC)')
plt.legend(loc=2)
ax=plt.subplot(4,1,2)
ax.grid()
plt.plot(tm[0:i],Q1[0:i],'b-',label=r'$Q_1$')
plt.ylabel('Heater')
plt.legend(loc='best')
ax=plt.subplot(4,1,3)
ax.grid()
plt.plot(tm[0:i],T1[0:i],'r.',label=r'$T_1$ measured')
plt.plot(tm[0:i],Tp[0:i],'k-',label=r'$T_1$ energy balance')
plt.plot(tm[0:i],Tpl[0:i],'g-',label=r'$T_1$ linear model')

```

```
plt.ylabel('Temperature (degC)')
plt.legend(loc=2)
ax=plt.subplot(4,1,4)
ax.grid()
plt.plot(tm[0:i],error_sp[0:i],'r-',label='Set Point Error')
plt.plot(tm[0:i],error_eb[0:i],'k-',label='Energy Balance Error')
plt.plot(tm[0:i],error_fopdt[0:i],'g-',label='Linear Model Error')
plt.ylabel('Cumulative Error')
plt.legend(loc='best')
plt.xlabel('Time (sec)')
plt.draw()
plt.pause(0.05)

# Turn off heaters
a.Q1(0)
a.Q2(0)
# Save figure
plt.savefig('test_PID_dl.png')

# Allow user to end loop with Ctrl-C
except KeyboardInterrupt:
    # Disconnect from Arduino
    a.Q1(0)
    a.Q2(0)
    print('Shutting down')
    a.close()
    plt.savefig('test_PID_dl.png')

# Make sure serial connection still closes when there's an error
except:
    # Disconnect from Arduino
    a.Q1(0)
    a.Q2(0)
    print('Error: Shutting down')
    a.close()
    plt.savefig('test_PID_dl.png')
    raise

a.close()
```

Opening connection
iTCLab connected via Arduino on port COM3

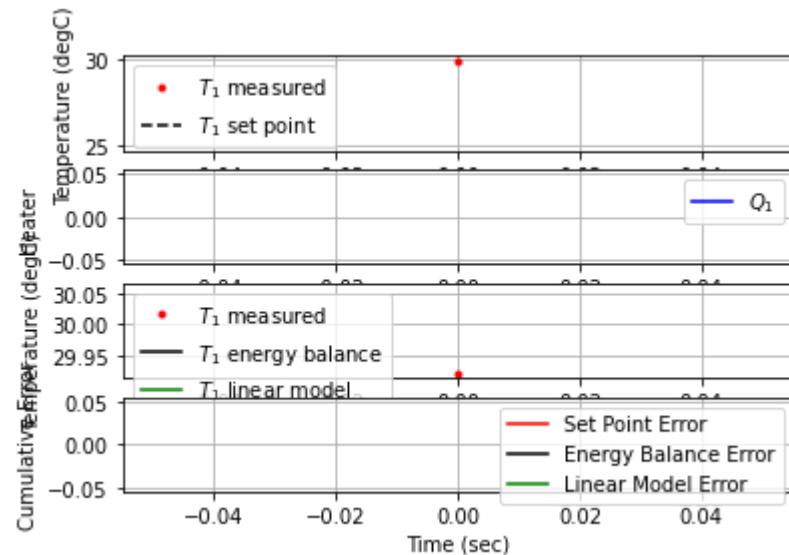
LED On

Running Main Loop. Ctrl-C to end.

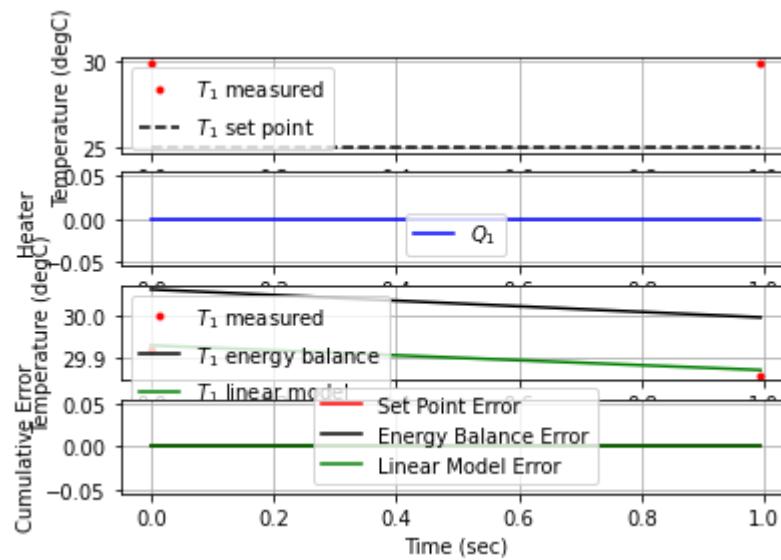
Time	SP	PV	Q1	=	P	+	I	+	D
0.0	25.00	29.92	0.00		0.00		0.00		0.00

<Figure size 720x504 with 0 Axes>

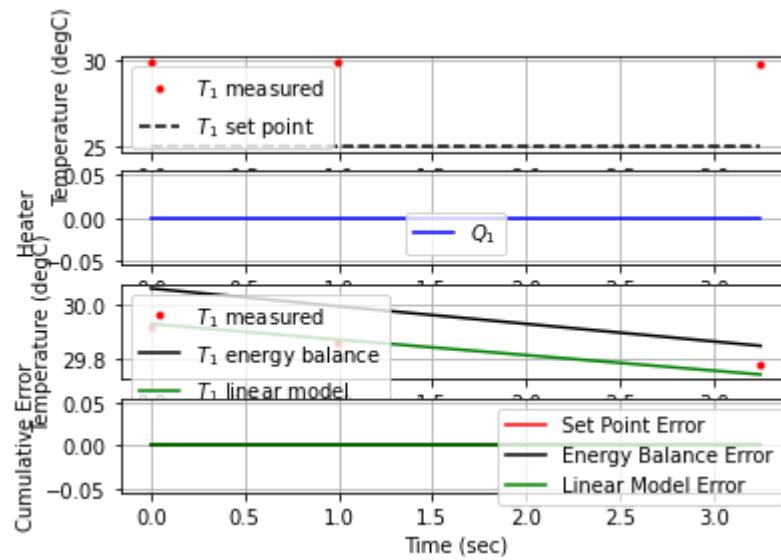
1.0	25.00	29.86	0.00	-0.93	0.00	0.00
-----	-------	-------	------	-------	------	------



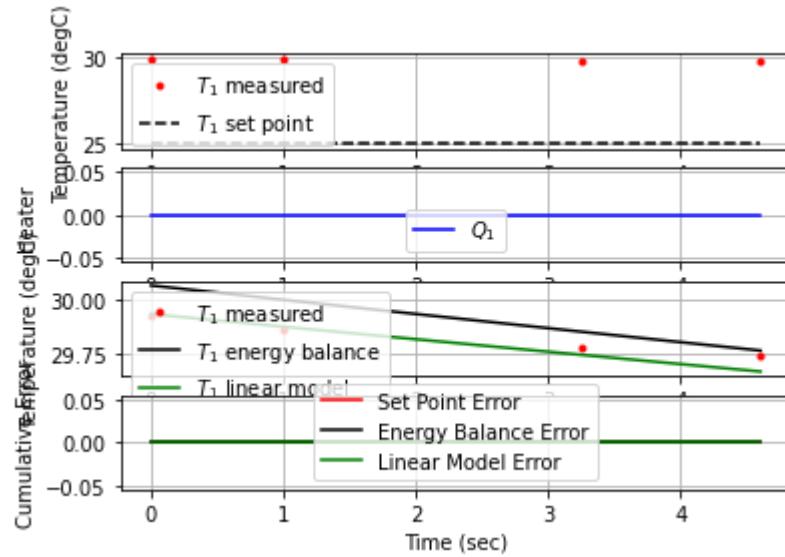
3.3	25.00	29.78	0.00	-0.91	0.00	0.00
-----	-------	-------	------	-------	------	------



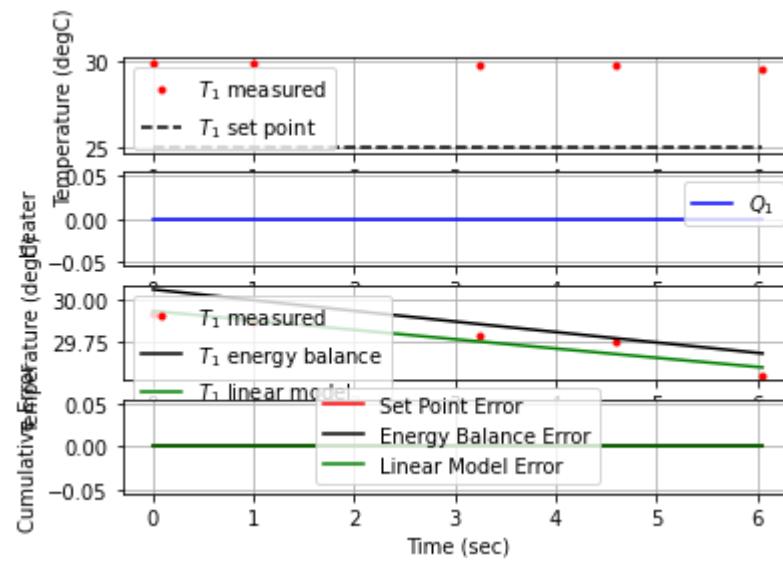
4.6 25.00 29.74 0.00 -0.90 0.00 0.00



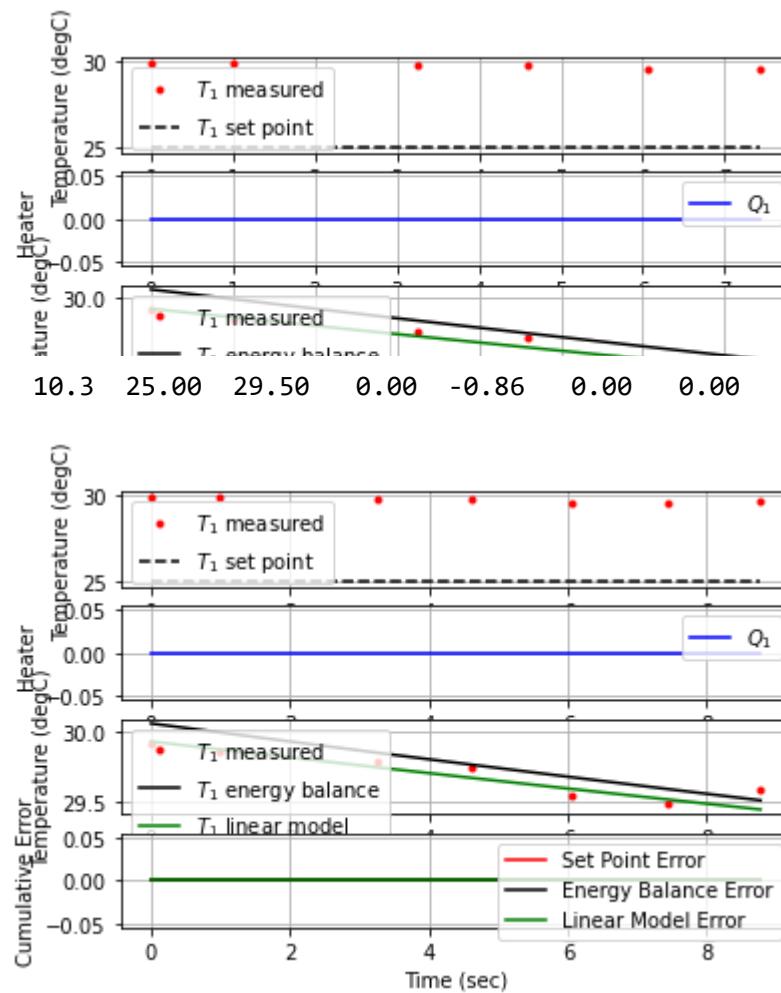
6.1 25.00 29.54 0.00 -0.87 0.00 0.01



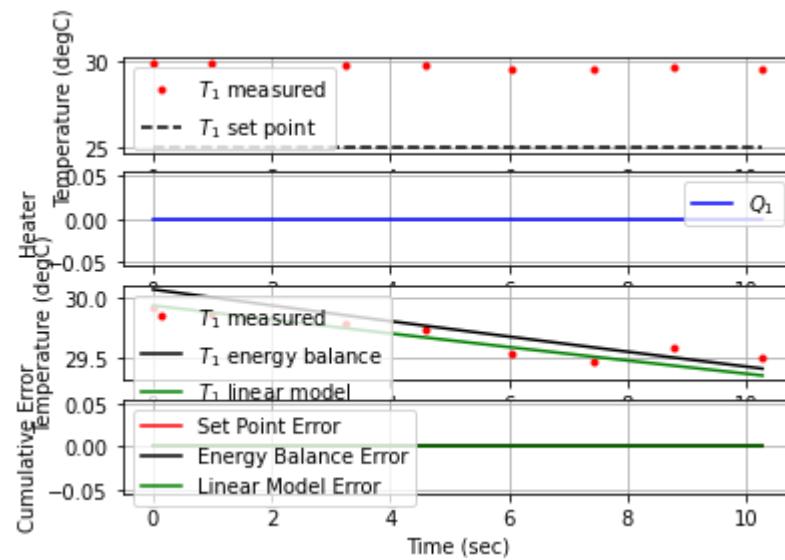
7.4 25.00 29.48 0.00 -0.86 0.00 0.00



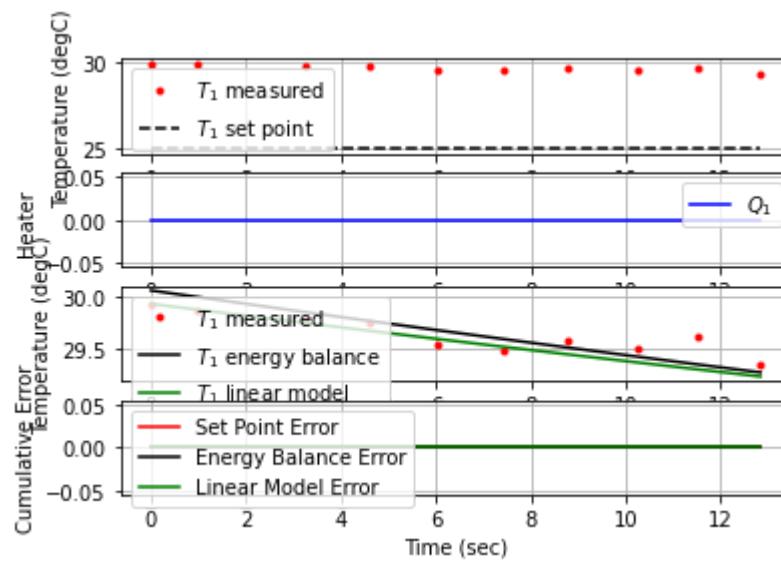
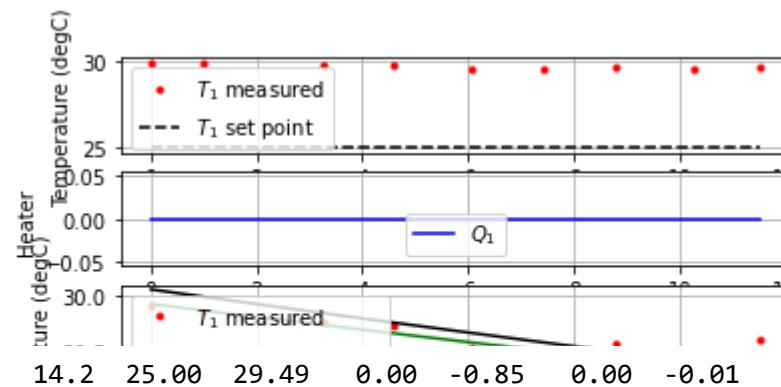
8.8 25.00 29.58 0.00 -0.87 0.00 -0.00



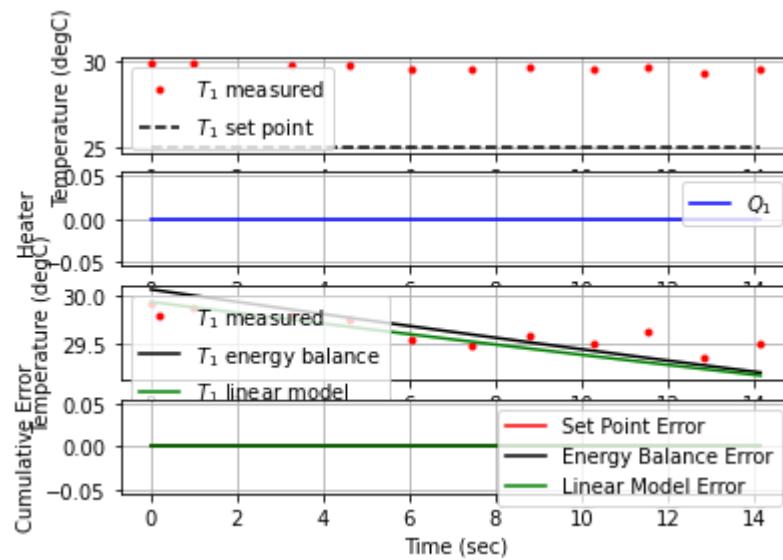
11.5 25.00 29.62 0.00 -0.88 0.00 -0.00



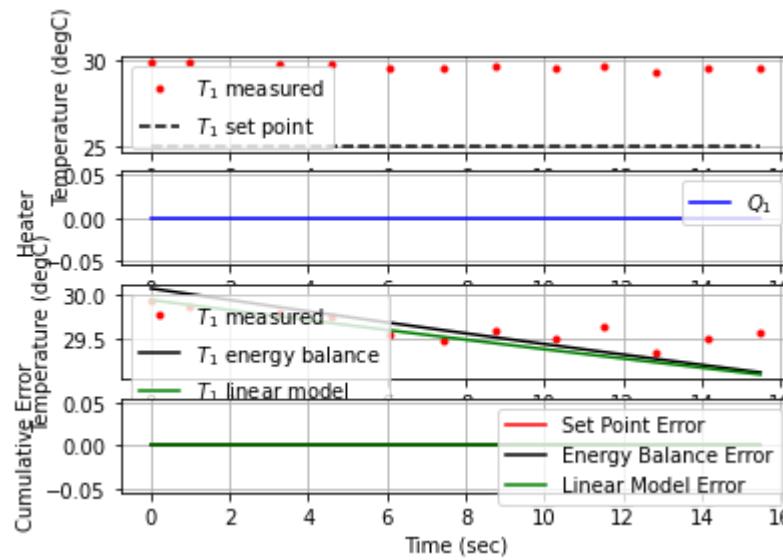
12.8 25.00 29.34 0.00 -0.84 0.00 0.01



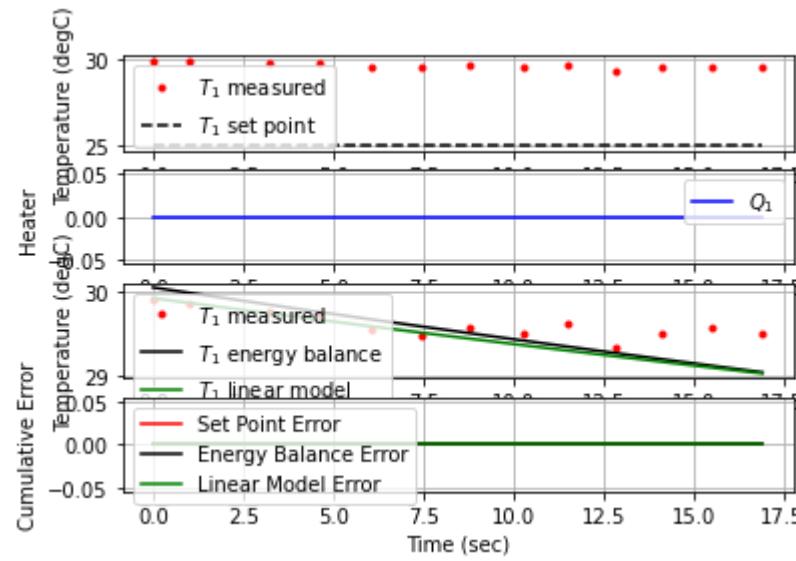
15.5 25.00 29.57 0.00 -0.87 0.00 -0.00



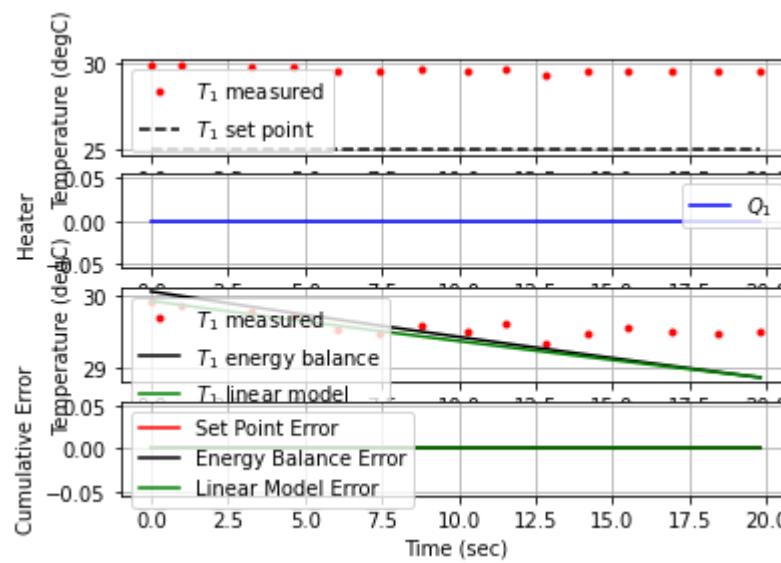
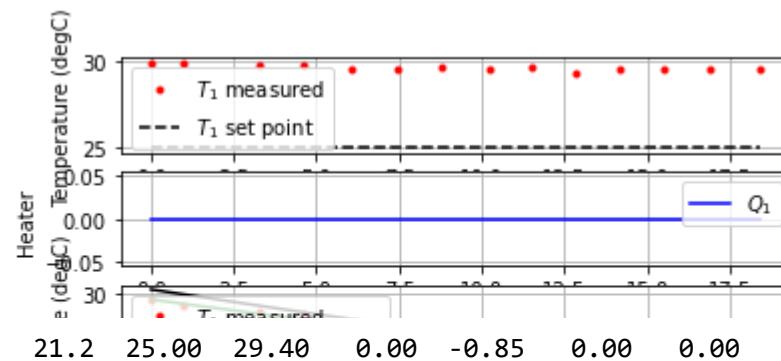
16.9 25.00 29.51 0.00 -0.86 0.00 0.00



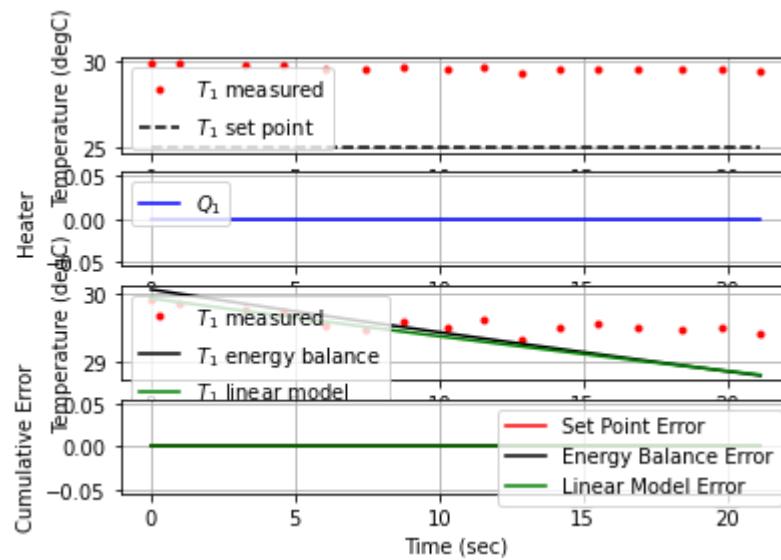
18.4 25.00 29.47 0.00 -0.86 0.00 0.00



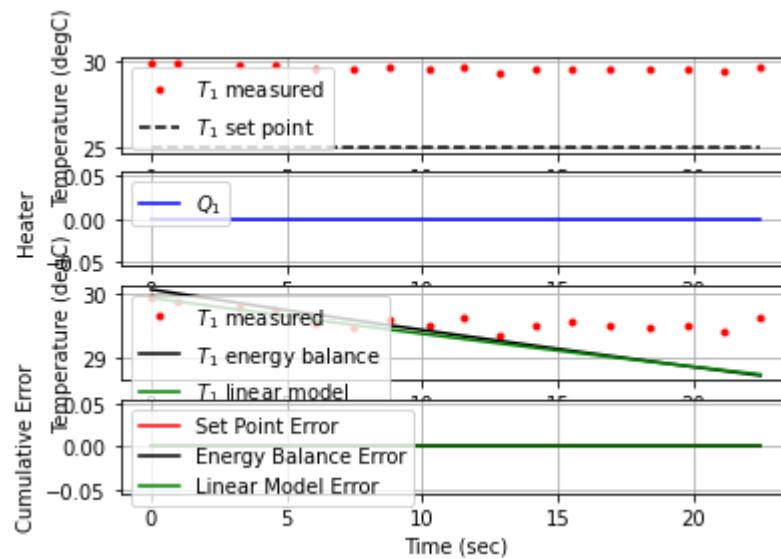
19.8 25.00 29.51 0.00 -0.86 0.00 -0.00



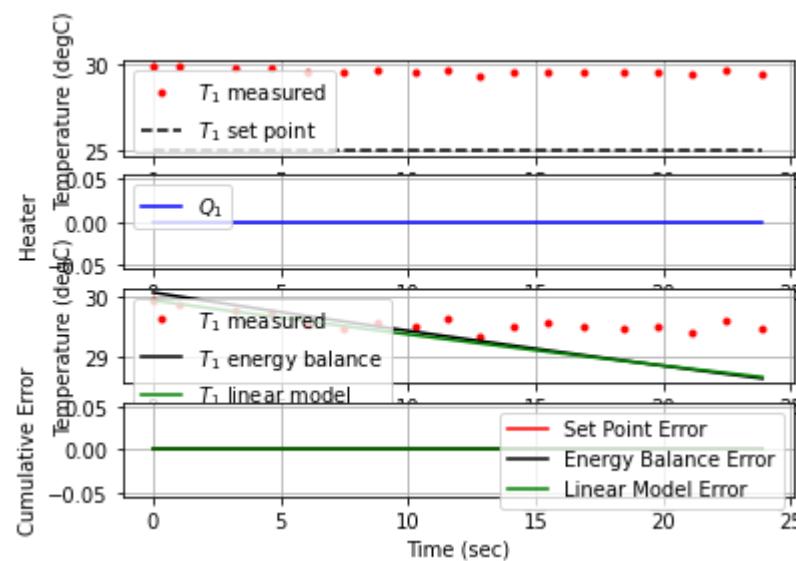
22.5 25.00 29.61 0.00 -0.87 0.00 -0.01



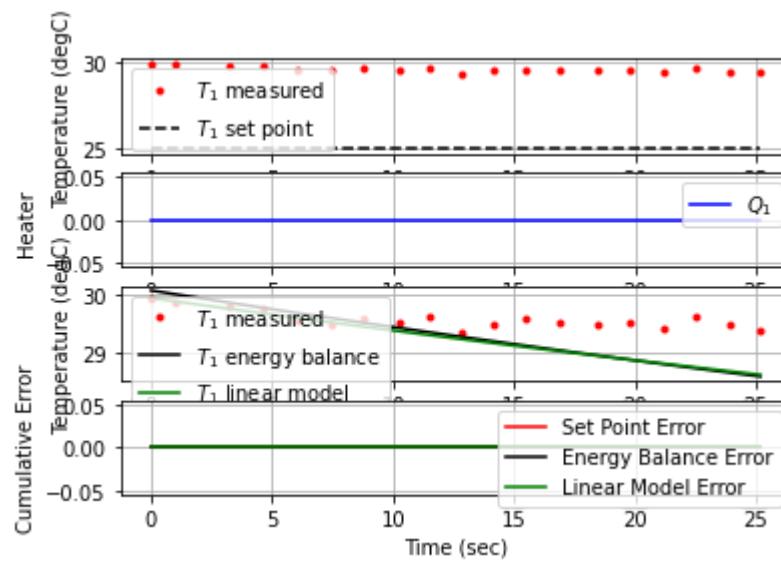
23.9 25.00 29.46 0.00 -0.86 0.00 0.00



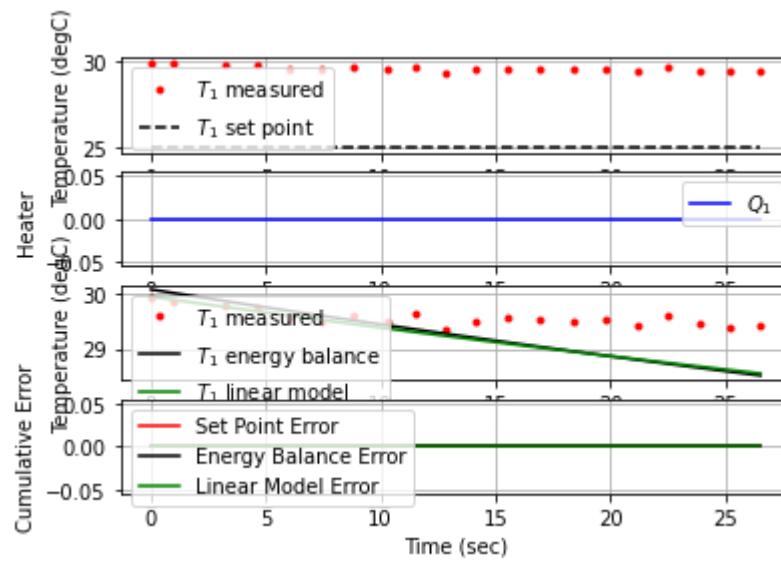
25.2 25.00 29.39 0.00 -0.84 0.00 0.00



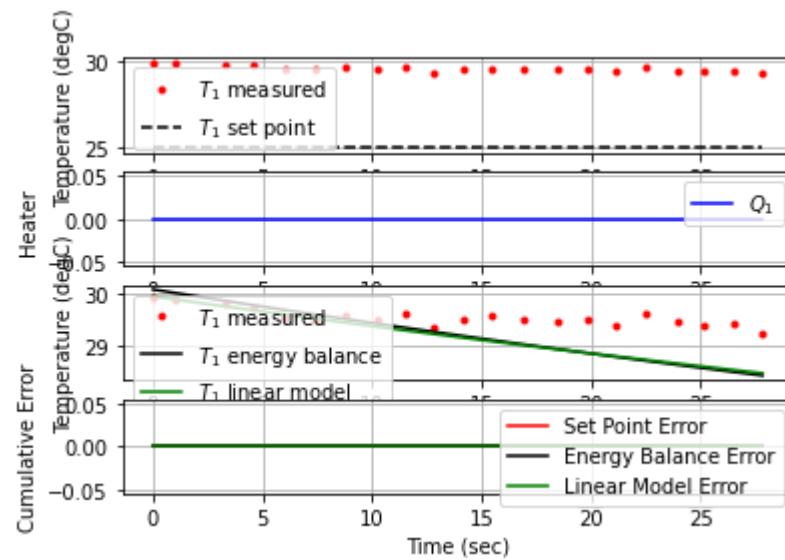
26.5 25.00 29.41 0.00 -0.84 0.00 -0.00



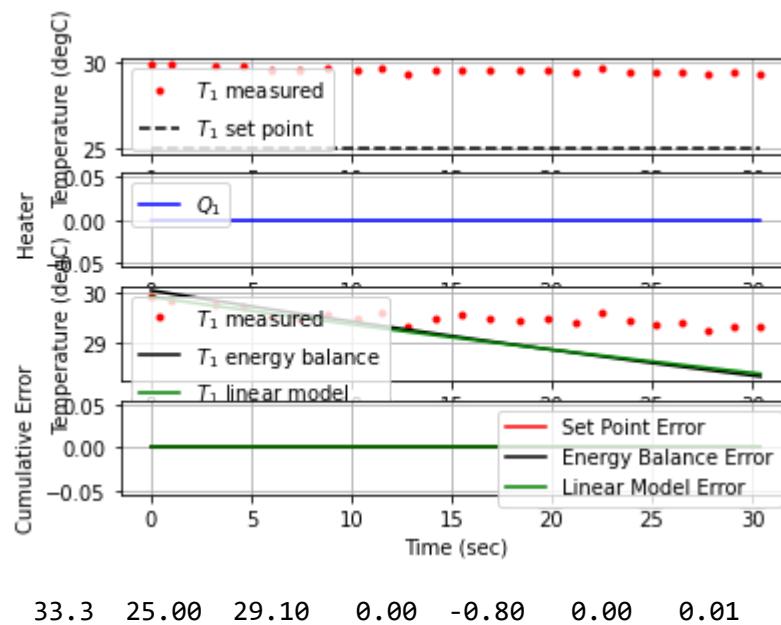
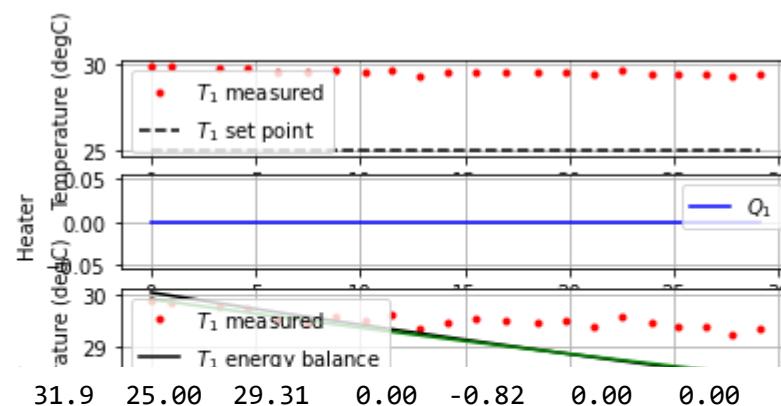
27.8 25.00 29.25 0.00 -0.82 0.00 0.01

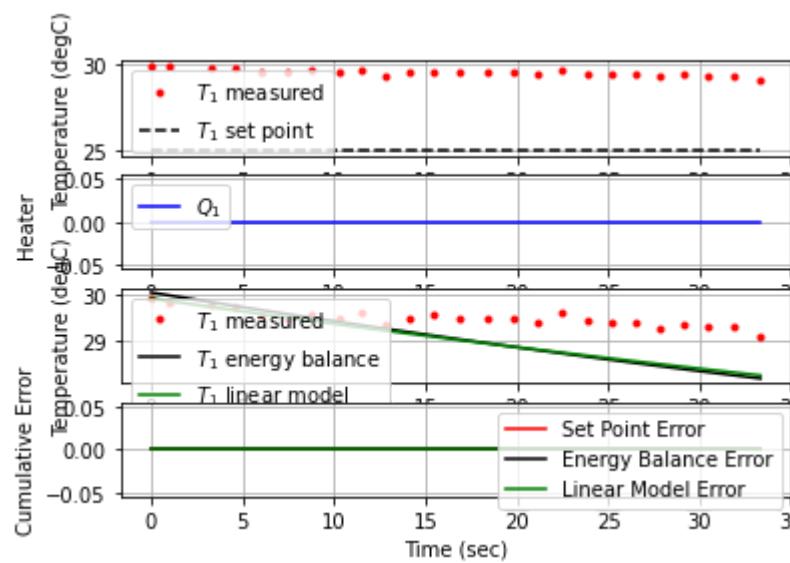
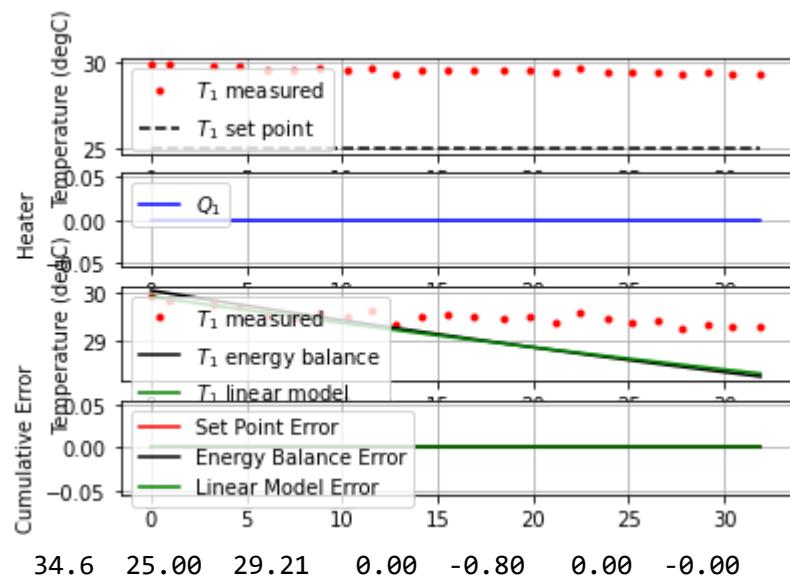


29.1 25.00 29.35 0.00 -0.83 0.00 -0.00

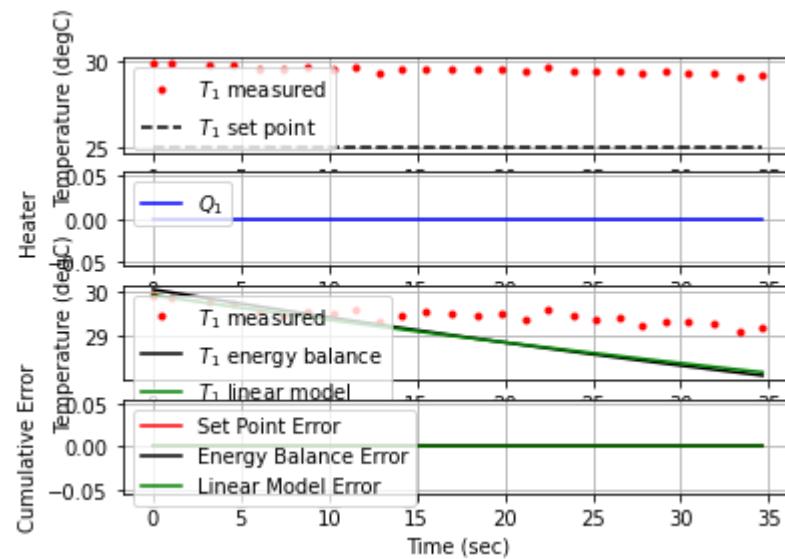


30.4 25.00 29.32 0.00 -0.83 0.00 0.00

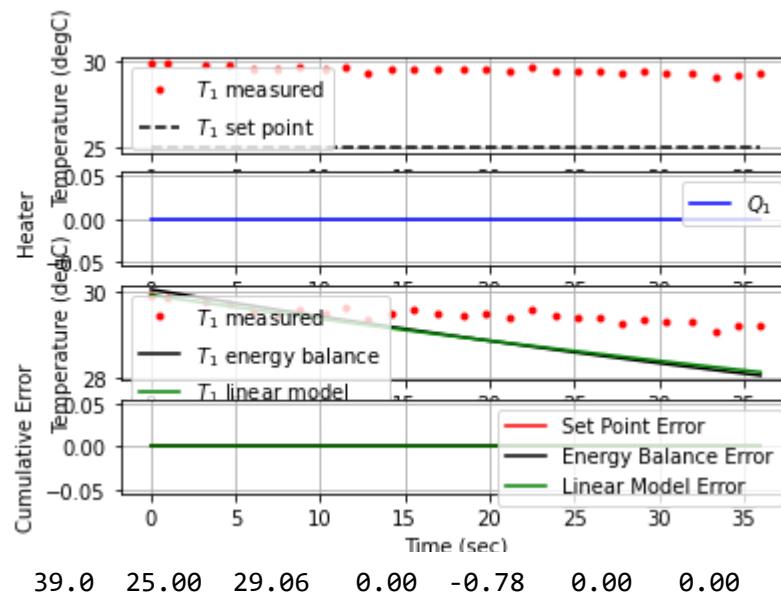




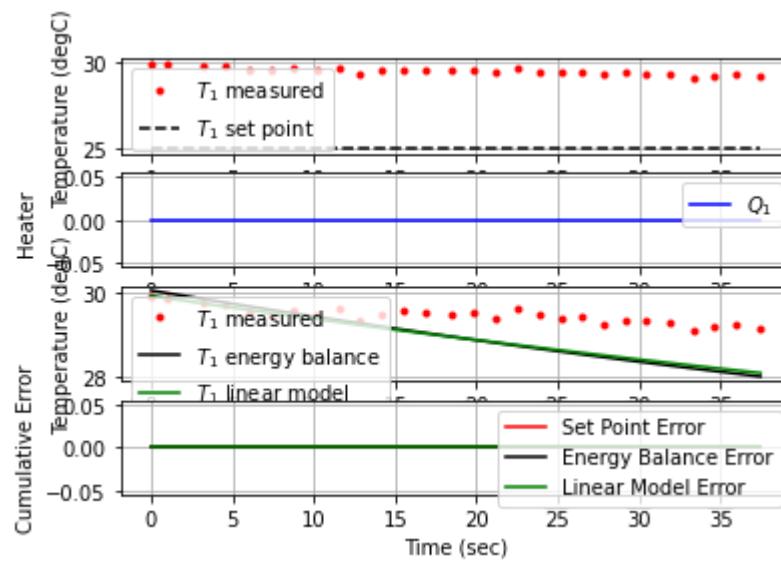
36.0 25.00 29.24 0.00 -0.81 0.00 -0.00



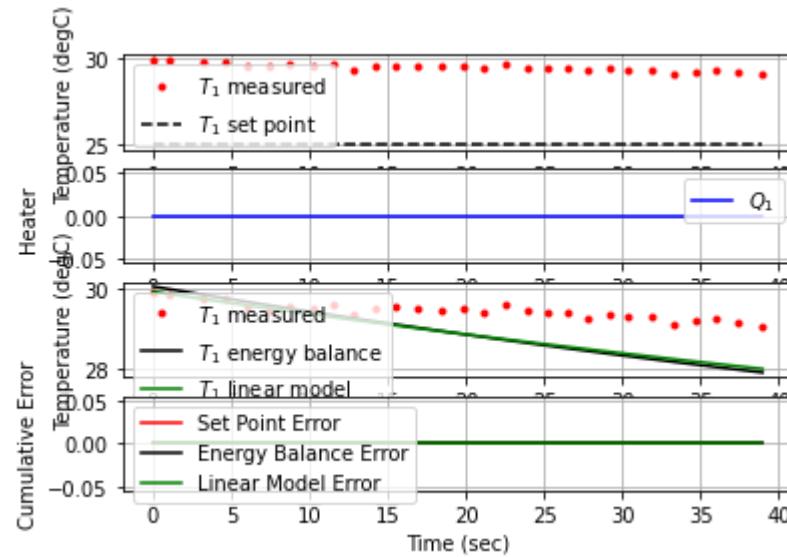
37.5 25.00 29.14 0.00 -0.80 0.00 0.00



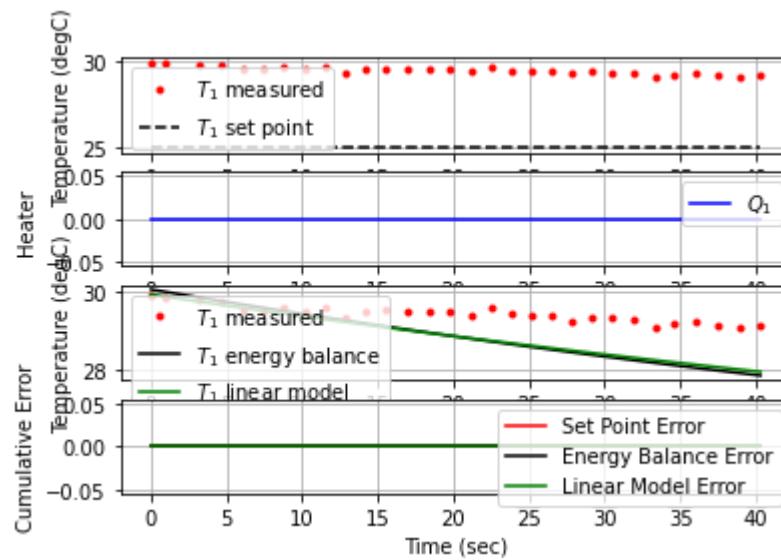
39.0 25.00 29.06 0.00 -0.78 0.00 0.00



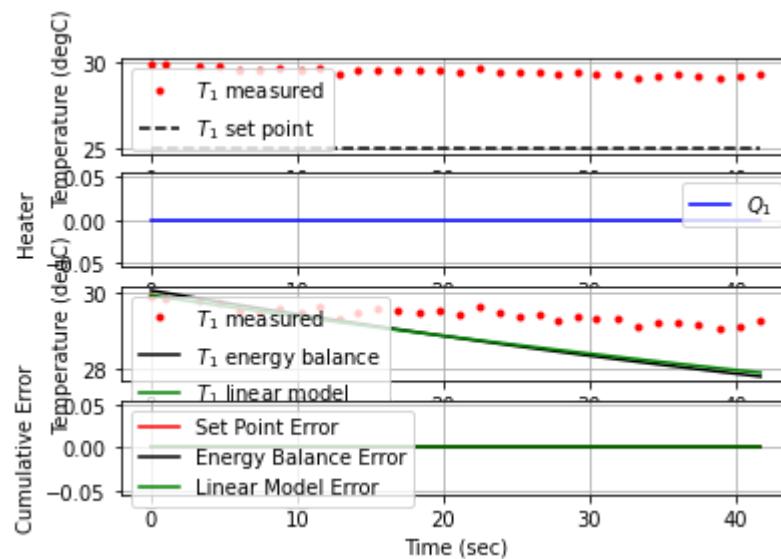
40.3 25.00 29.12 0.00 -0.79 0.00 -0.00



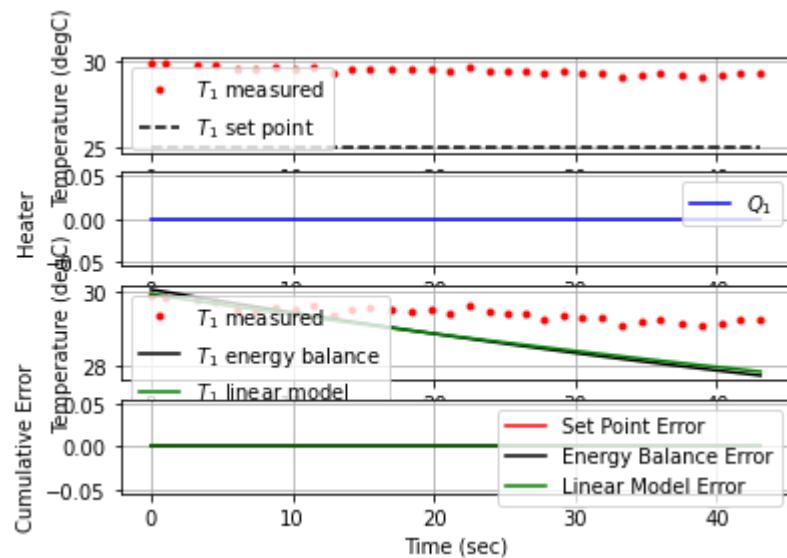
41.7 25.00 29.27 0.00 -0.81 0.00 -0.00



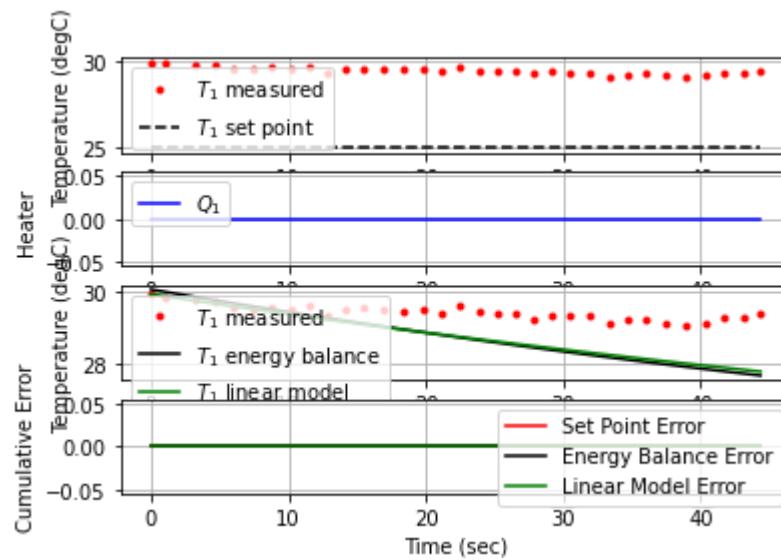
43.1 25.00 29.27 0.00 -0.82 0.00 -0.00



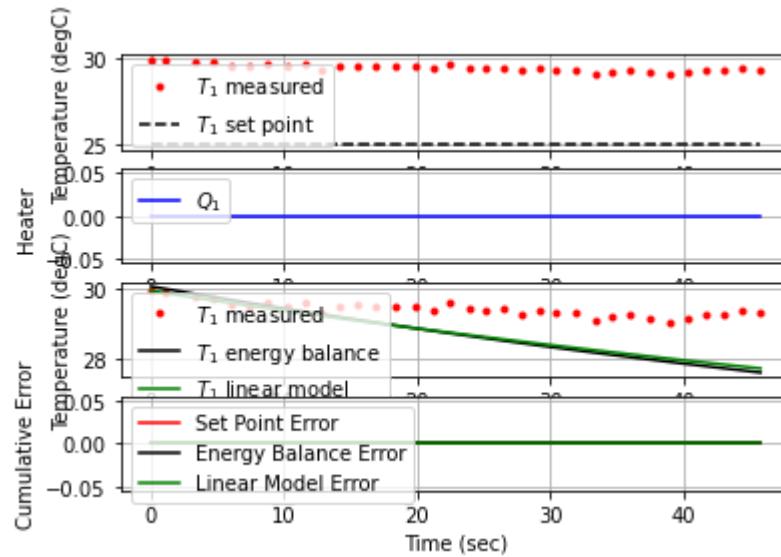
44.4 25.00 29.40 0.00 -0.84 0.00 -0.00



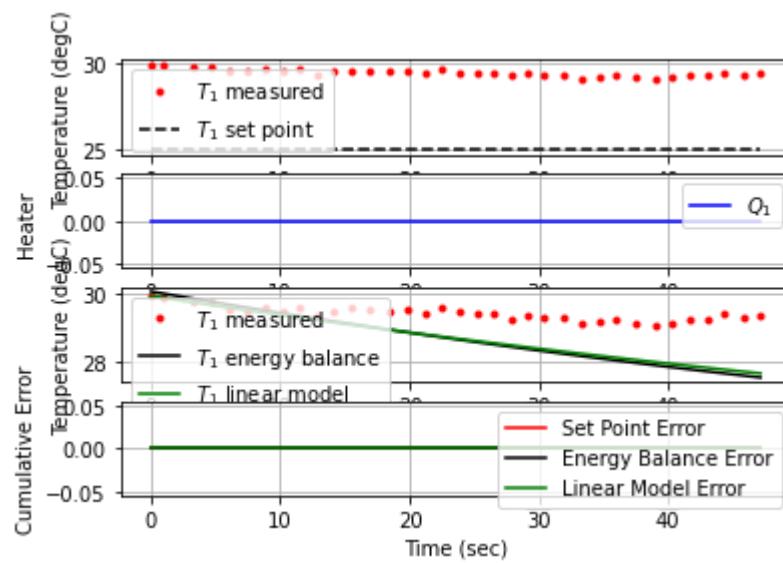
45.8 25.00 29.31 0.00 -0.83 0.00 0.00



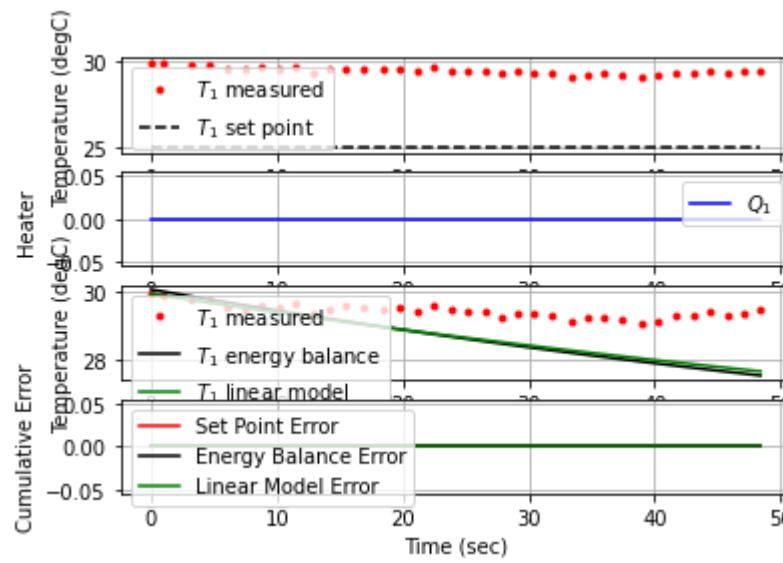
47.1 25.00 29.36 0.00 -0.83 0.00 -0.00



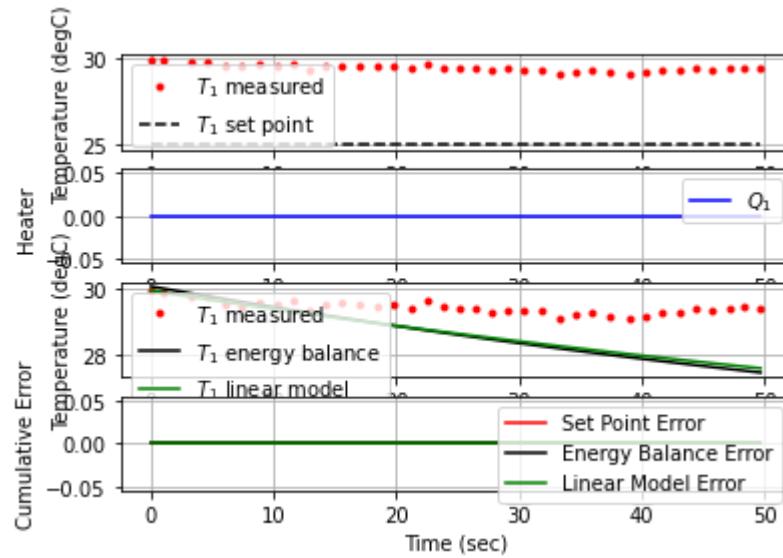
48.4 25.00 29.44 0.00 -0.85 0.00 -0.00



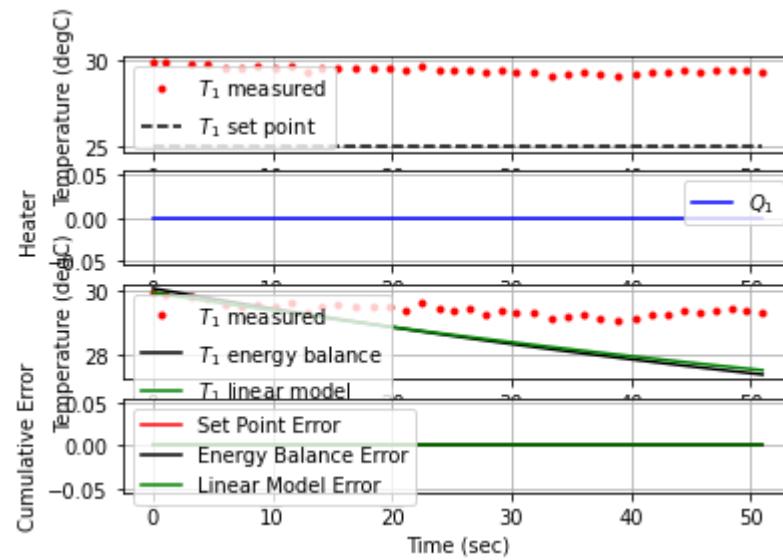
49.7 25.00 29.39 0.00 -0.84 0.00 0.00



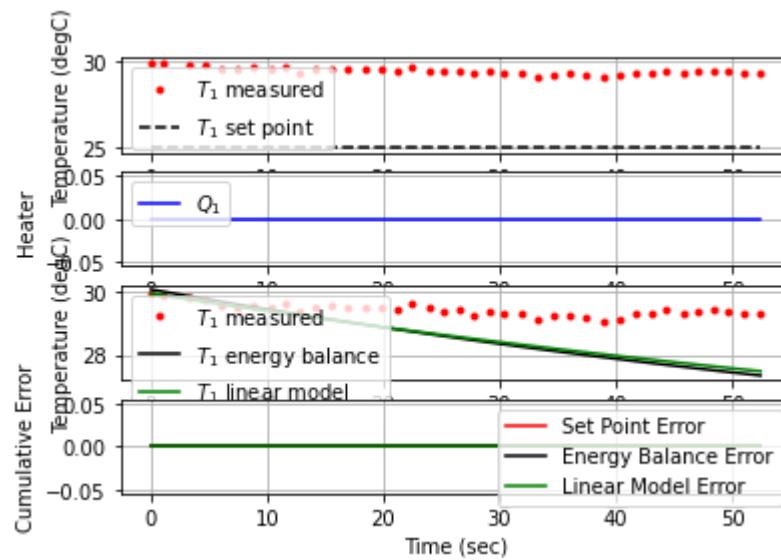
51.0 25.00 29.29 0.00 -0.83 0.00 0.00



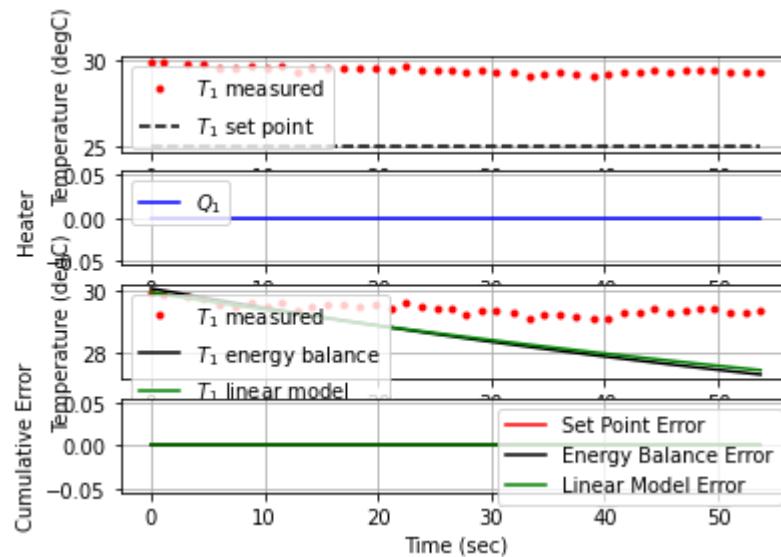
52.4 25.00 29.28 0.00 -0.82 0.00 0.00



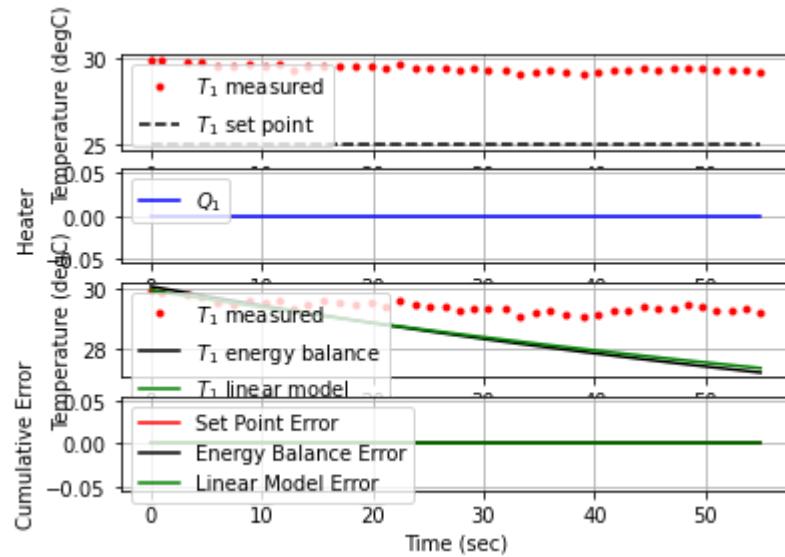
53.7 25.00 29.33 0.00 -0.83 0.00 -0.00



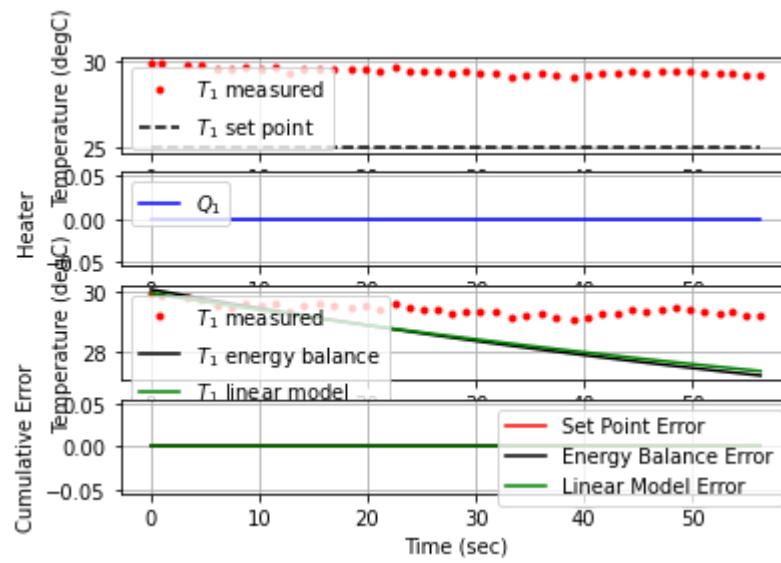
55.0 25.00 29.20 0.00 -0.81 0.00 0.00



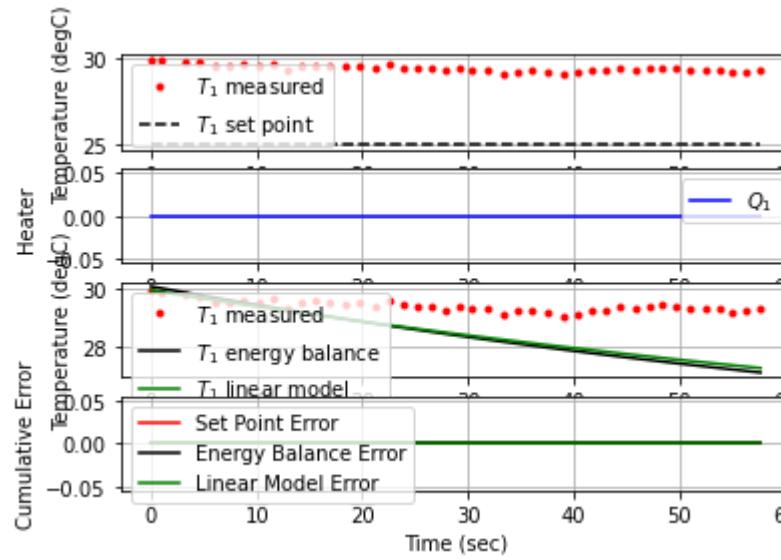
56.3 25.00 29.21 0.00 -0.81 0.00 -0.00



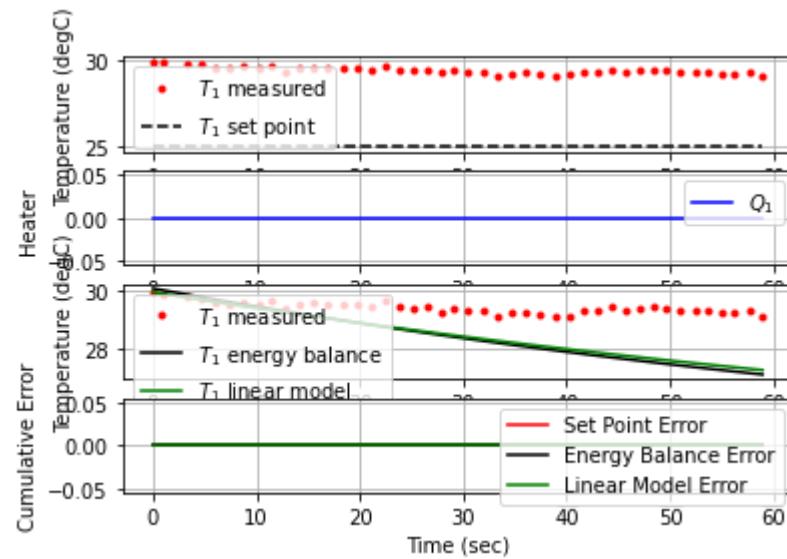
57.7 25.00 29.32 0.00 -0.82 0.00 -0.00



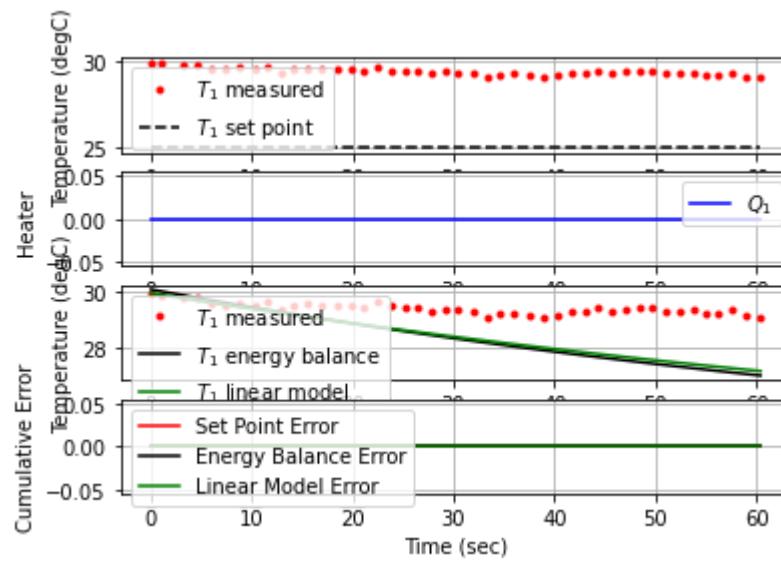
59.0 25.00 29.11 0.00 -0.80 0.00 0.01



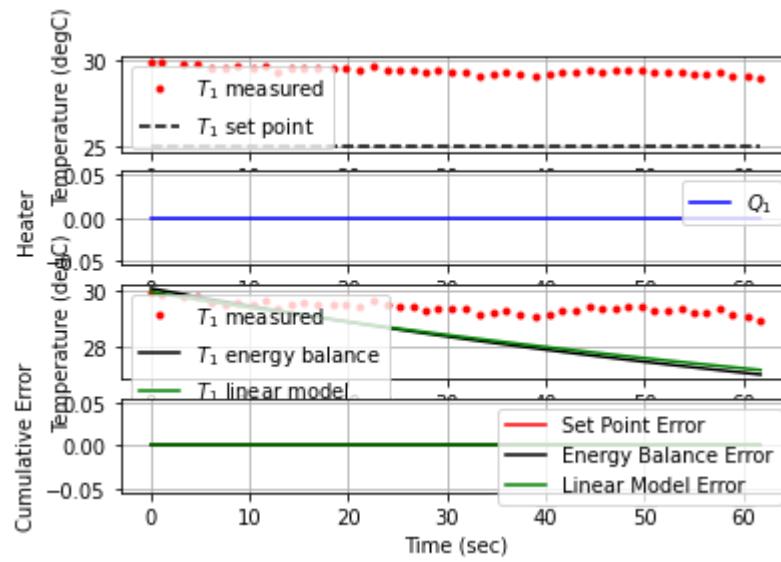
60.4 25.00 29.04 0.00 -0.78 0.00 0.00



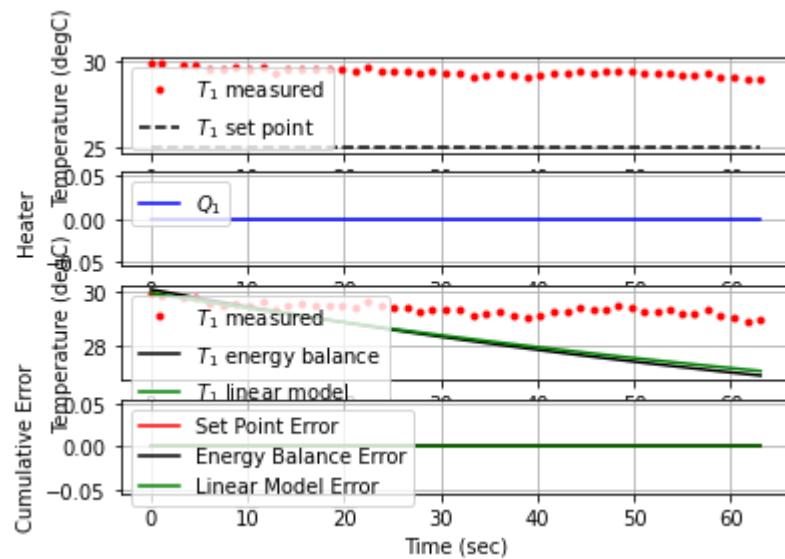
61.8 25.00 28.92 0.00 -0.76 0.00 0.00



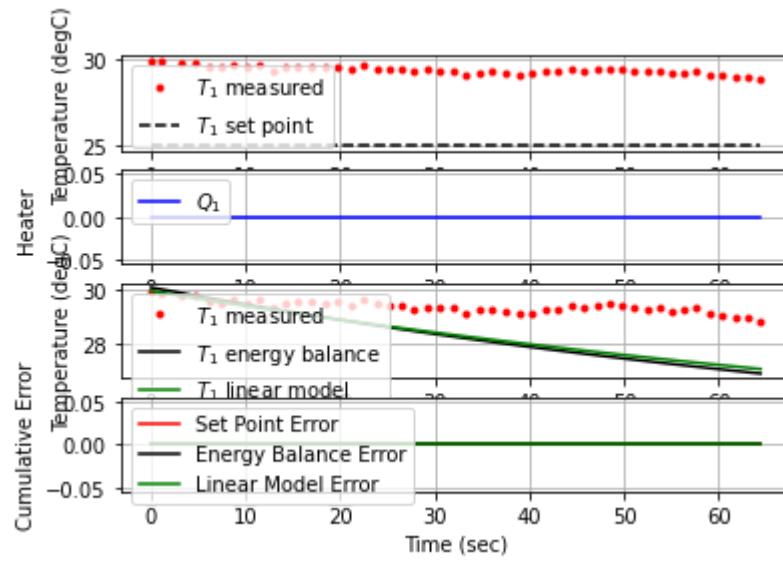
63.1 25.00 28.94 0.00 -0.76 0.00 -0.00



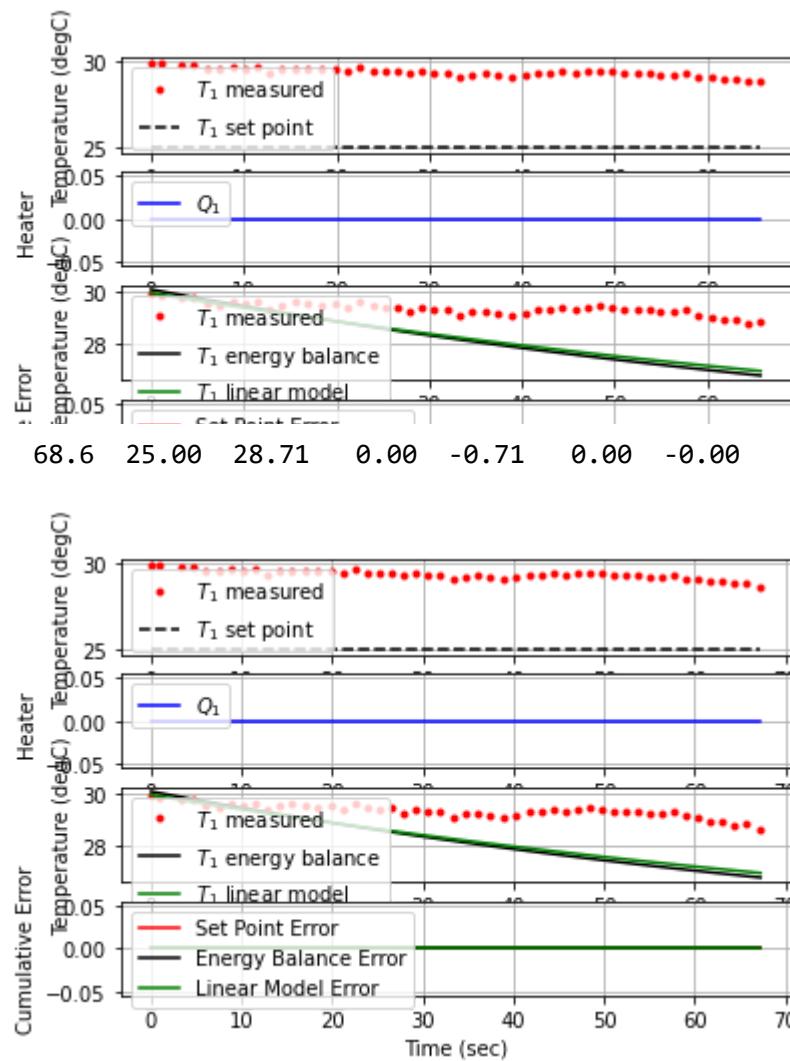
64.4 25.00 28.79 0.00 -0.74 0.00 0.01



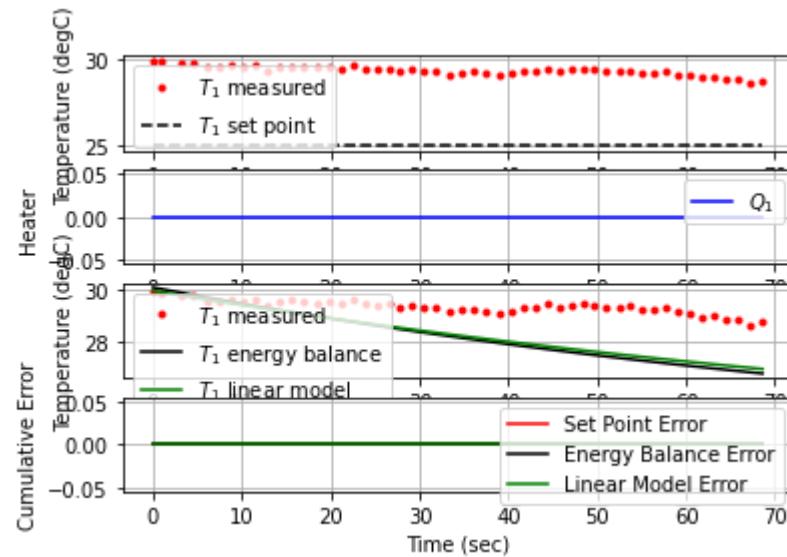
65.7 25.00 28.85 0.00 -0.74 0.00 -0.00



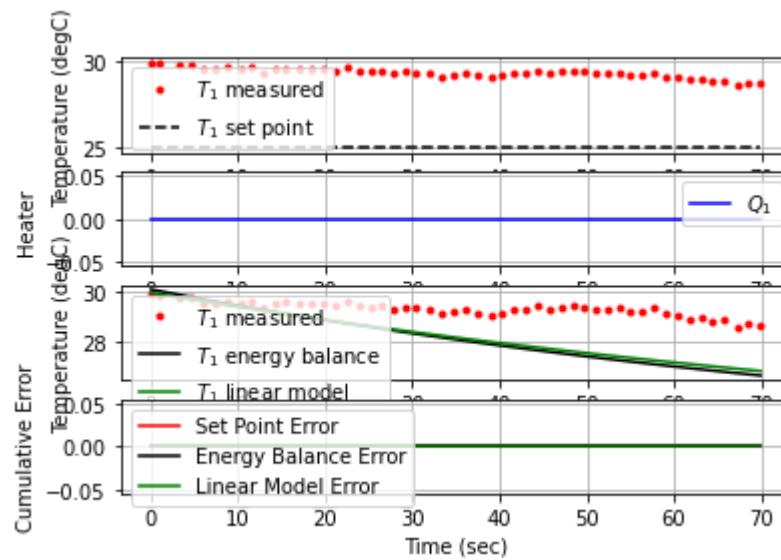
67.3 25.00 28.60 0.00 -0.71 0.00 0.01



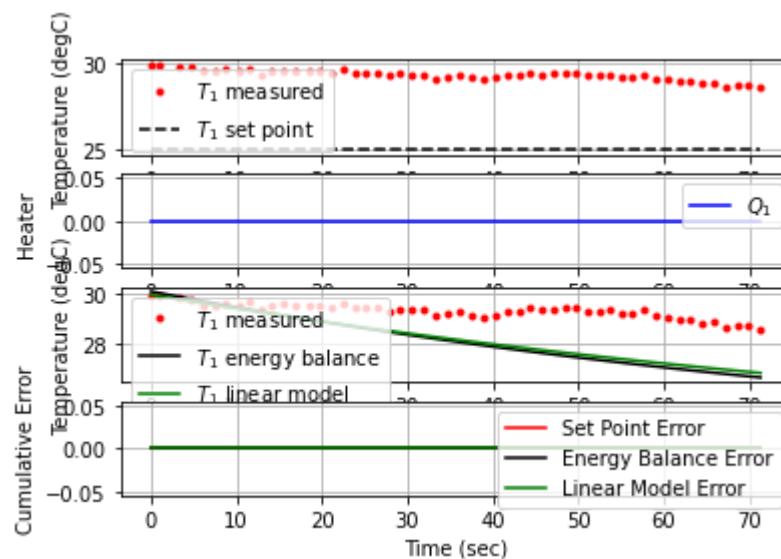
69.9 25.00 28.68 0.00 -0.71 0.00 0.00



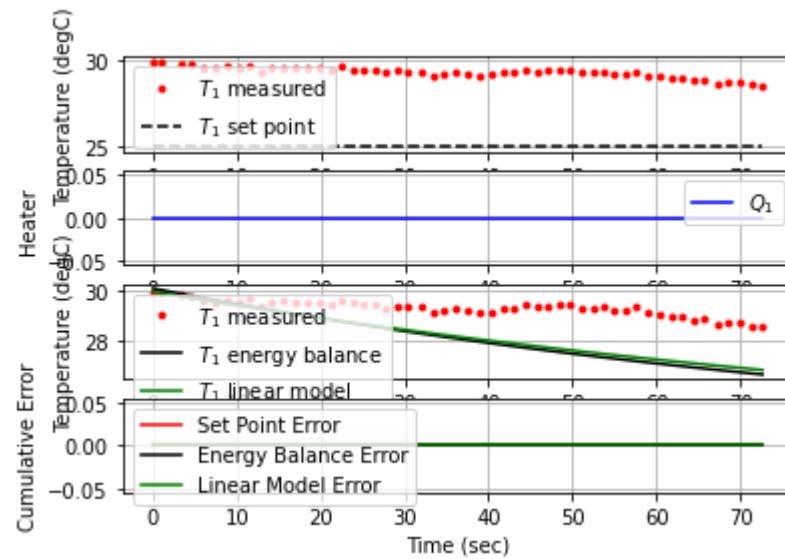
71.3 25.00 28.55 0.00 -0.69 0.00 0.00



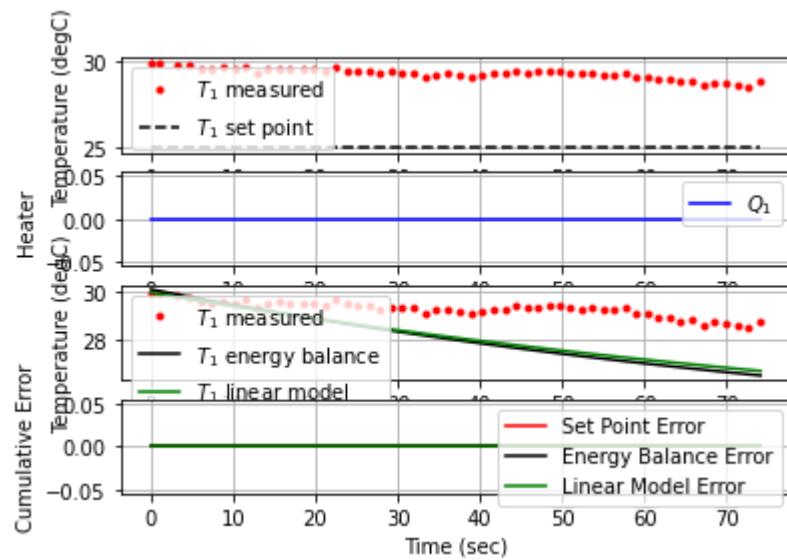
72.7 25.00 28.54 0.00 -0.68 0.00 0.00



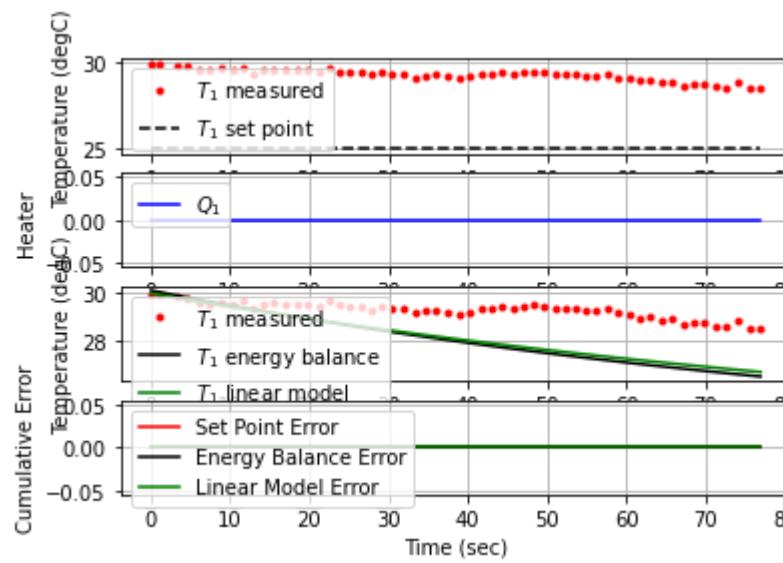
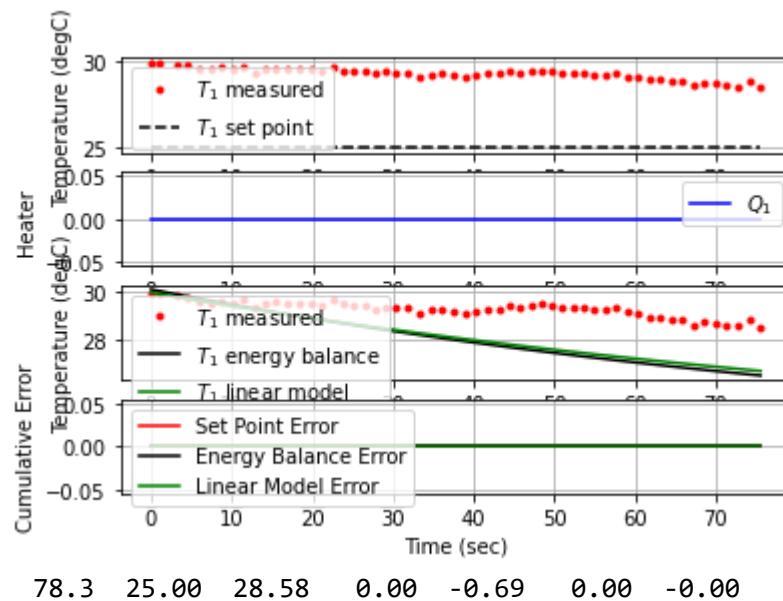
74.2 25.00 28.79 0.00 -0.72 0.00 -0.01



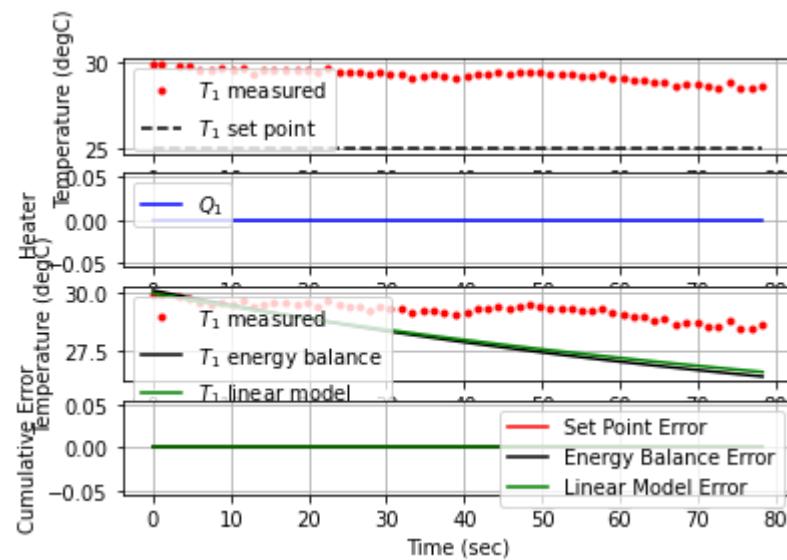
75.5 25.00 28.48 0.00 -0.69 0.00 0.01



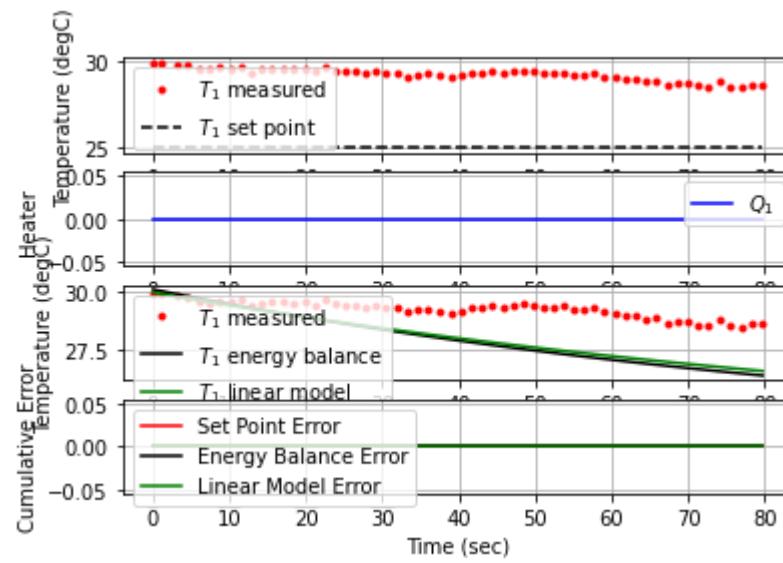
77.0 25.00 28.45 0.00 -0.67 0.00 0.00



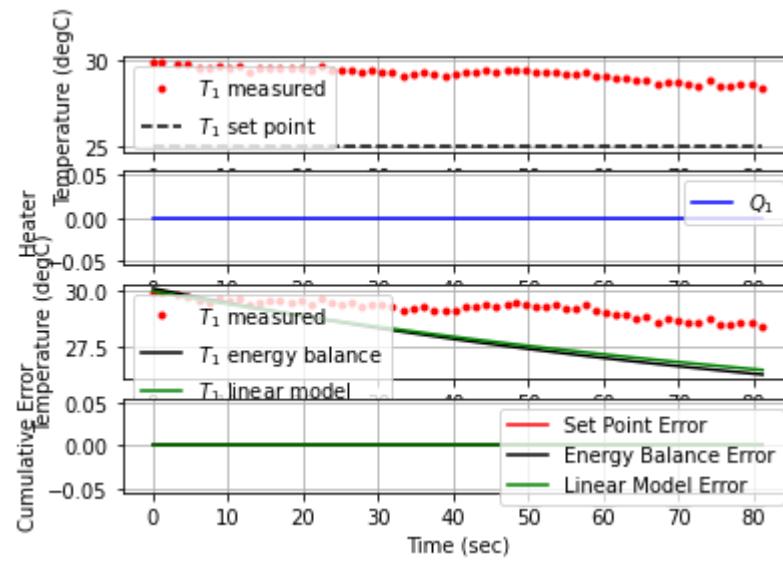
79.7 25.00 28.56 0.00 -0.69 0.00 0.00



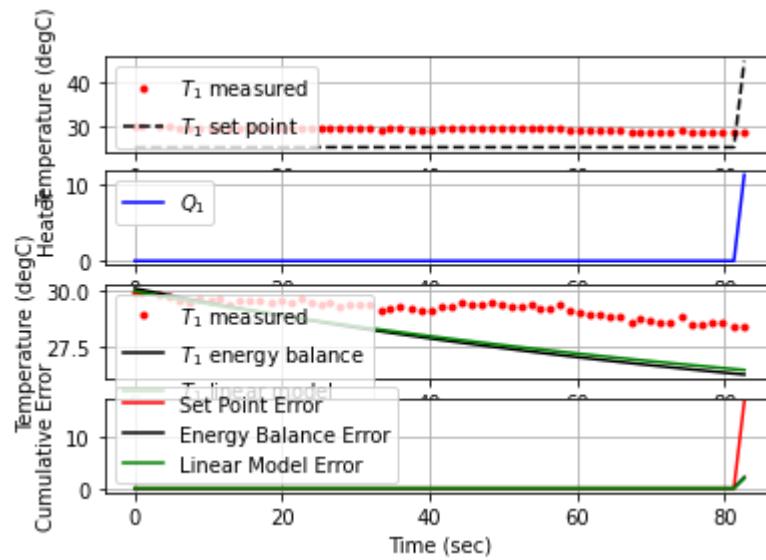
81.2 25.00 28.42 0.00 -0.67 0.00 0.00



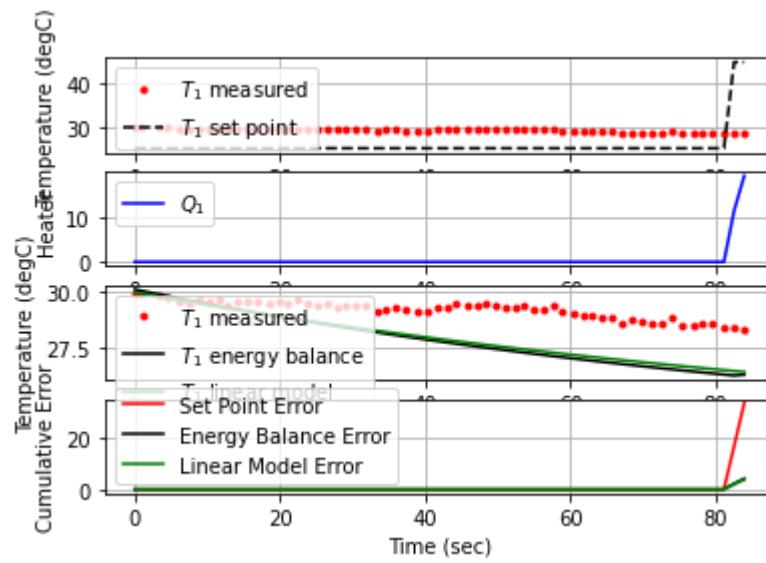
82.6 45.00 28.39 11.27 3.61 7.65 0.00



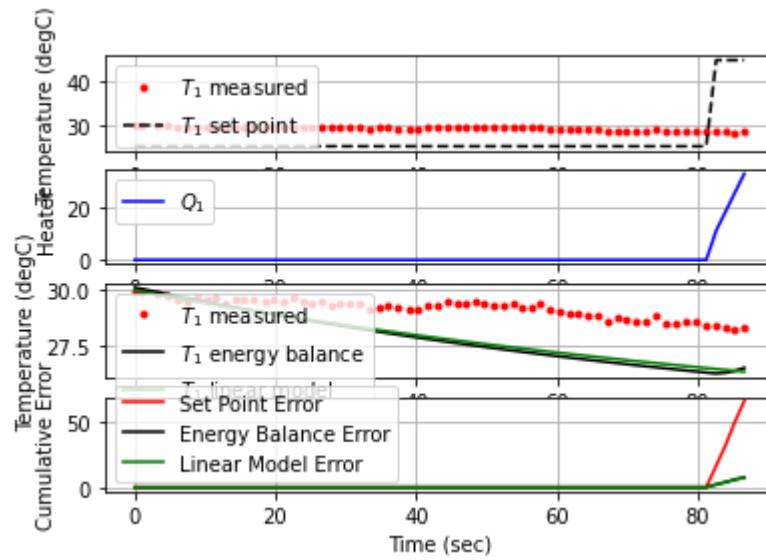
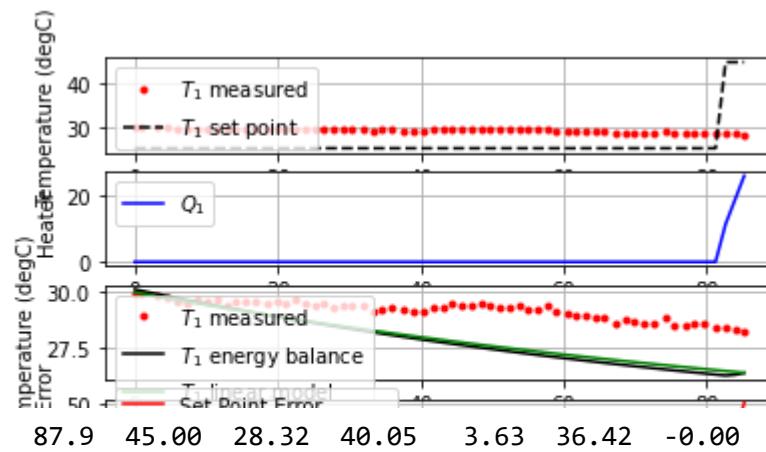
84.0 45.00 28.28 19.01 3.64 15.37 0.00

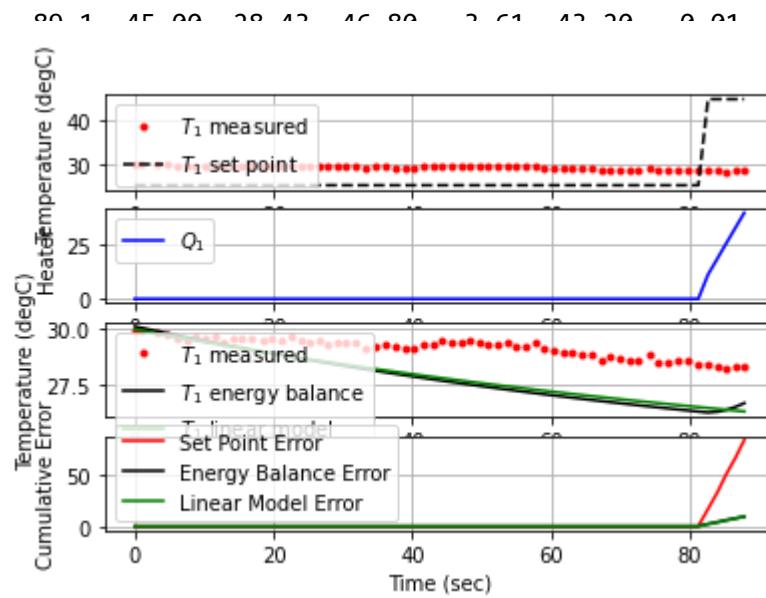


85.3 45.00 28.21 25.72 3.65 22.07 0.00

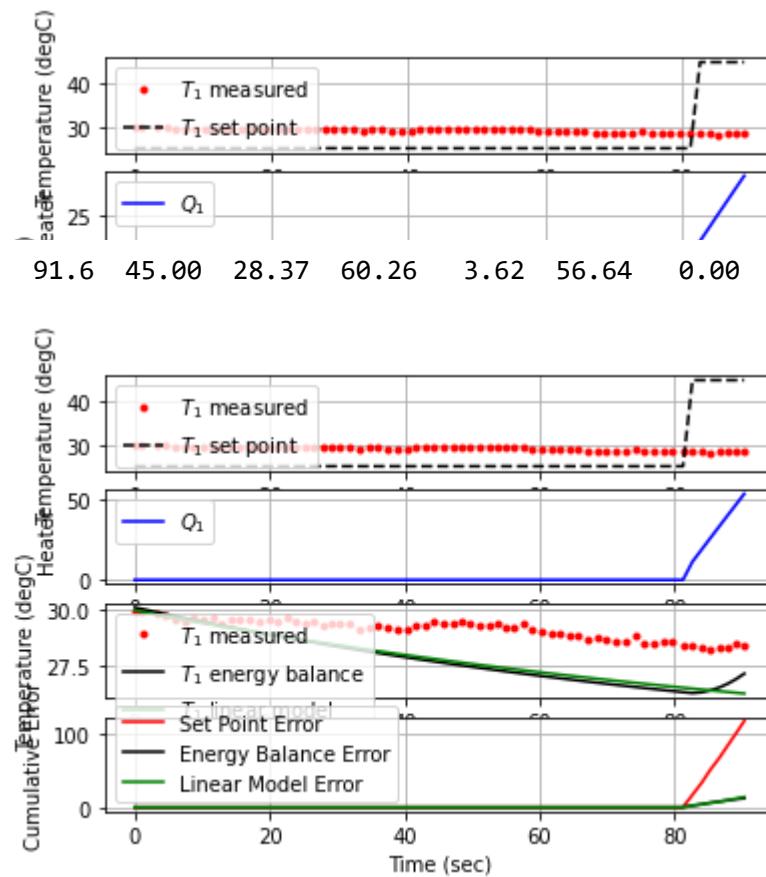


86.6 45.00 28.30 33.32 3.63 29.69 -0.00

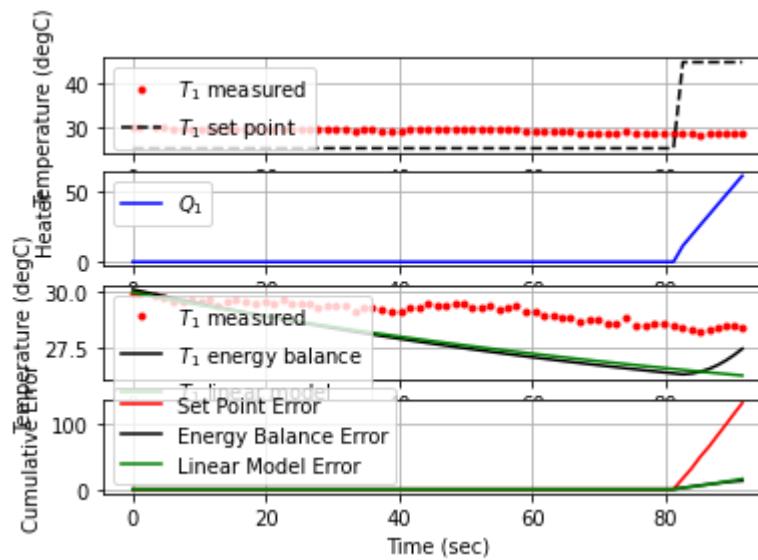




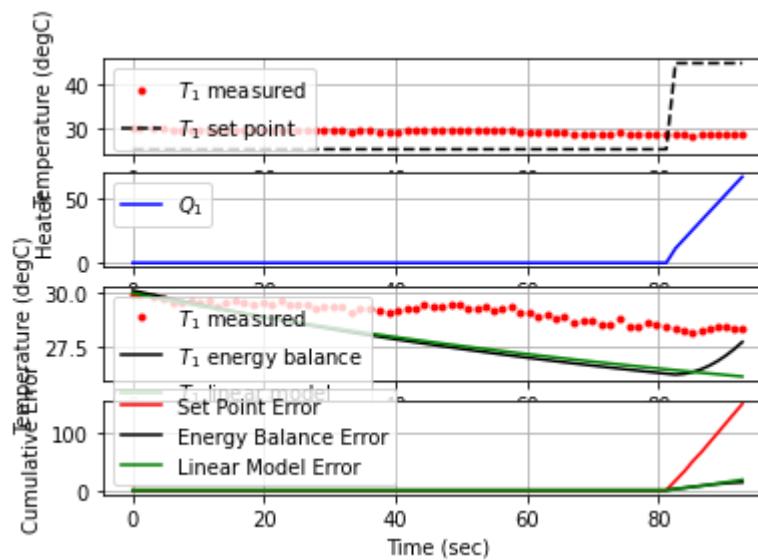
90.3 45.00 28.41 53.44 3.61 49.83 0.00



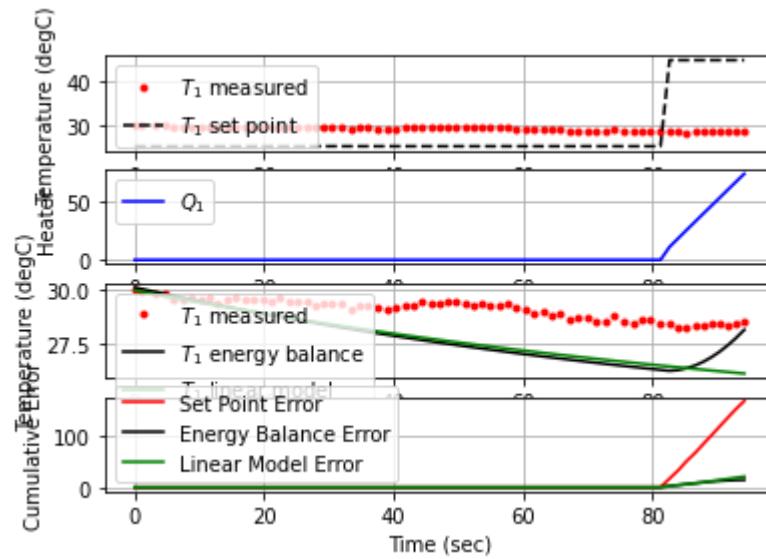
92.8 45.00 28.39 67.06 3.61 63.45 -0.00



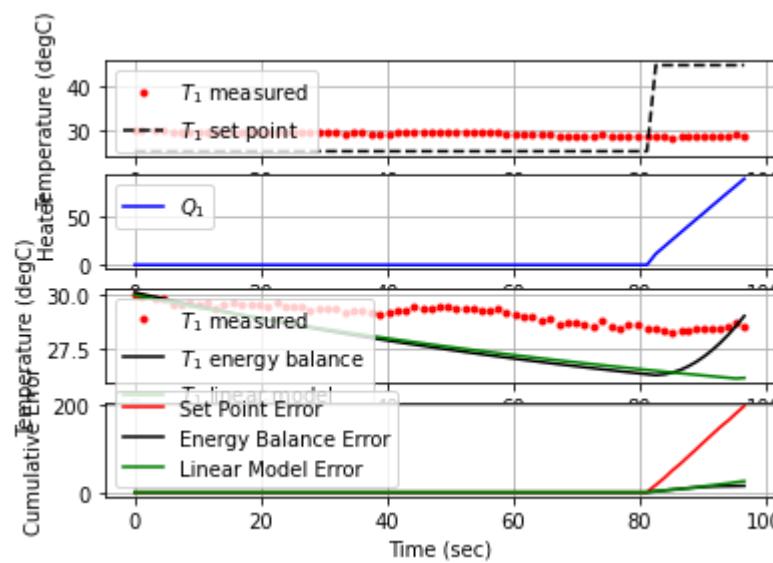
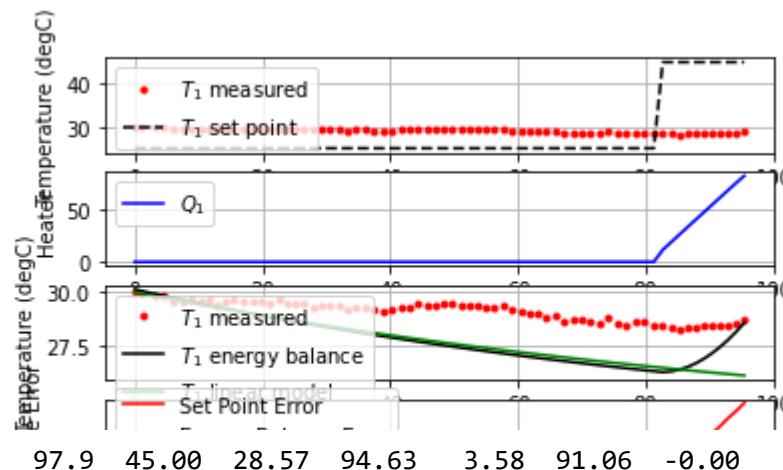
94.2 45.00 28.49 74.48 3.59 70.90 -0.00



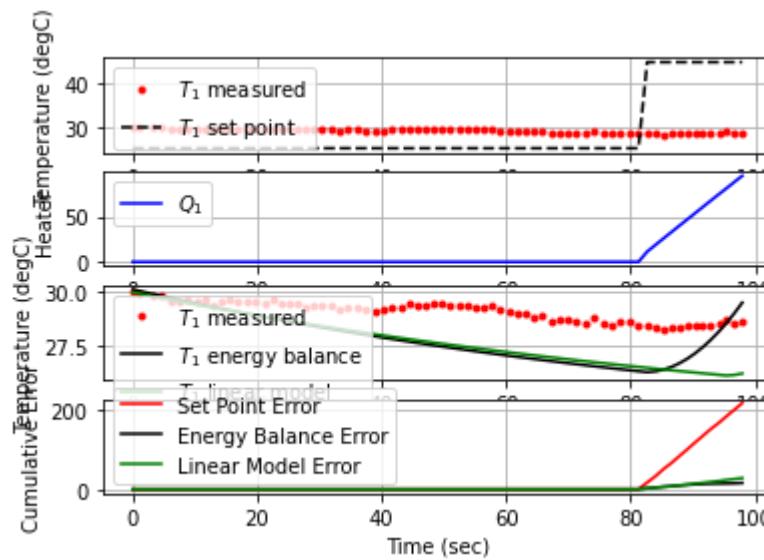
95.4 45.00 28.72 80.94 3.54 77.40 -0.01



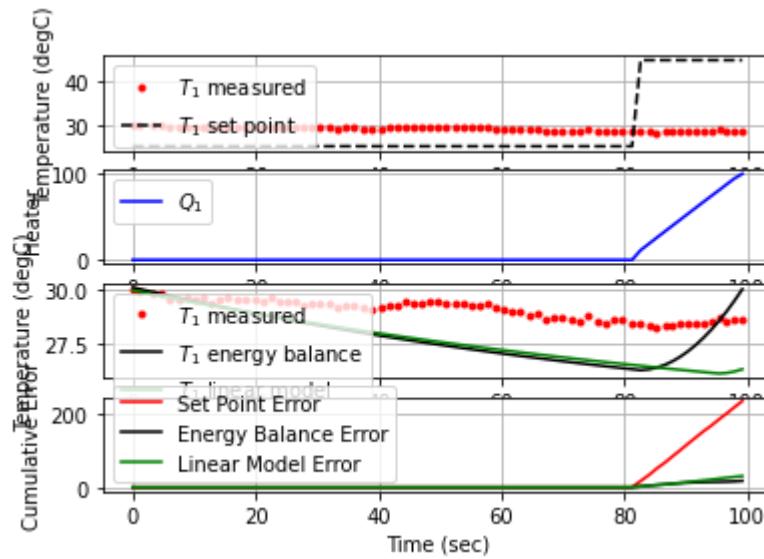
96.7 45.00 28.52 87.92 3.59 84.33 0.01

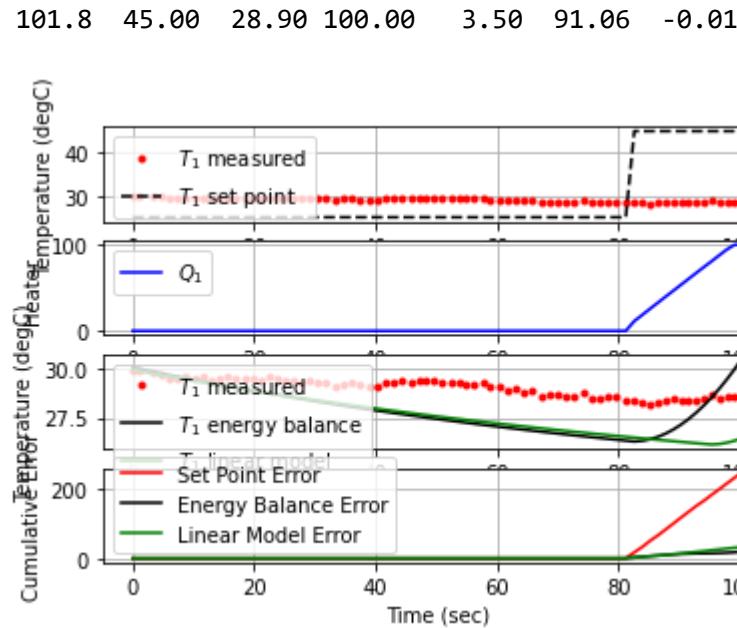


99.2 45.00 28.59 100.00 3.57 91.06 -0.00

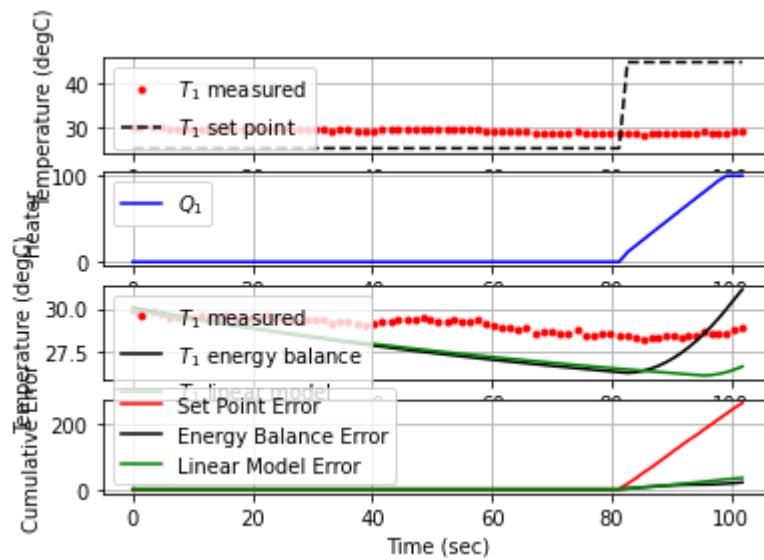


100.4 45.00 28.75 100.00 3.54 91.06 -0.01

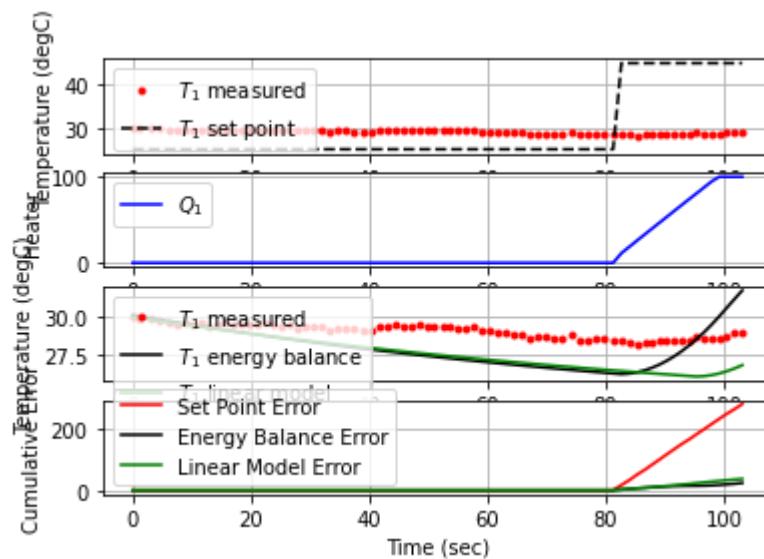




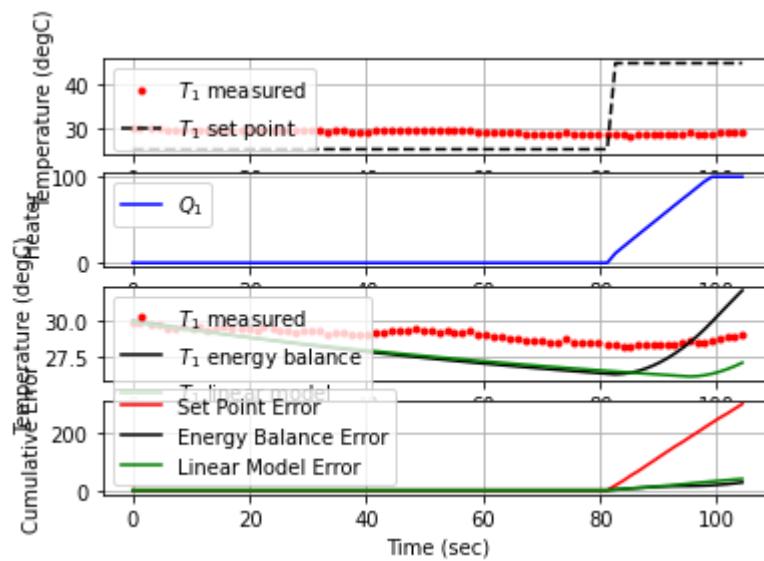
103.1 45.00 28.99 100.00 3.48 91.06 -0.00



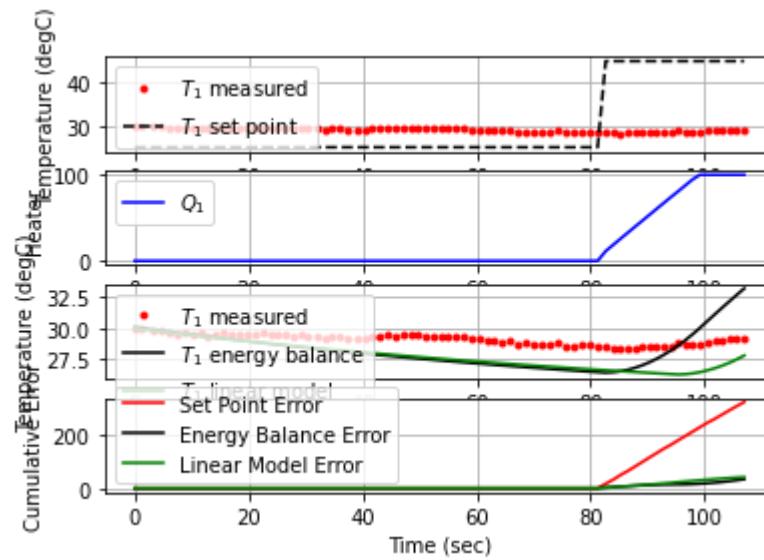
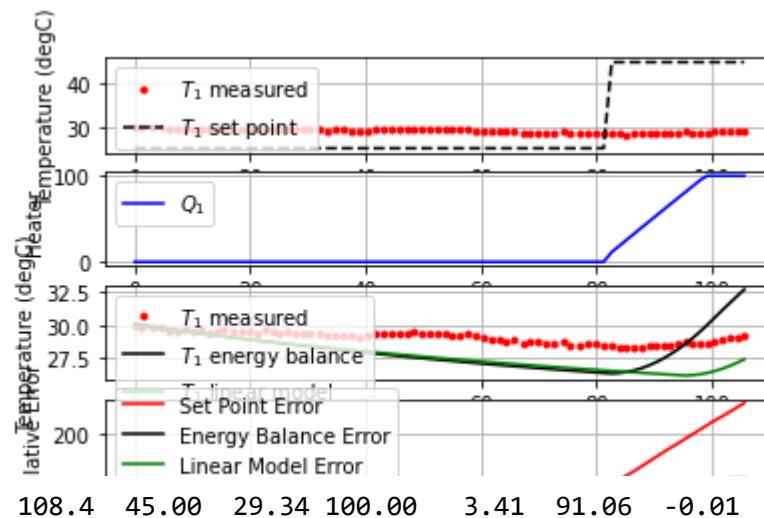
104.3 45.00 29.08 100.00 3.46 91.06 -0.00

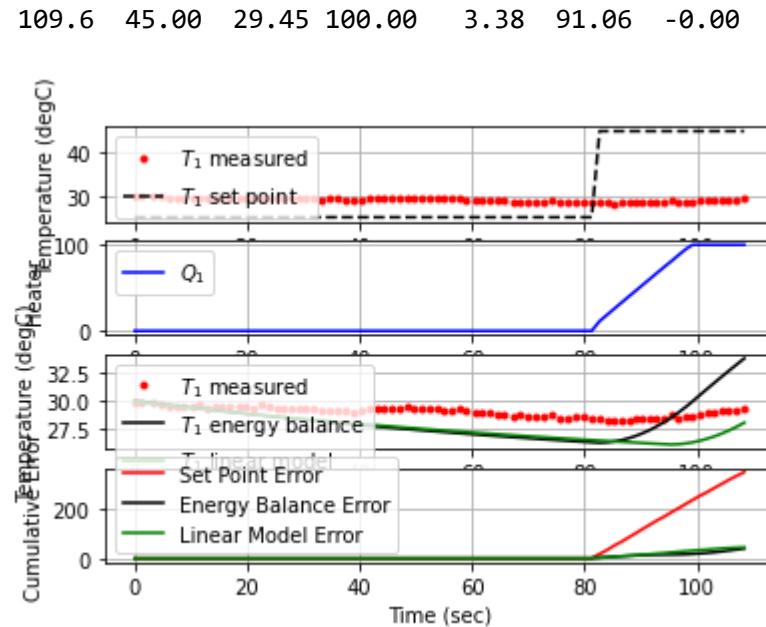


105.6 45.00 29.14 100.00 3.45 91.06 -0.00

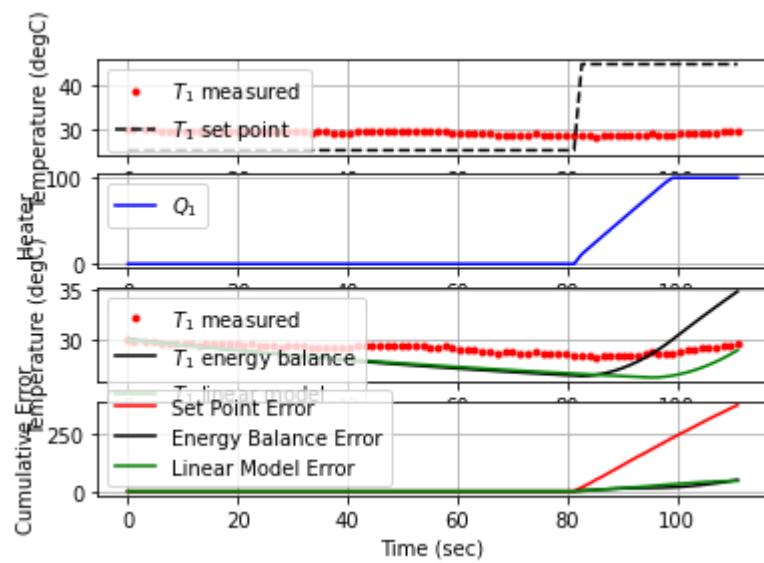
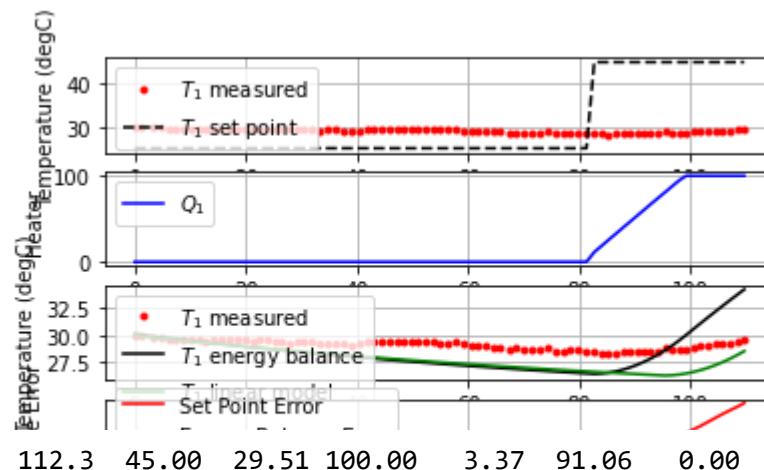


107.0 45.00 29.16 100.00 3.45 91.06 -0.00

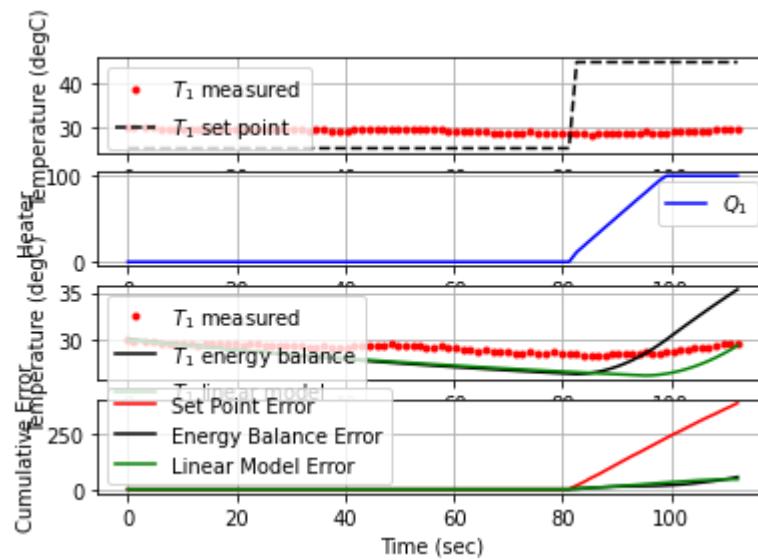




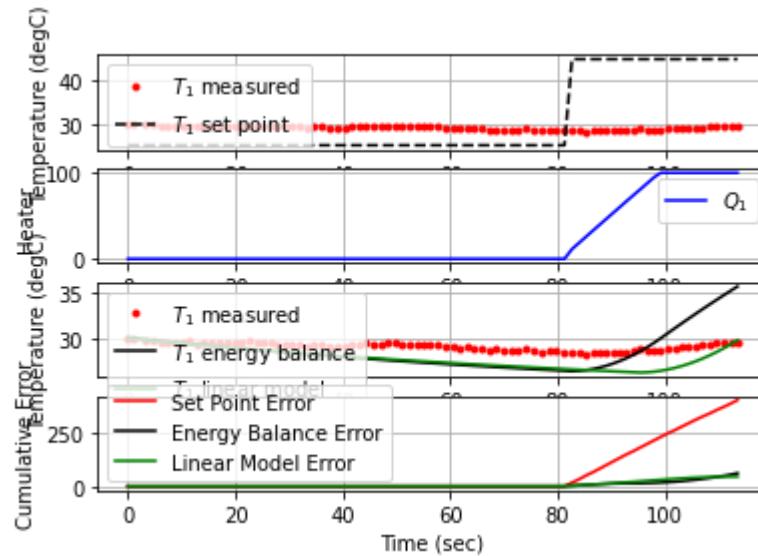
111.0 45.00 29.53 100.00 3.37 91.06 -0.00



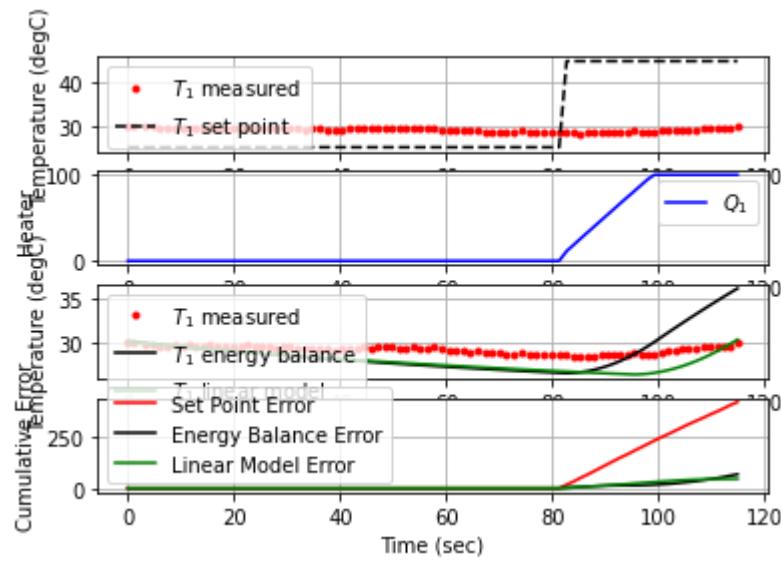
113.5 45.00 29.52 100.00 3.37 91.06 -0.00



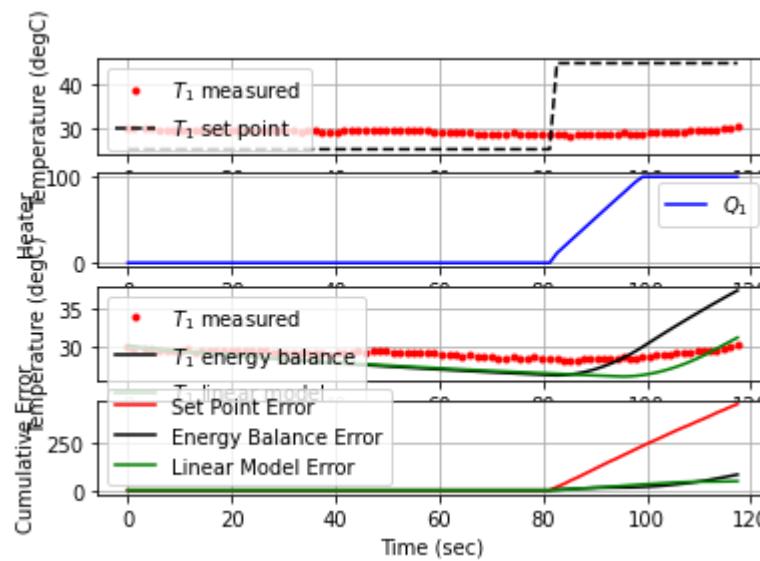
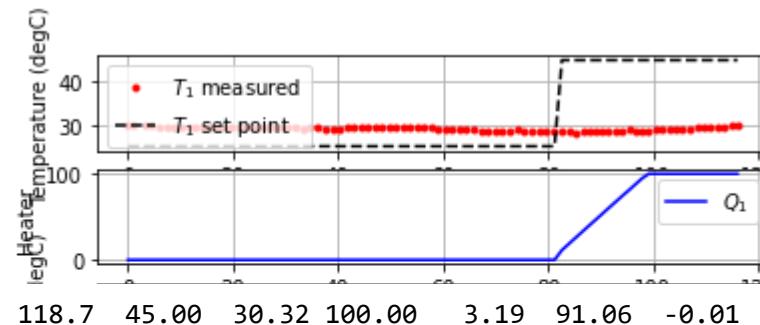
114.8 45.00 29.79 100.00 3.31 91.06 -0.01



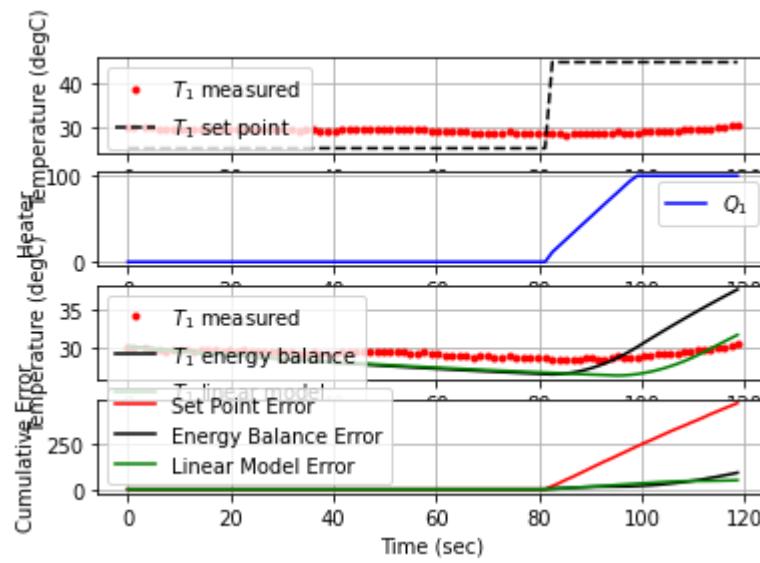
116.1 45.00 29.90 100.00 3.29 91.06 -0.01



117.4 45.00 30.19 100.00 3.22 91.06 -0.01

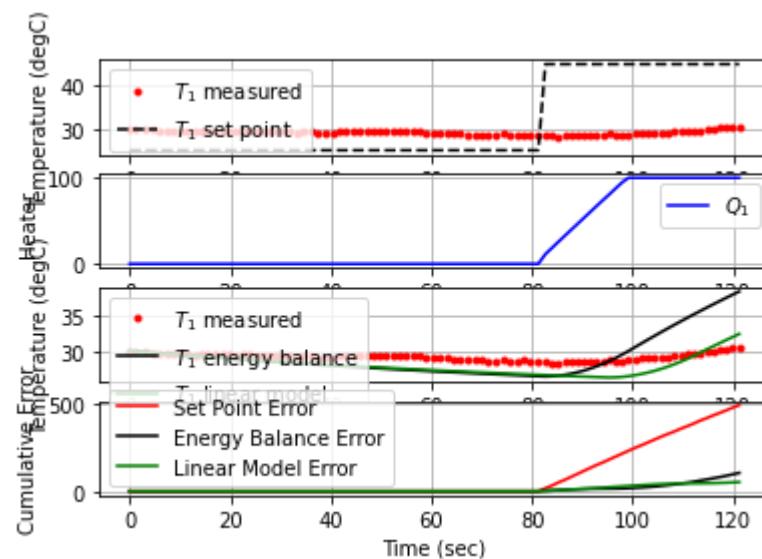


119.9 45.00 30.38 100.00 3.18 91.06 -0.00

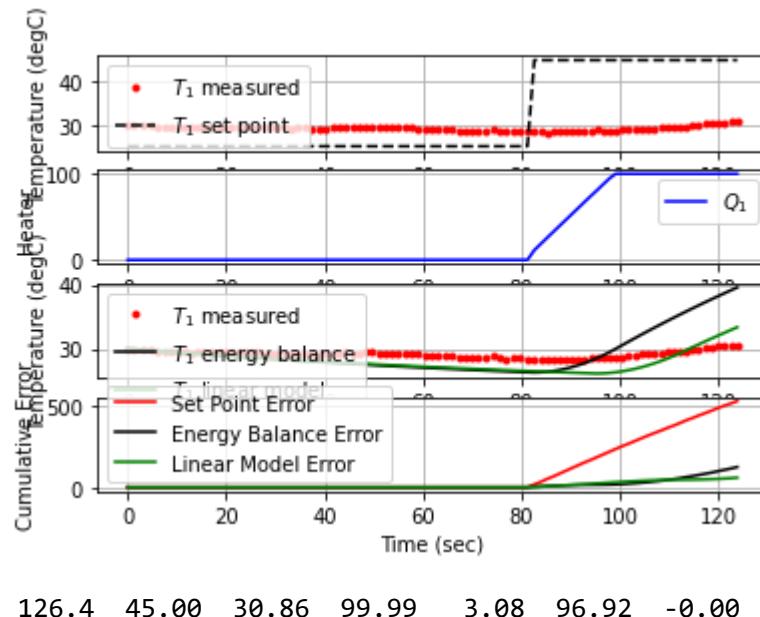
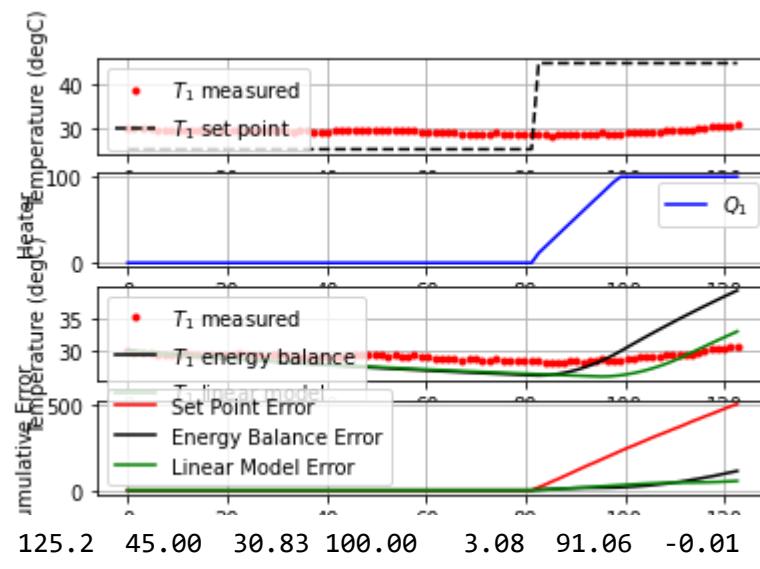


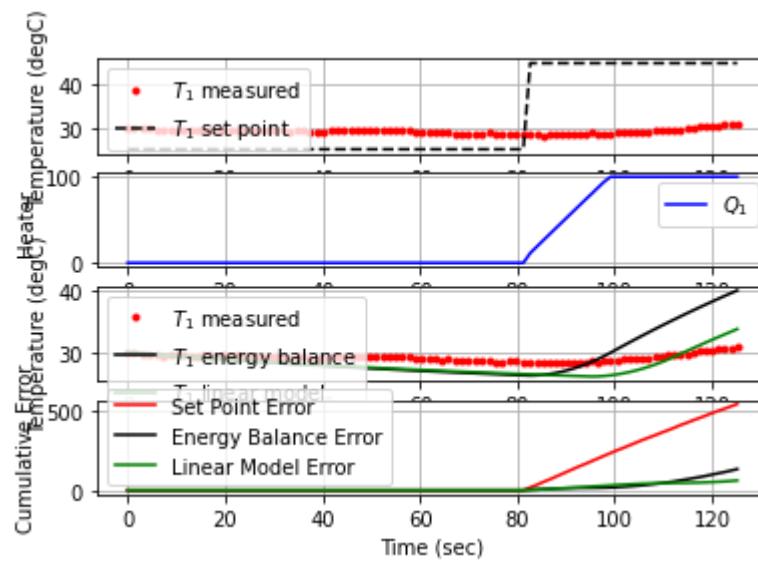
121.2 45.00 30.51 100.00 3.15 91.06 -0.01

122.6 45.00 30.58 100.00 3.14 91.06 -0.00

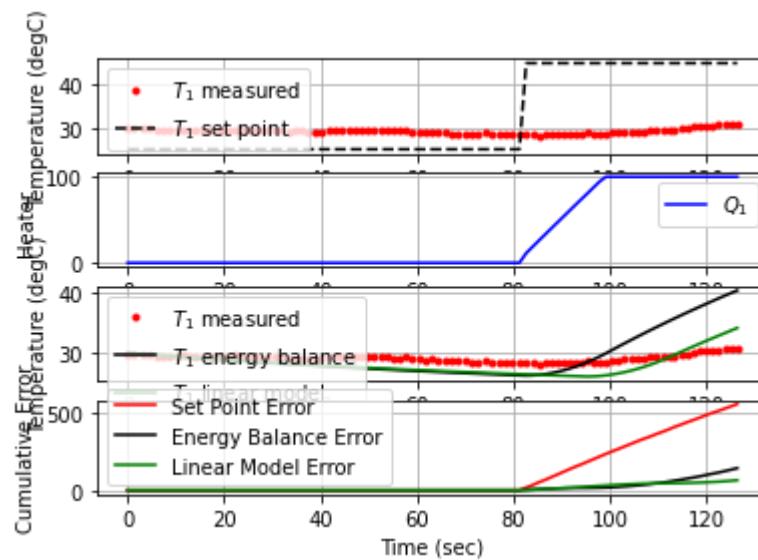


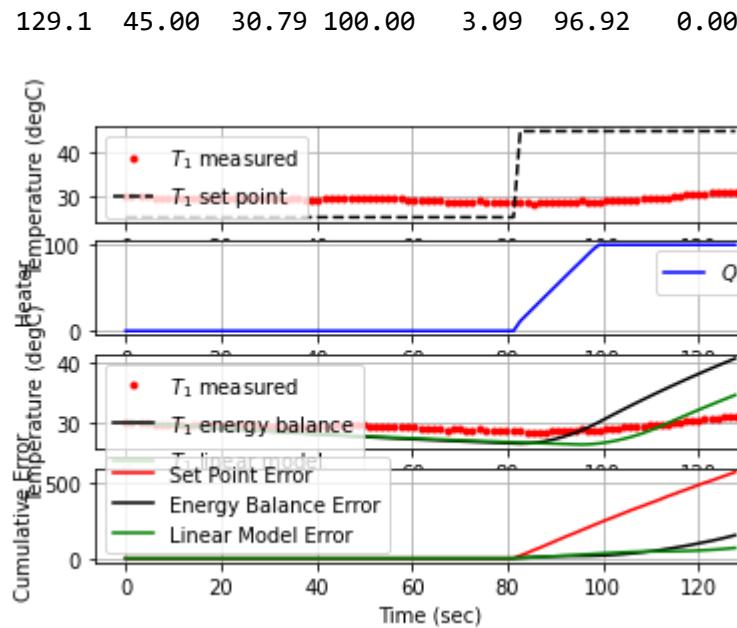
123.9 45.00 30.60 100.00 3.13 91.06 -0.00



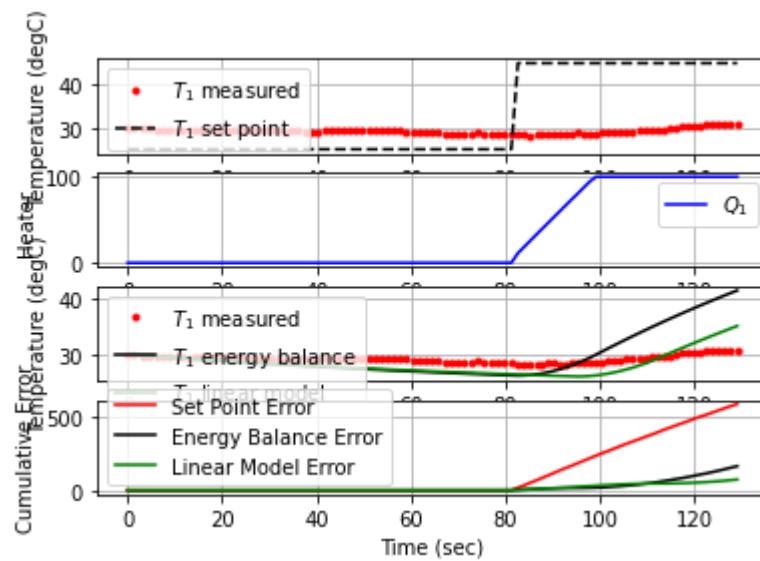


127.7 45.00 30.85 100.00 3.08 96.92 0.00

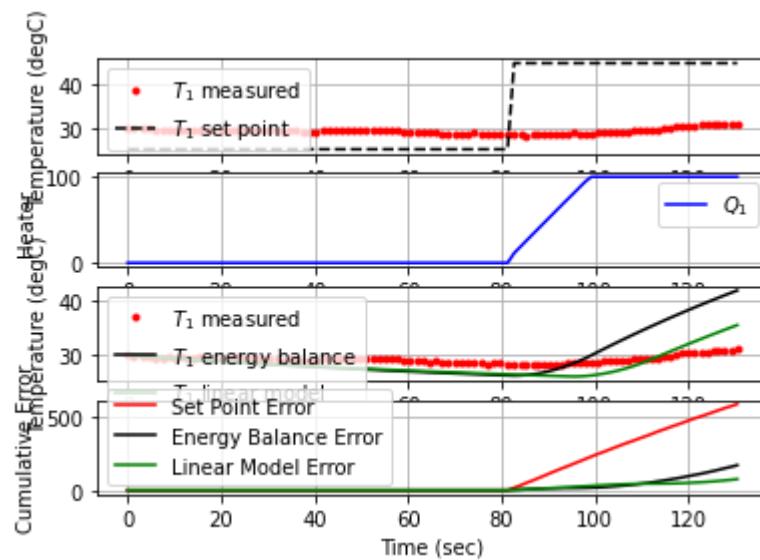




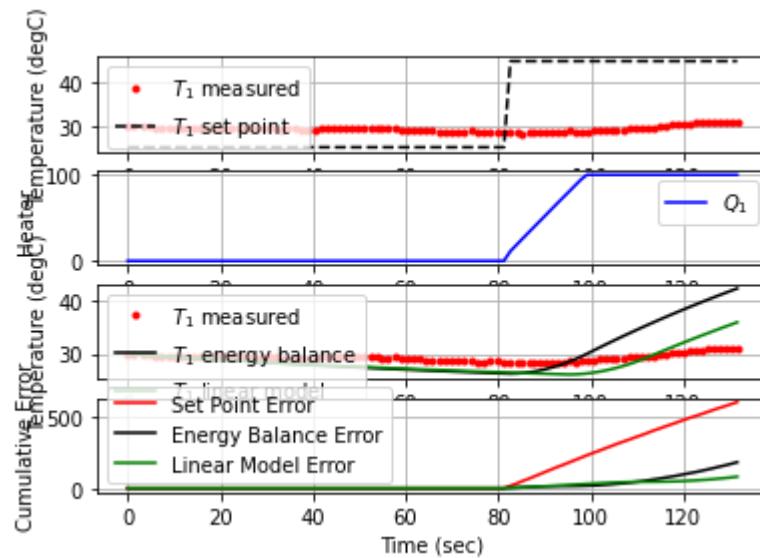
130.4 45.00 31.01 100.00 3.04 96.92 -0.01



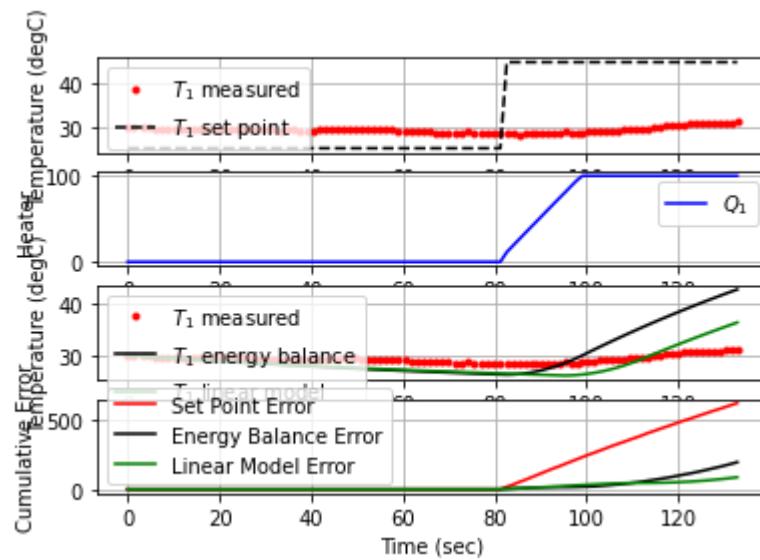
131.6 45.00 30.98 100.00 3.05 96.92 0.00



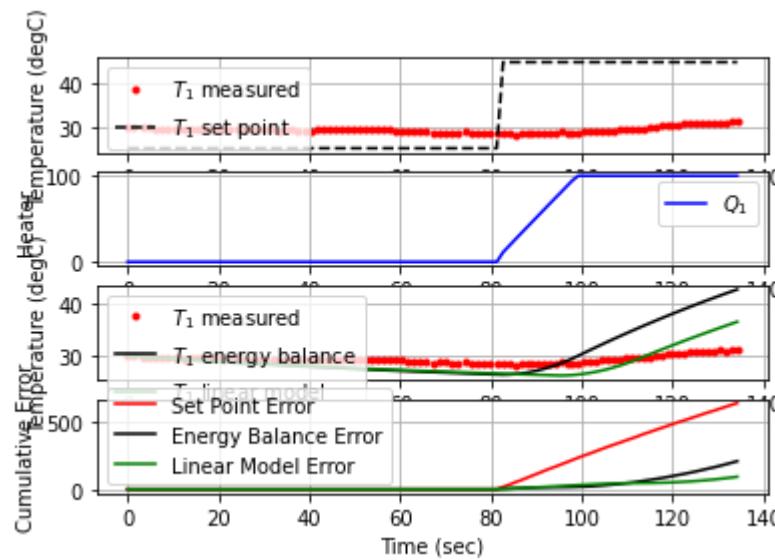
132.9 45.00 31.12 100.00 3.02 96.92 -0.01



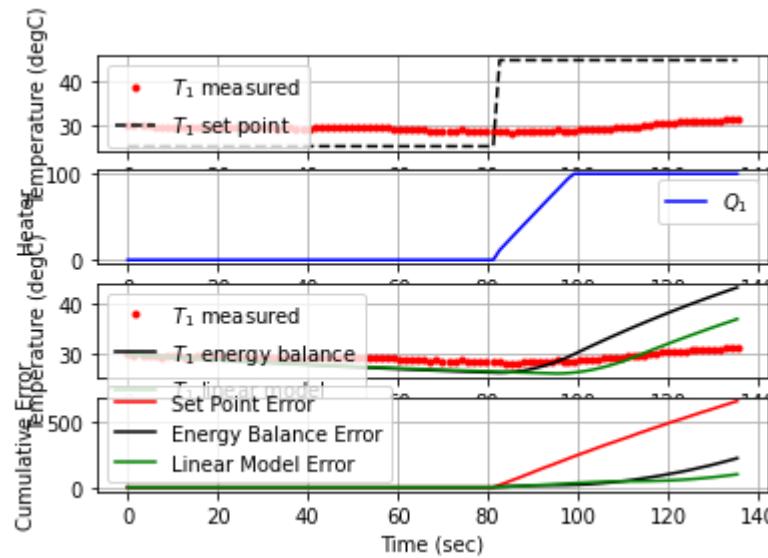
134.2 45.00 31.24 100.00 2.99 96.92 -0.01



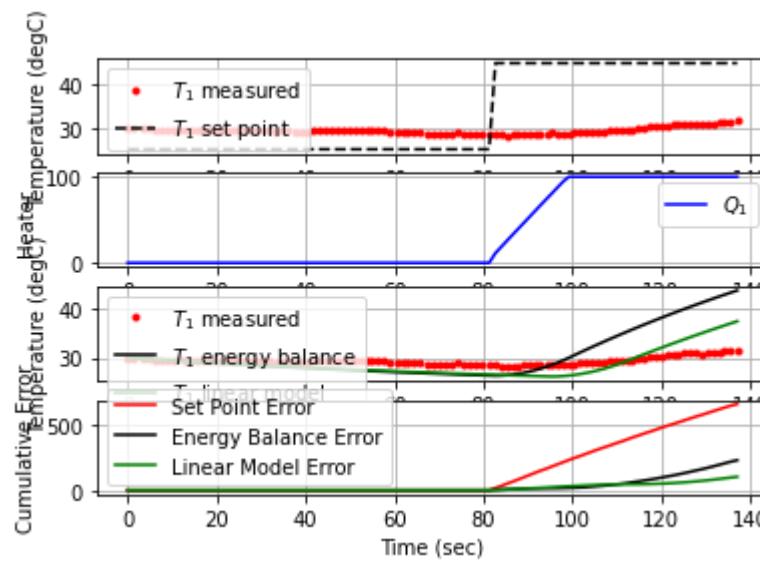
135.5 45.00 31.45 100.00 2.95 96.92 -0.01



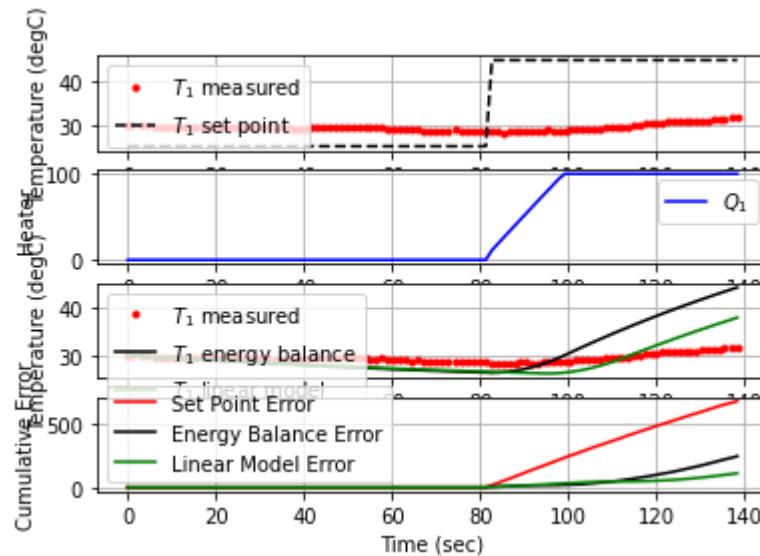
137.0 45.00 31.63 100.00 2.91 96.92 -0.01



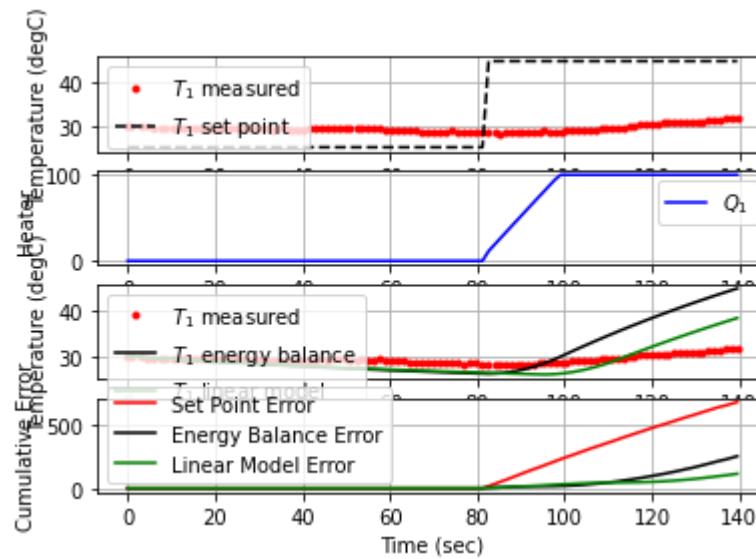
138.3 45.00 31.68 100.00 2.90 96.92 -0.00



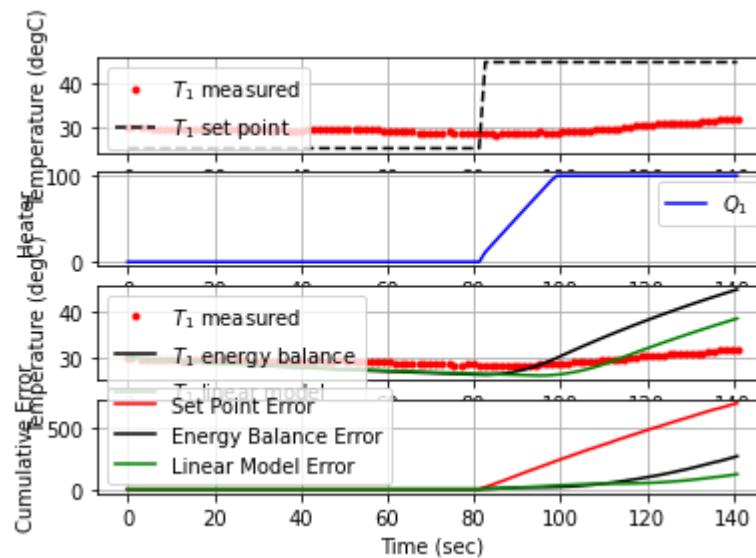
139.6 45.00 31.81 100.00 2.87 96.92 -0.01



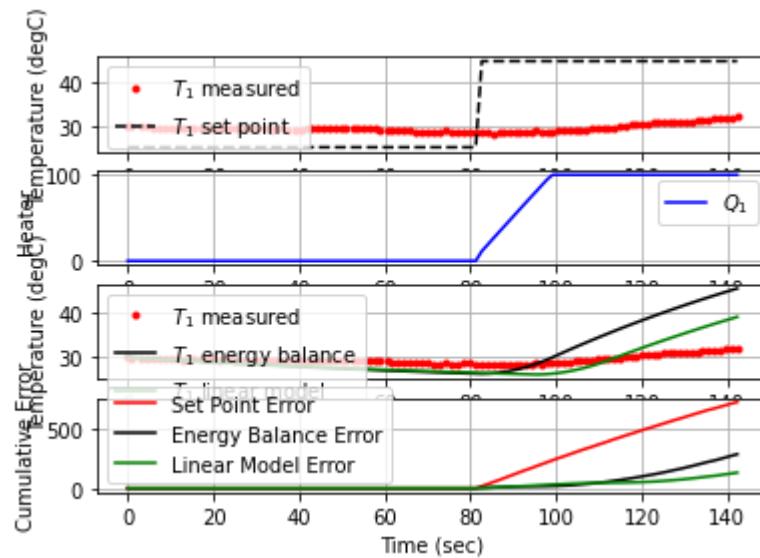
140.9 45.00 31.96 100.00 2.84 96.92 -0.01



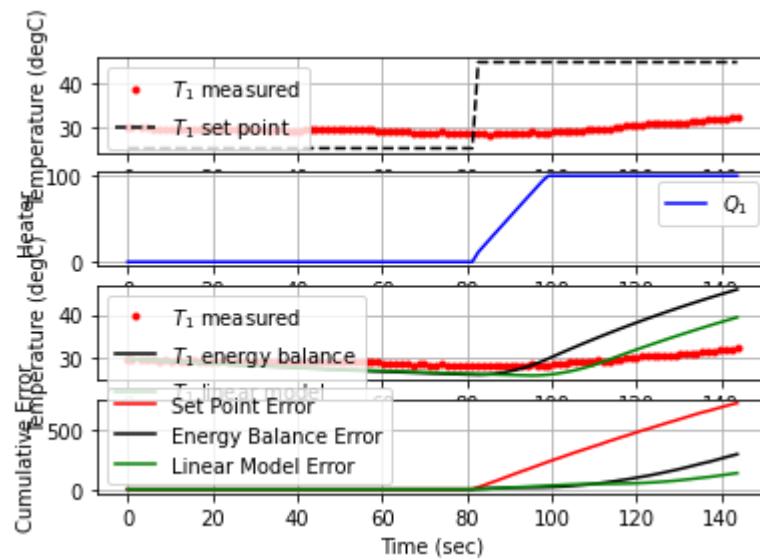
142.3 45.00 32.08 100.00 2.81 96.92 -0.00



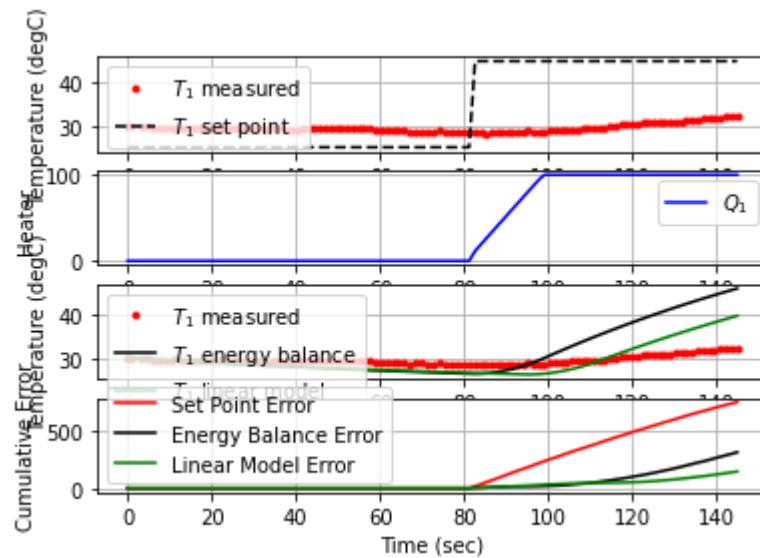
143.7 45.00 32.28 100.00 2.77 96.92 -0.01



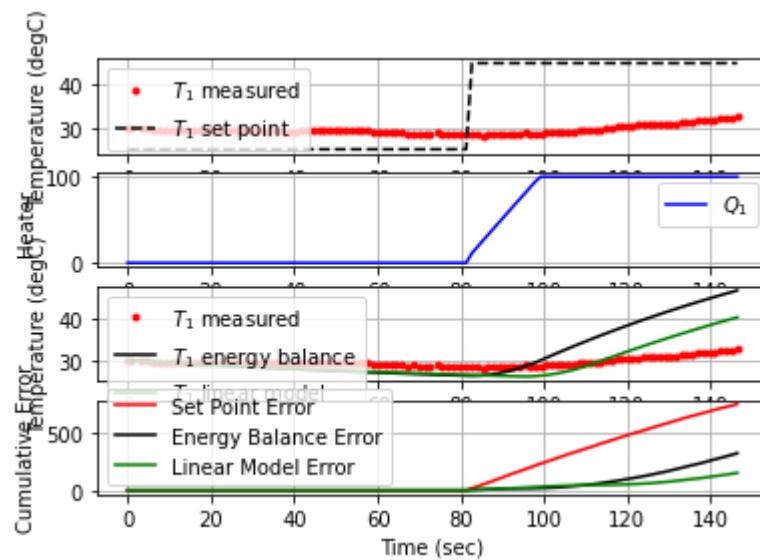
145.0 45.00 32.34 100.00 2.75 96.92 -0.00



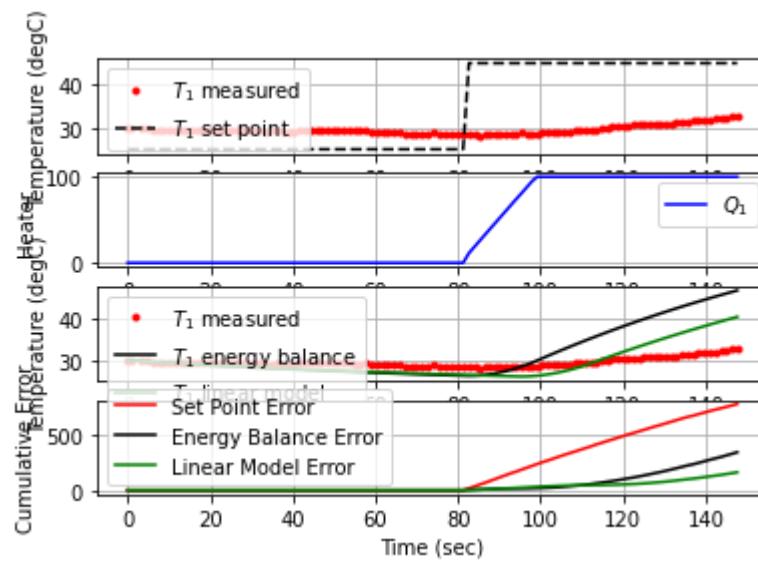
146.3 45.00 32.64 100.00 2.69 96.92 -0.01



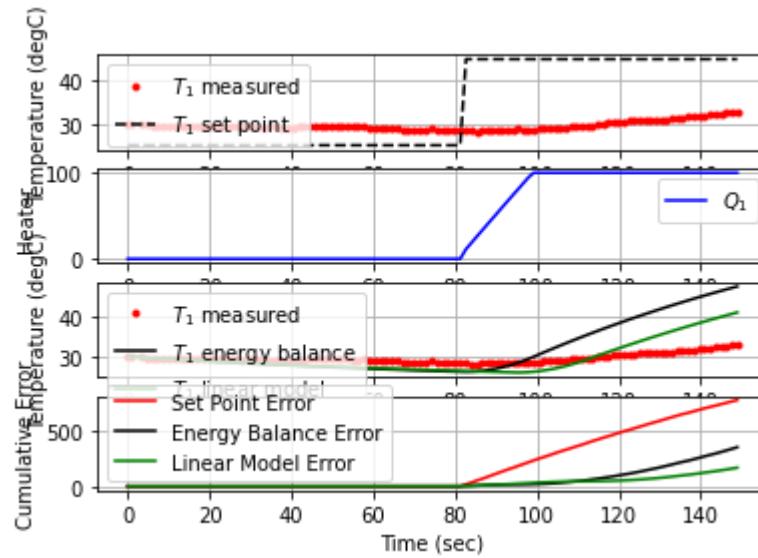
147.6 45.00 32.75 100.00 2.66 96.92 -0.00



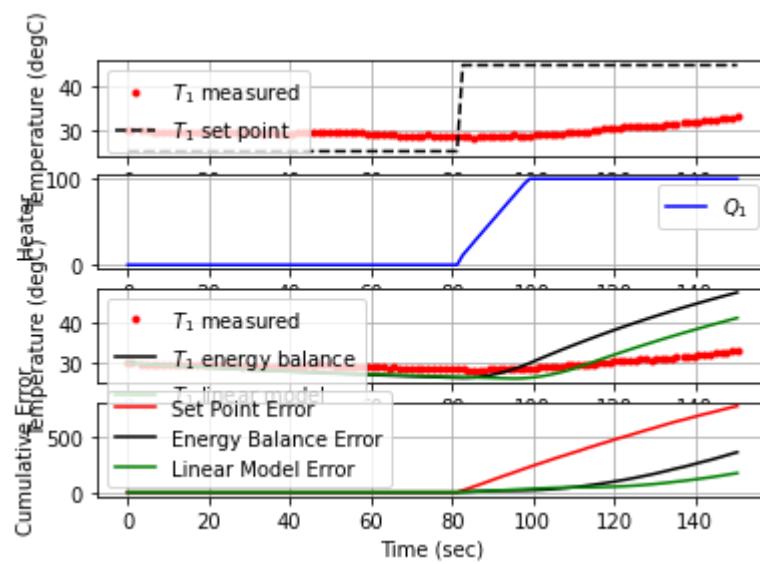
148.9 45.00 32.86 100.00 2.64 96.92 -0.00



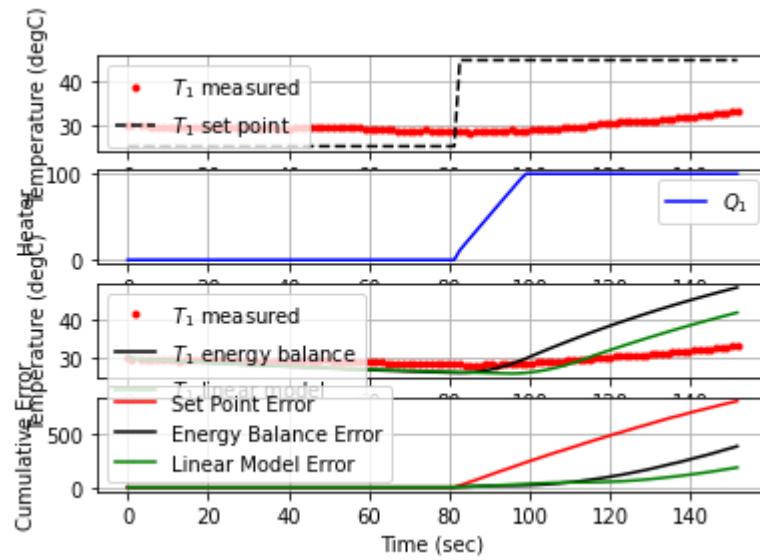
150.4 45.00 33.10 100.00 2.59 96.92 -0.01



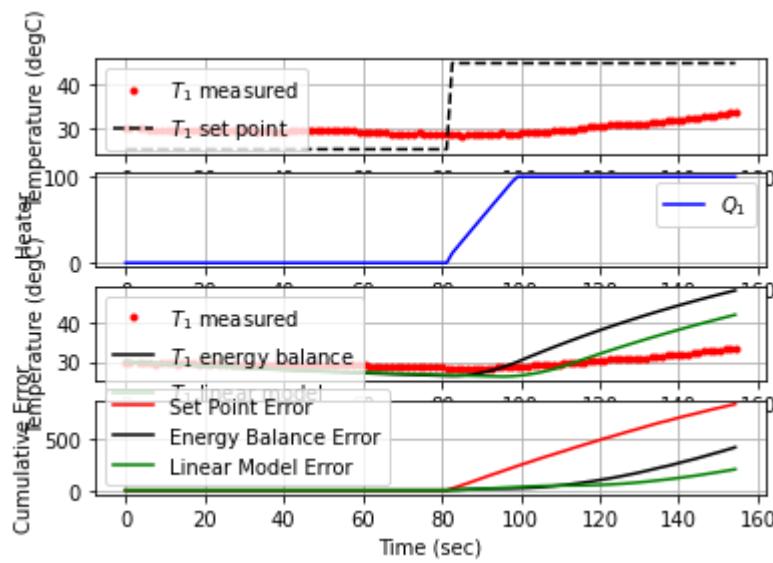
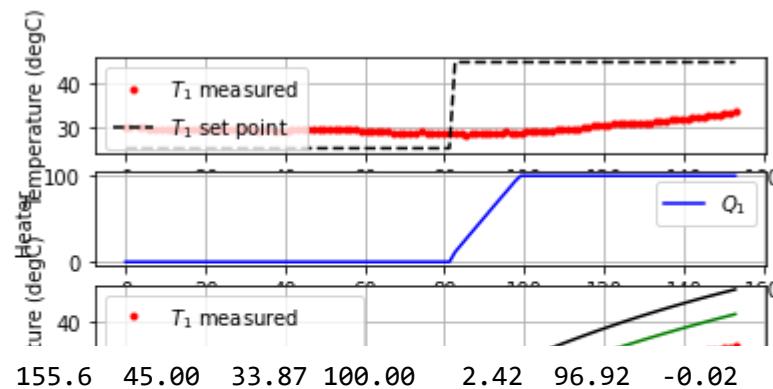
151.7 45.00 33.33 100.00 2.54 96.92 -0.01

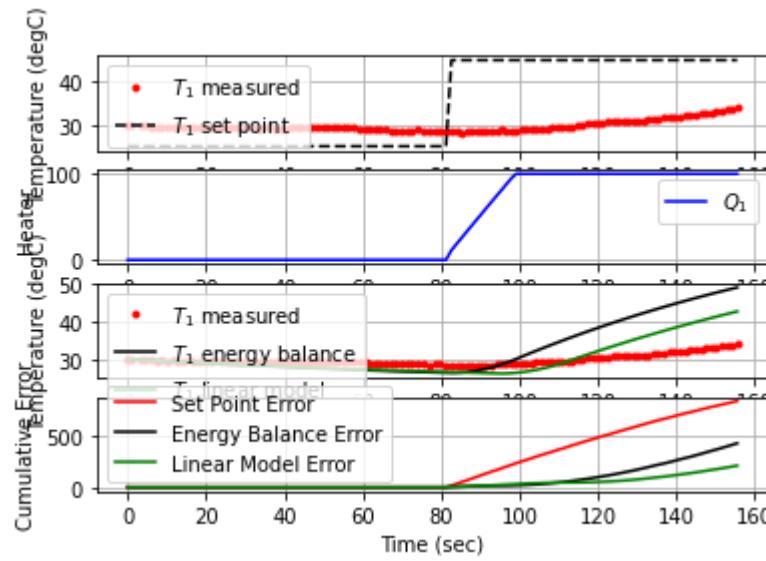


153.0 45.00 33.57 100.00 2.48 96.92 -0.01

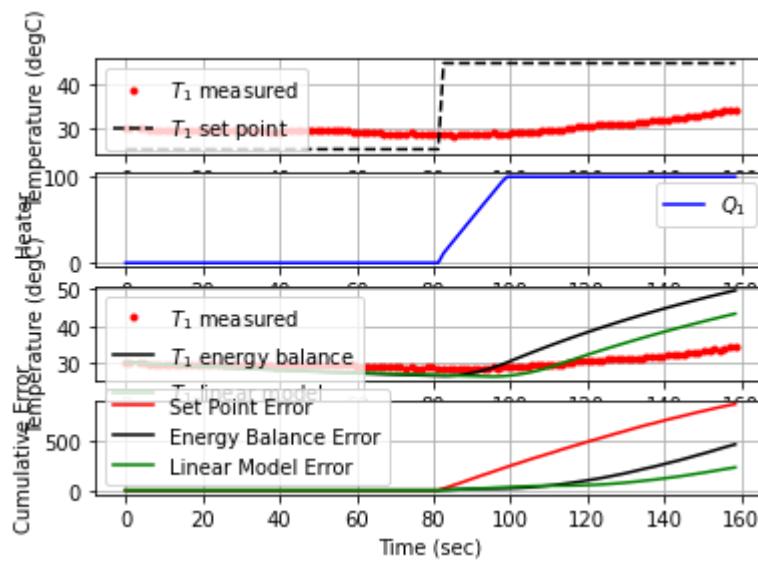
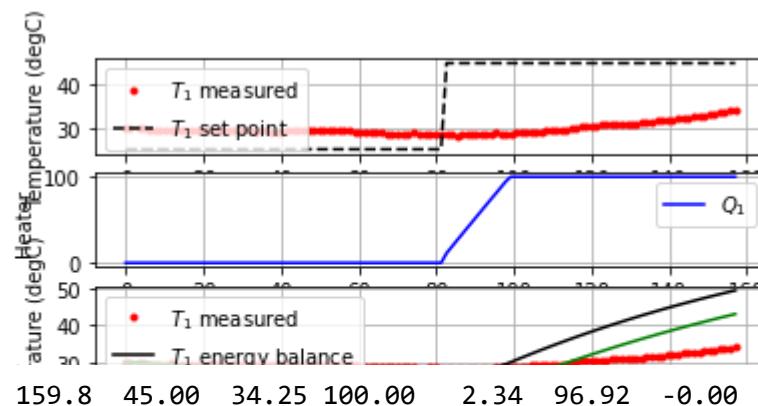


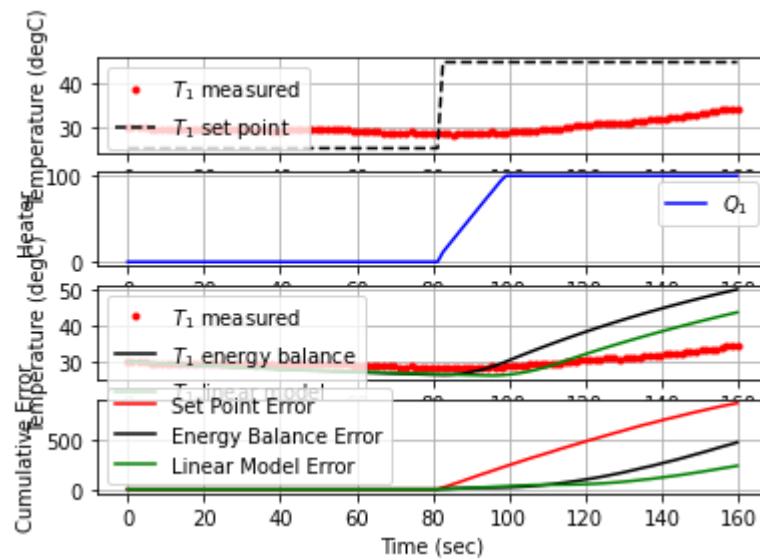
154.3 45.00 33.45 100.00 2.51 96.92 0.01



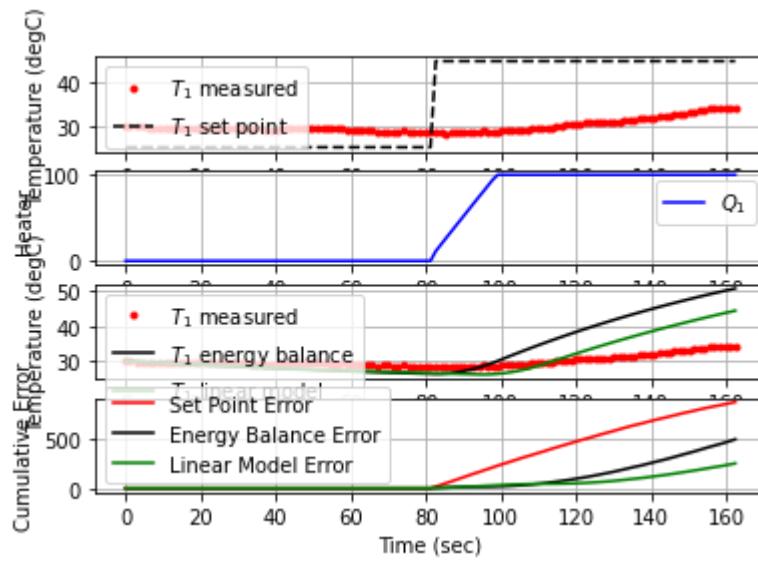
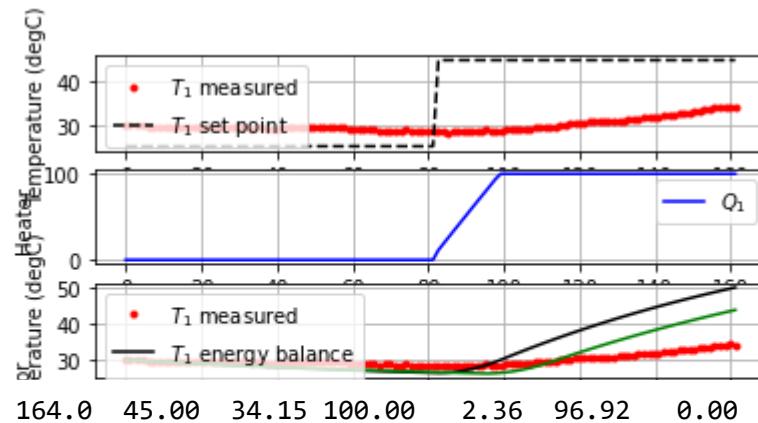


158.5 45.00 34.20 100.00 2.35 96.92 -0.00

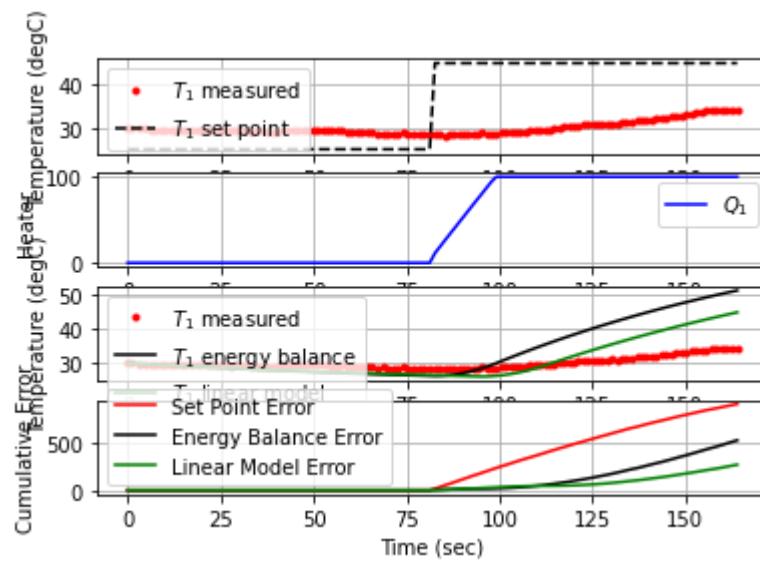




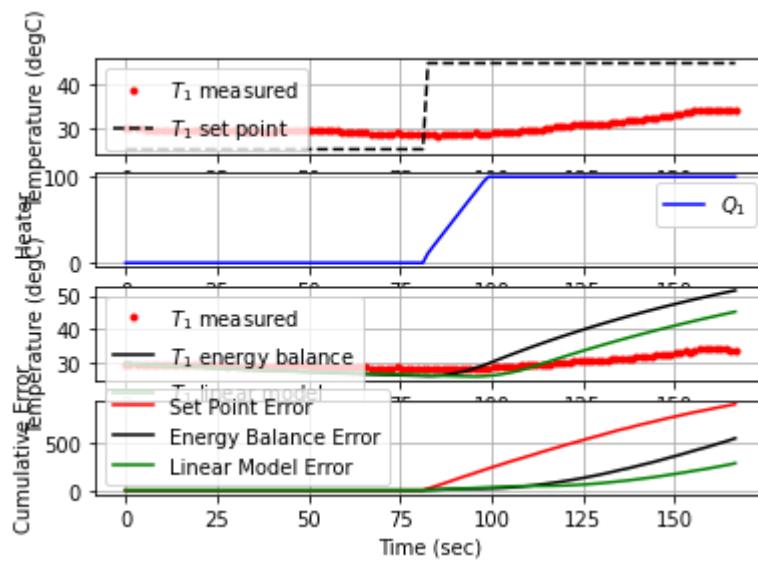
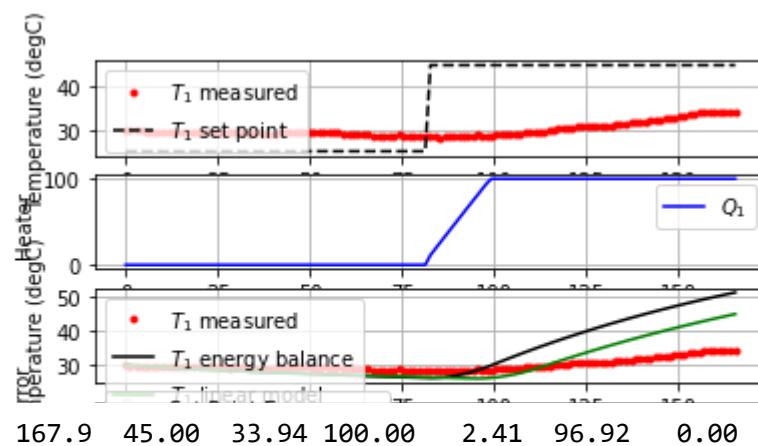
162.5 45.00 34.26 100.00 2.33 96.92 -0.00



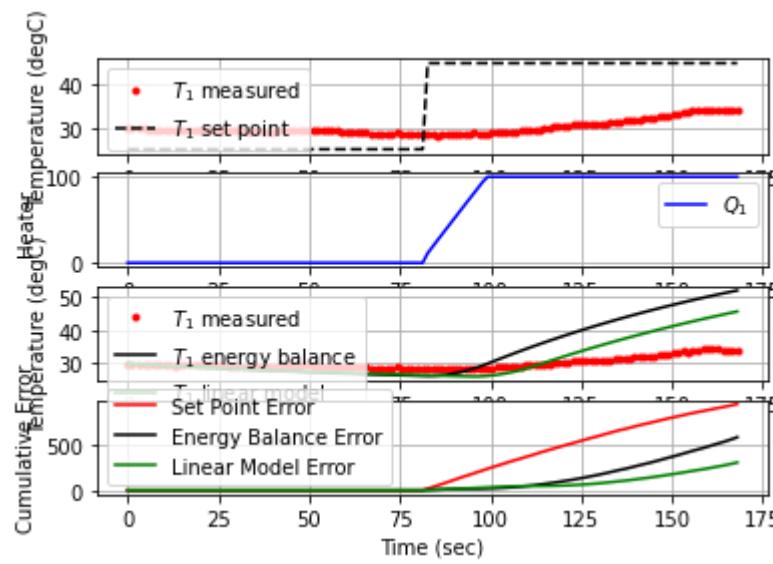
165.3 45.00 34.06 100.00 2.38 96.92 0.00



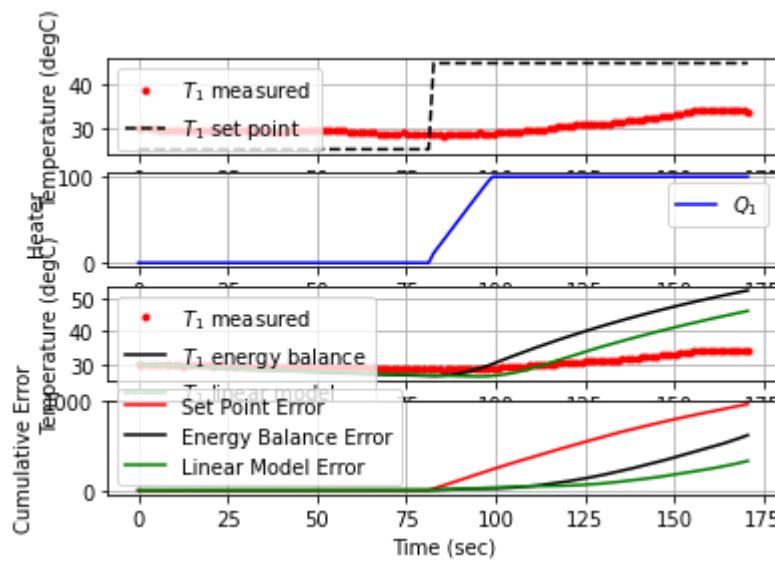
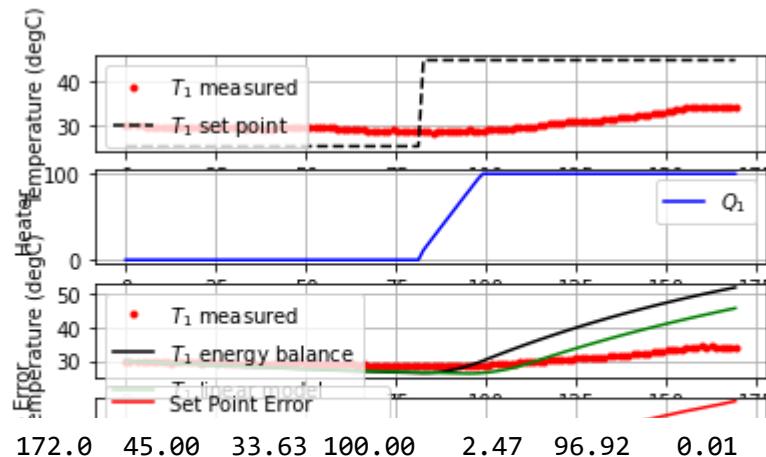
166.6 45.00 33.95 100.00 2.40 96.92 0.00



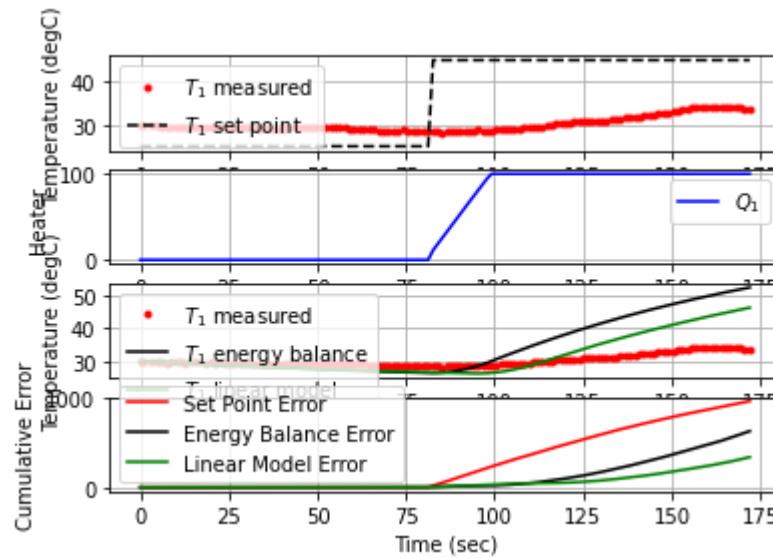
169.2 45.00 33.90 100.00 2.41 96.92 0.00



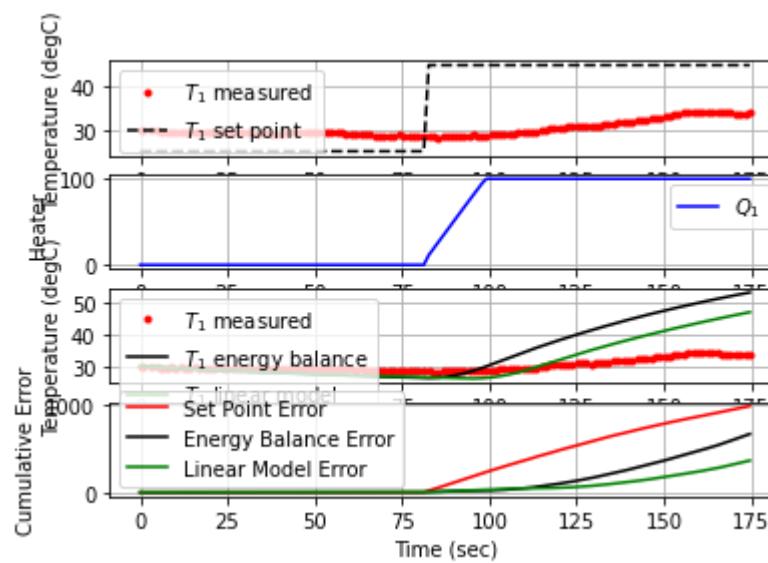
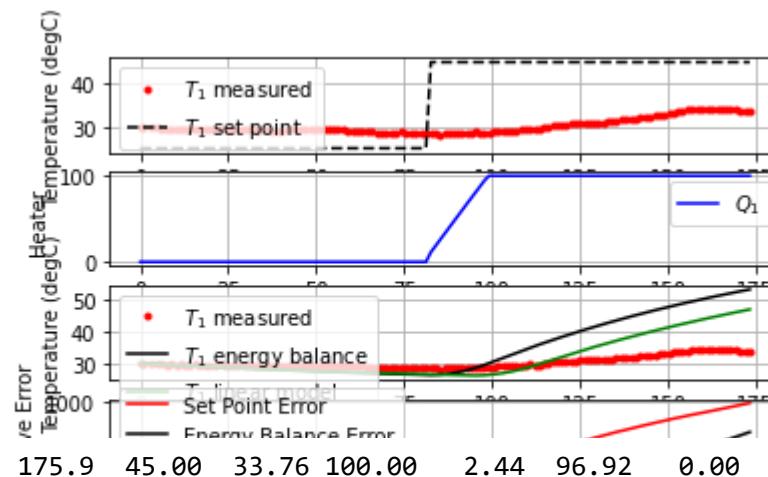
170.5 45.00 33.81 100.00 2.43 96.92 0.00

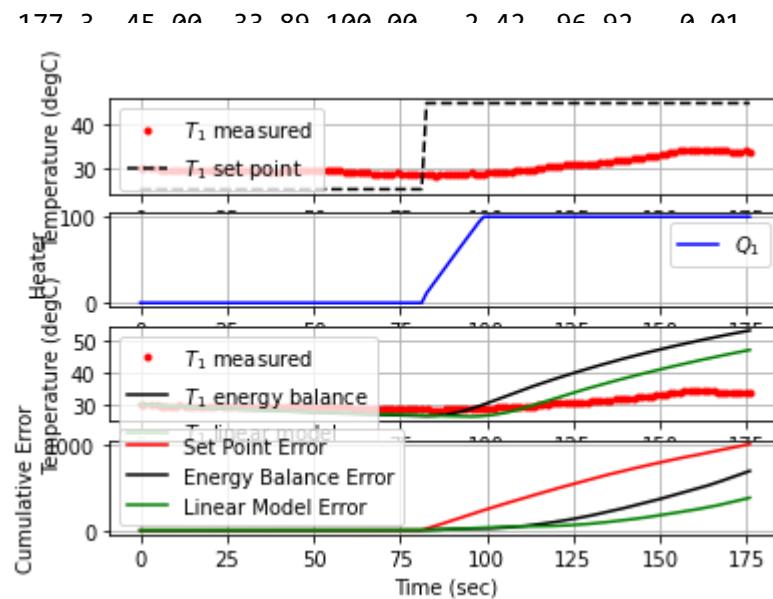


173.3 45.00 33.60 100.00 2.48 96.92 0.00

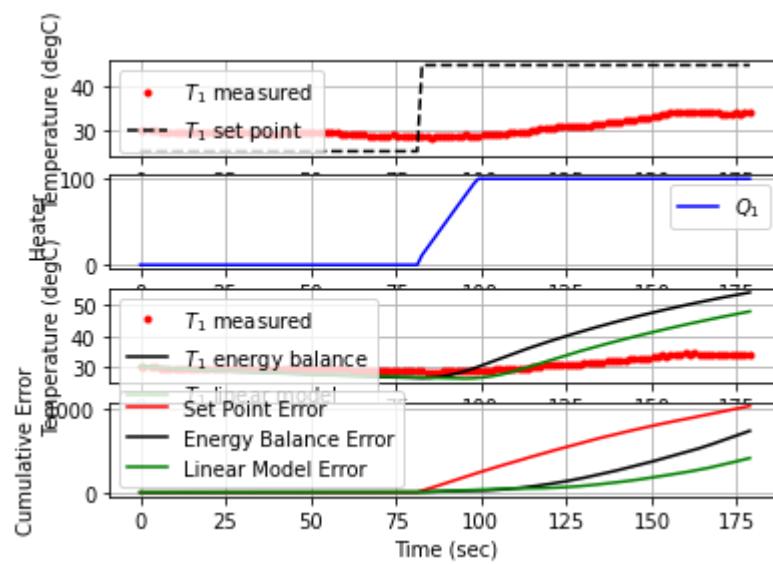
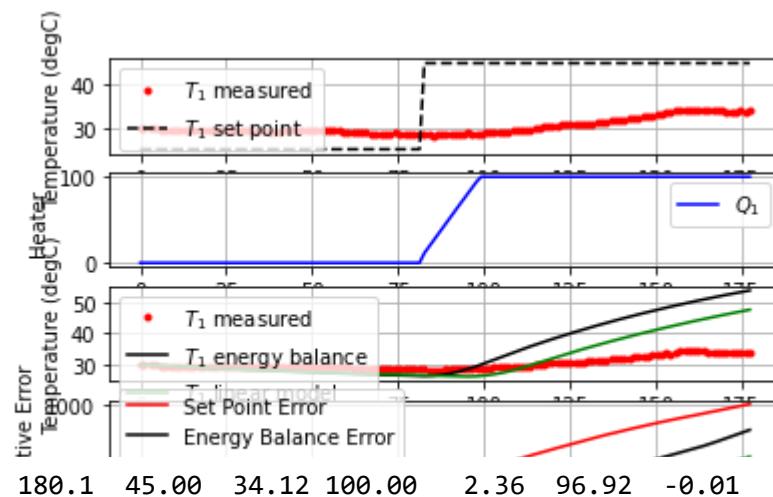


174.6 45.00 33.85 100.00 2.42 96.92 -0.01

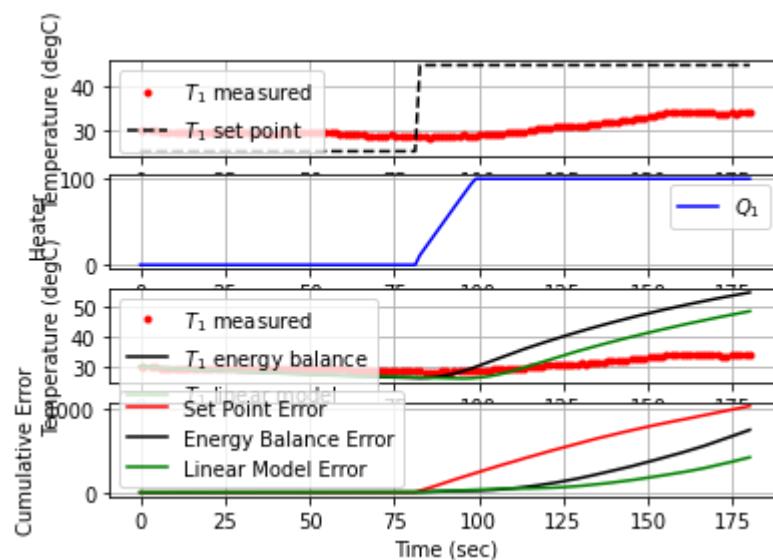




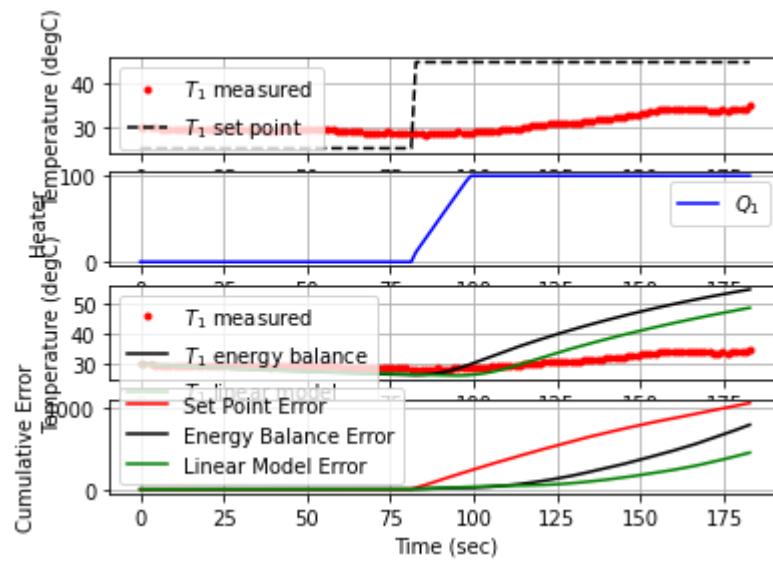
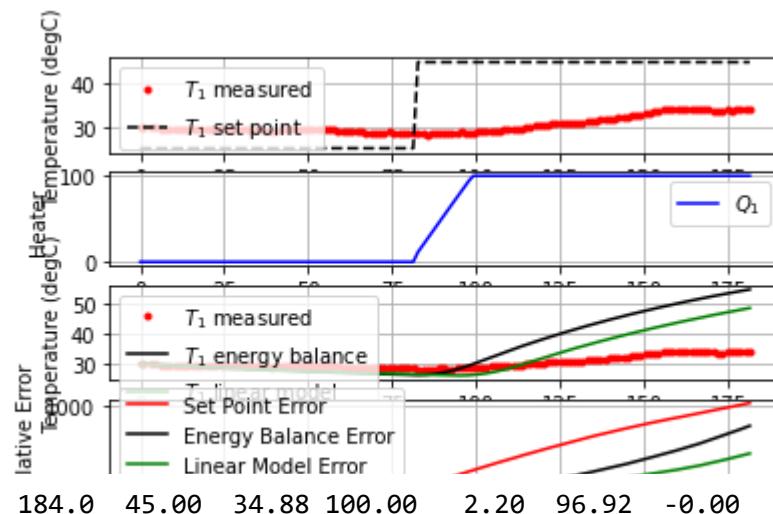
178.8 45.00 33.87 100.00 2.42 96.92 0.00



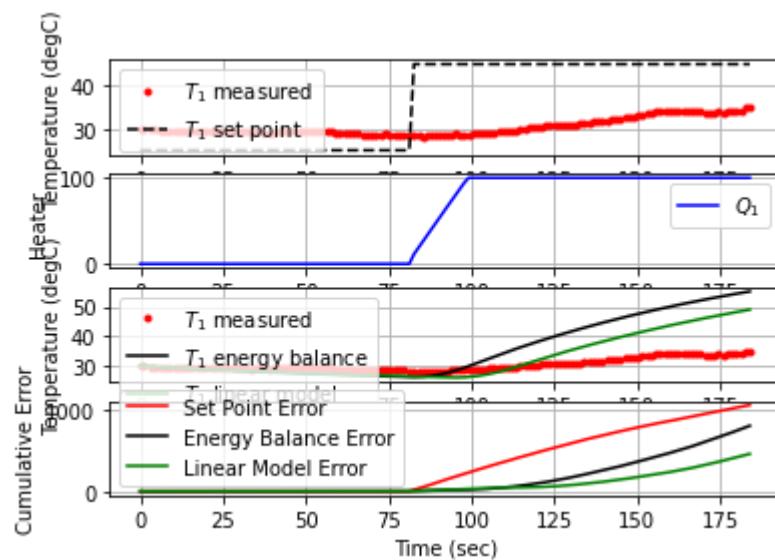
181.4 45.00 34.16 100.00 2.36 96.92 -0.00



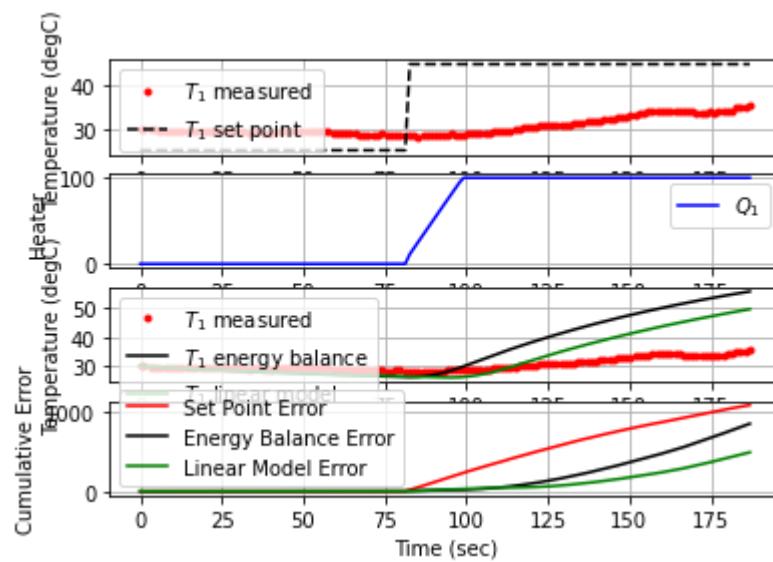
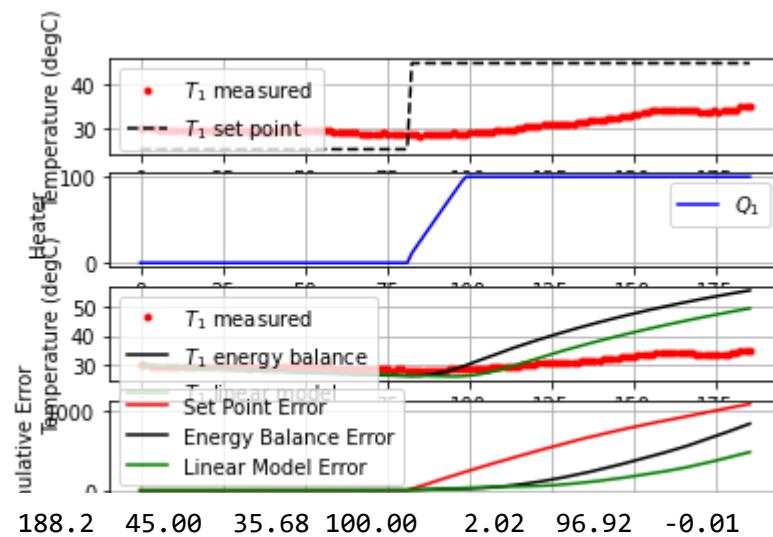
182.7 45.00 34.78 100.00 2.21 96.92 -0.03



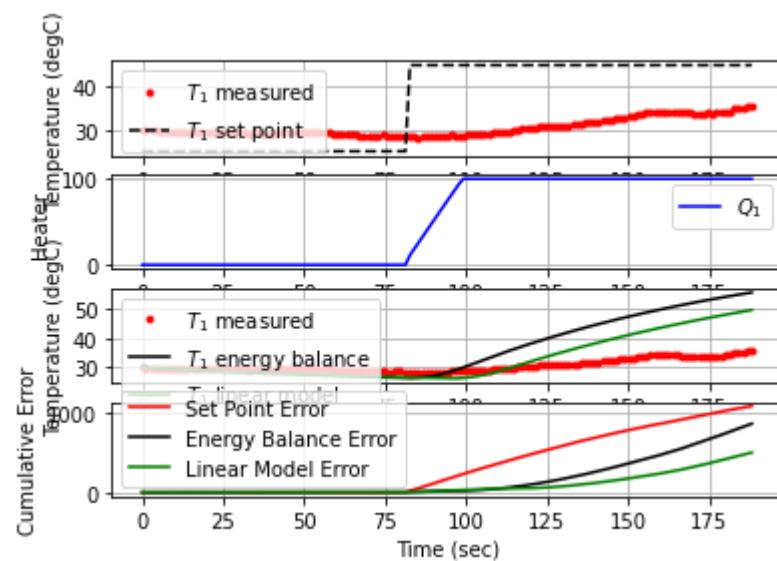
185.5 45.00 35.15 100.00 2.14 96.92 -0.01



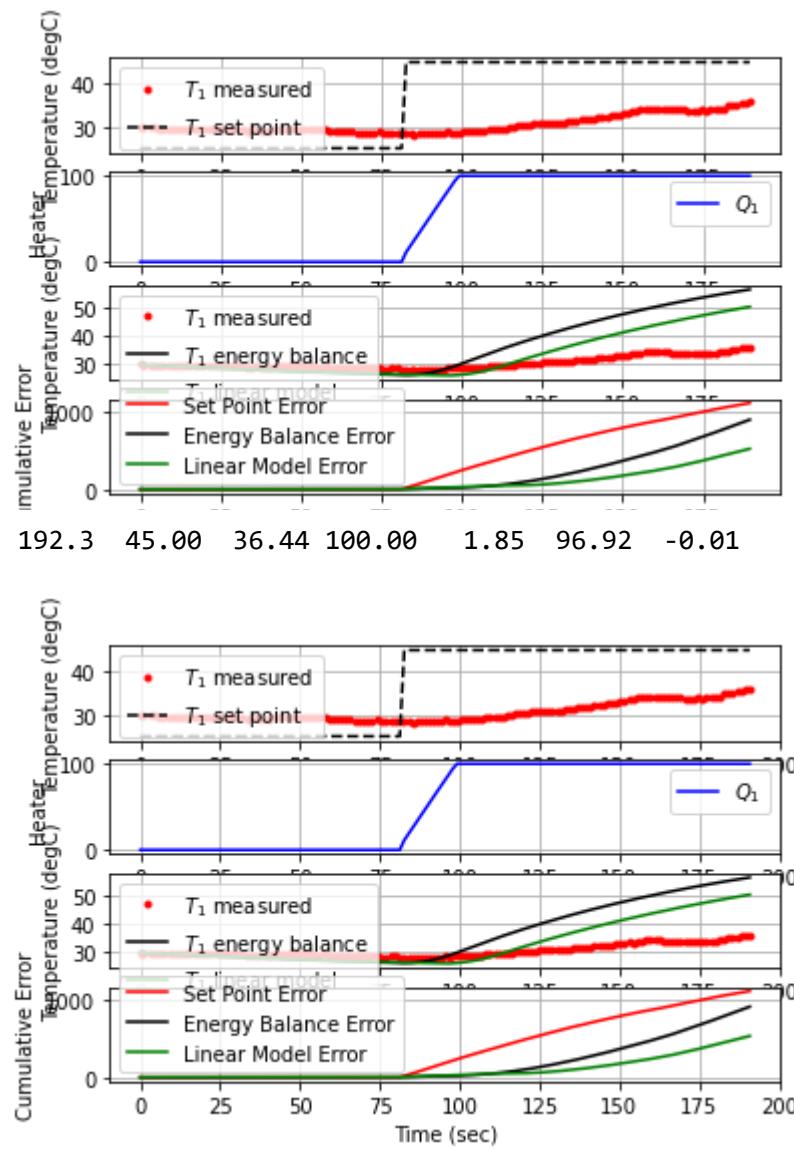
186.9 45.00 35.52 100.00 2.05 96.92 -0.02



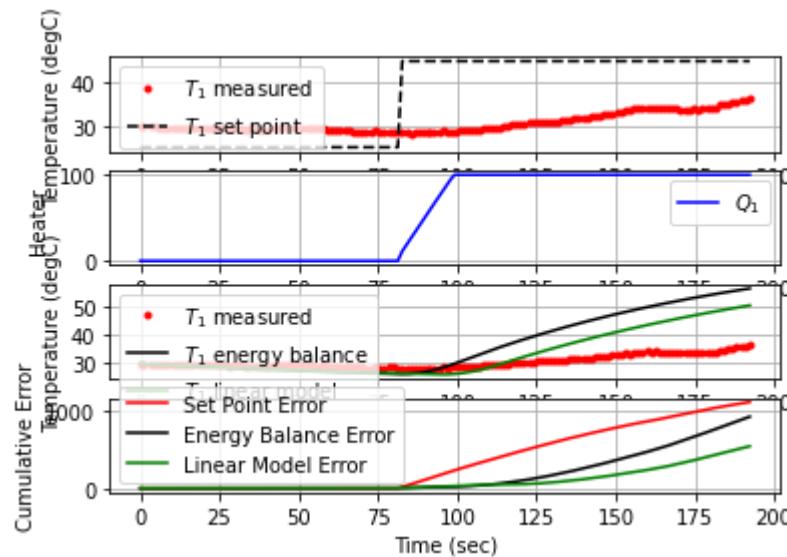
189.5 45.00 35.95 100.00 1.96 96.92 -0.01



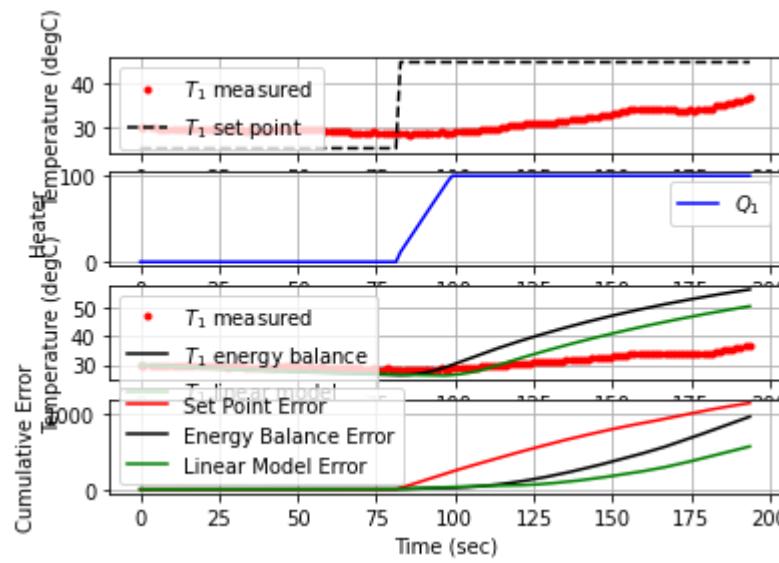
190.8 45.00 36.14 100.00 1.92 96.92 -0.01



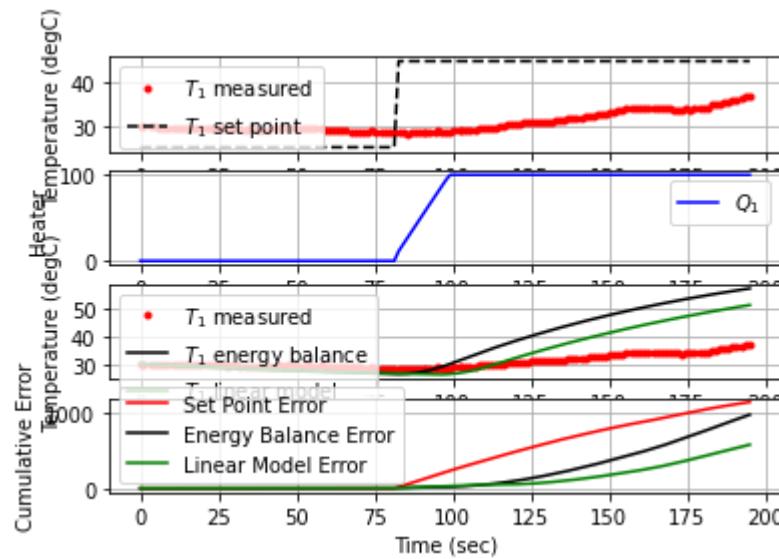
193.6 45.00 36.63 100.00 1.81 96.92 -0.01

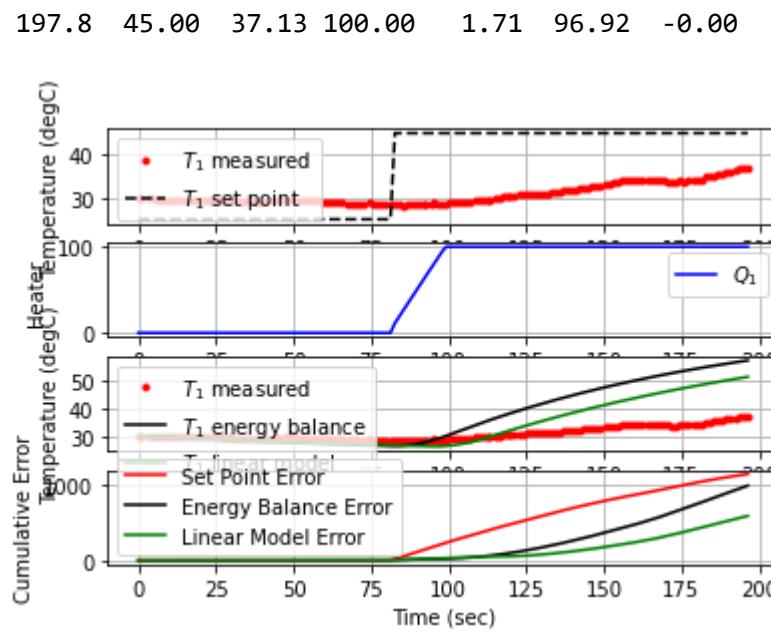


194.9 45.00 36.84 100.00 1.77 96.92 -0.01

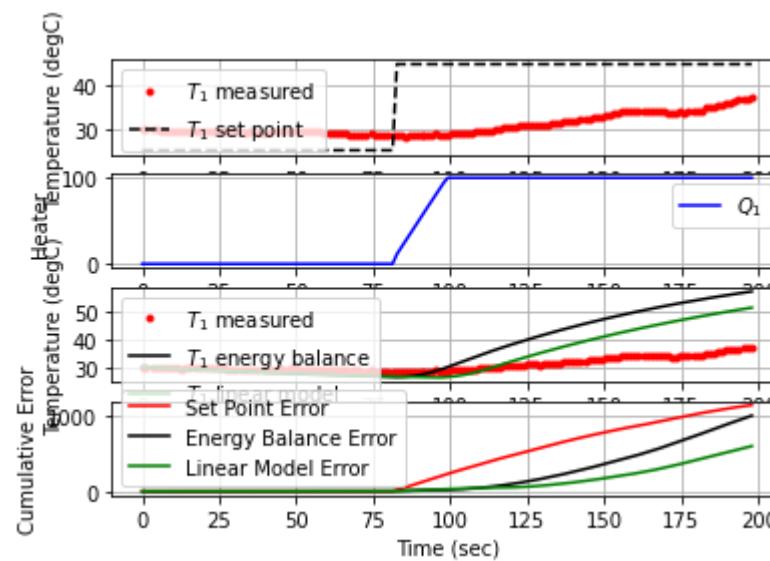


196.3 45.00 37.01 100.00 1.73 96.92 -0.01

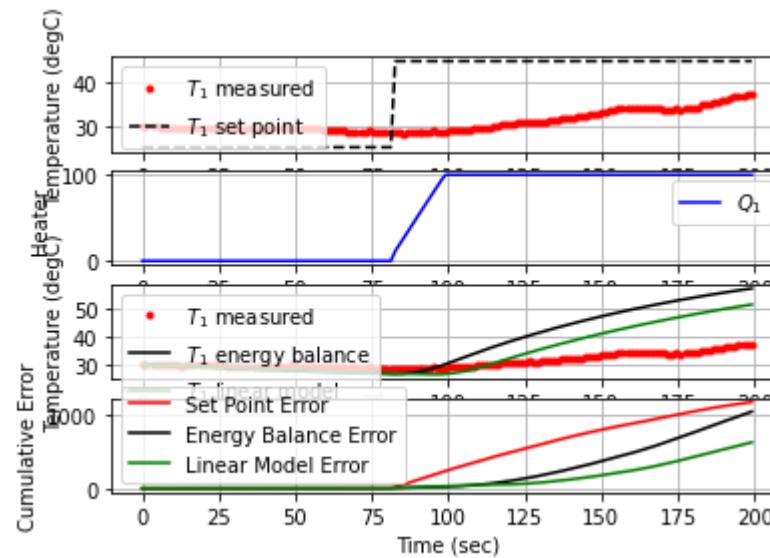




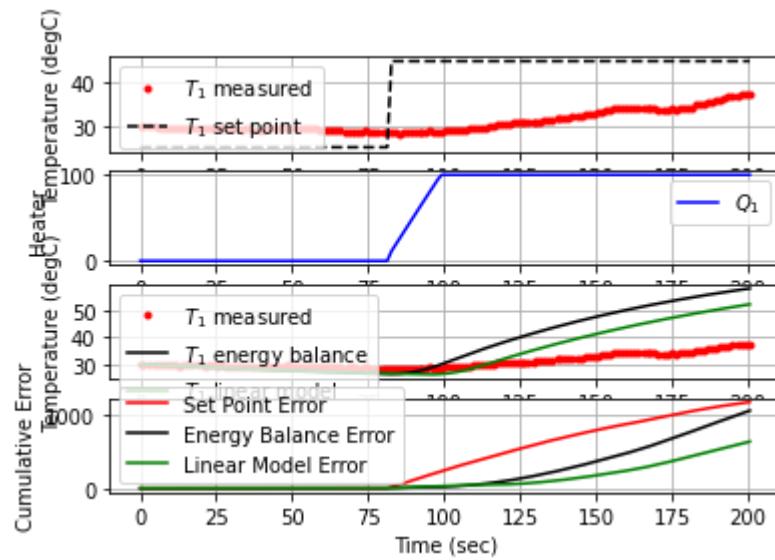
199.2 45.00 37.12 100.00 1.71 96.92 0.00



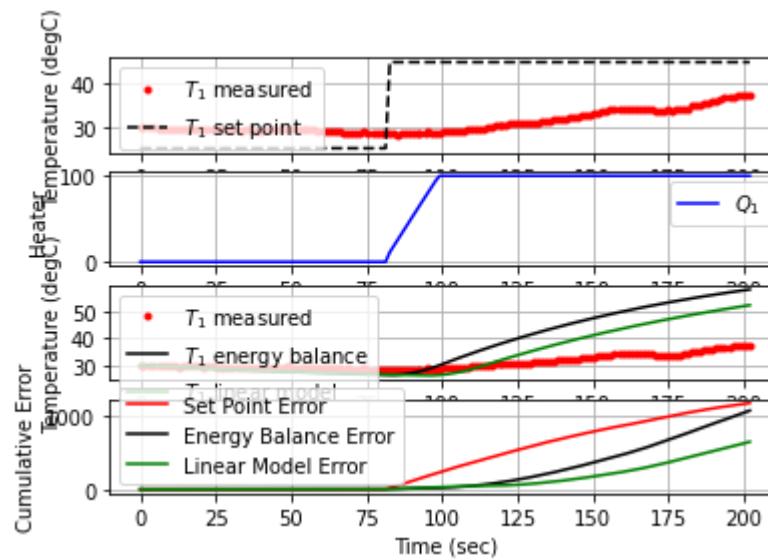
200.5 45.00 37.30 100.00 1.67 96.92 -0.01



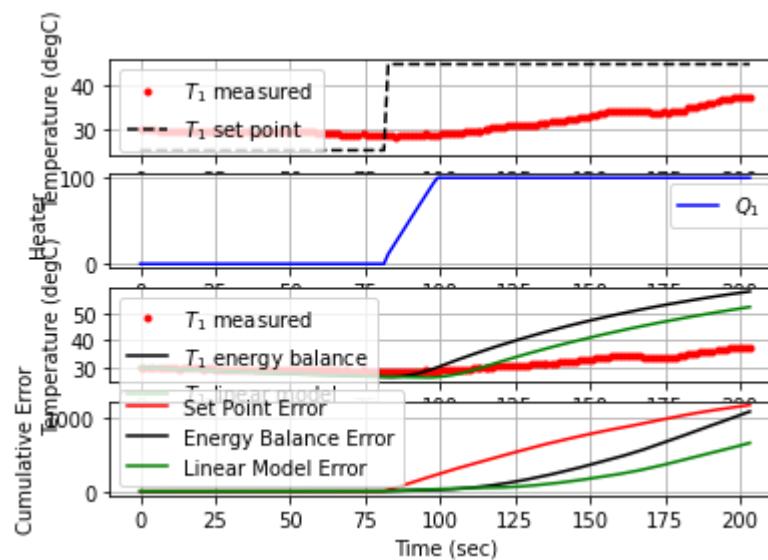
201.8 45.00 37.38 100.00 1.65 96.92 -0.00



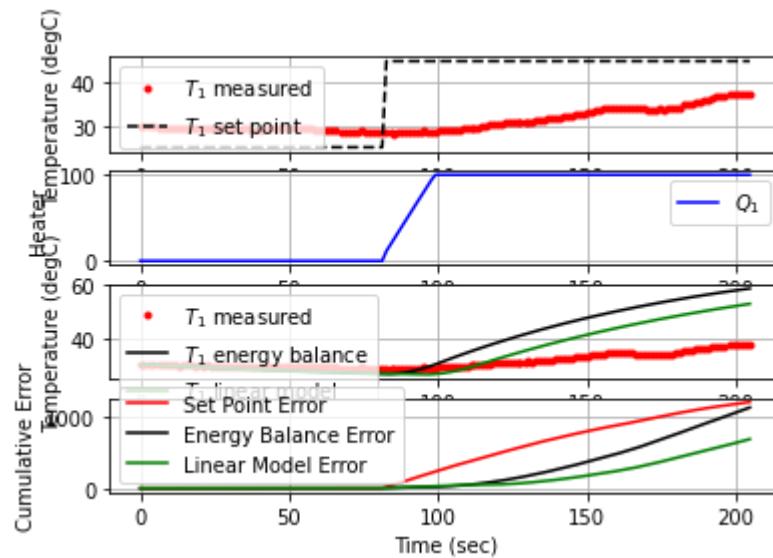
203.2 45.00 37.22 100.00 1.69 96.92 0.01



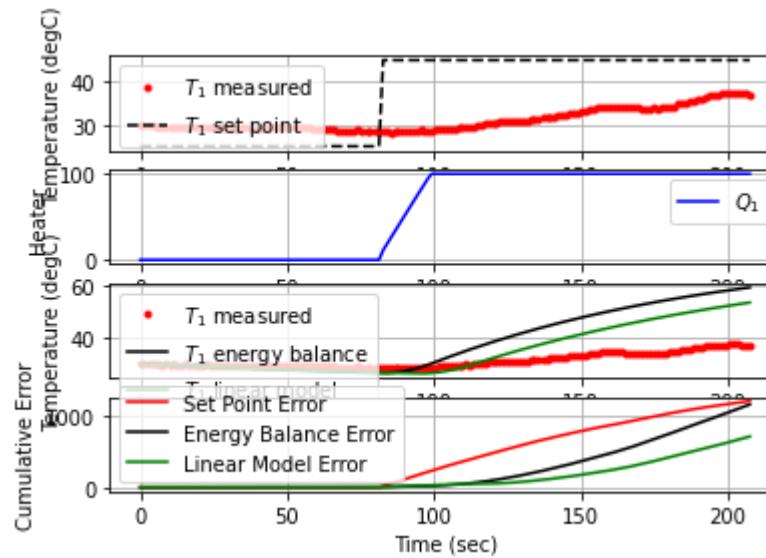
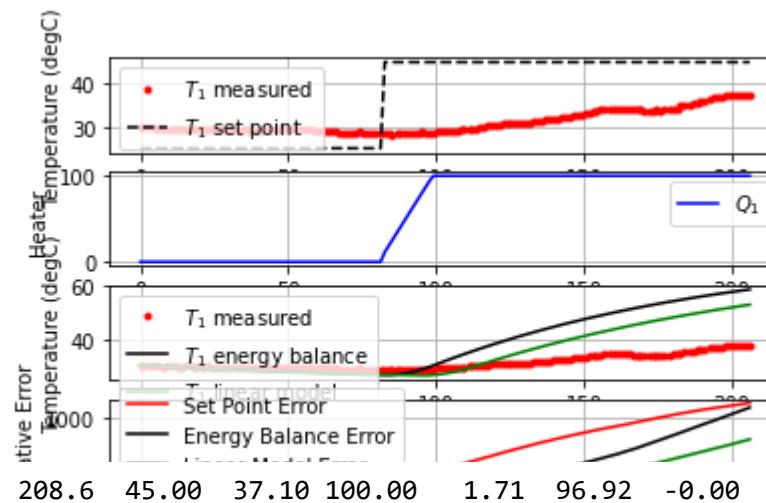
204.7 45.00 37.15 100.00 1.70 96.92 0.00



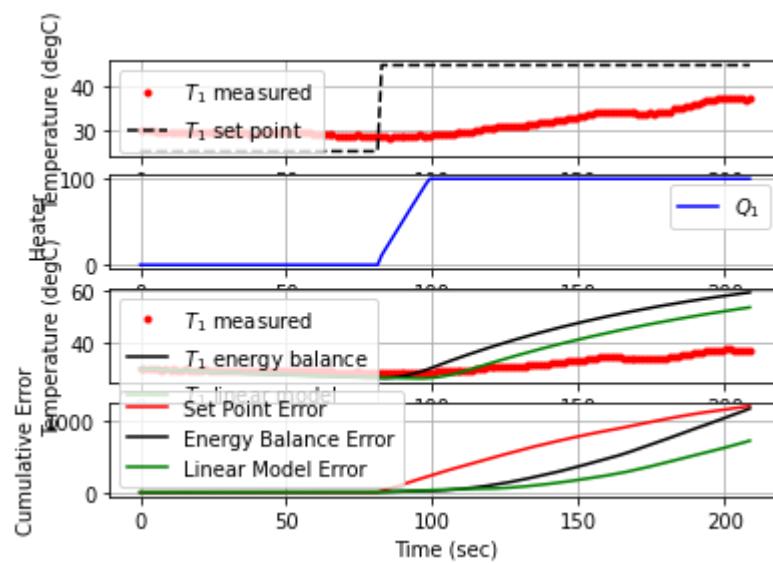
206.0 45.00 37.14 100.00 1.71 96.92 0.00



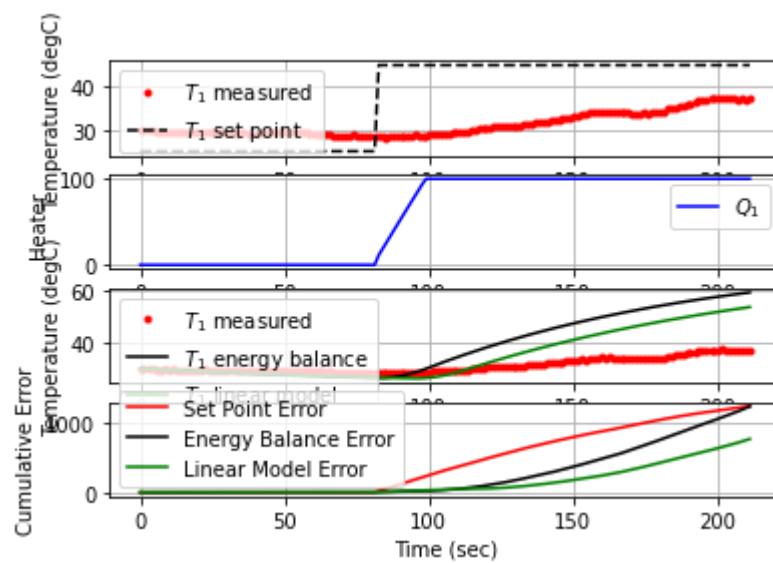
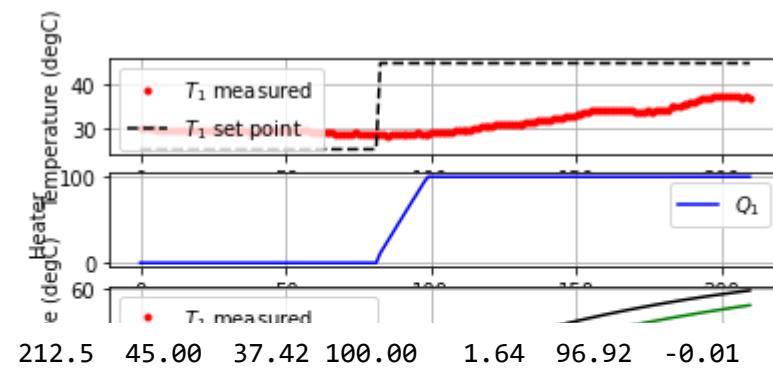
207.4 45.00 37.09 100.00 1.72 96.92 0.00

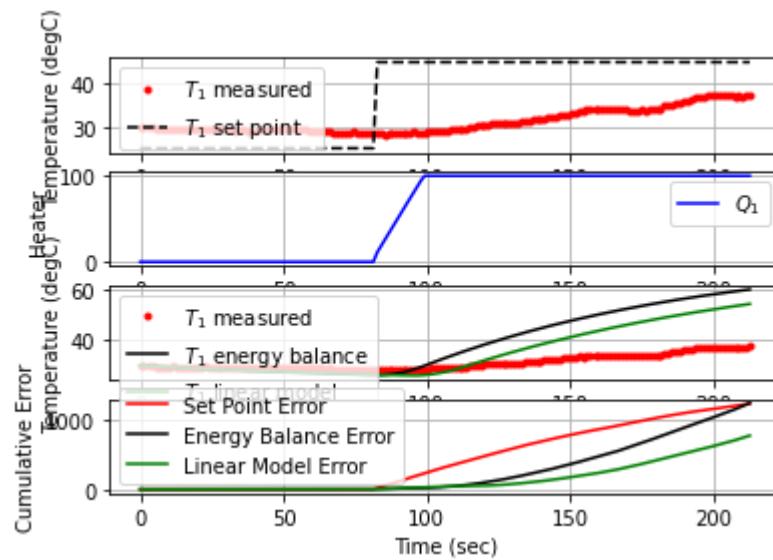


209.9 45.00 36.99 100.00 1.74 96.92 0.01



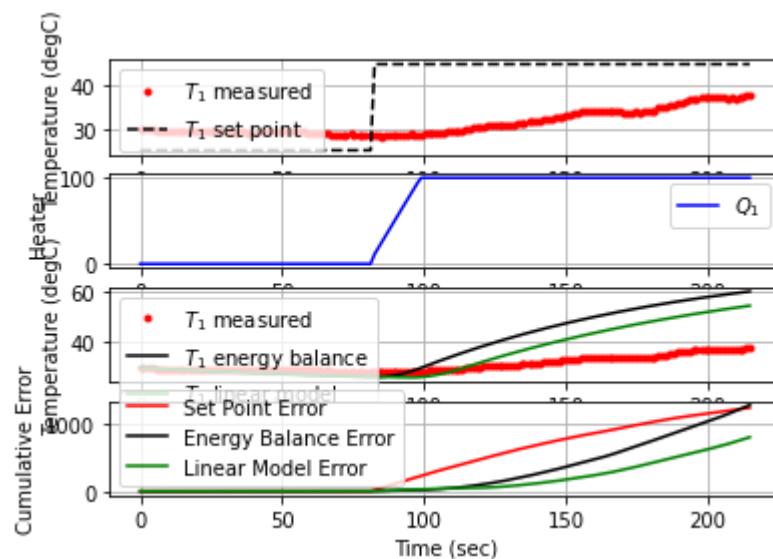
211.2 45.00 37.10 100.00 1.71 96.92 -0.00



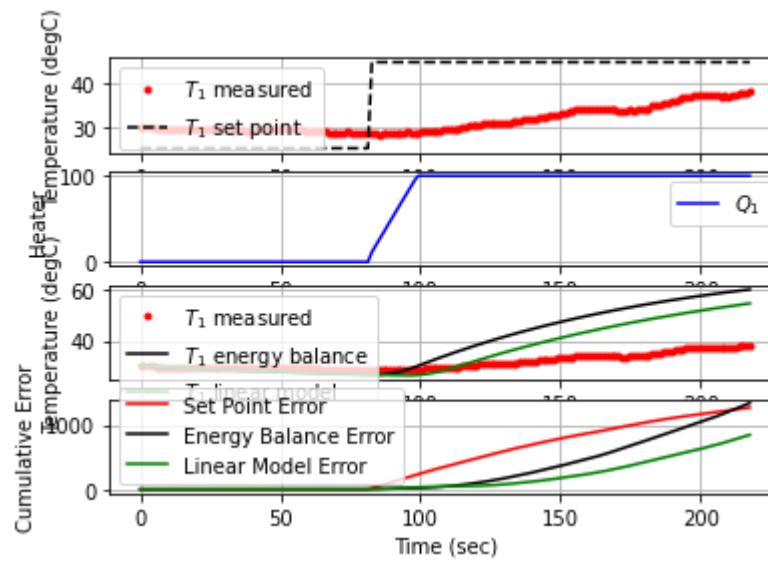
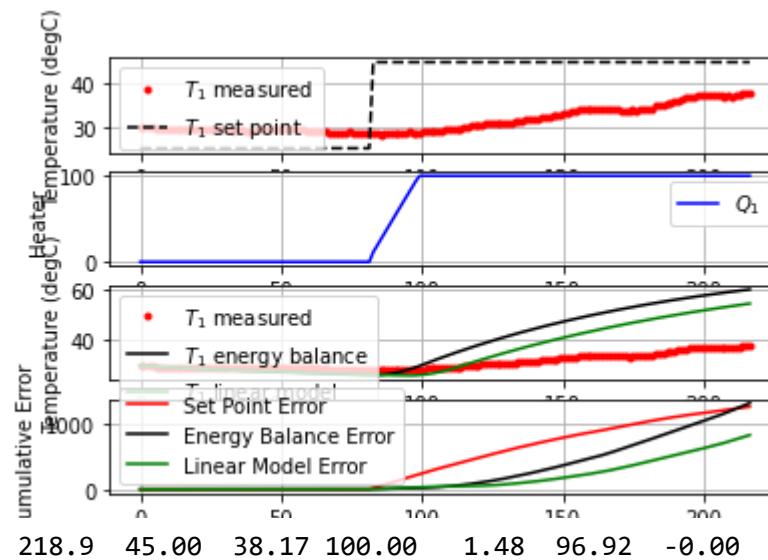


215.0 45.00 37.86 100.00 1.54 96.92 -0.01

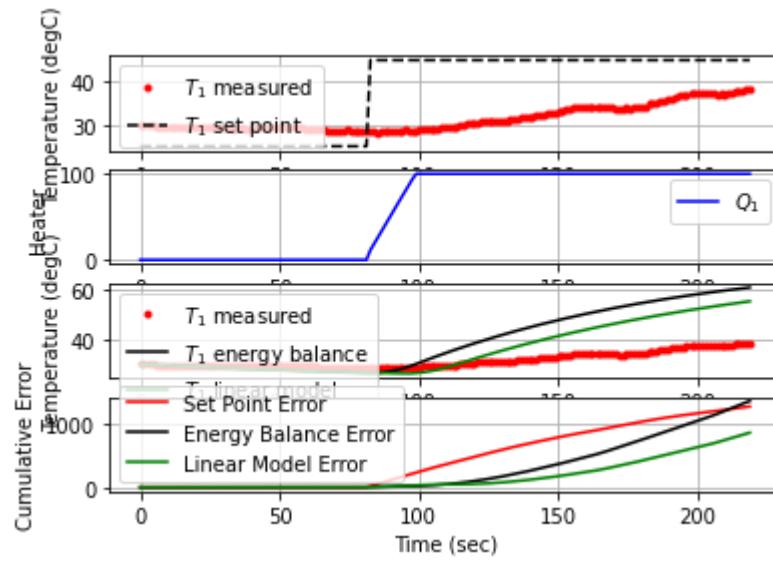
216.2 45.00 37.85 100.00 1.55 96.92 0.00



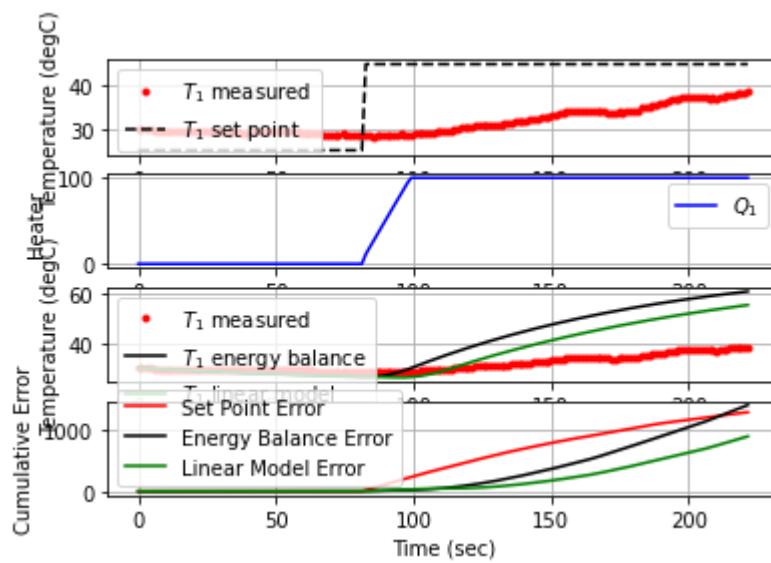
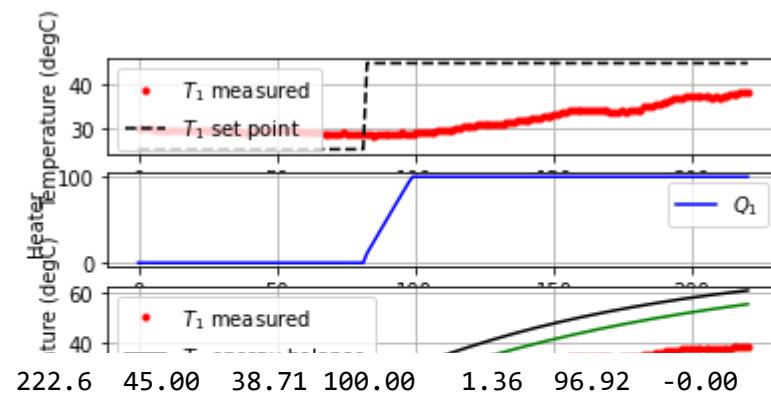
217.5 45.00 38.07 100.00 1.50 96.92 -0.01



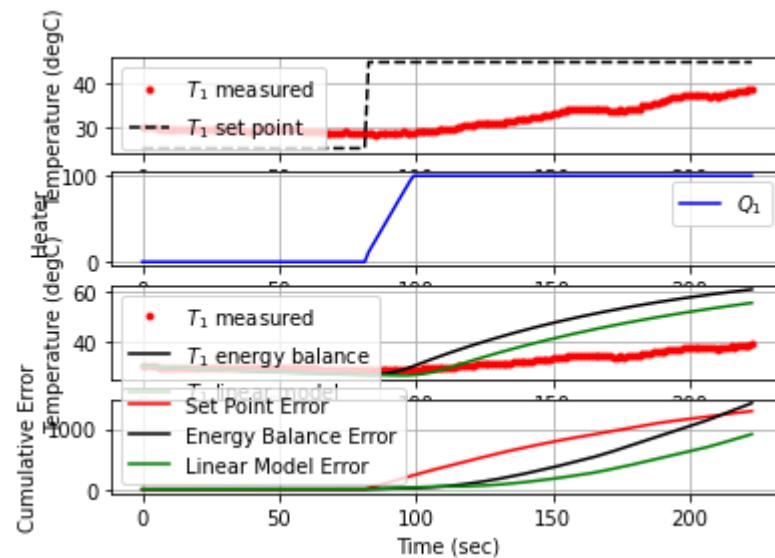
220.1 45.00 38.18 100.00 1.48 96.92 -0.00



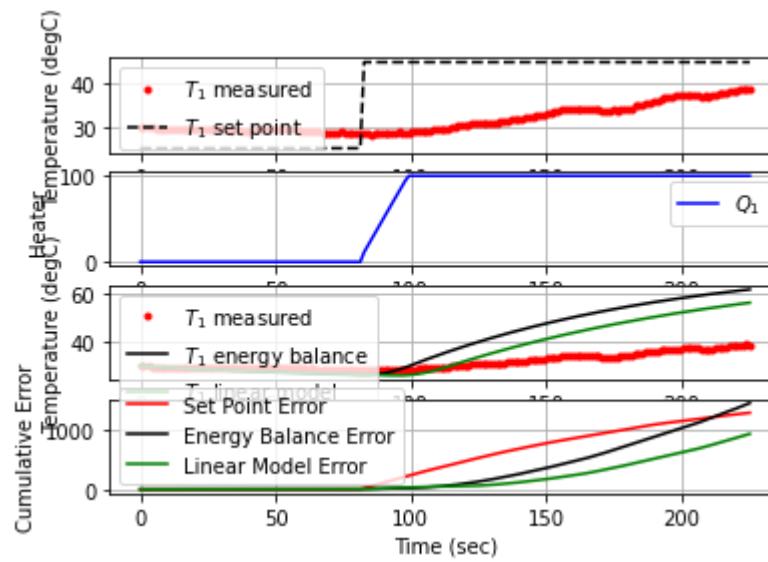
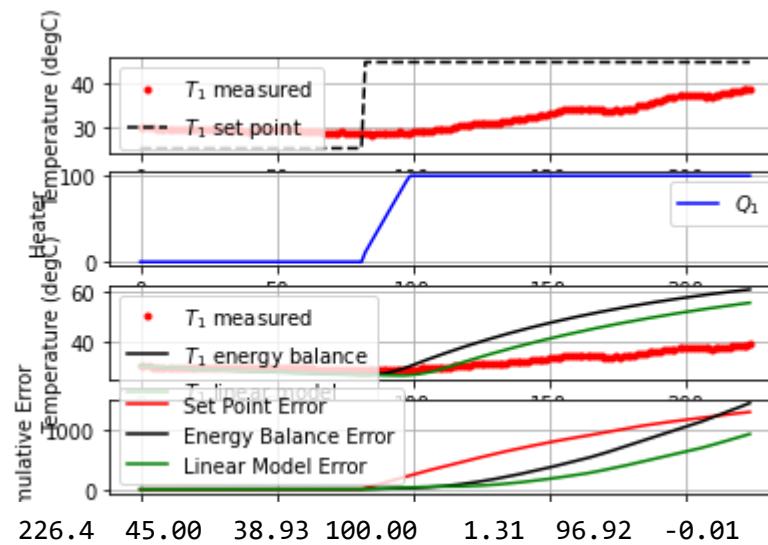
221.4 45.00 38.61 100.00 1.37 96.92 -0.02



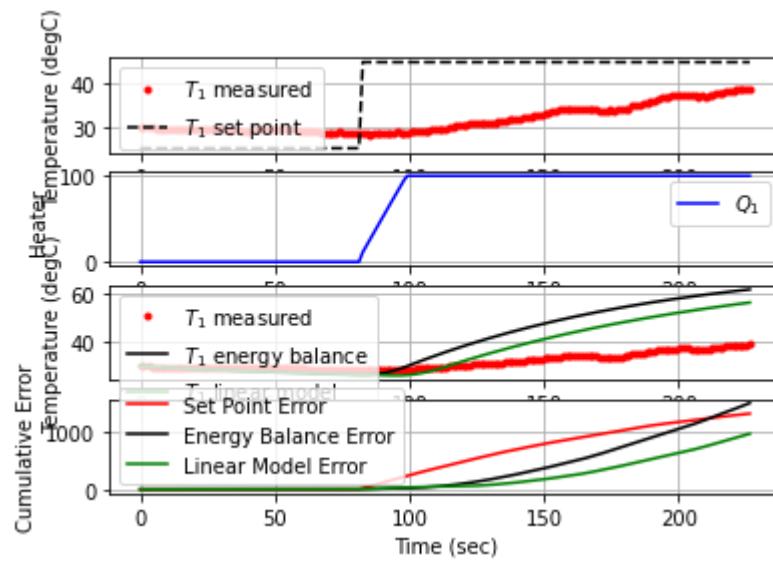
223.8 45.00 38.80 100.00 1.34 96.92 -0.00



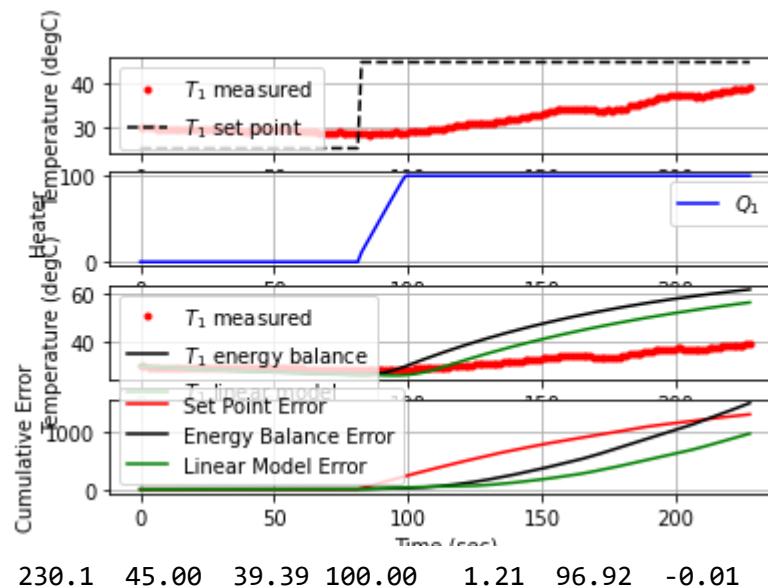
225.0 45.00 38.74 100.00 1.35 96.92 0.00



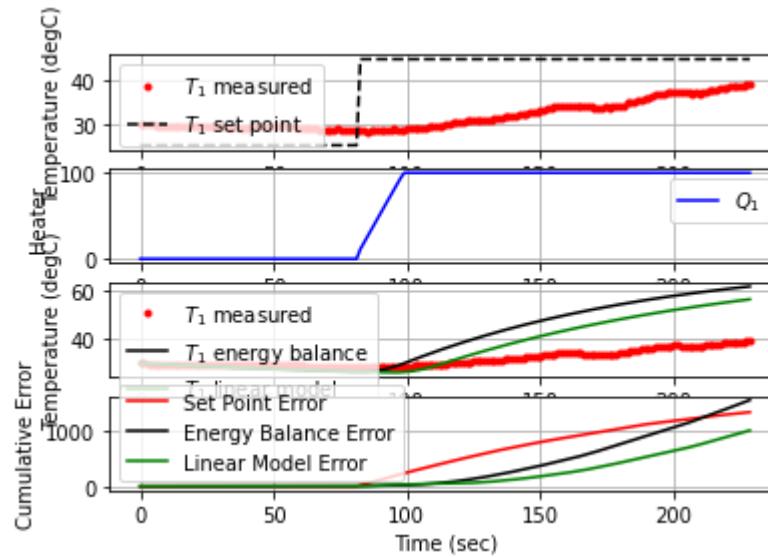
227.6 45.00 39.15 100.00 1.26 96.92 -0.01



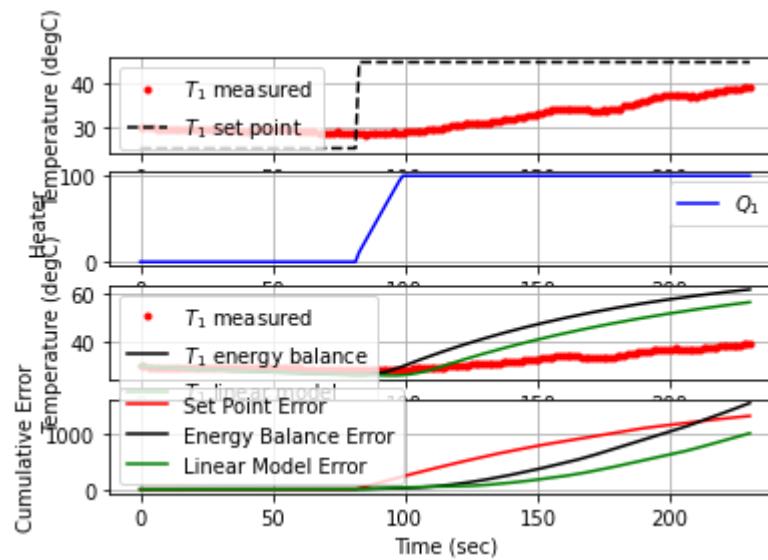
228.9 45.00 39.24 100.00 1.24 96.92 -0.00



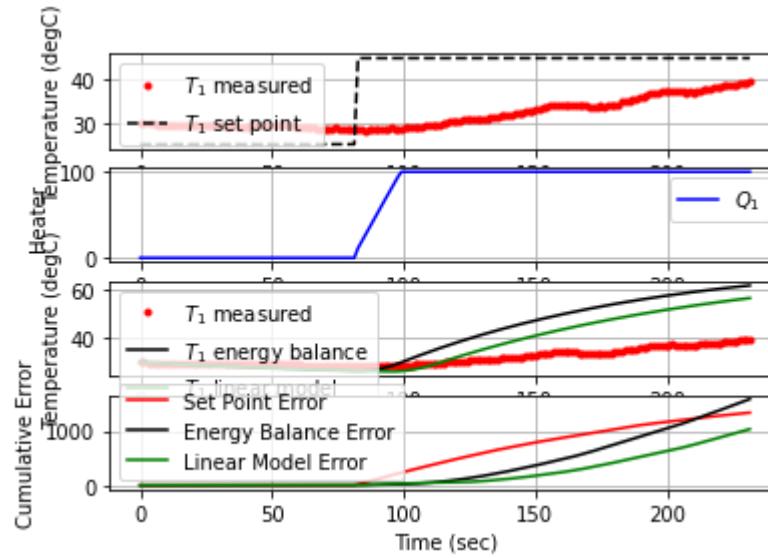
230.1 45.00 39.39 100.00 1.21 96.92 -0.01



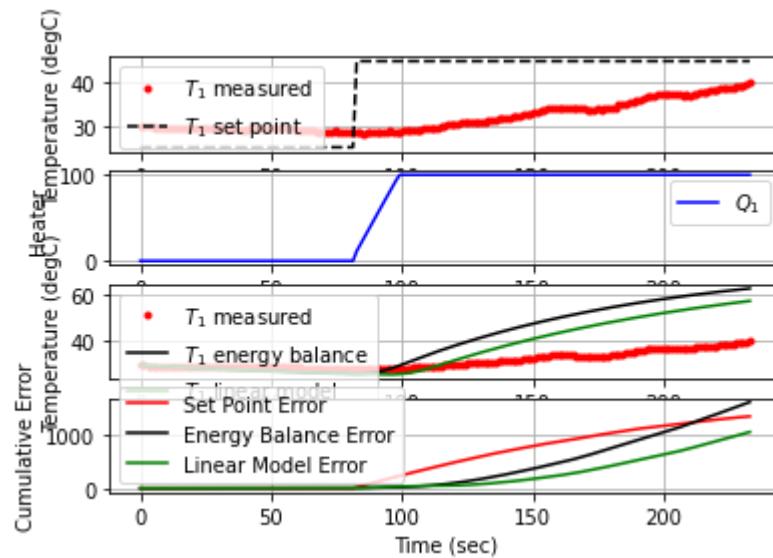
231.4 45.00 39.61 100.00 1.16 96.92 -0.01



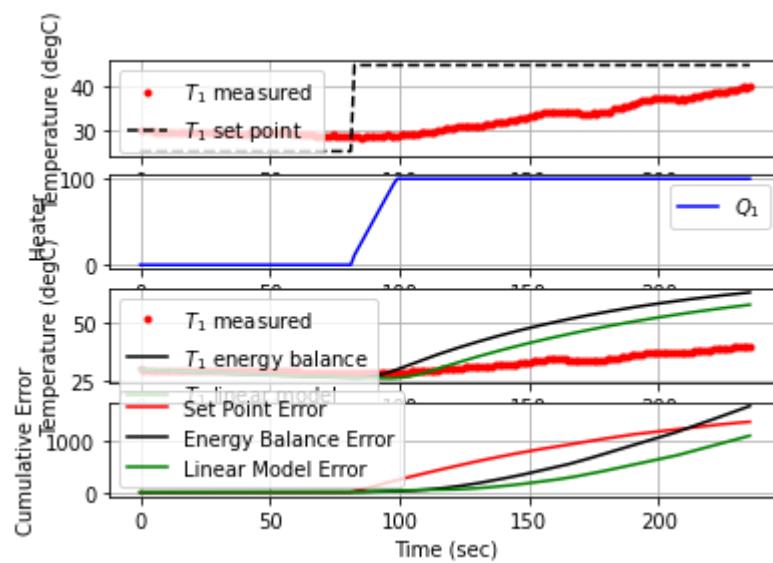
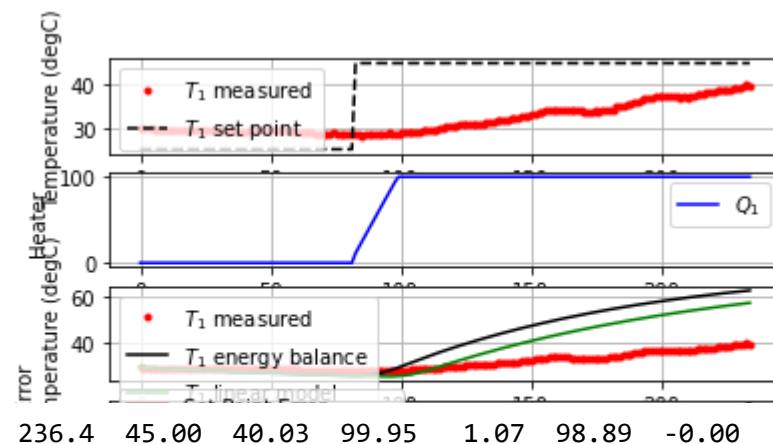
232.8 45.00 40.02 100.00 1.06 96.92 -0.02



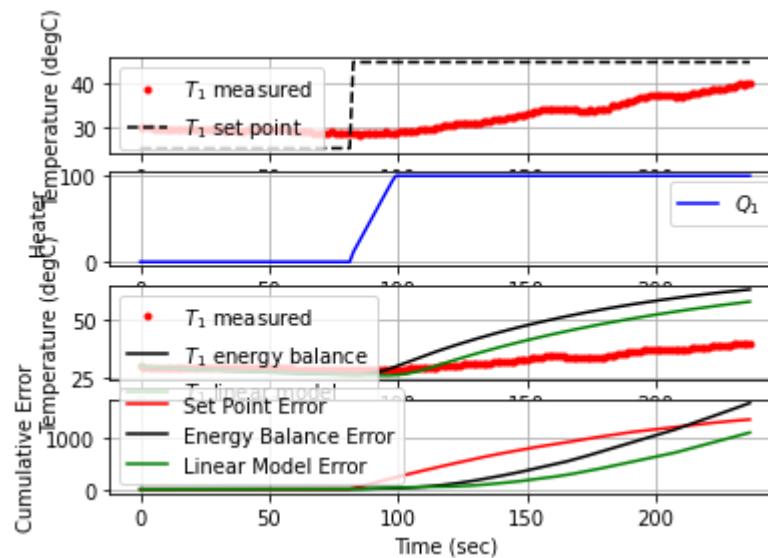
234.0 45.00 39.76 100.00 1.13 96.92 0.01



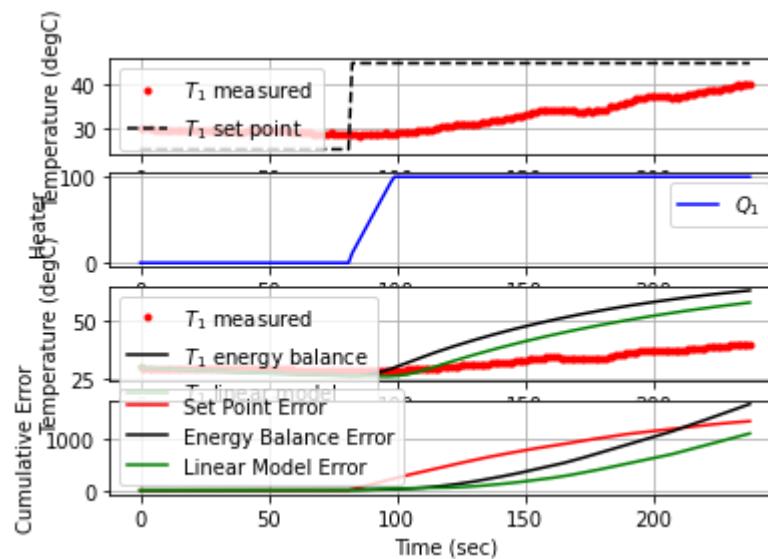
235.2 45.00 39.93 100.00 1.09 96.92 -0.01

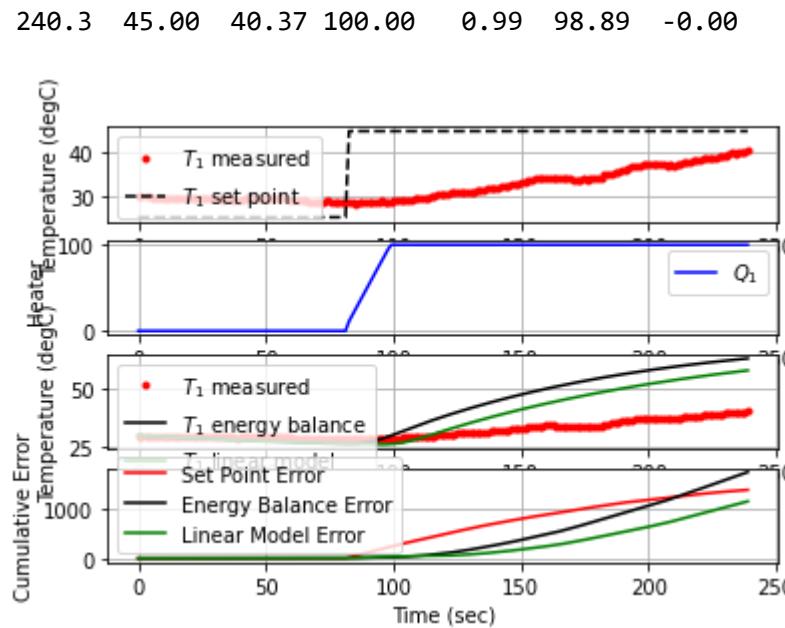


237.7 45.00 40.07 100.00 1.06 98.89 -0.00

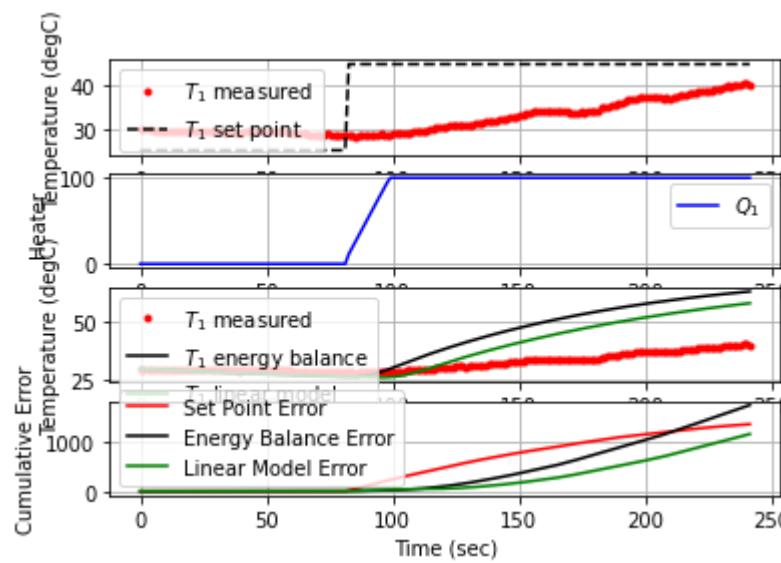
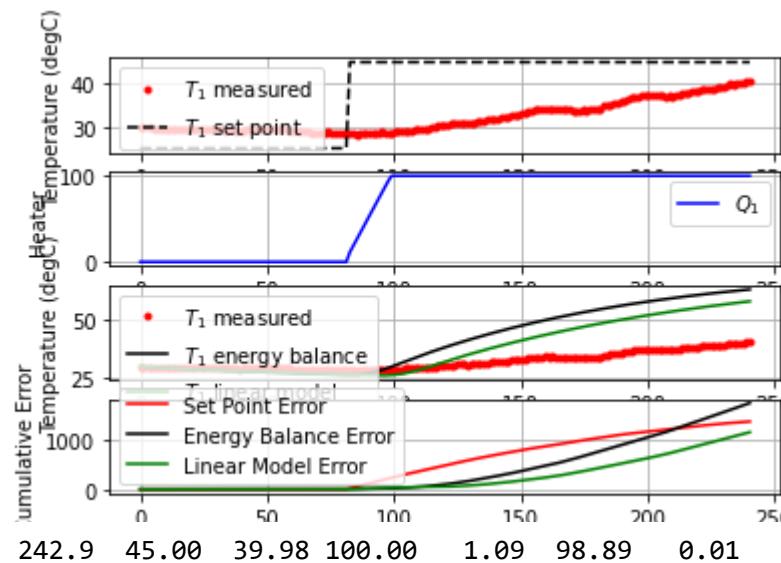


238.9 45.00 40.37 100.00 0.99 98.89 -0.01

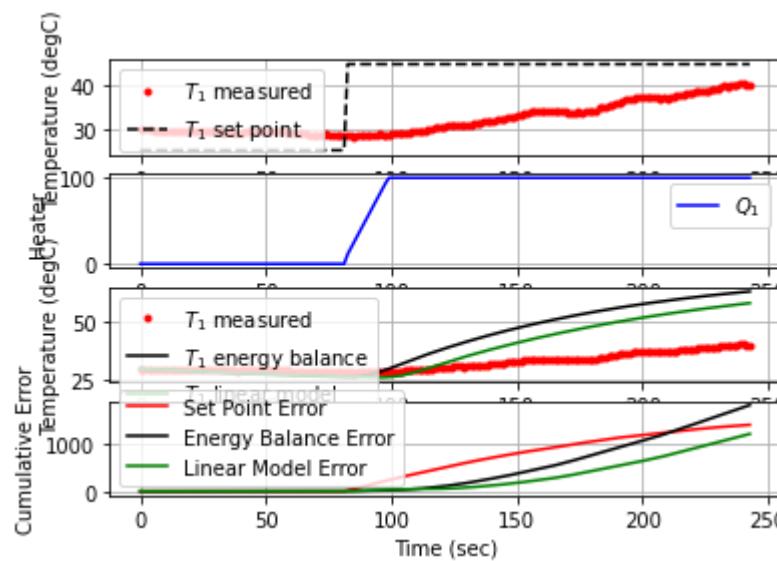




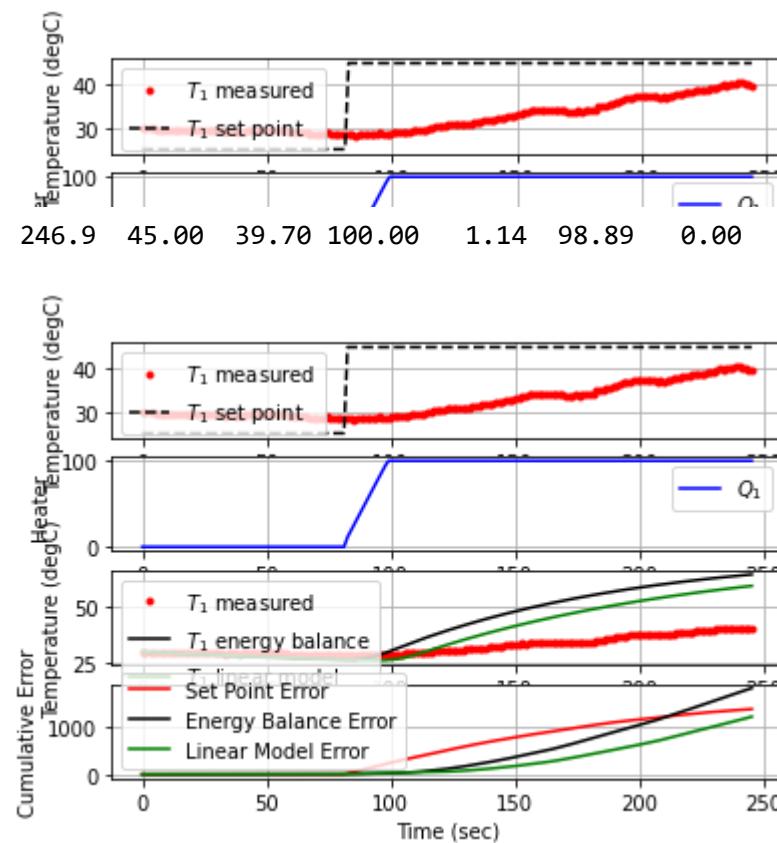
241.6 45.00 40.23 100.00 1.03 98.89 0.01



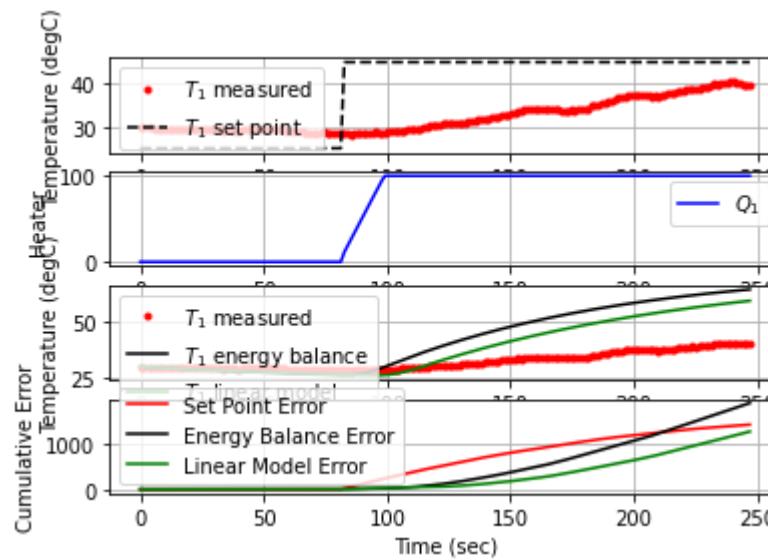
244.1 45.00 39.77 100.00 1.13 98.89 0.01



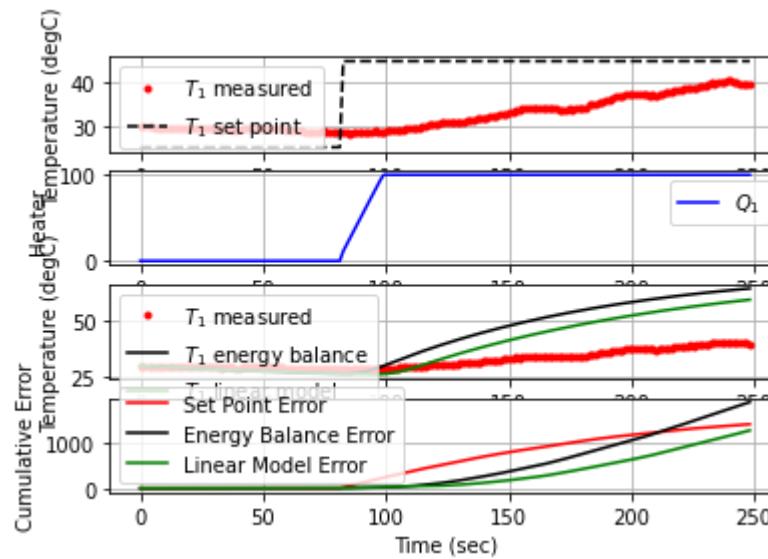
245.4 45.00 39.81 100.00 1.12 98.89 -0.00

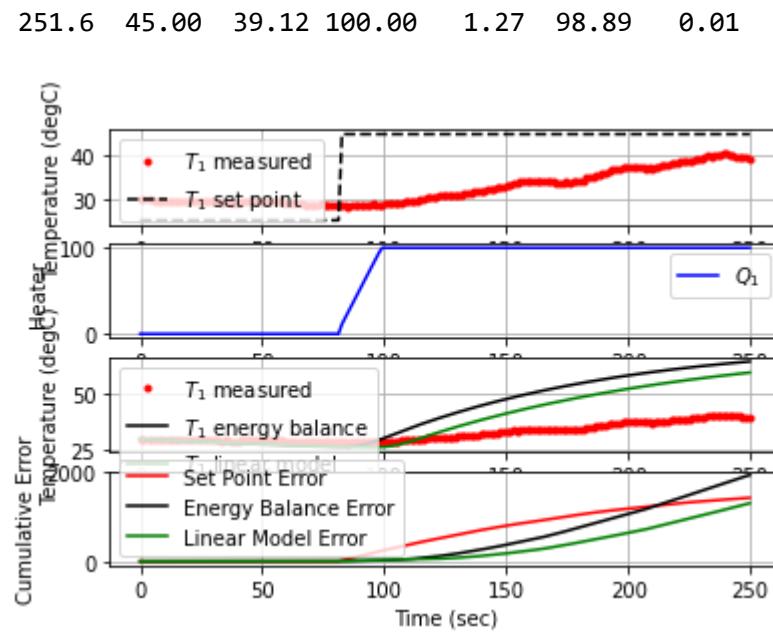


248.2 45.00 39.50 100.00 1.19 98.89 0.01

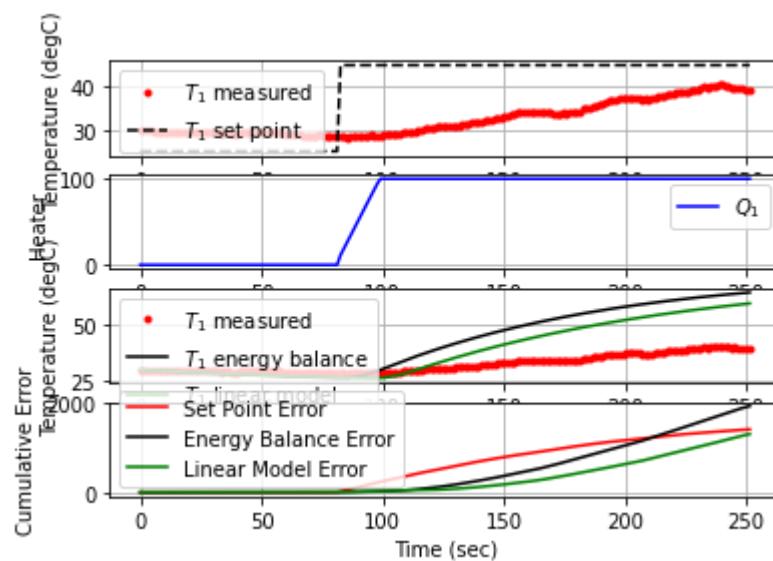


249.8 45.00 39.28 100.00 1.24 98.89 0.01

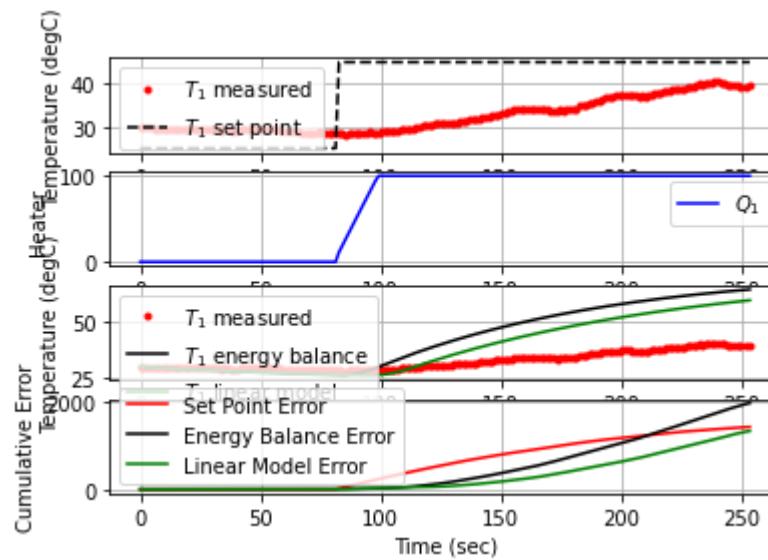




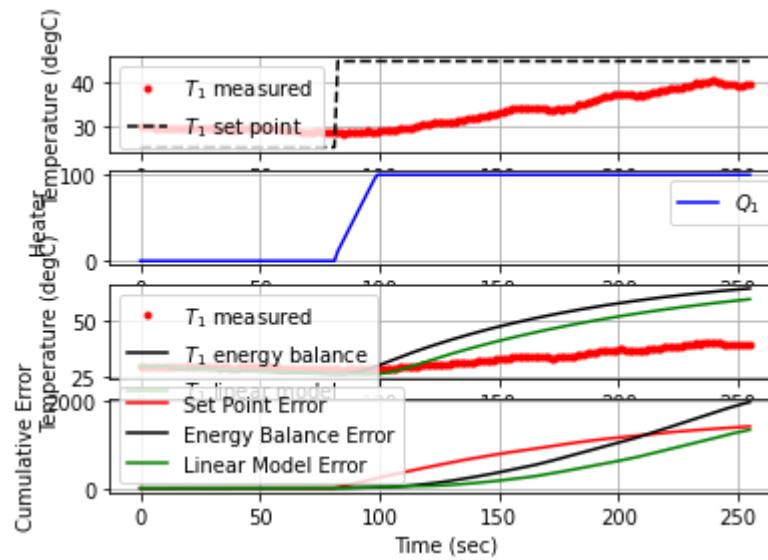
253.5 45.00 39.44 100.00 1.19 98.89 -0.01



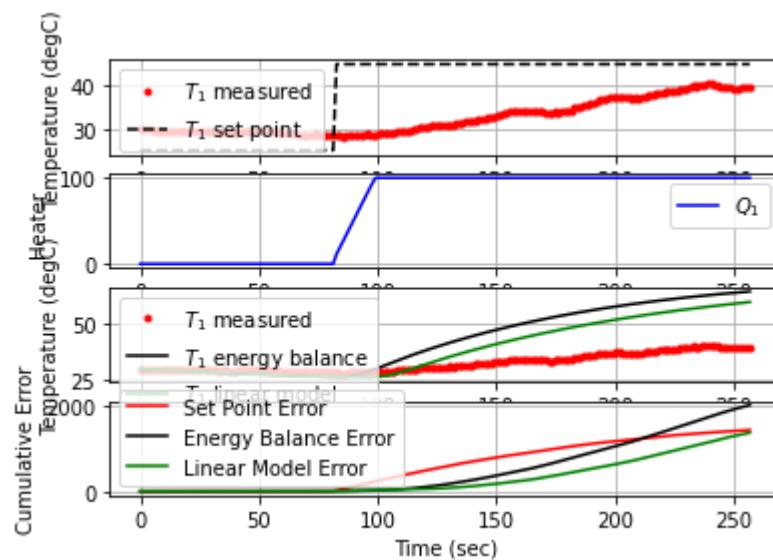
255.0 45.00 39.82 100.00 1.10 98.89 -0.01



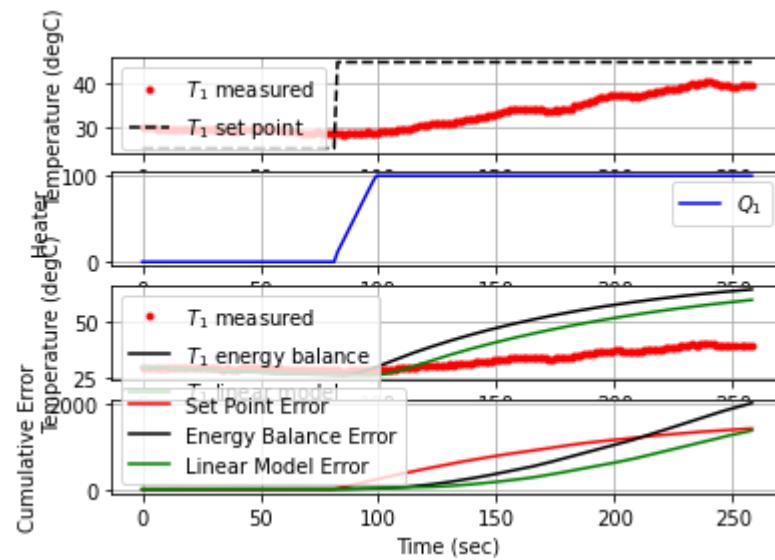
256.7 45.00 39.84 100.00 1.11 98.89 -0.00



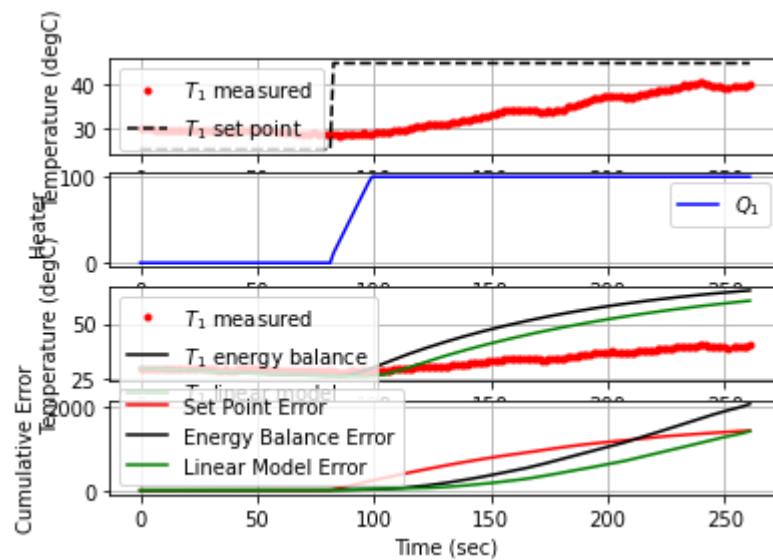
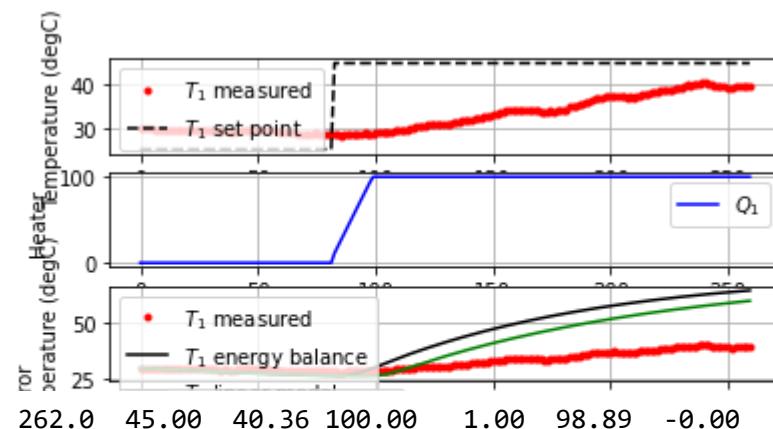
258.0 45.00 39.76 100.00 1.13 98.89 0.00



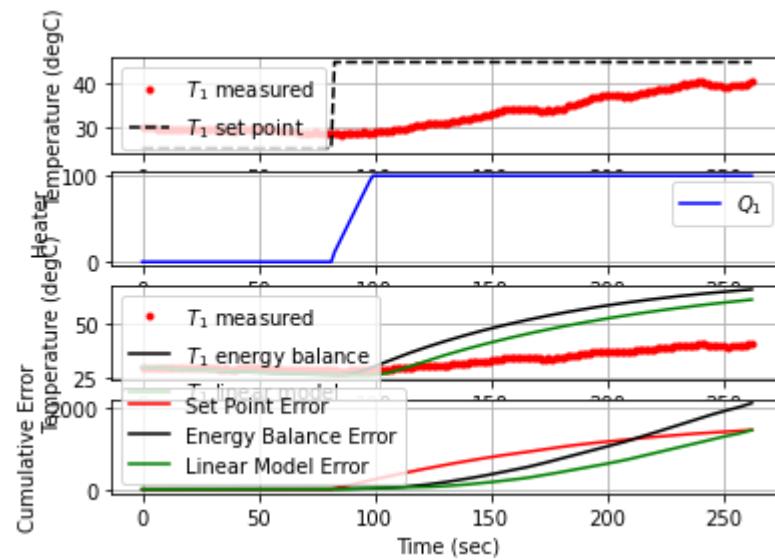
259.3 45.00 39.85 100.00 1.11 98.89 -0.00



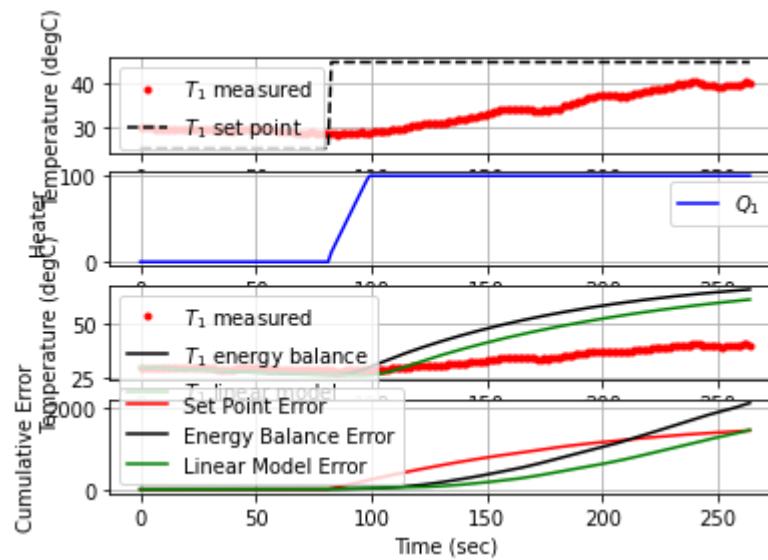
260.7 45.00 40.34 100.00 0.98 98.89 -0.02



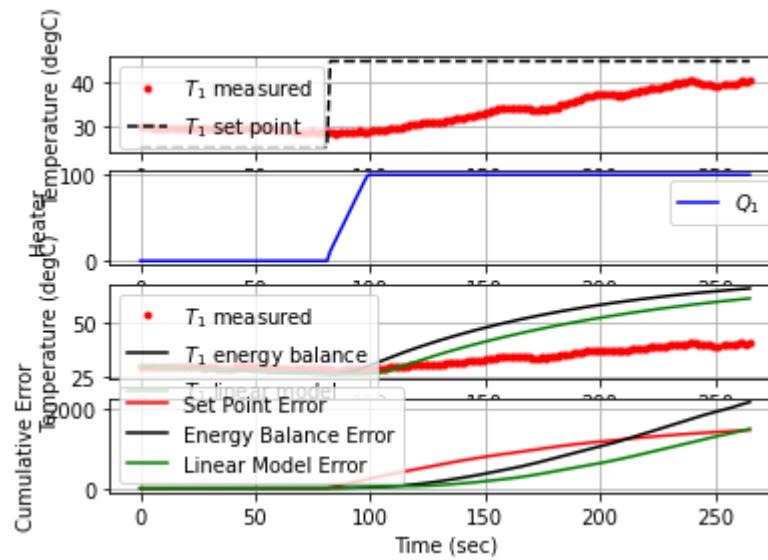
263.6 45.00 40.15 100.00 1.05 98.89 0.01



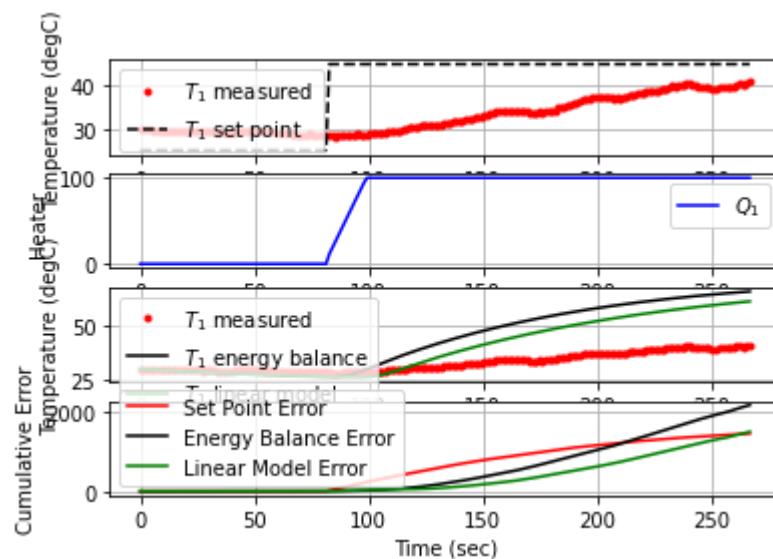
265.1 45.00 40.53 100.00 0.95 98.89 -0.01



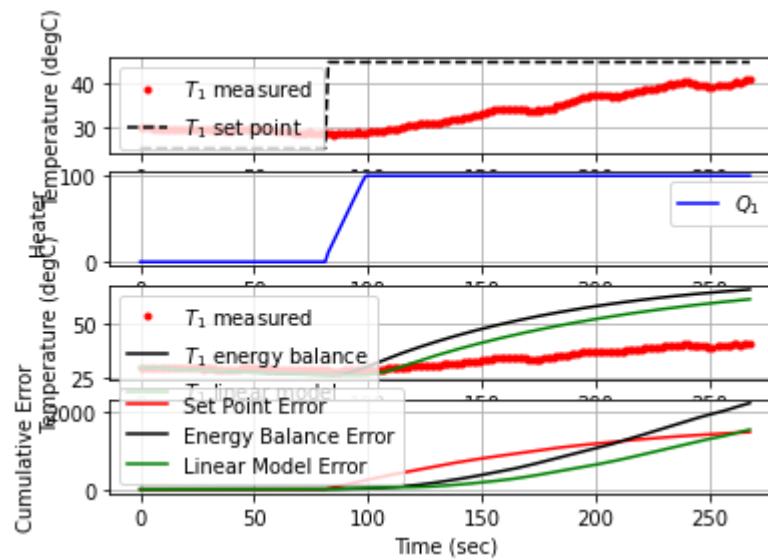
266.5 45.00 40.86 100.00 0.88 98.89 -0.01



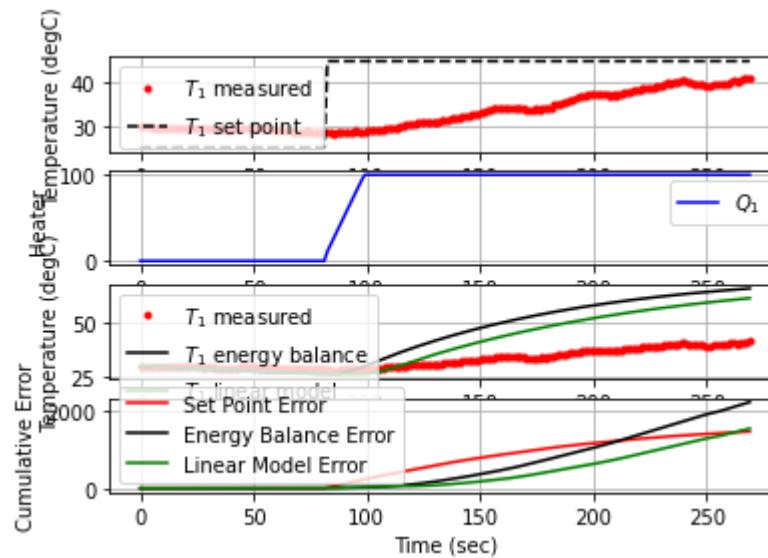
267.8 45.00 40.95 100.00 0.86 98.89 -0.00



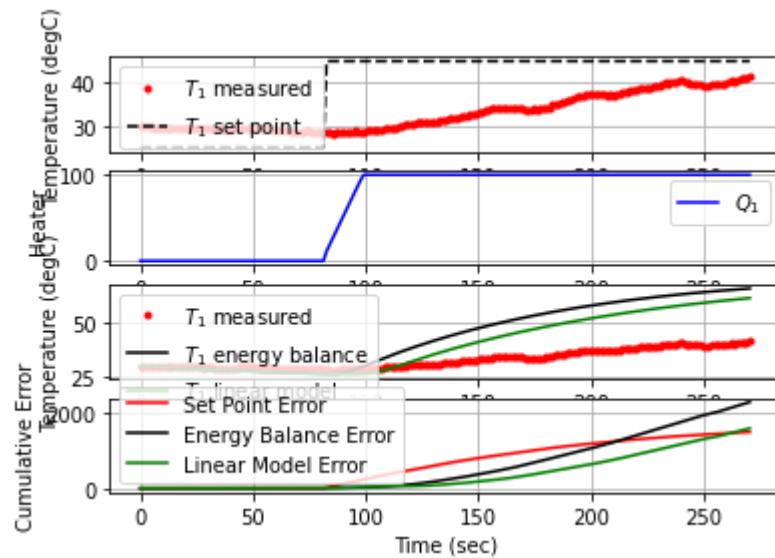
269.1 45.00 41.26 100.00 0.79 98.89 -0.01



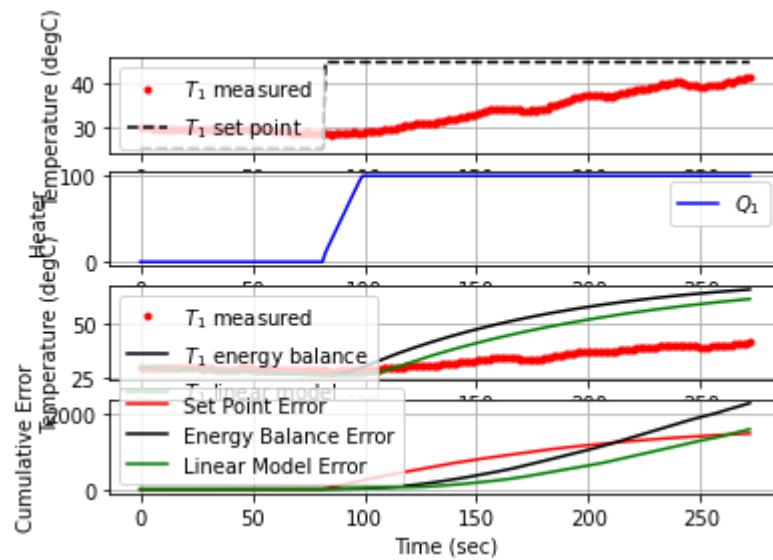
270.4 45.00 41.30 100.00 0.79 98.89 -0.00



271.8 45.00 41.56 100.00 0.73 98.89 -0.01

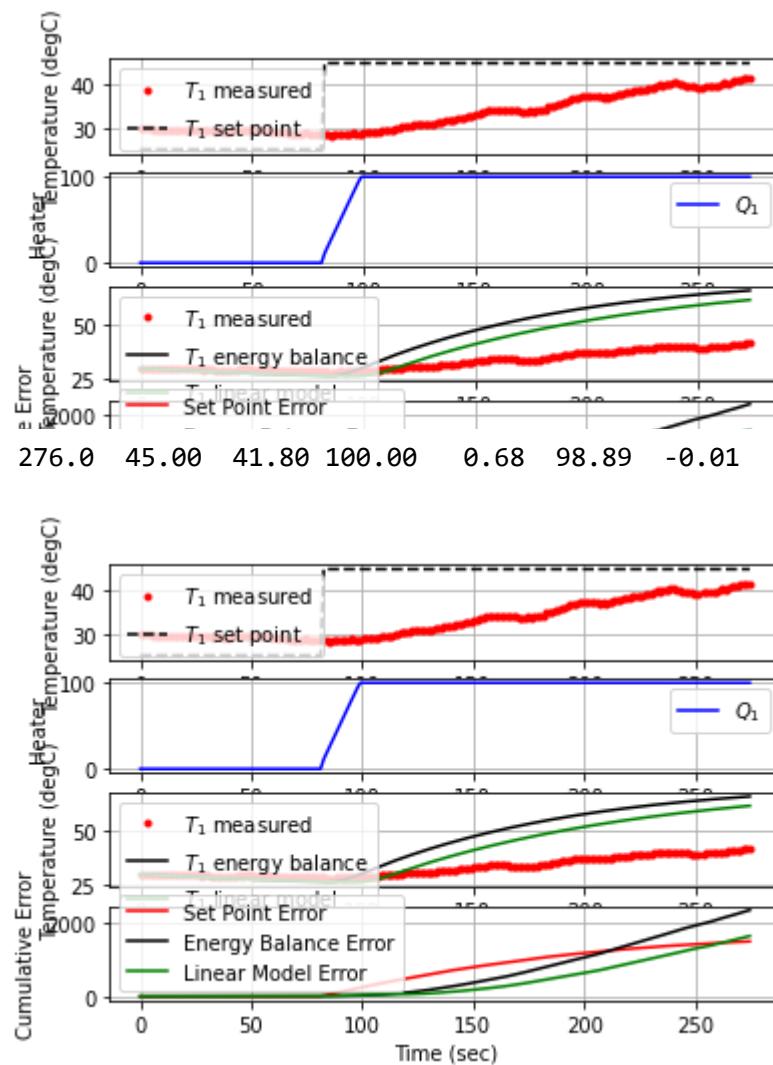


273.2 45.00 41.62 100.00 0.72 98.89 -0.00

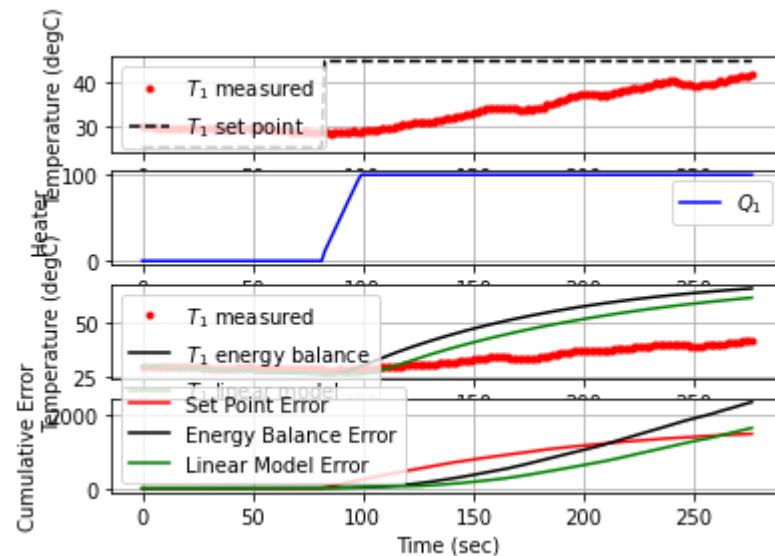


274.6 45.00 41.66 100.00 0.71 98.89 -0.00

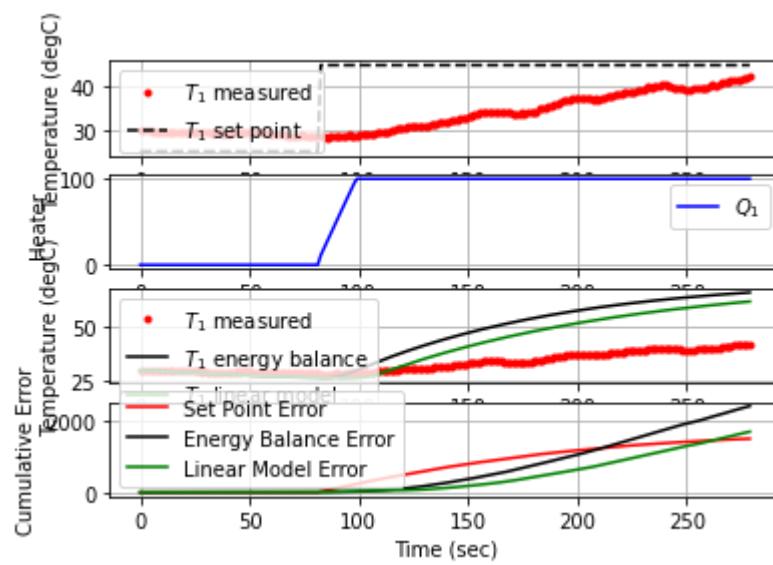
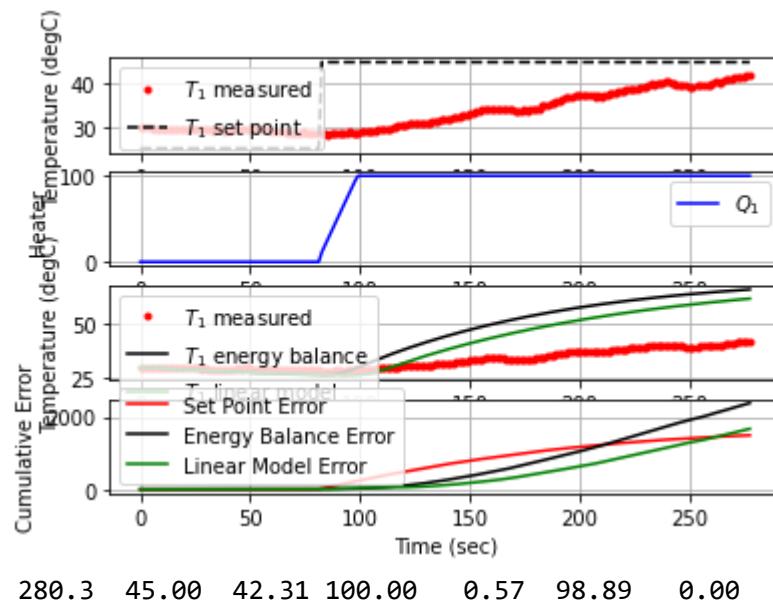




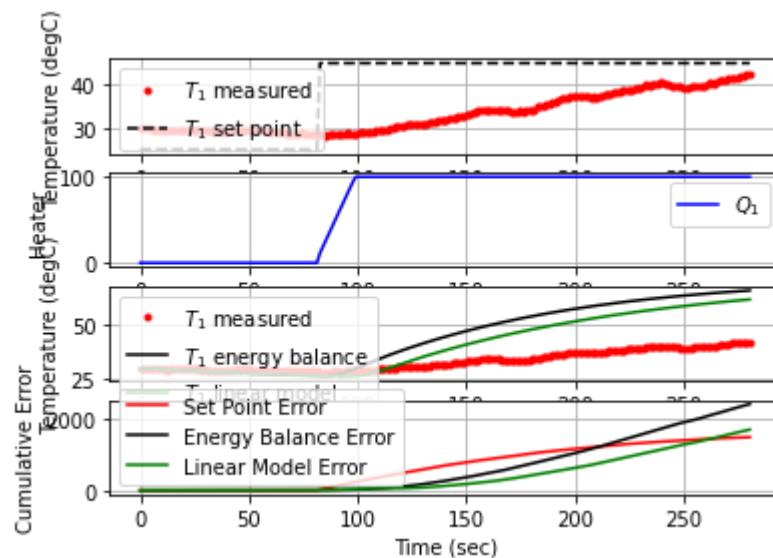
277.5 45.00 42.06 100.00 0.62 98.89 -0.01



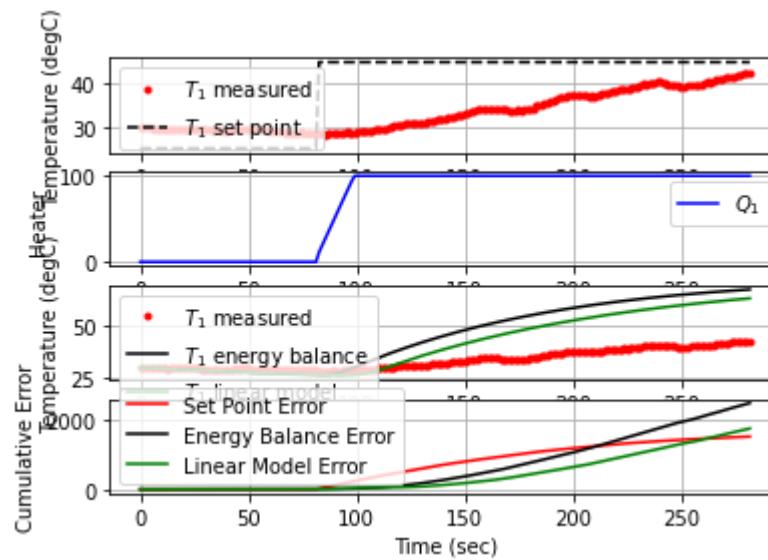
279.0 45.00 42.41 100.00 0.54 98.89 -0.01



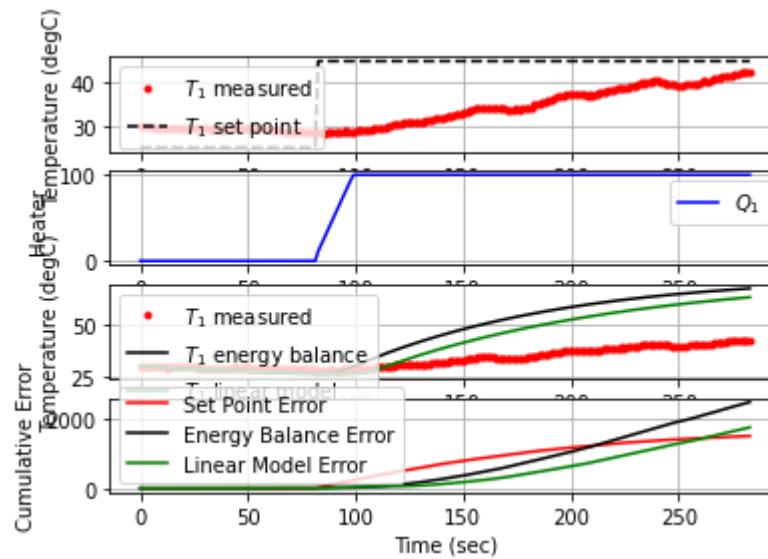
281.7 45.00 42.35 100.00 0.56 98.89 -0.00



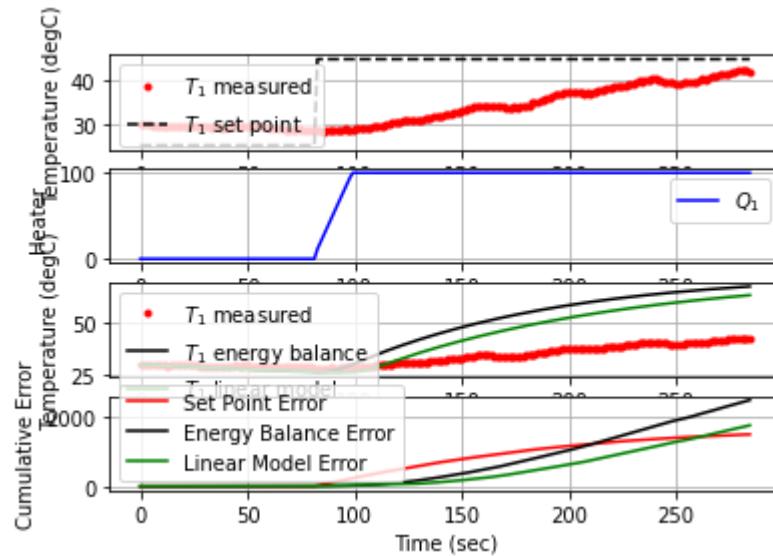
283.1 45.00 42.22 100.00 0.59 98.89 0.01



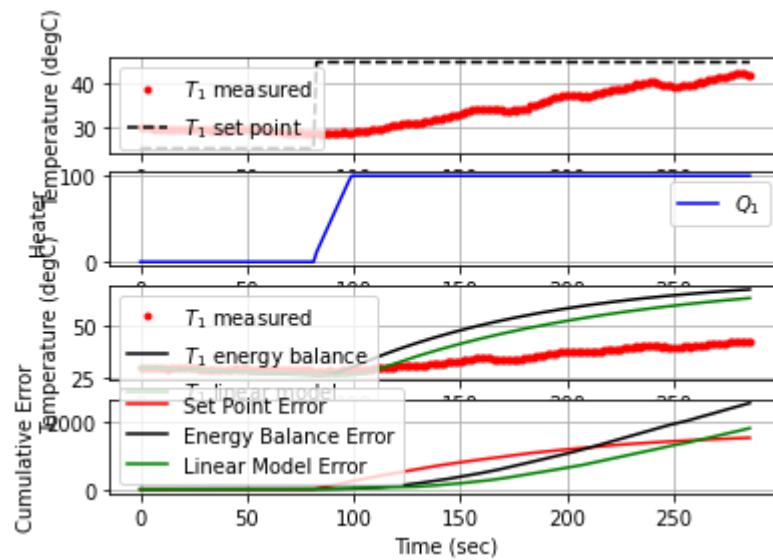
284.4 45.00 41.83 100.00 0.68 98.89 0.02



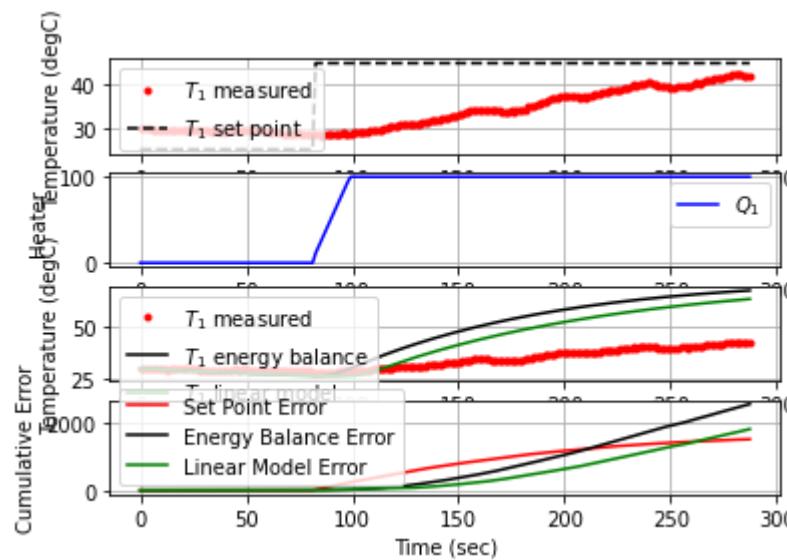
285.7 45.00 41.95 100.00 0.64 98.89 -0.01

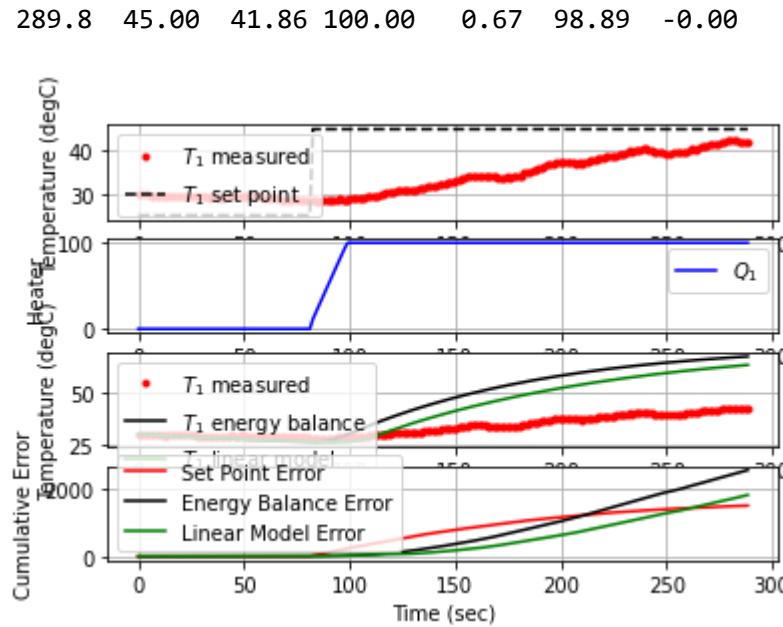


287.2 45.00 41.98 100.00 0.64 98.89 -0.00

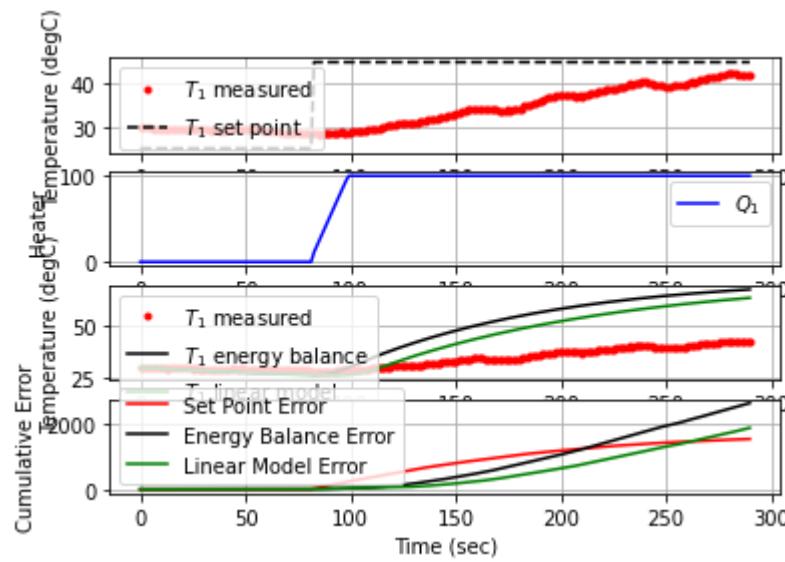


288.5 45.00 41.86 100.00 0.67 98.89 0.01

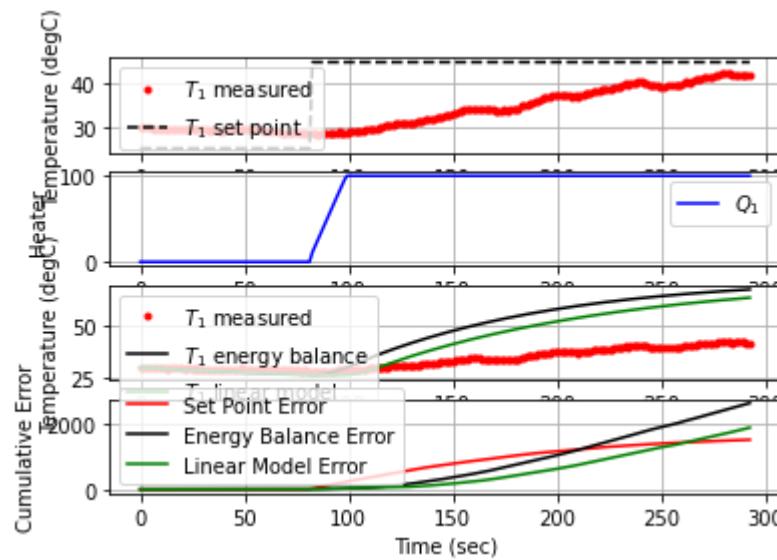
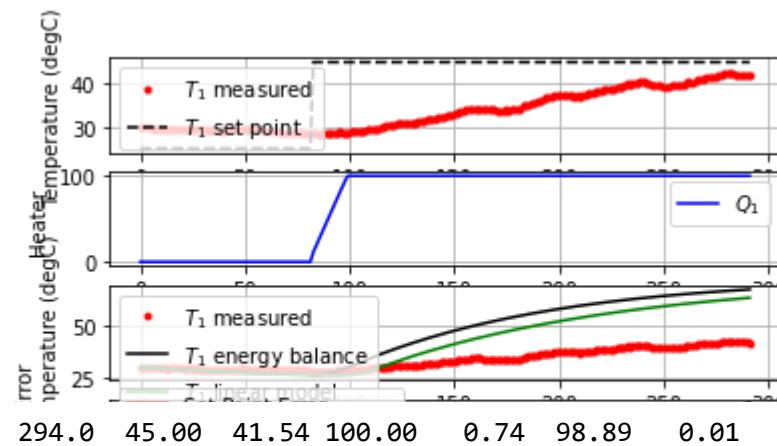




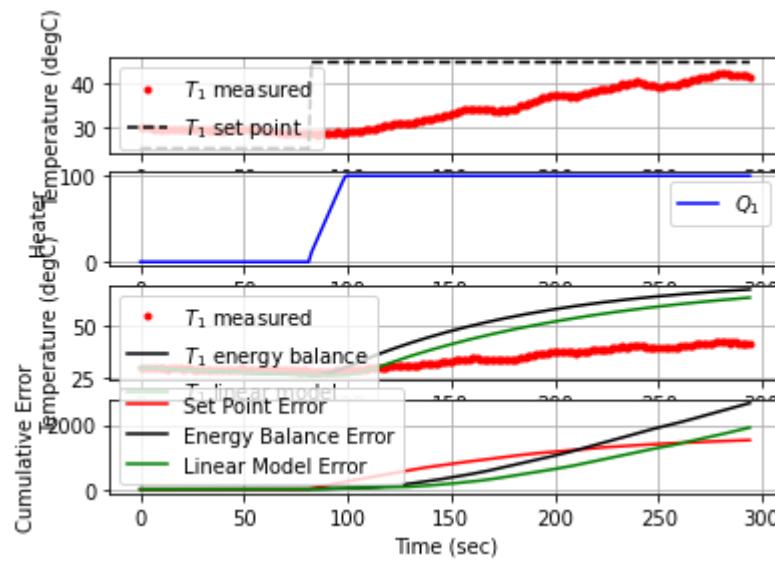
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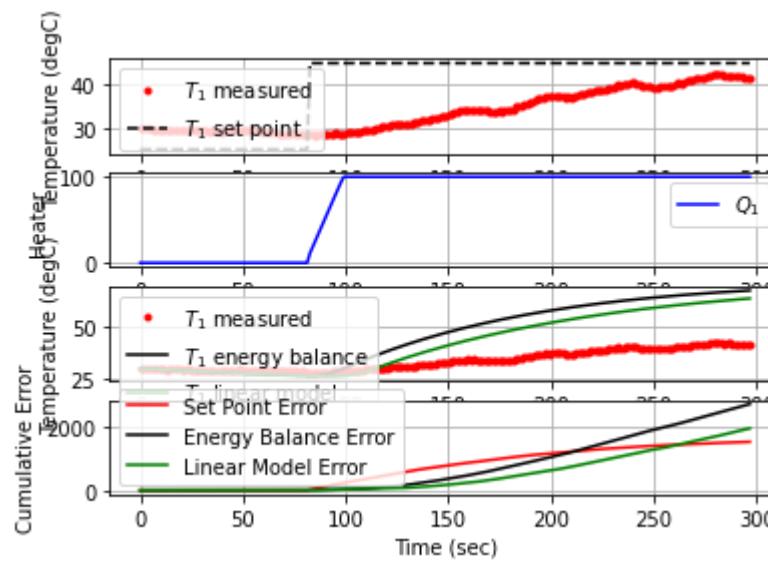
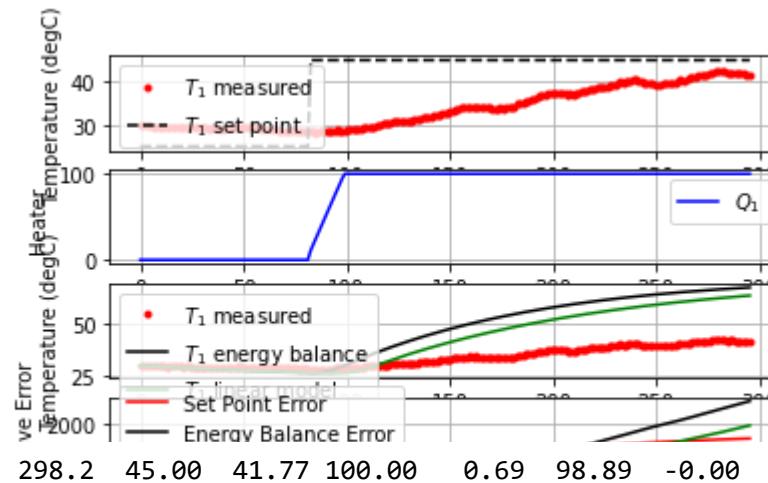
292.6 45.00 41.76 100.00 0.69 98.89 0.00



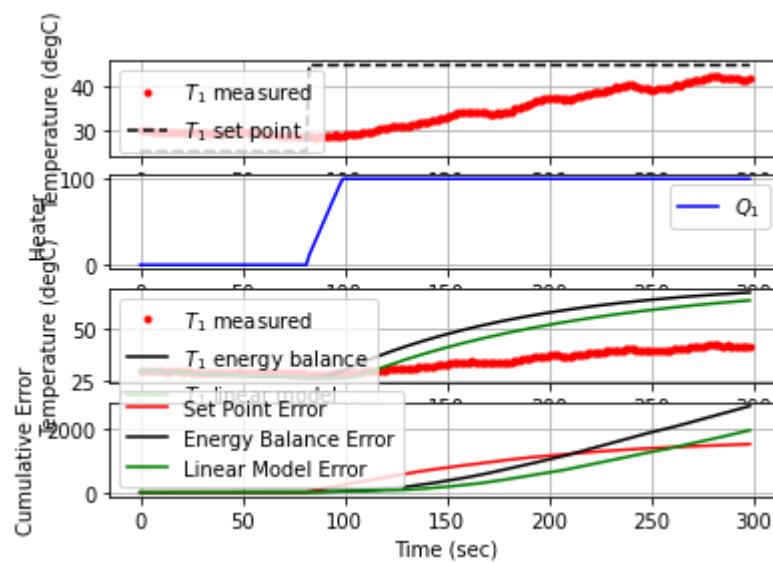
295.4 45.00 41.61 100.00 0.72 98.89 -0.00



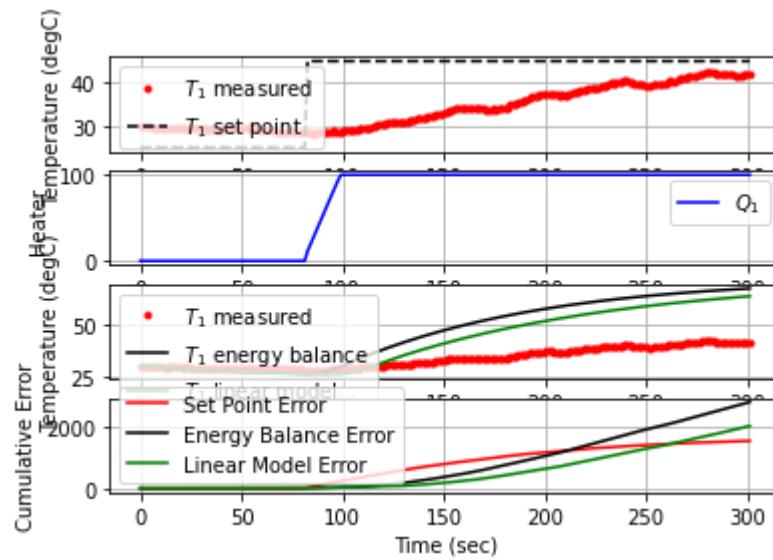
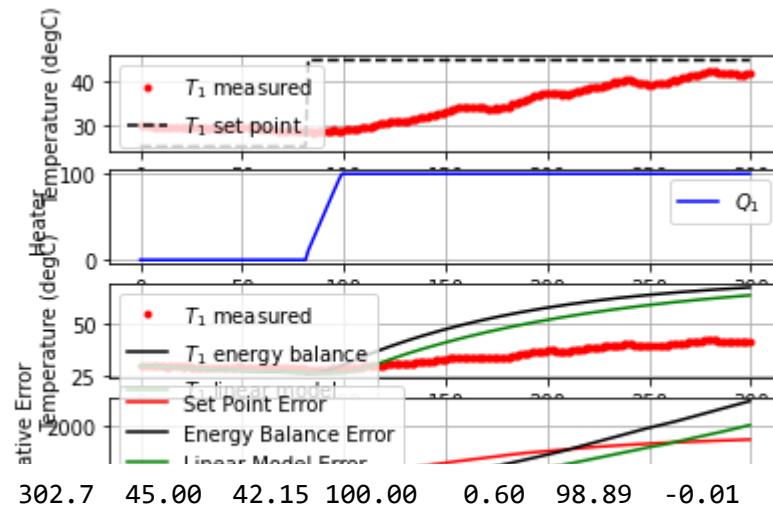
296.8 45.00 41.71 100.00 0.70 98.89 -0.00



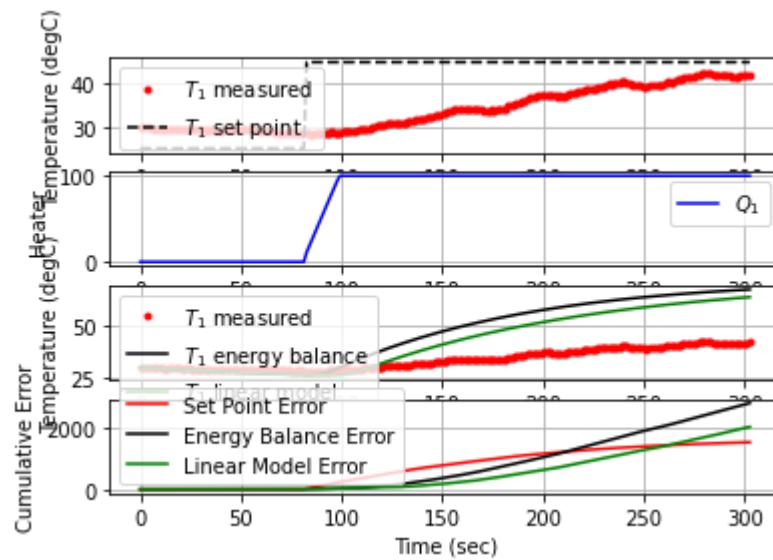
299.6 45.00 41.88 100.00 0.66 98.89 -0.00



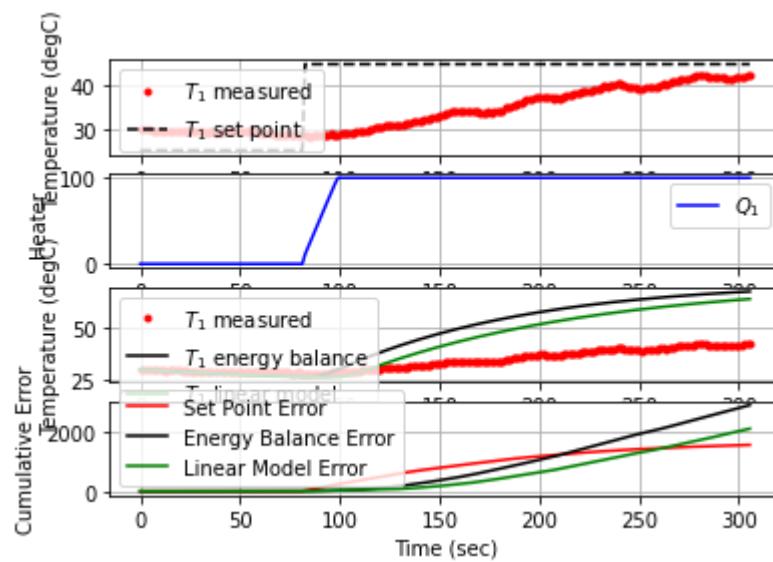
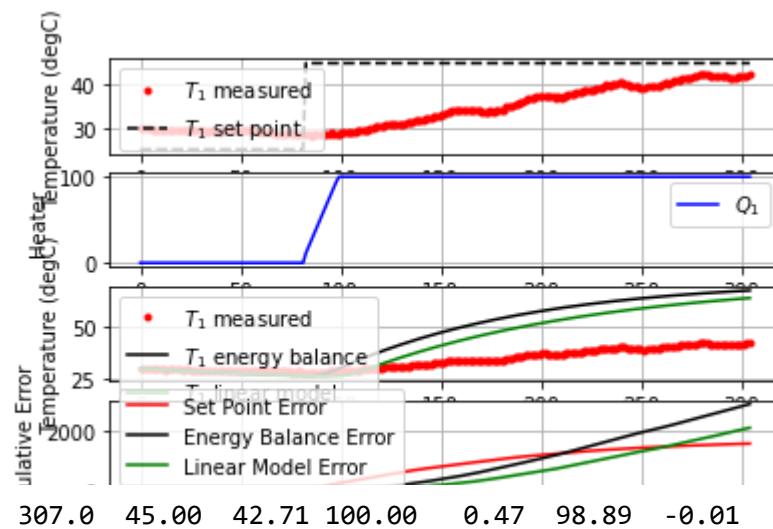
301.1 45.00 42.00 100.00 0.63 98.89 -0.00



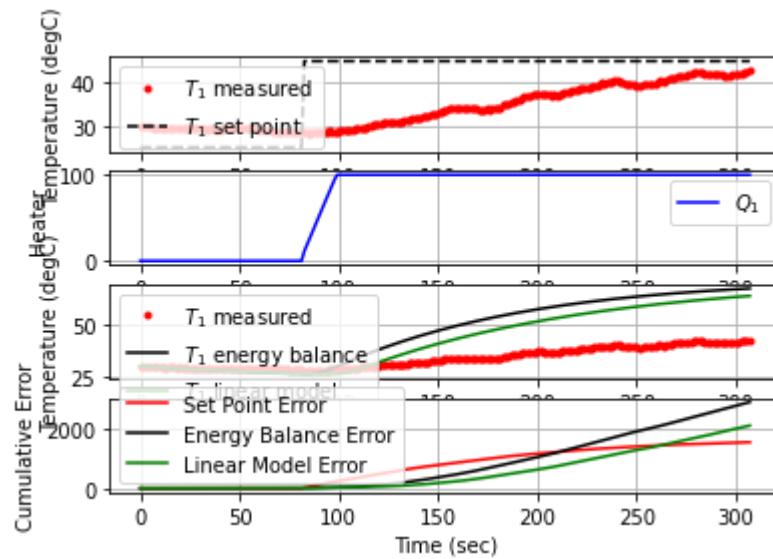
304.2 45.00 42.46 100.00 0.53 98.89 -0.01



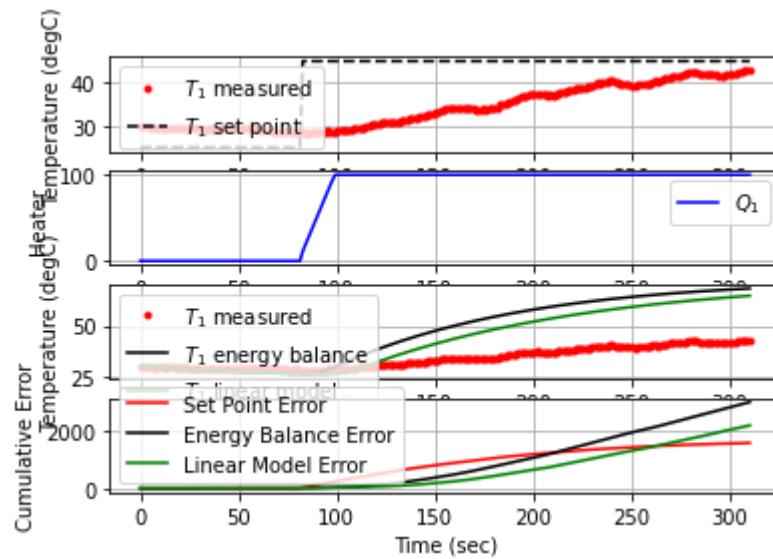
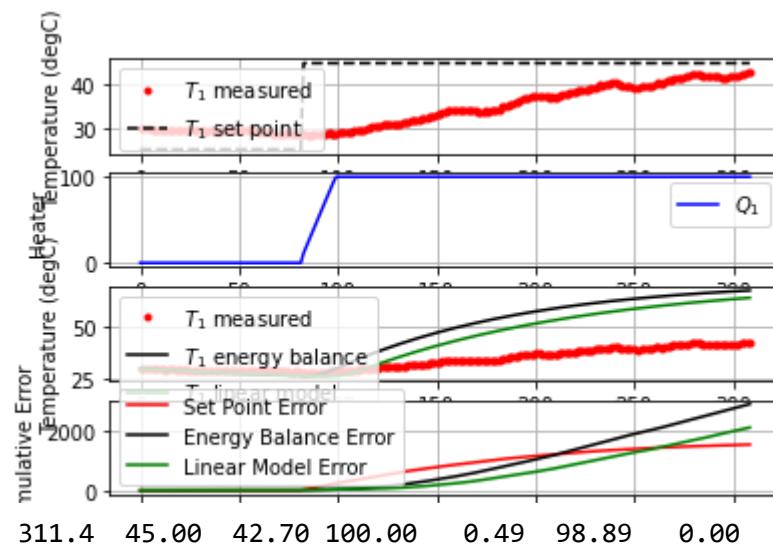
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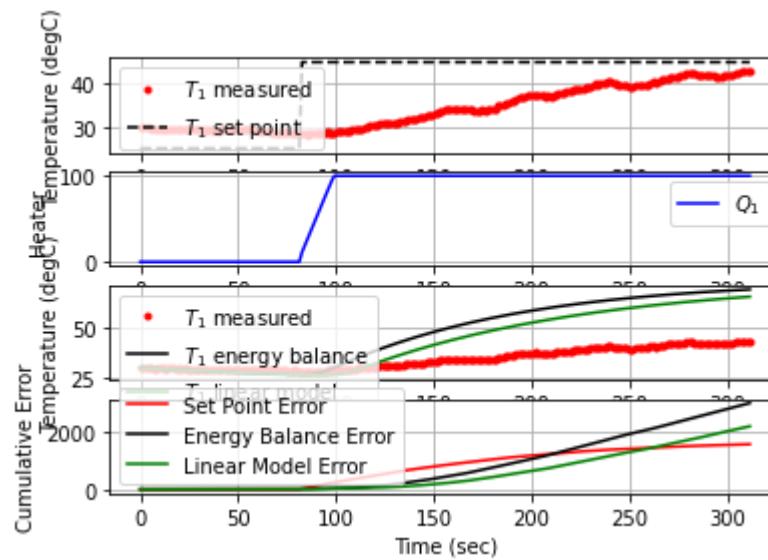
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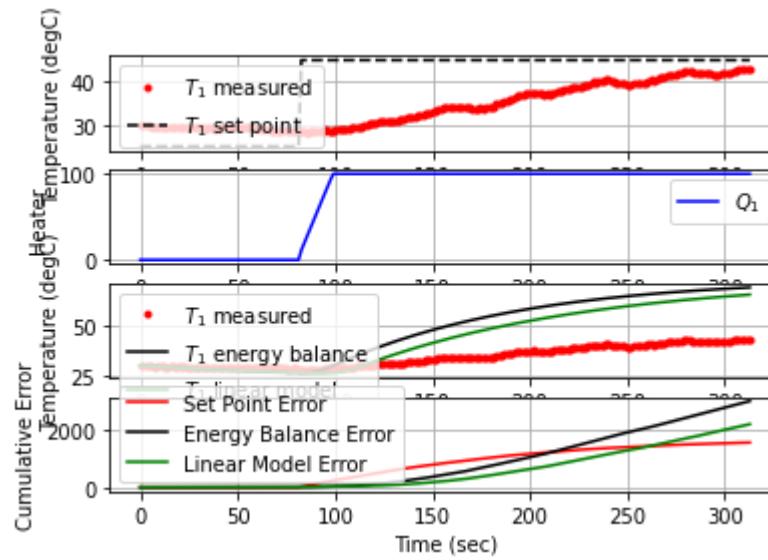
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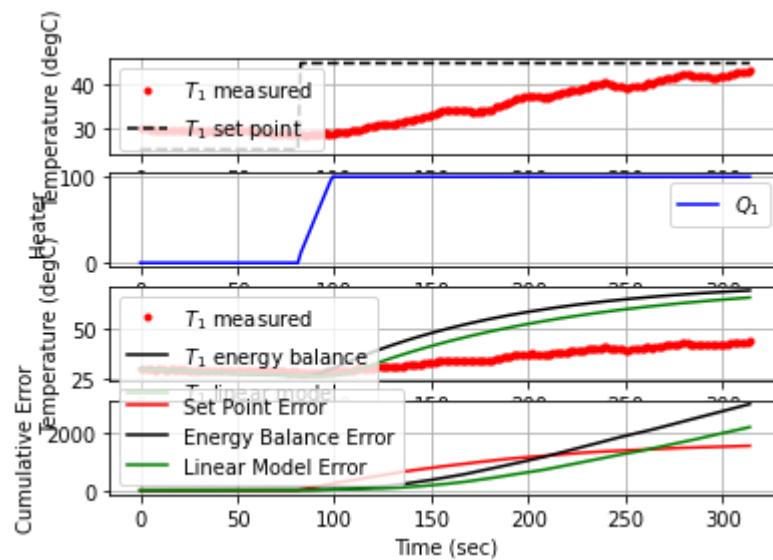
312.7 45.00 42.84 100.00 0.45 98.89 -0.01



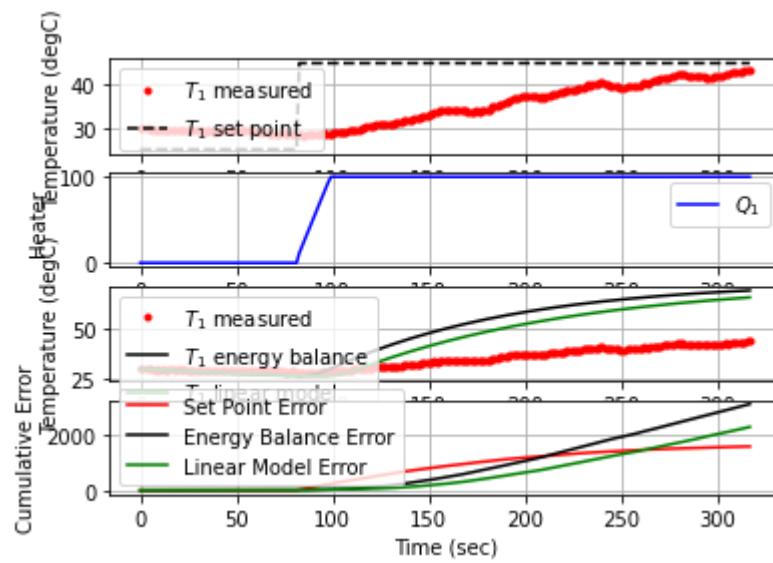
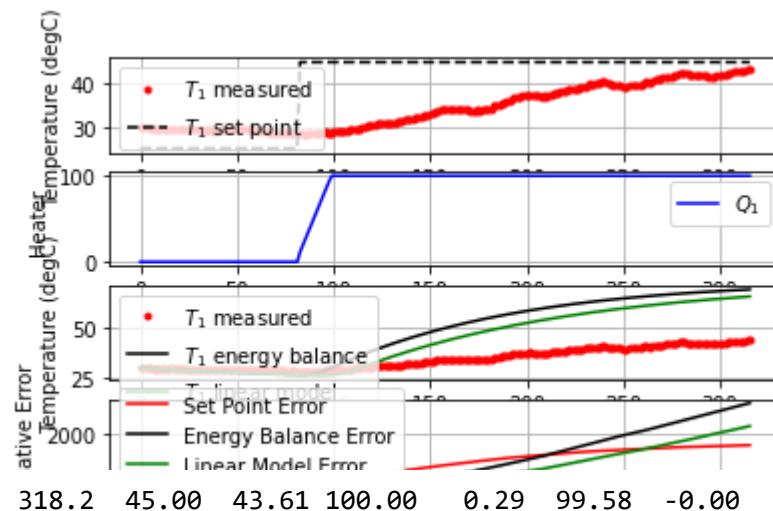
314.1 45.00 43.29 99.91 0.35 99.58 -0.02



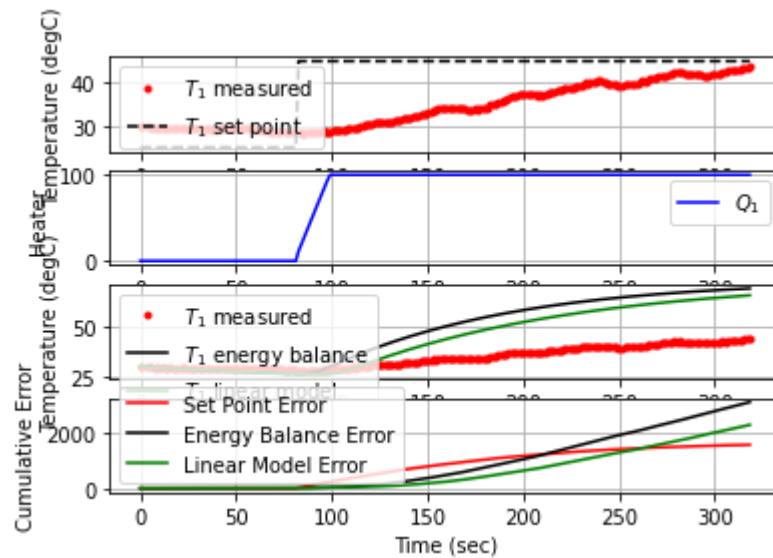
315.4 45.00 43.58 100.00 0.29 99.58 -0.01



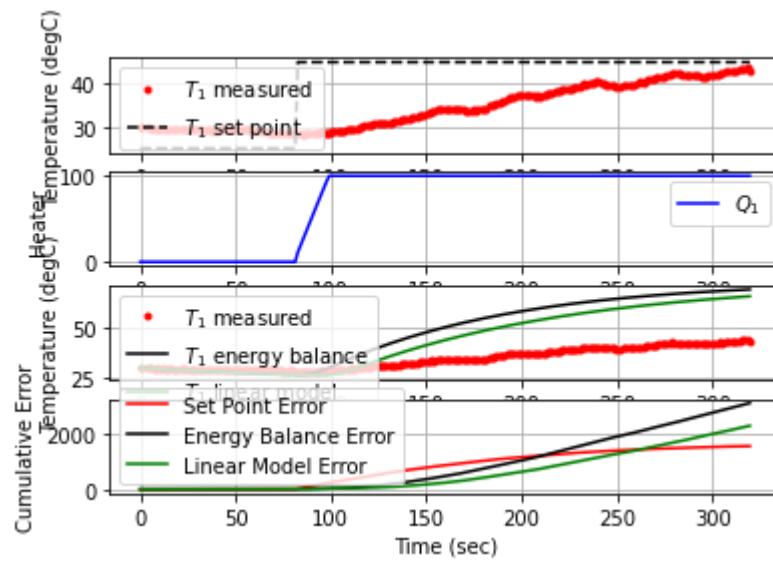
316.8 45.00 43.49 100.00 0.32 99.58 0.00



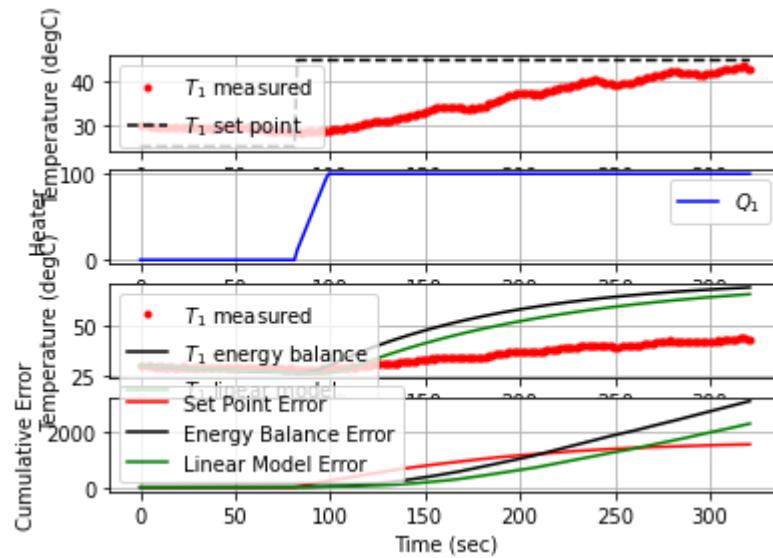
319.6 45.00 43.13 100.00 0.40 99.58 0.02



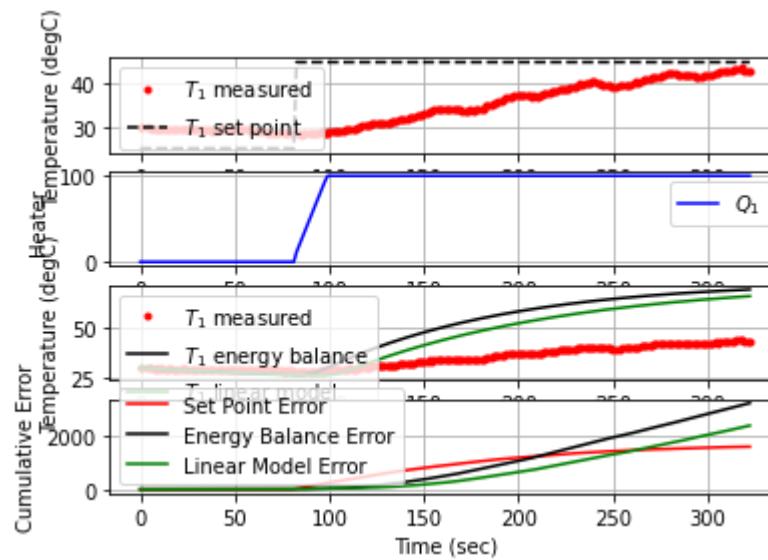
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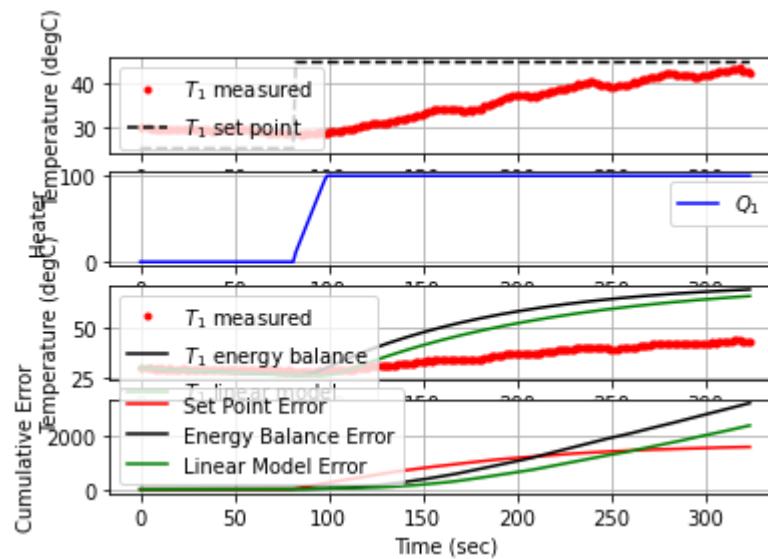
322.5 45.00 42.86 100.00 0.45 99.58 0.00



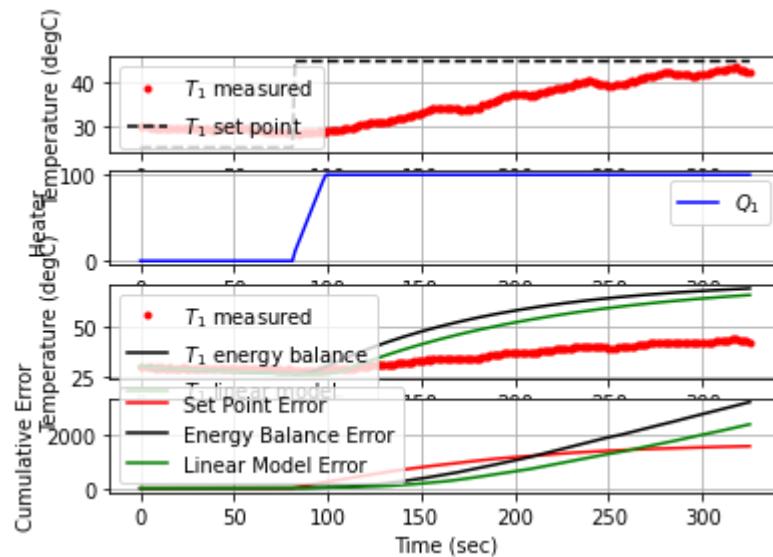
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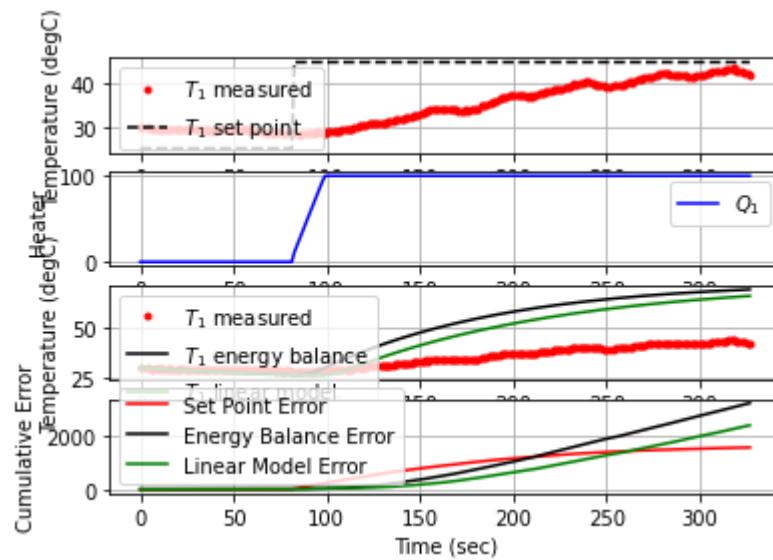
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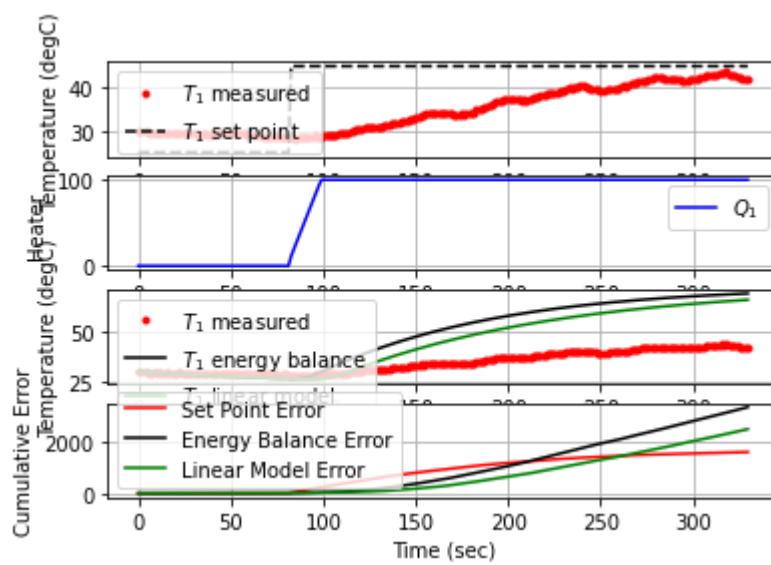
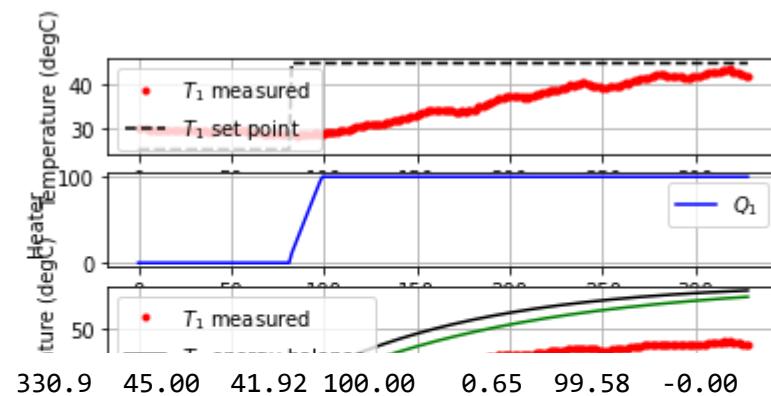
326.8 45.00 42.12 100.00 0.62 99.58 0.01

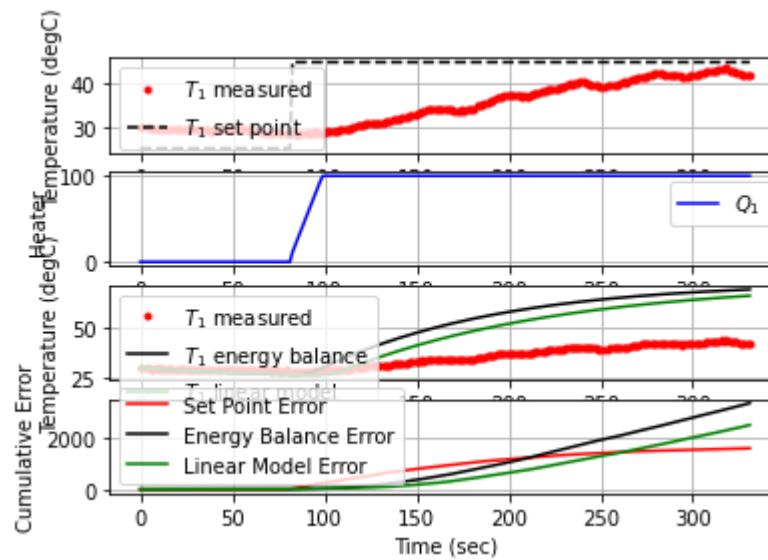


328.2 45.00 41.98 100.00 0.65 99.58 0.01

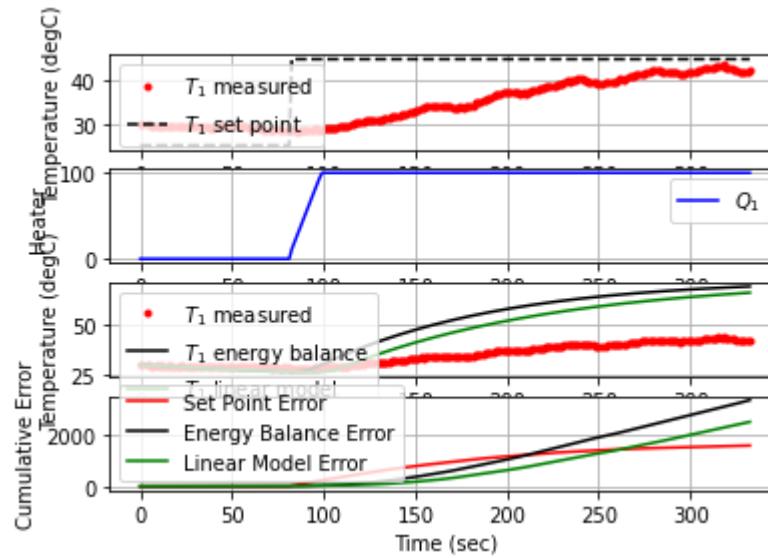


329.5 45.00 41.89 100.00 0.66 99.58 0.00

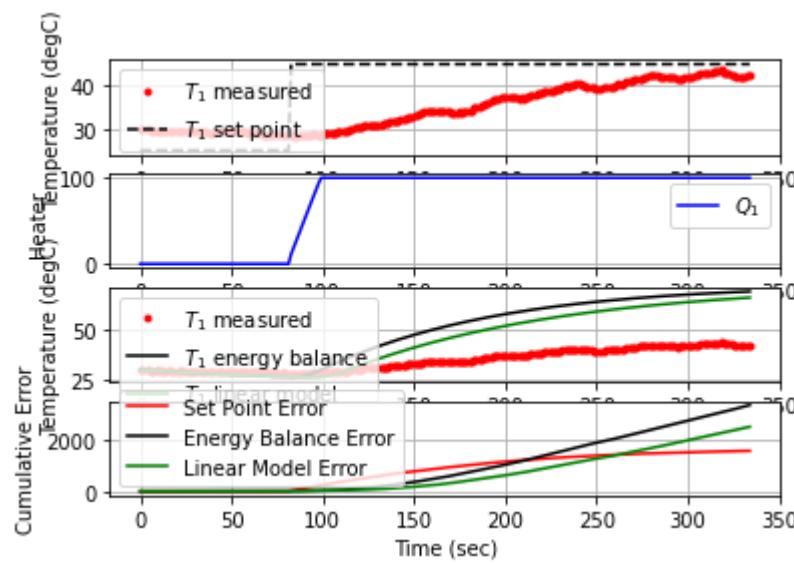




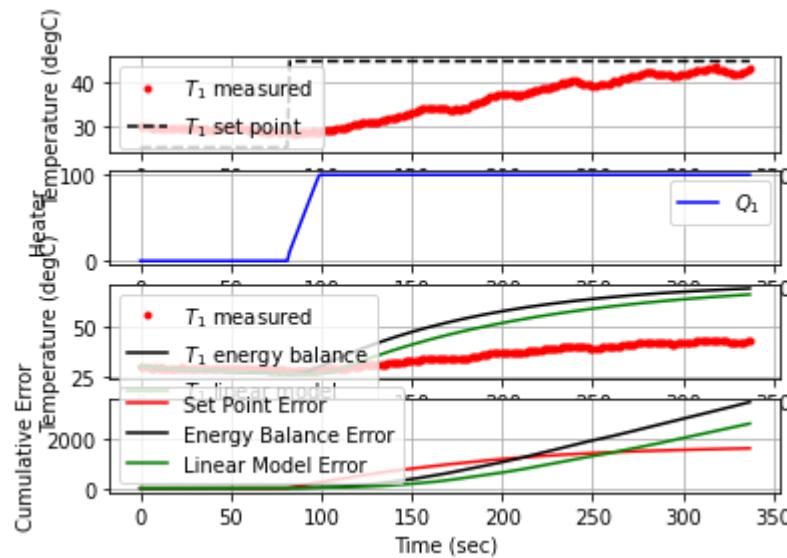
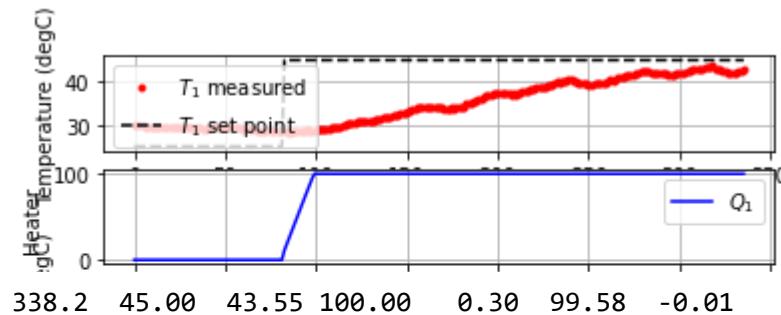
333.9 45.00 42.46 100.00 0.53 99.58 -0.01



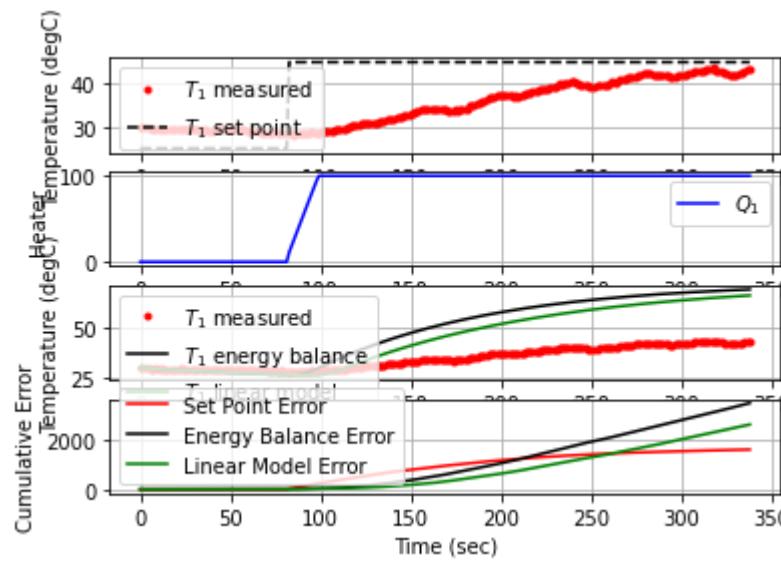
335.4 45.00 42.86 100.00 0.44 99.58 -0.01



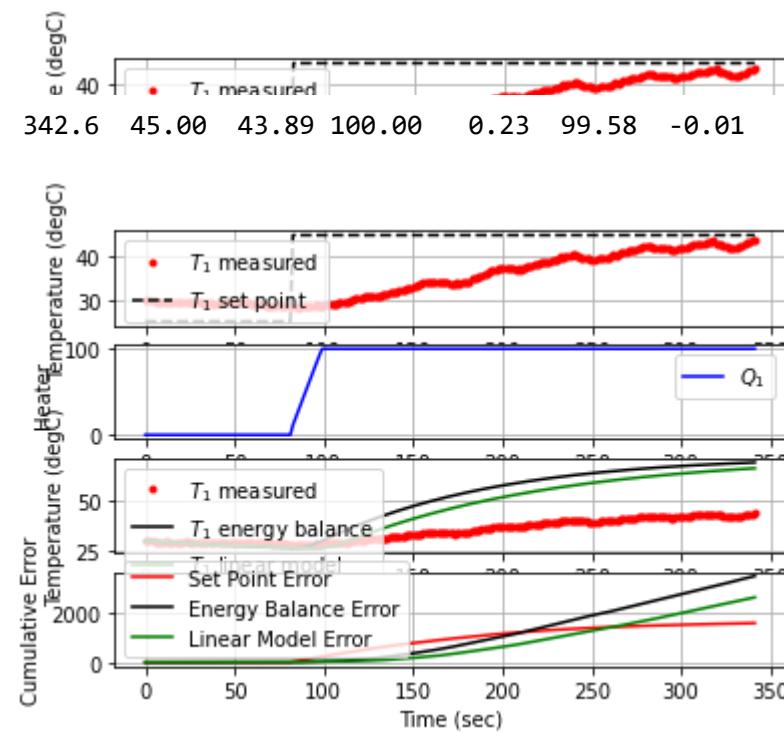
336.8 45.00 43.36 100.00 0.33 99.58 -0.02



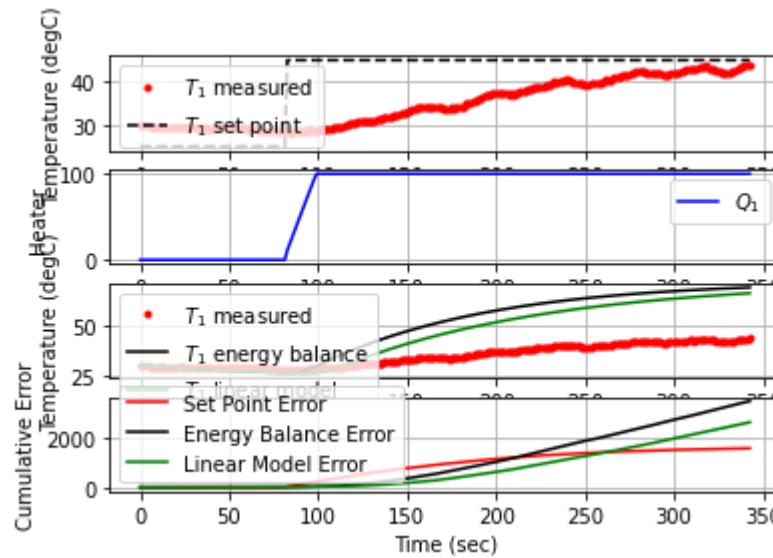
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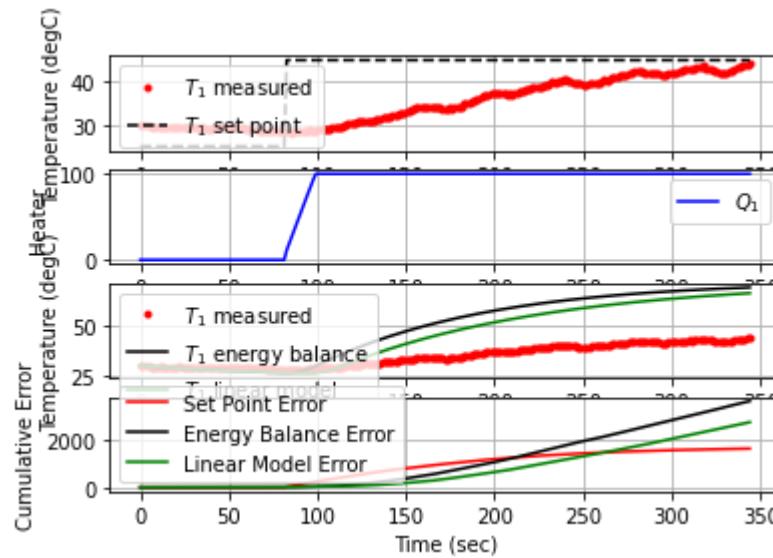
341.2 45.00 43.72 100.00 0.27 99.58 -0.00



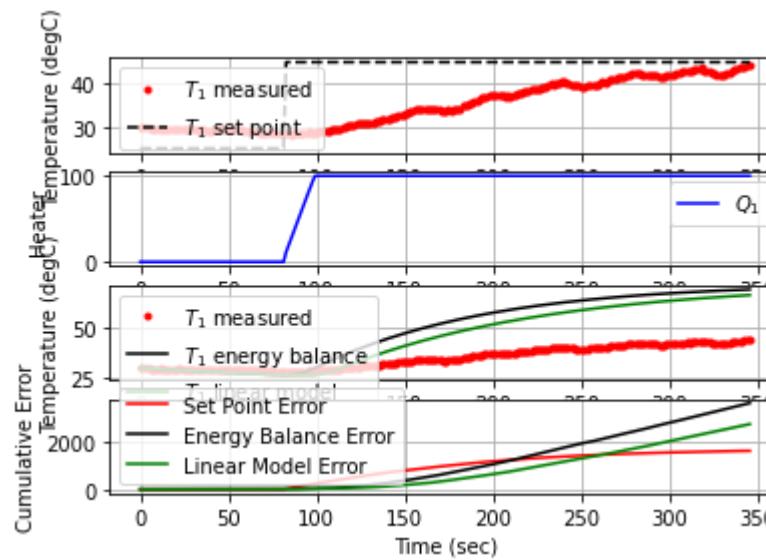
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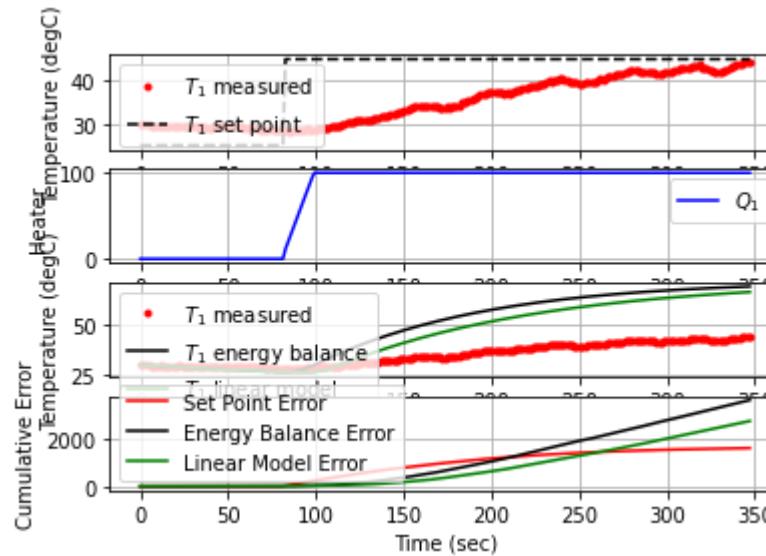
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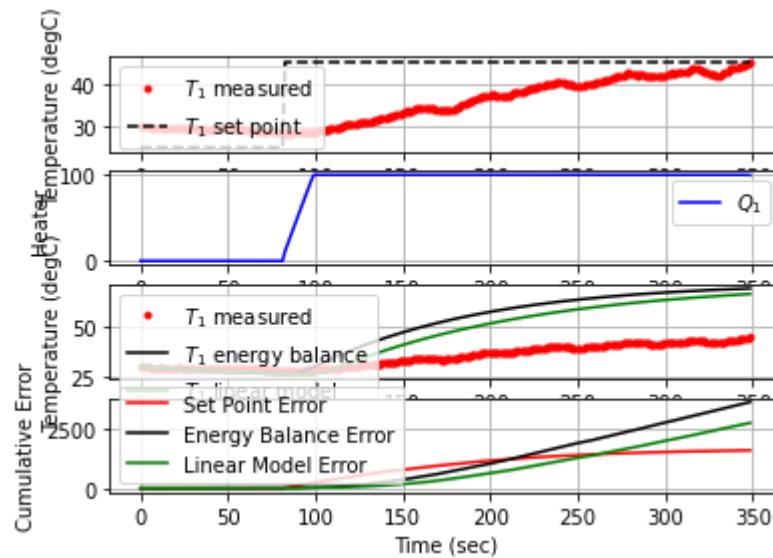
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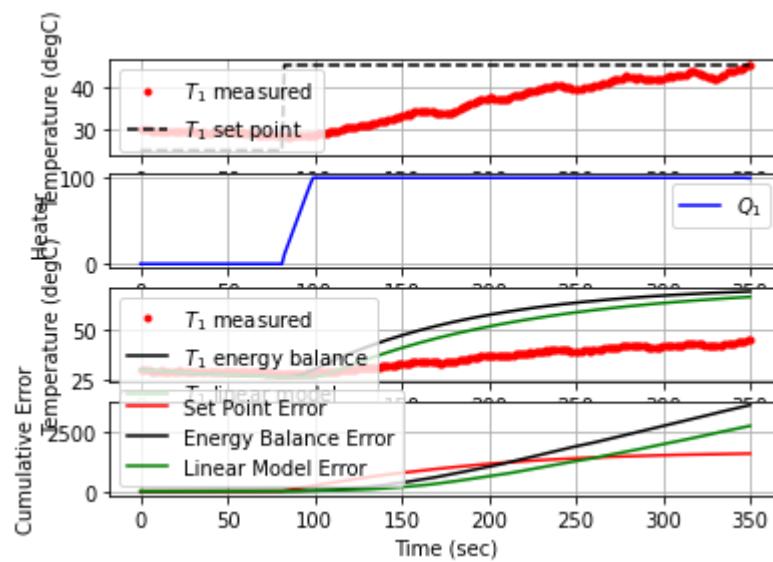
348.6 45.00 45.23 99.67 -0.04 99.73 -0.02



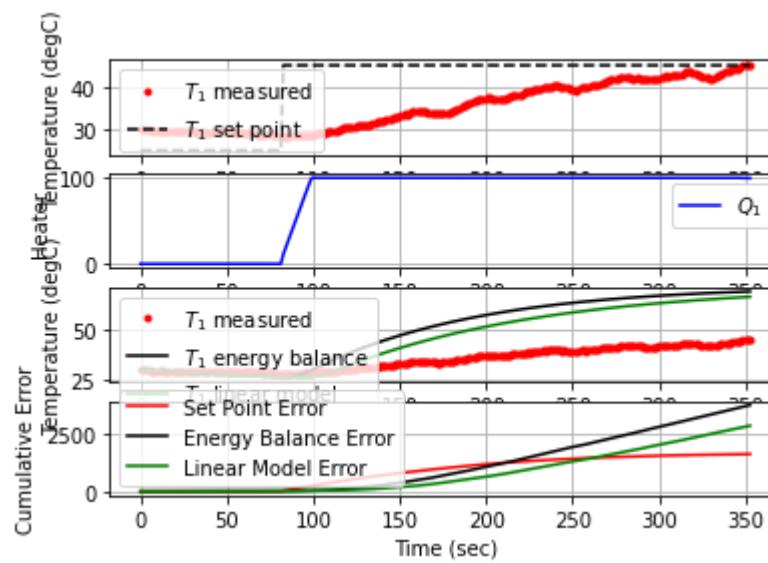
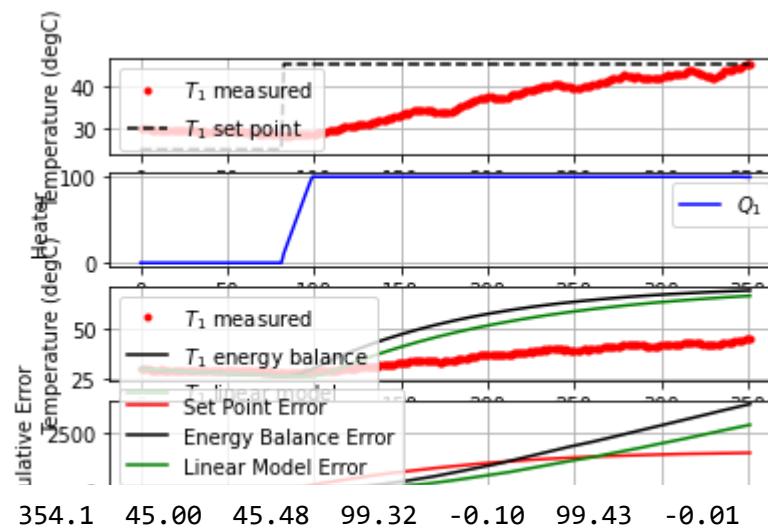
350.0 45.00 45.03 99.72 -0.01 99.72 0.01



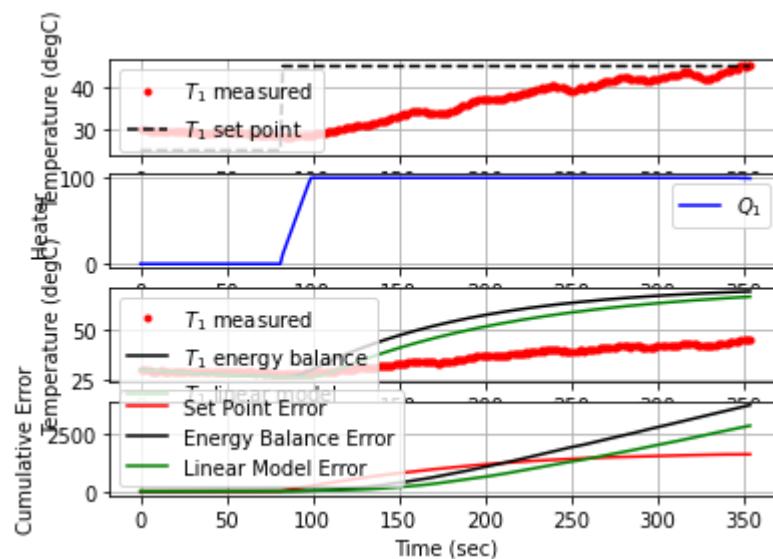
351.4 45.00 44.97 99.74 0.01 99.73 0.00



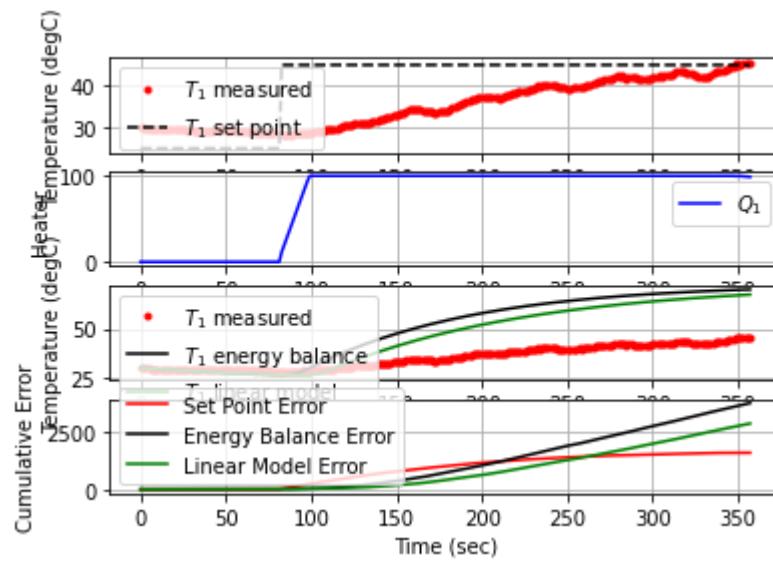
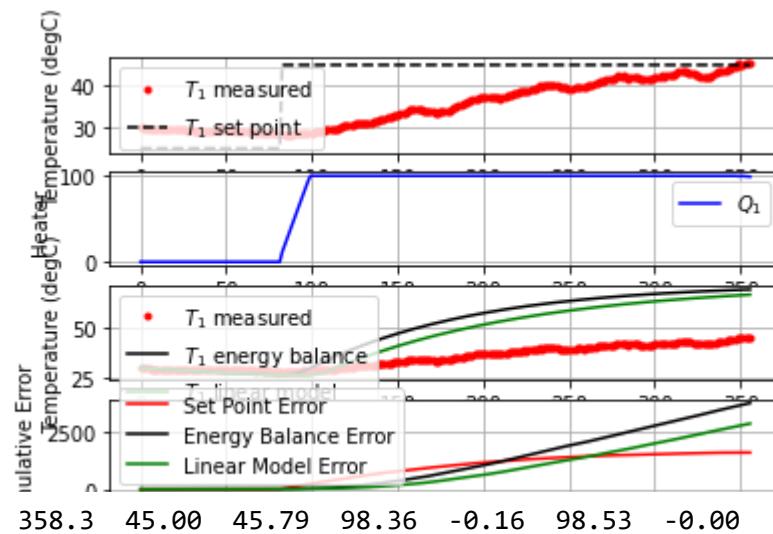
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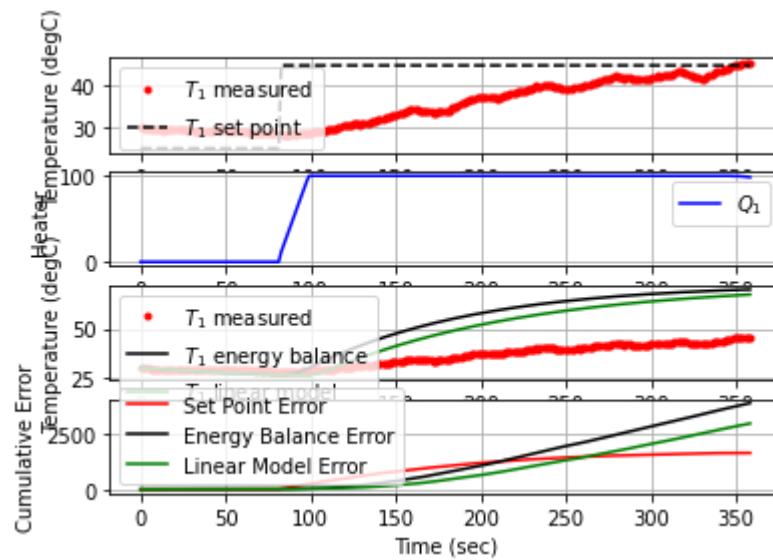
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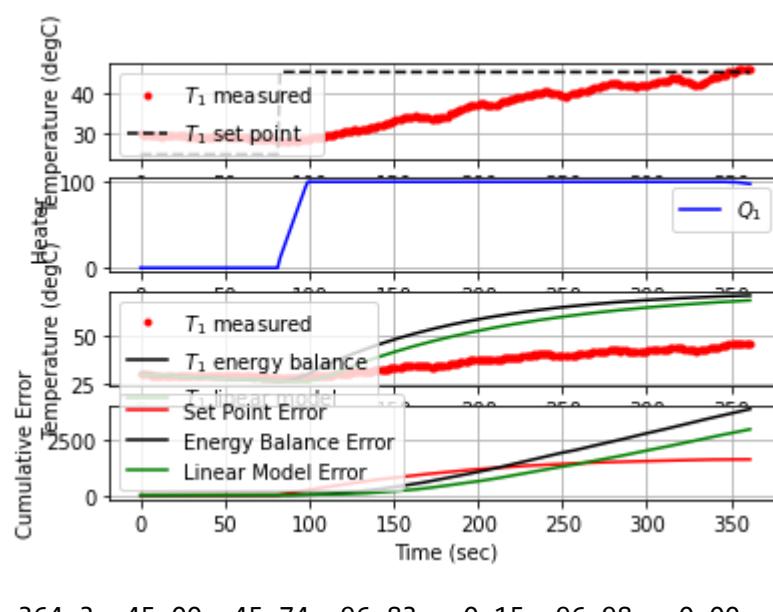
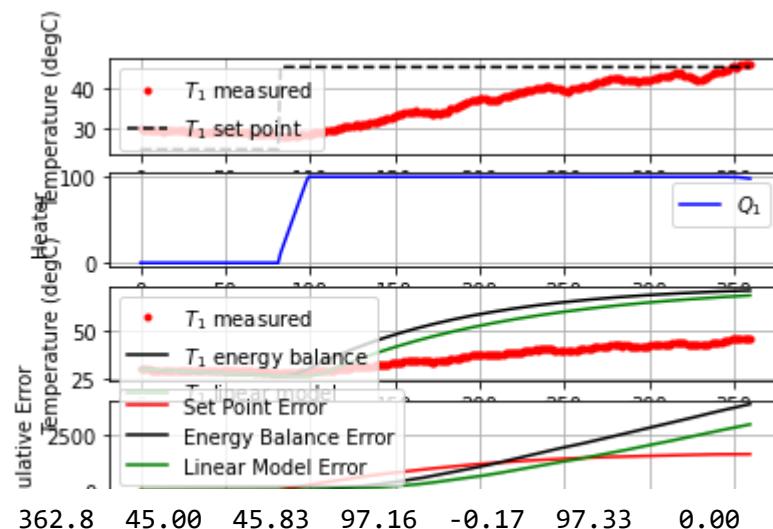
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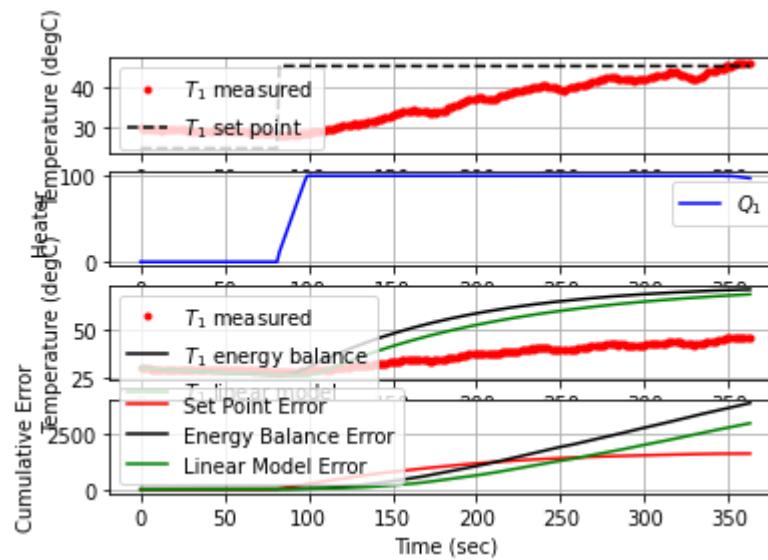


359.7 45.00 45.95 97.92 -0.19 98.12 -0.01

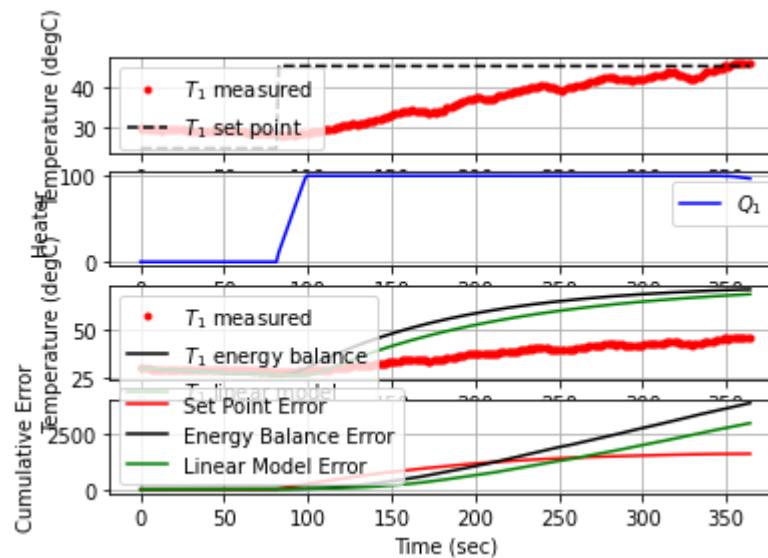


361.1 45.00 45.89 97.55 -0.18 97.73 0.00

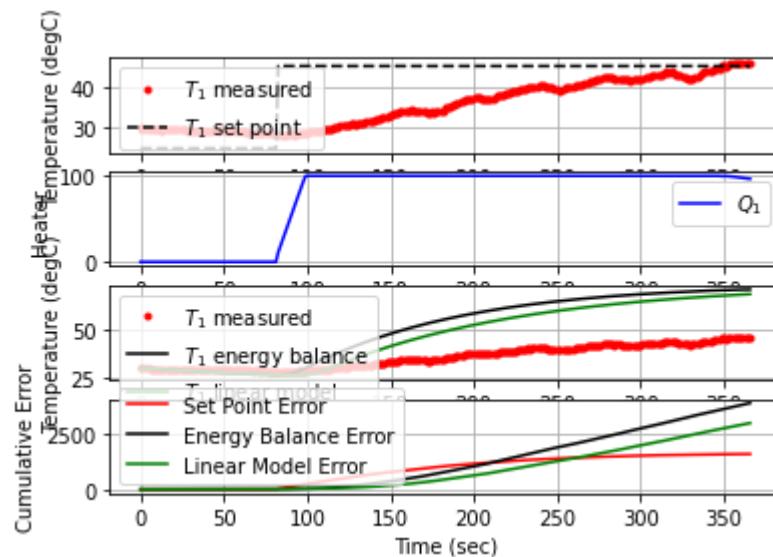




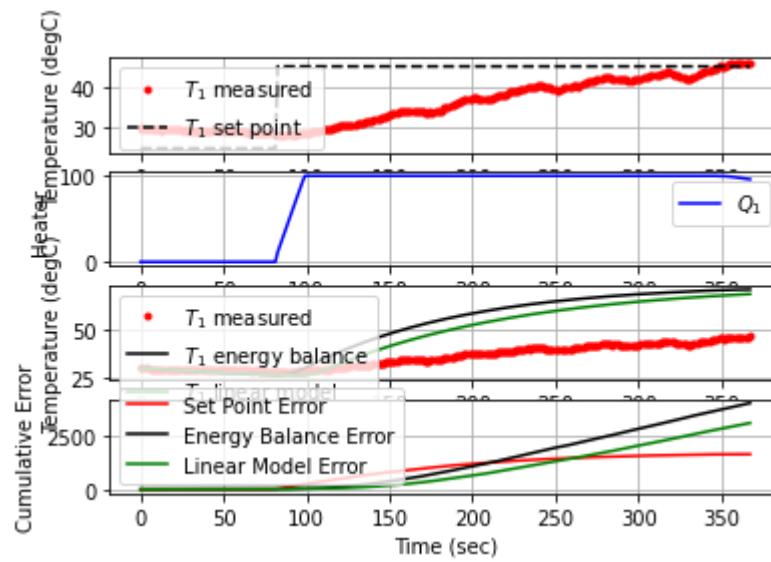
365.7 45.00 45.91 96.42 -0.18 96.61 -0.01



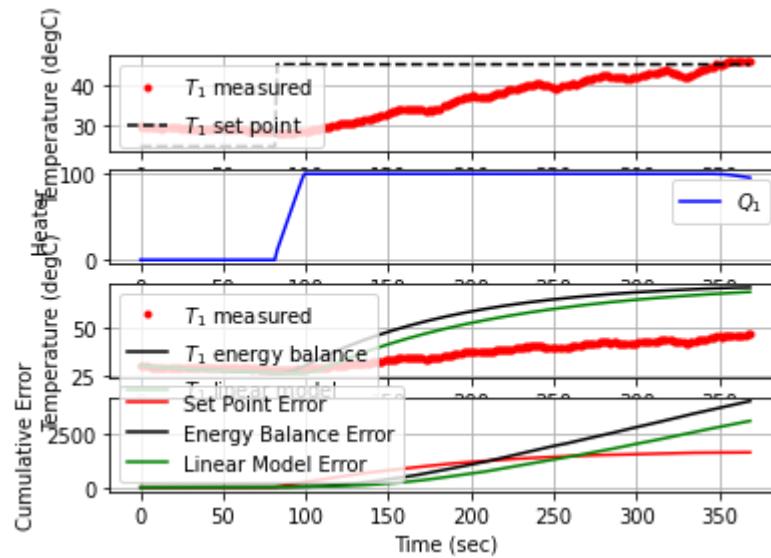
367.2 45.00 46.03 95.91 -0.21 96.12 -0.00



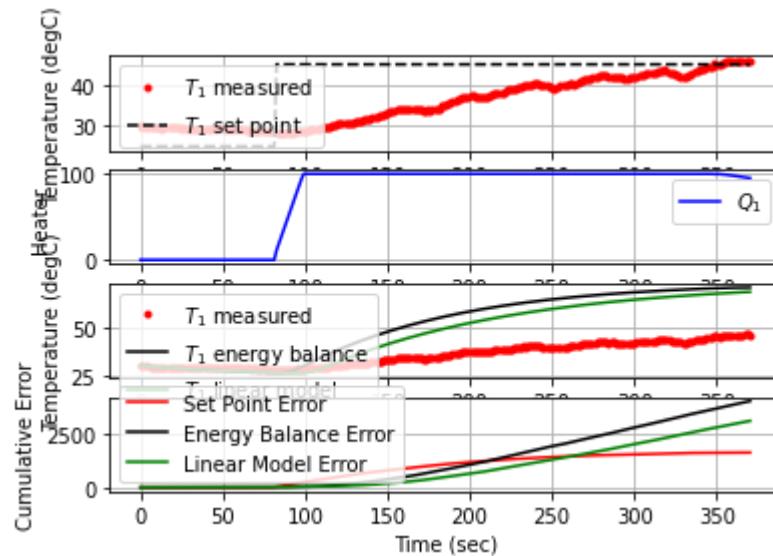
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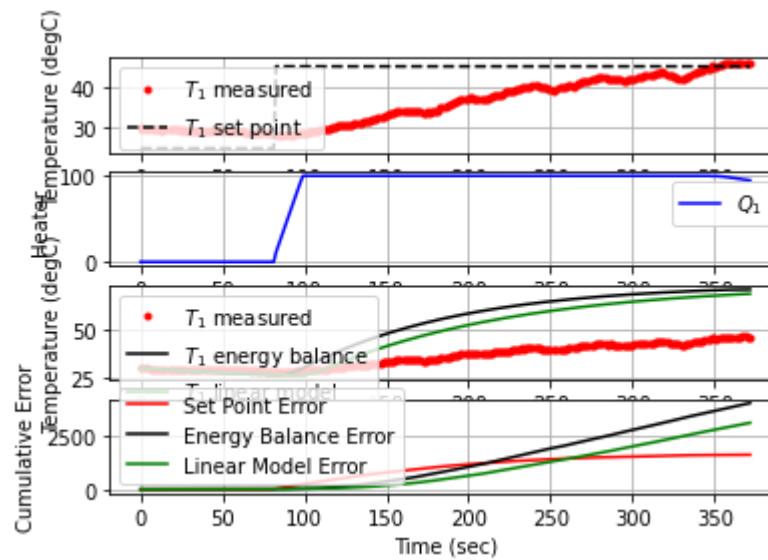
370.2 45.00 46.00 95.01 -0.20 95.21 0.00



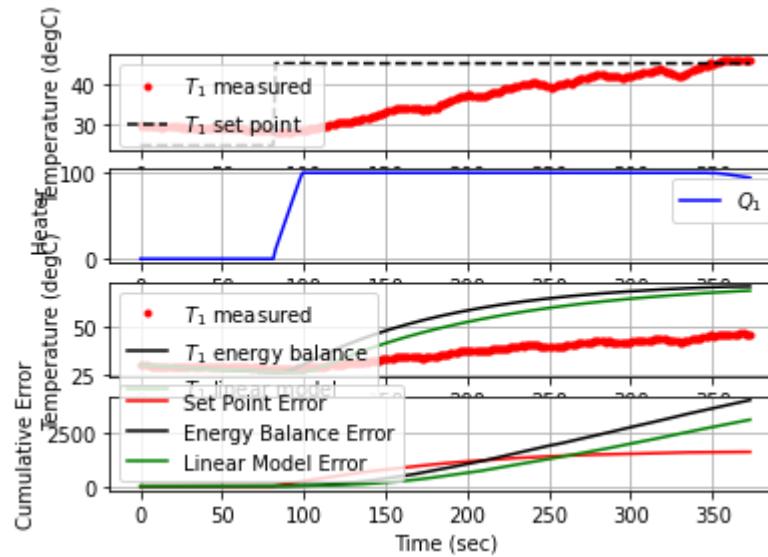
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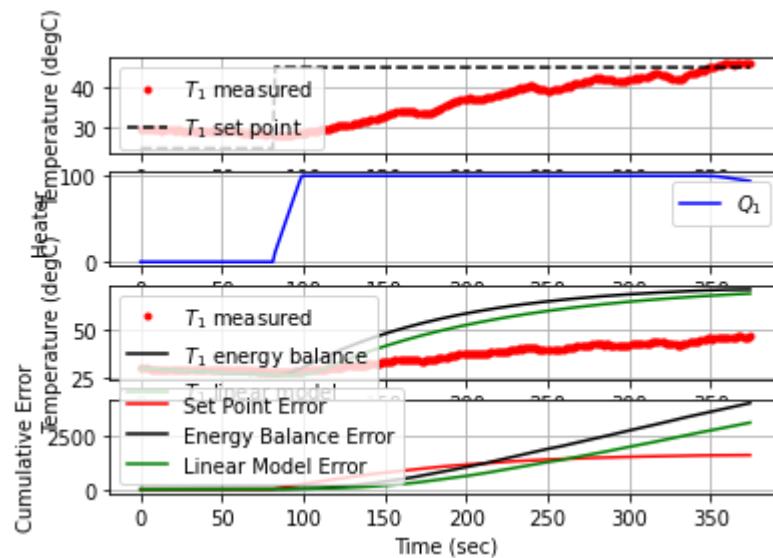
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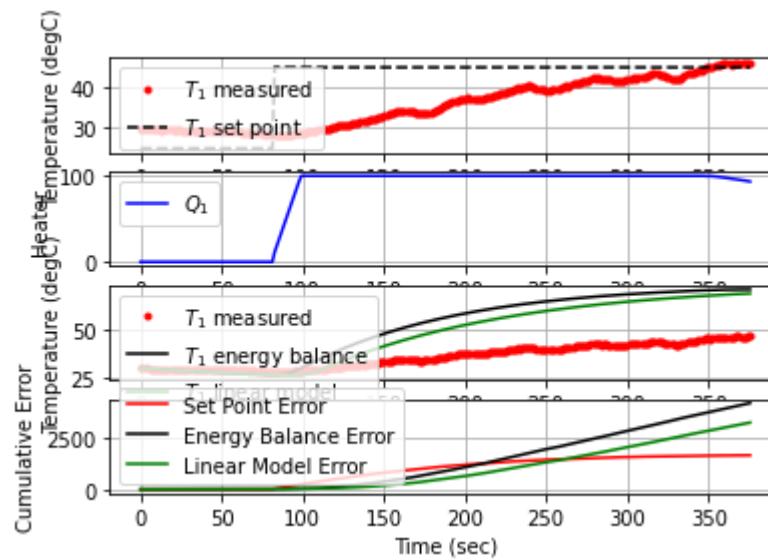
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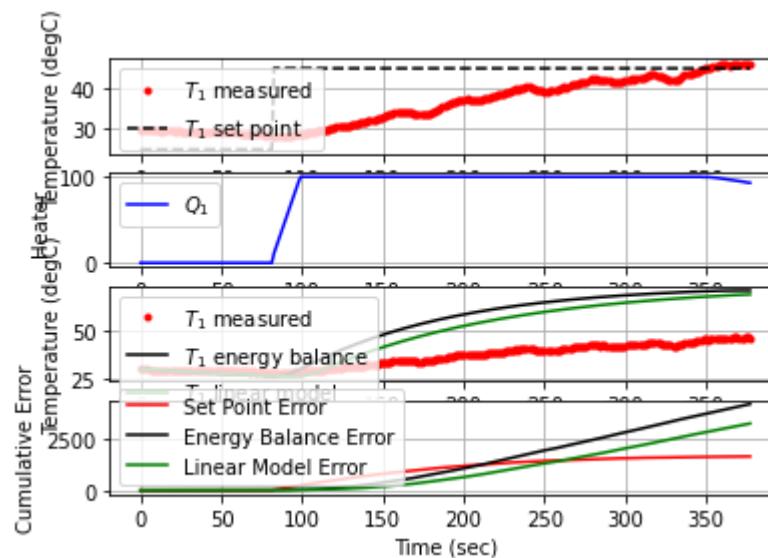
375.6 45.00 46.12 93.31 -0.23 93.53 0.01



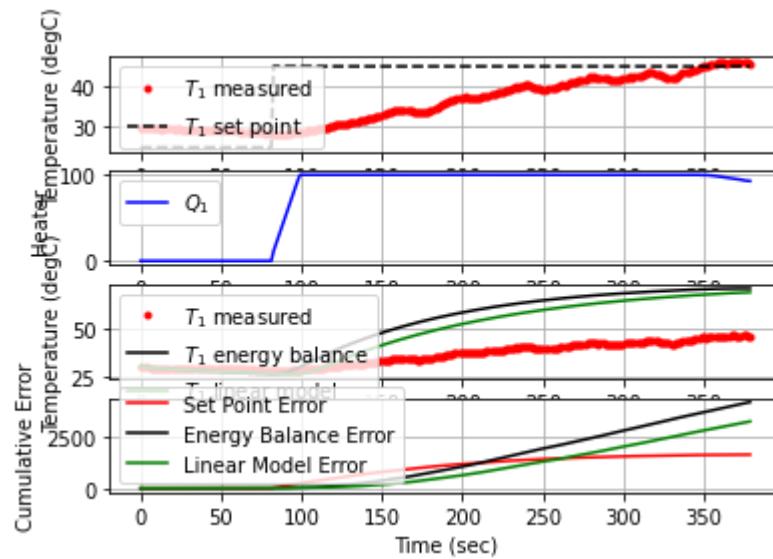
377.2 45.00 45.83 92.97 -0.17 93.13 0.01



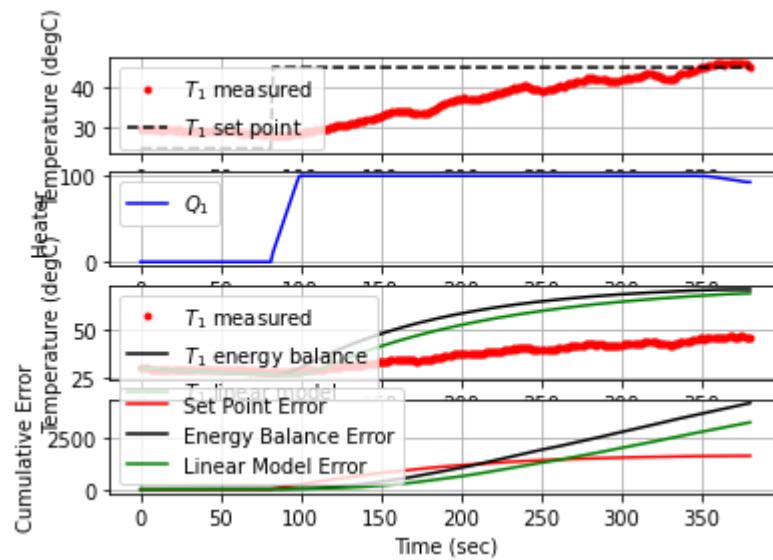
378.6 45.00 45.60 92.75 -0.12 92.86 0.01



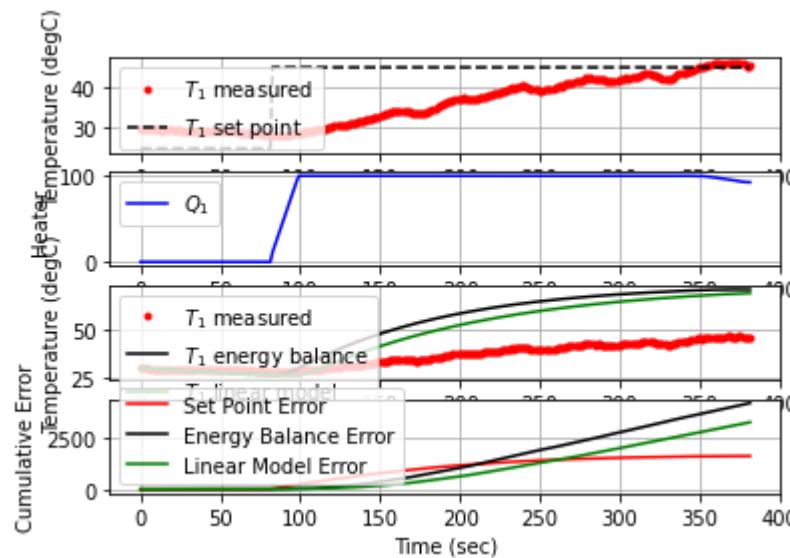
380.1 45.00 45.28 92.69 -0.06 92.74 0.01



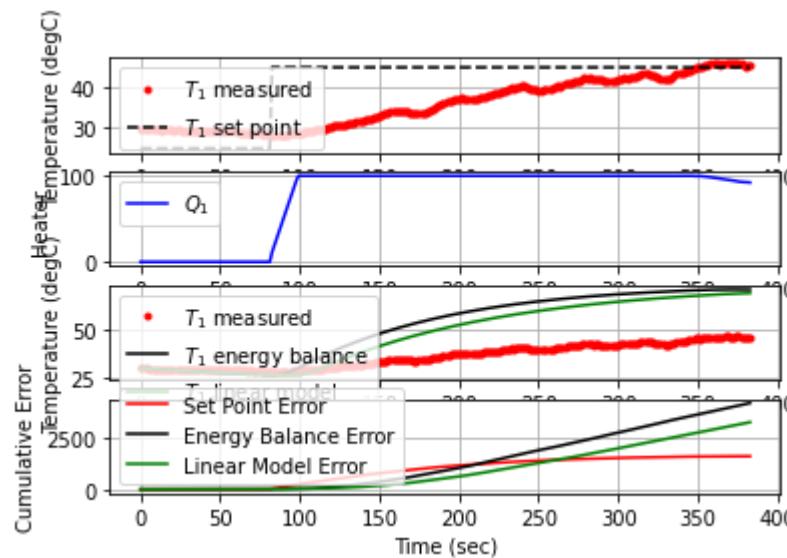
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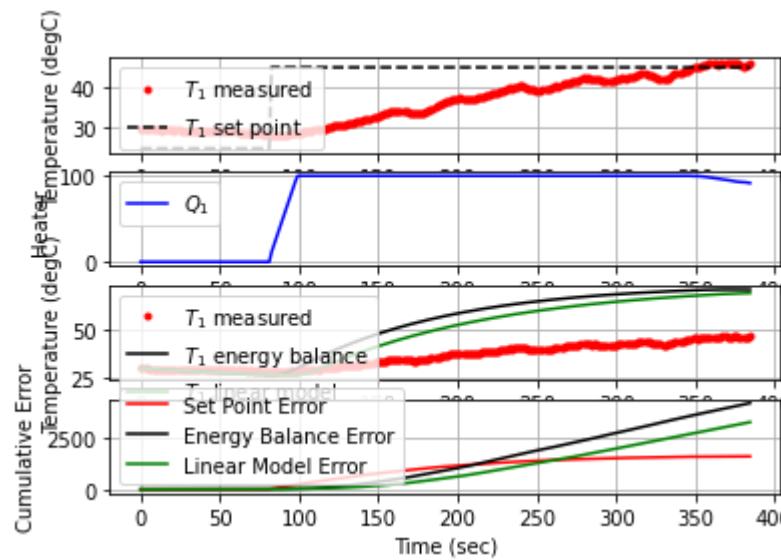
382.9 45.00 45.63 92.16 -0.13 92.29 -0.01



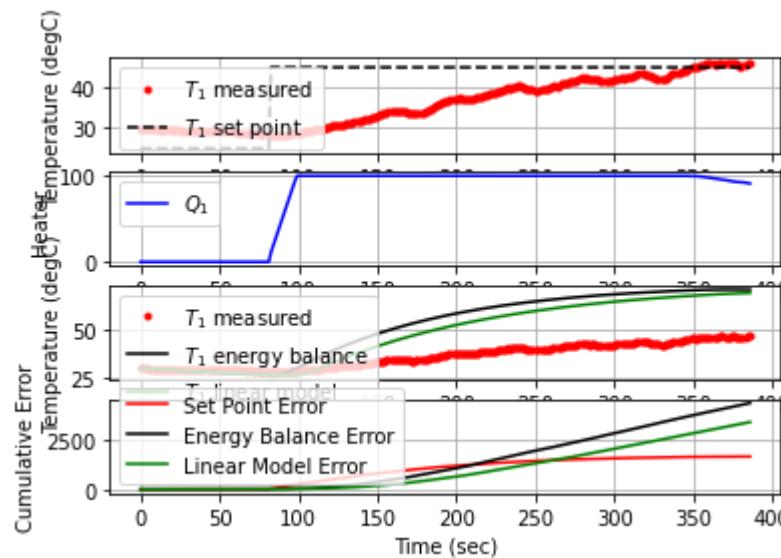
384.5 45.00 46.08 91.55 -0.21 91.78 -0.01



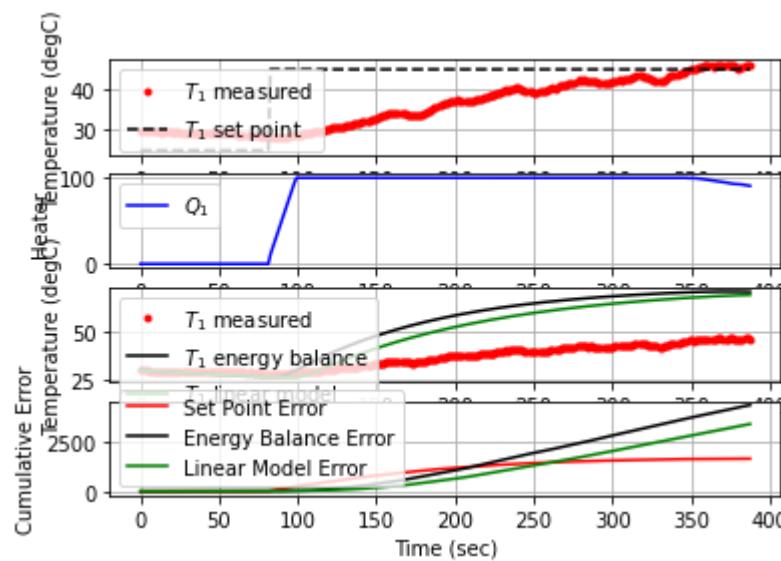
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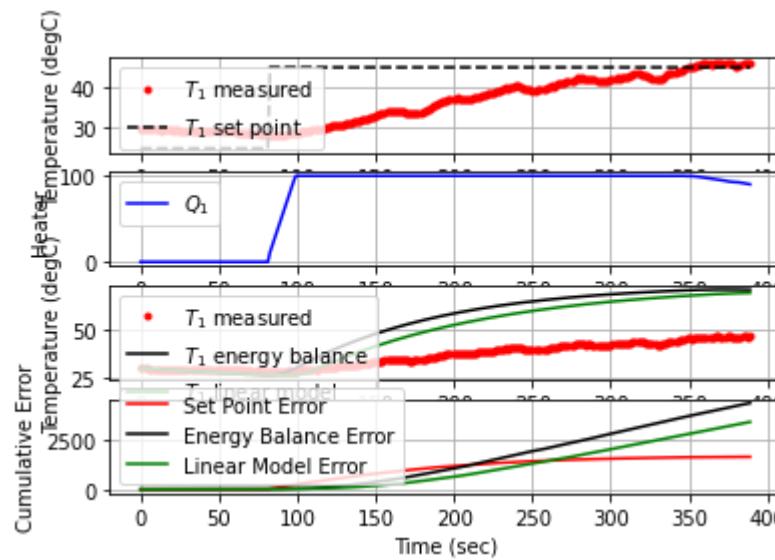
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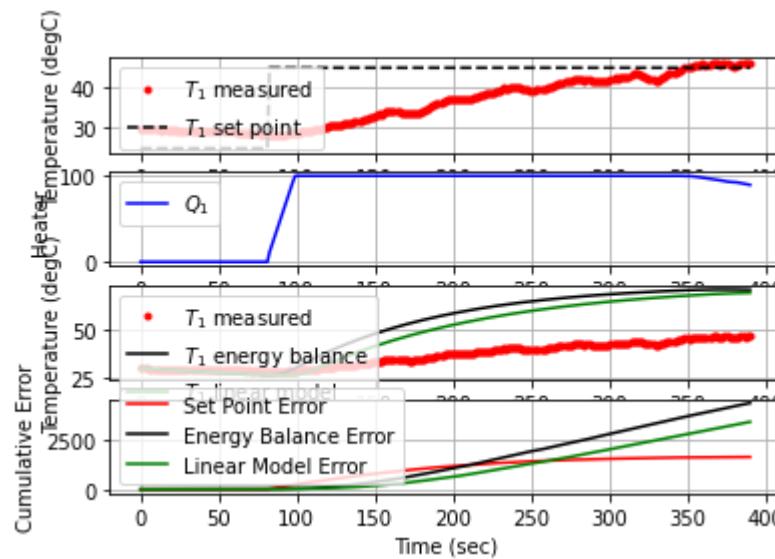
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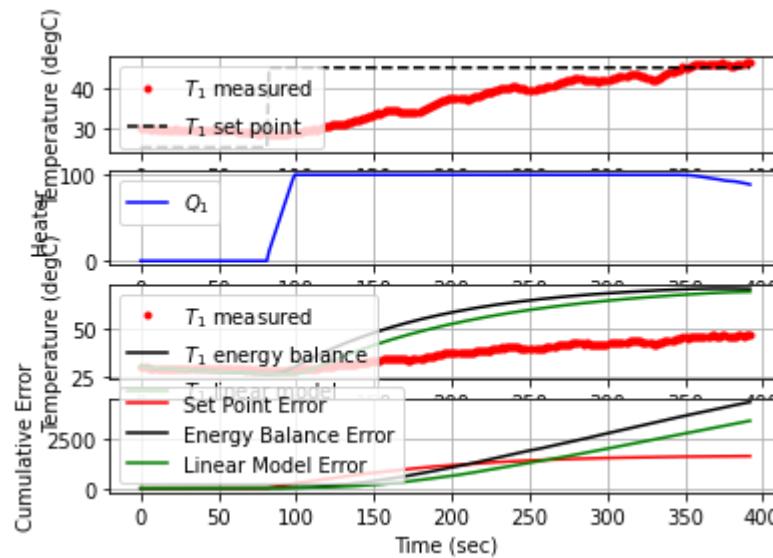
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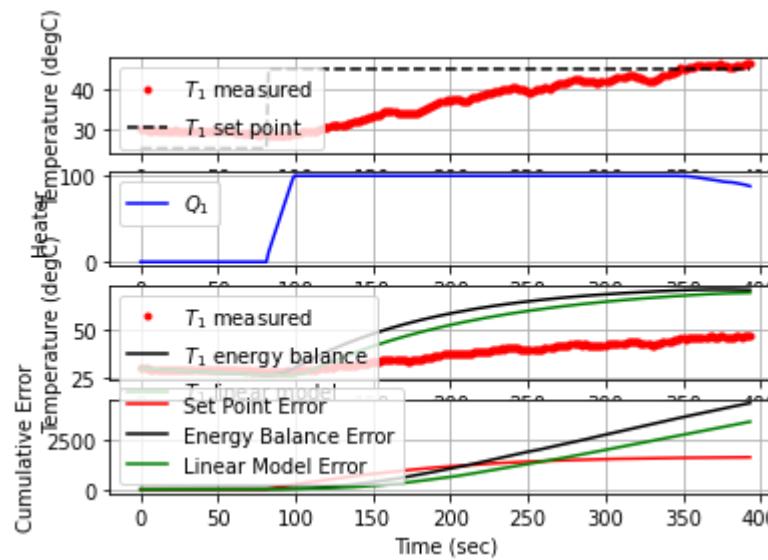
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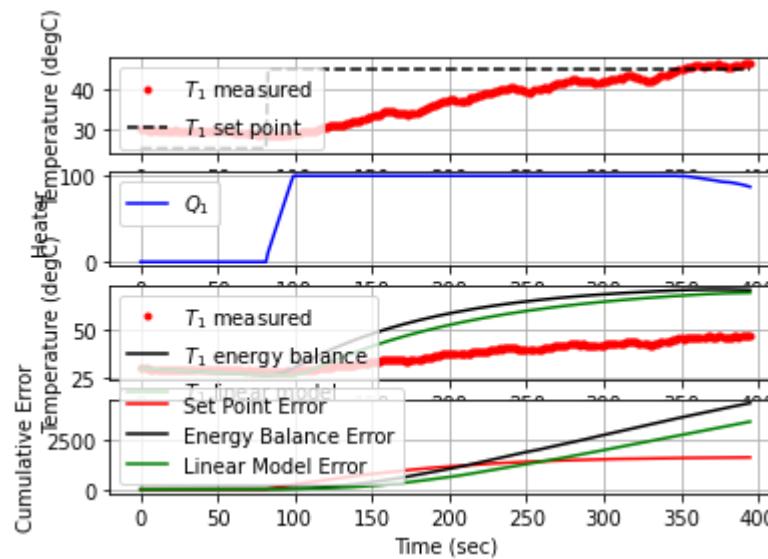
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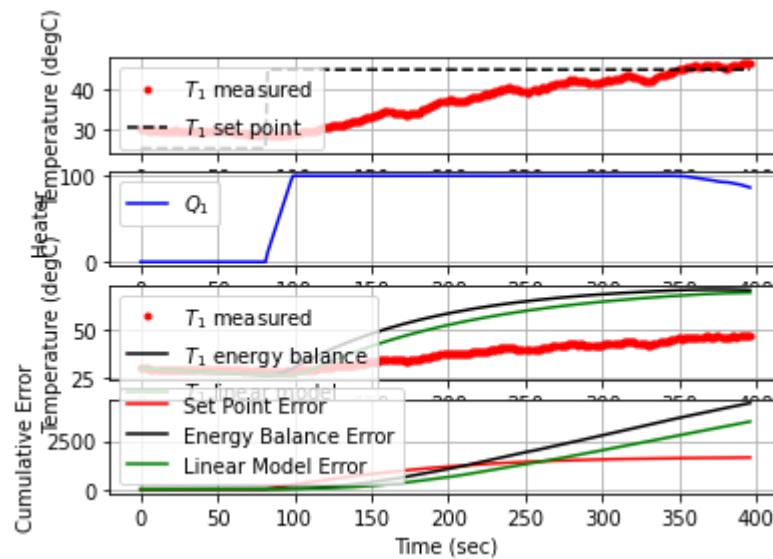
394.7 45.00 46.78 87.18 -0.35 87.53 -0.00



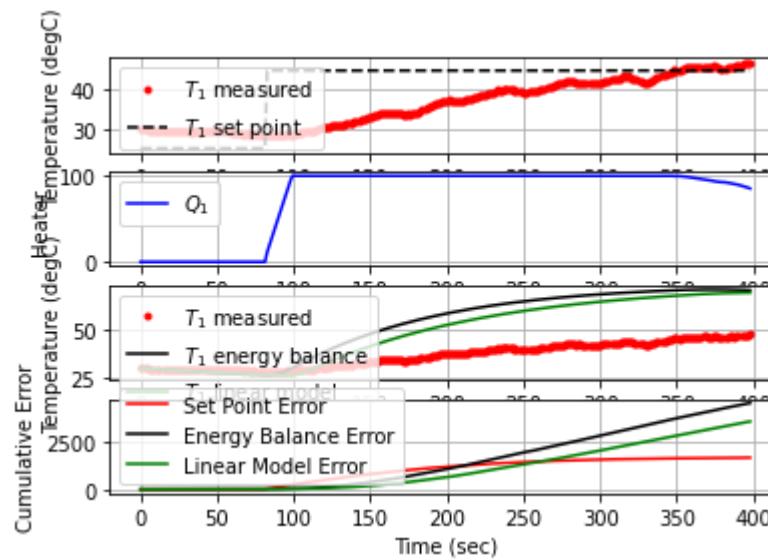
396.1 45.00 46.90 86.39 -0.37 86.77 -0.00



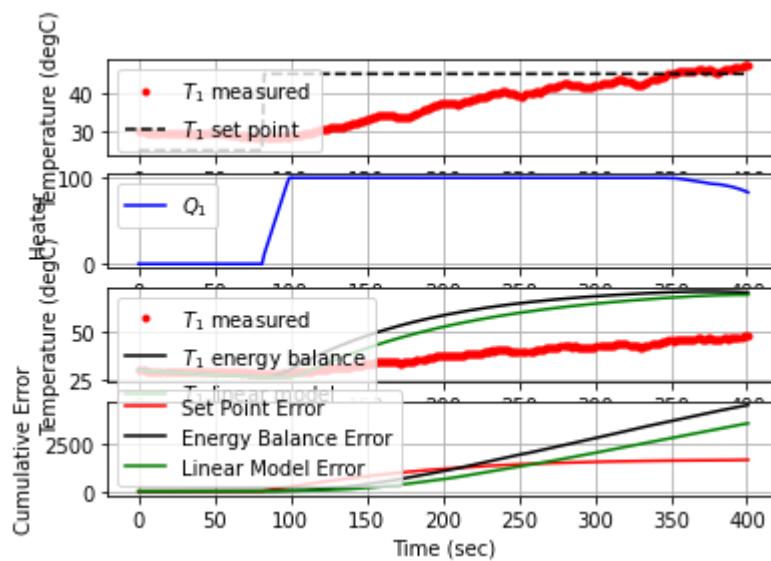
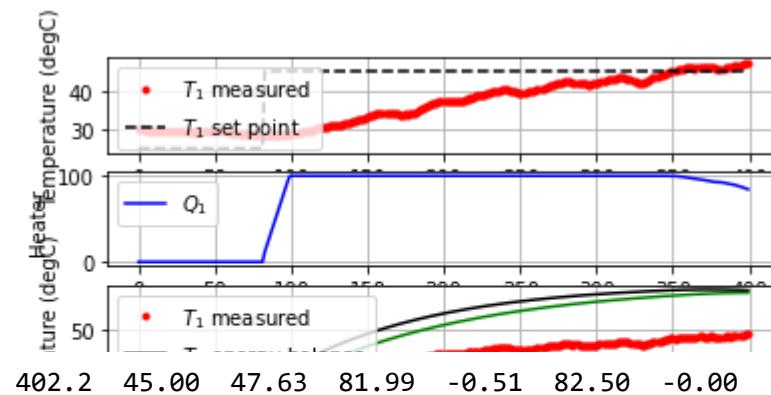
397.8 45.00 47.17 85.28 -0.42 85.71 -0.01

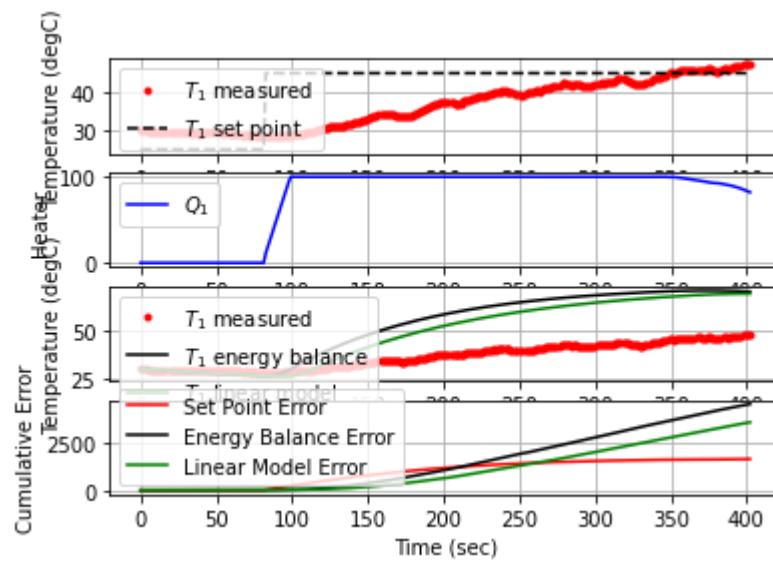


399.2 45.00 47.33 84.24 -0.45 84.70 -0.01

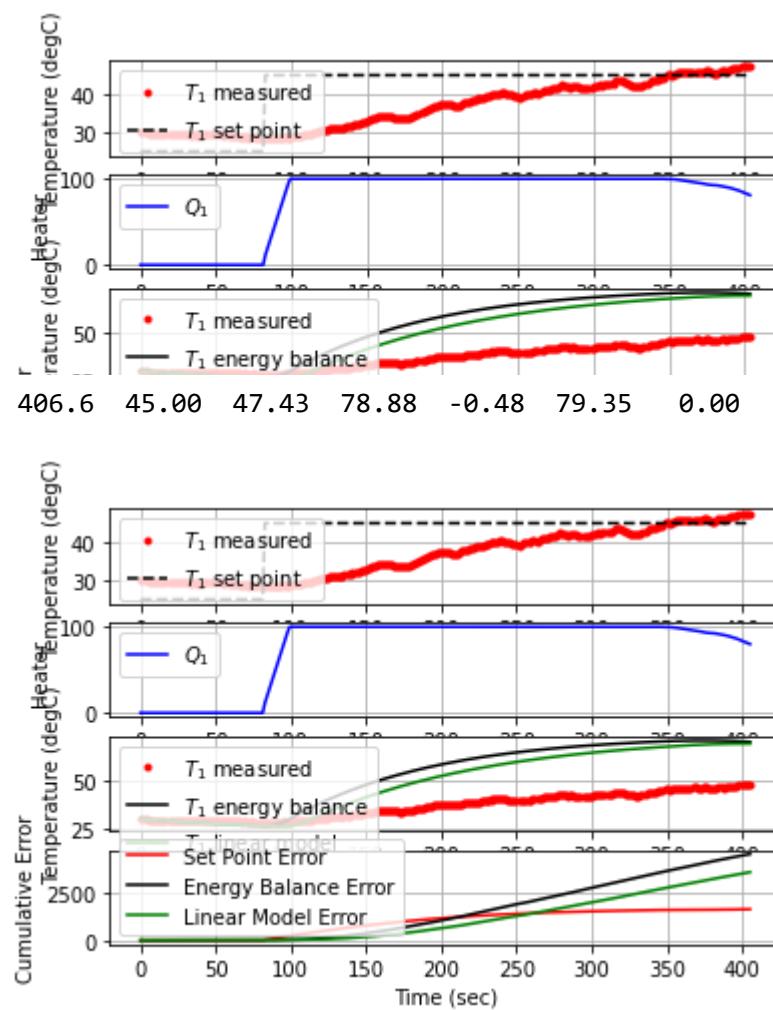


400.7 45.00 47.54 83.12 -0.49 83.62 -0.01

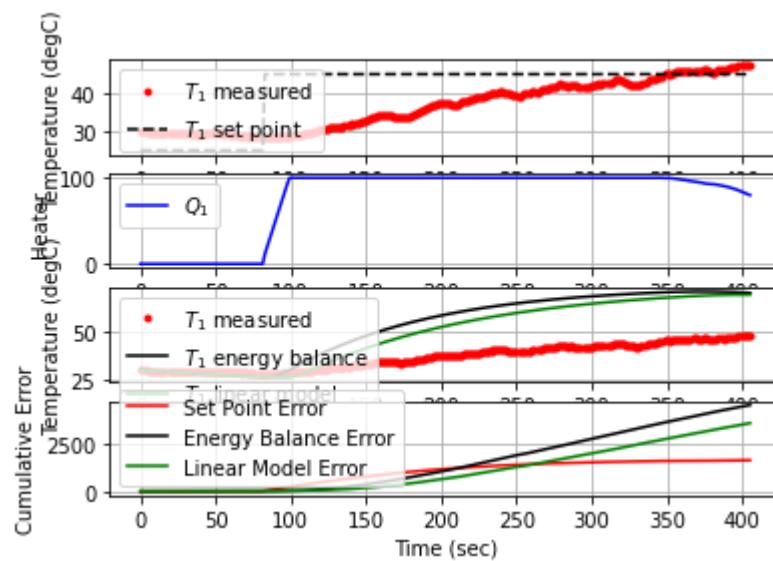




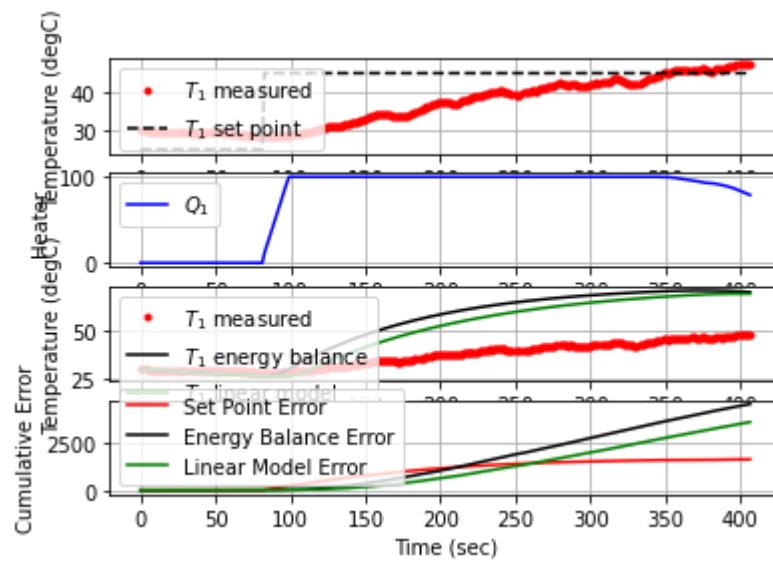
405.2 45.00 47.46 79.85 -0.48 80.34 -0.00



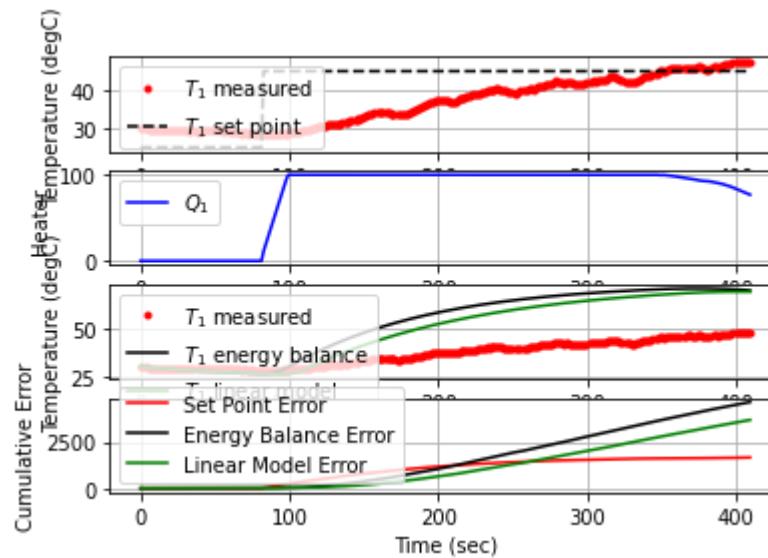
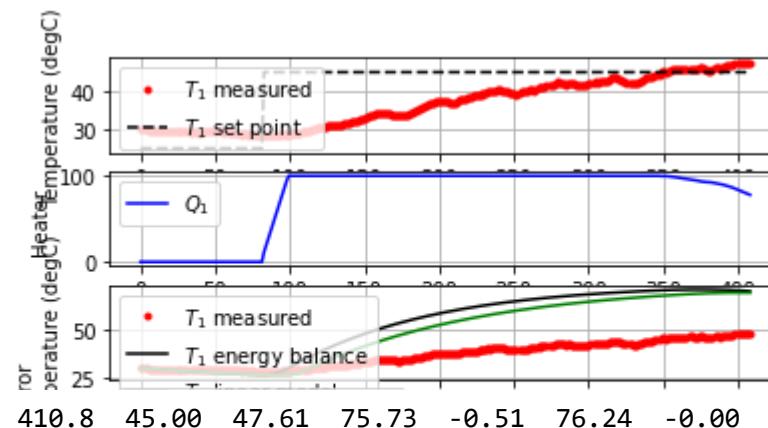
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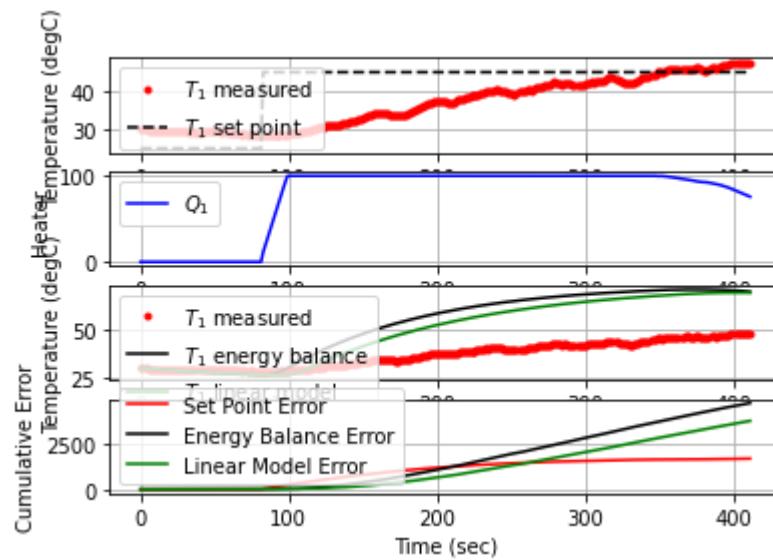
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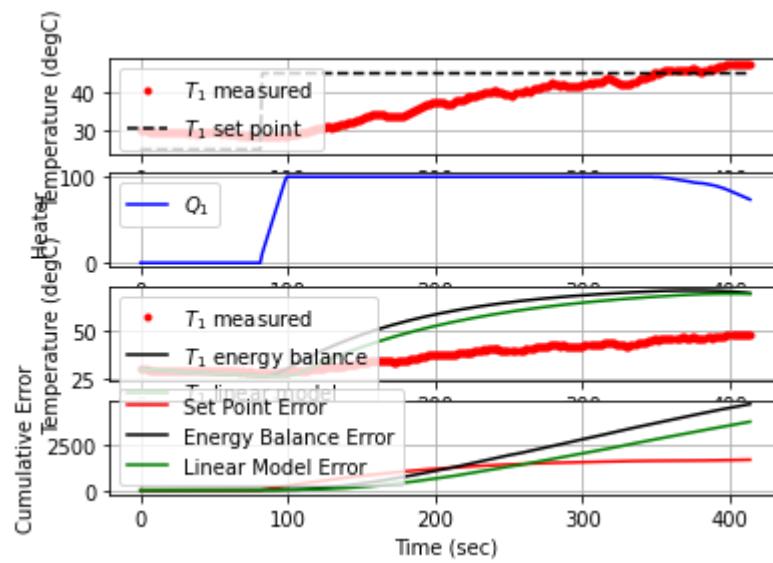
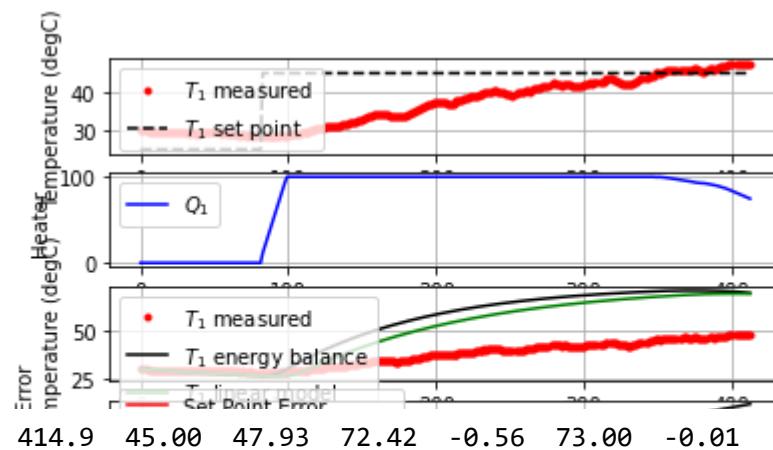
409.3 45.00 47.52 76.87 -0.49 77.37 -0.00



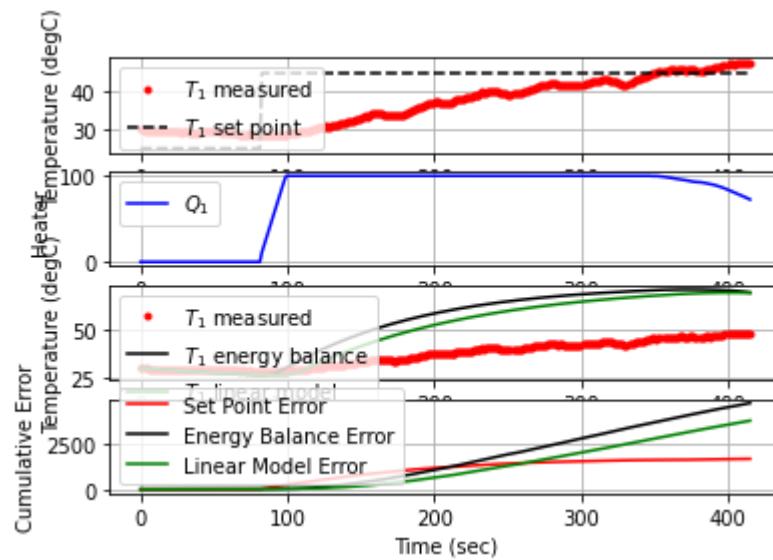
412.3 45.00 47.61 74.57 -0.51 75.08 -0.00



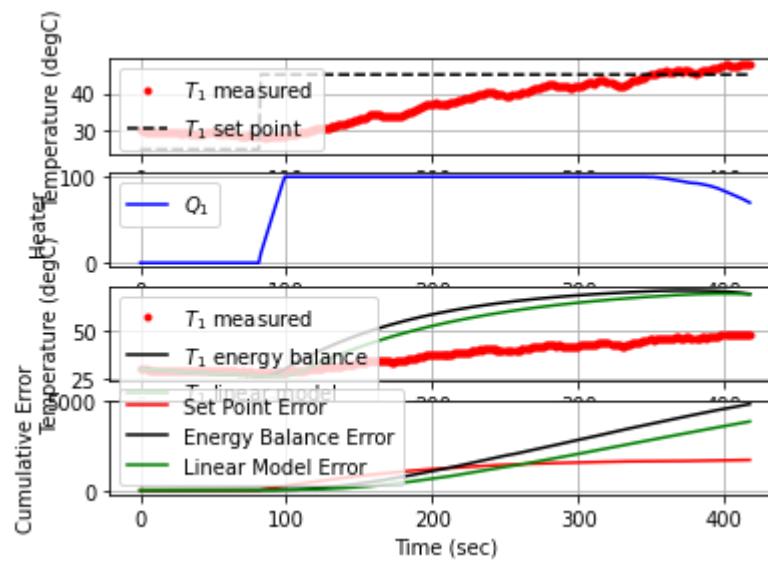
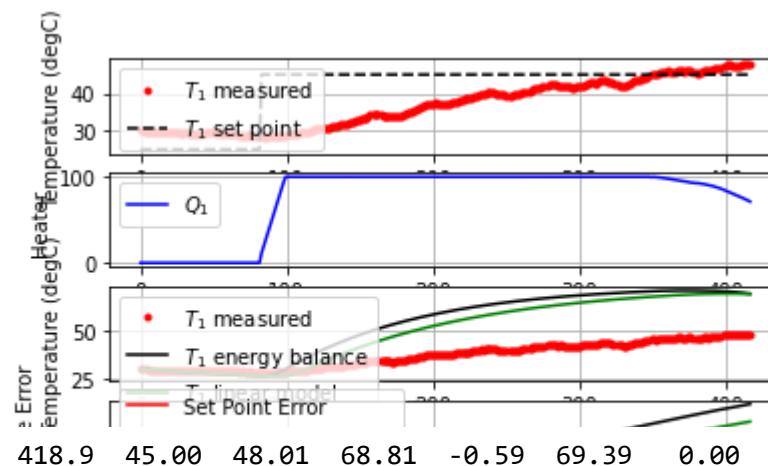
413.6 45.00 47.66 73.55 -0.52 74.07 -0.00



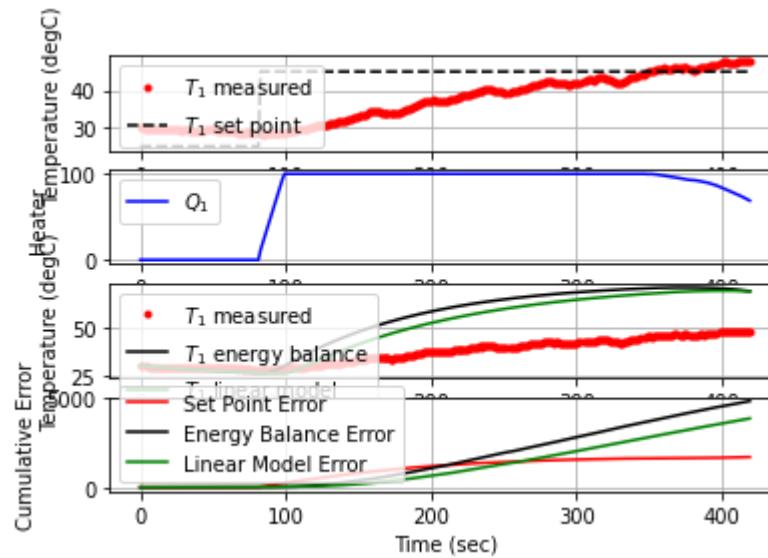
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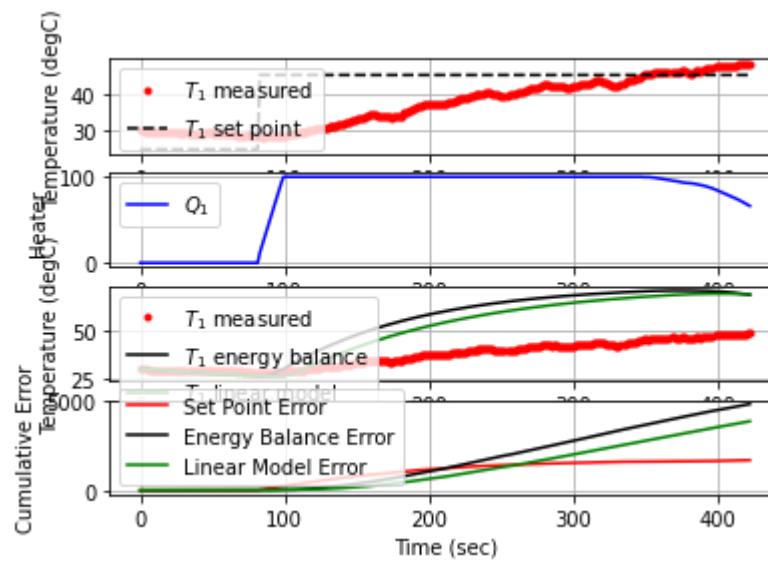
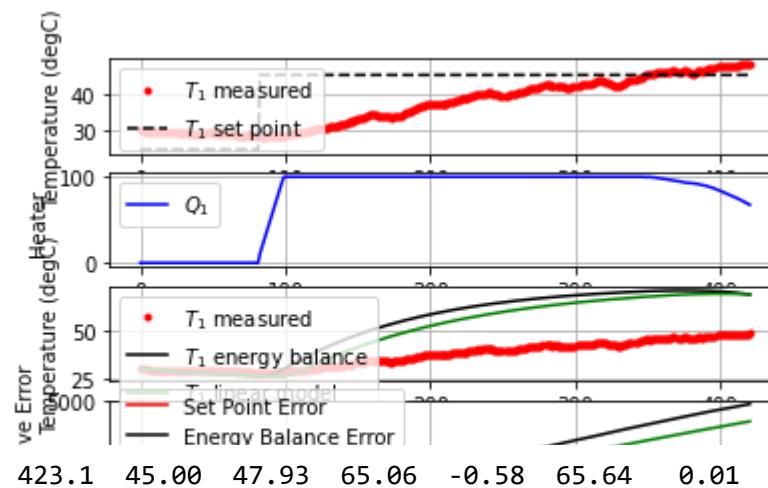
417.7 45.00 48.03 69.92 -0.59 70.51 0.00

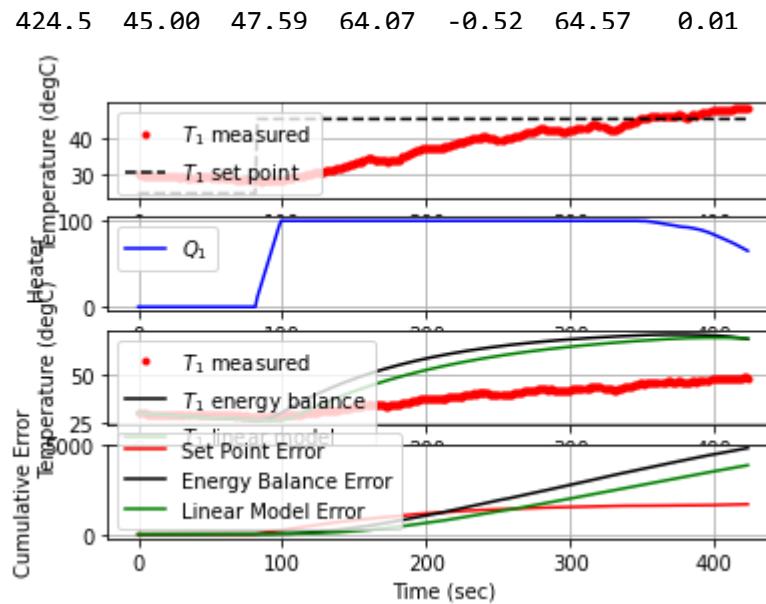


420.4 45.00 48.18 67.45 -0.61 68.06 -0.01

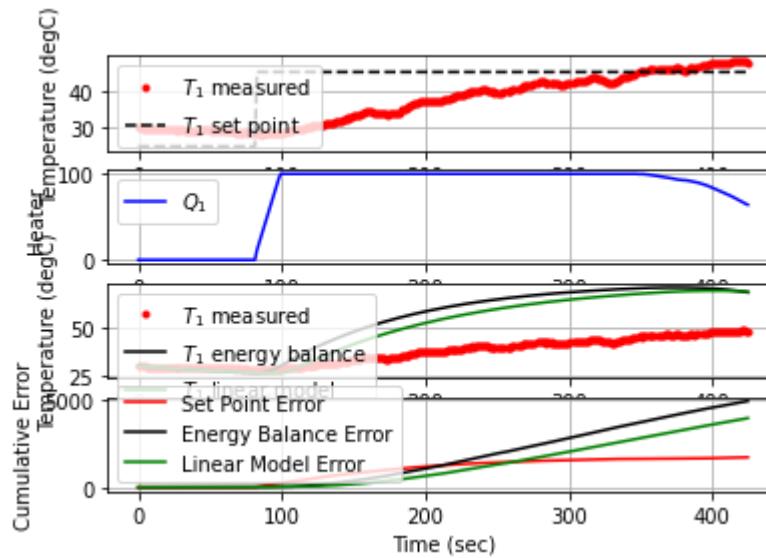


421.7 45.00 48.19 66.23 -0.62 66.85 -0.00

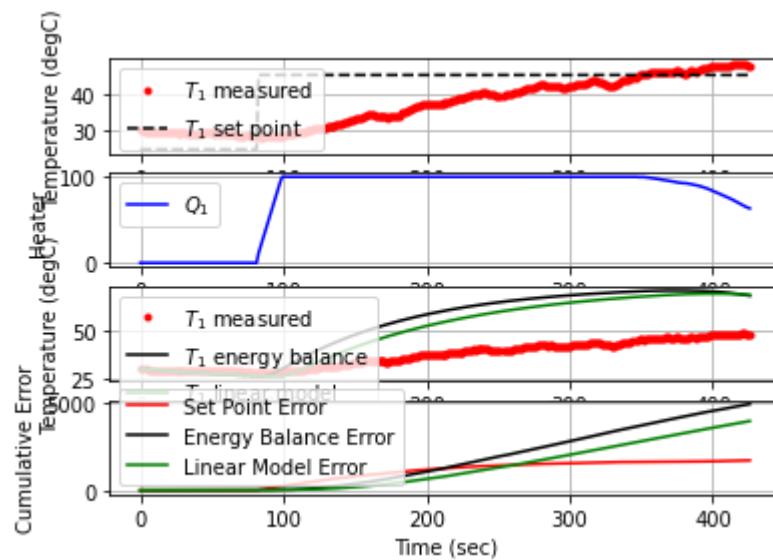




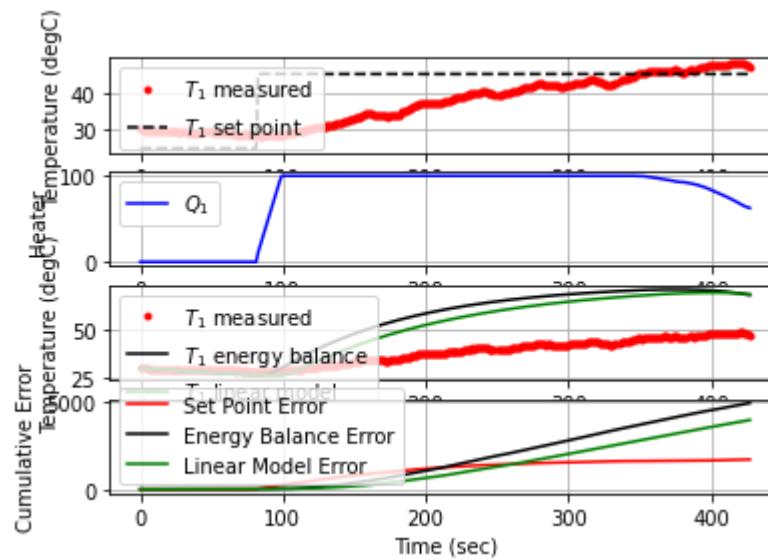
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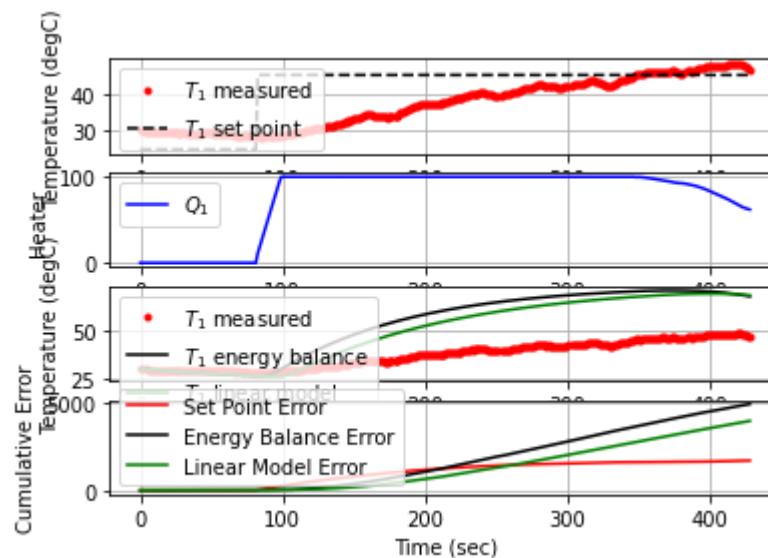
427.2 45.00 46.79 62.61 -0.36 62.96 0.01



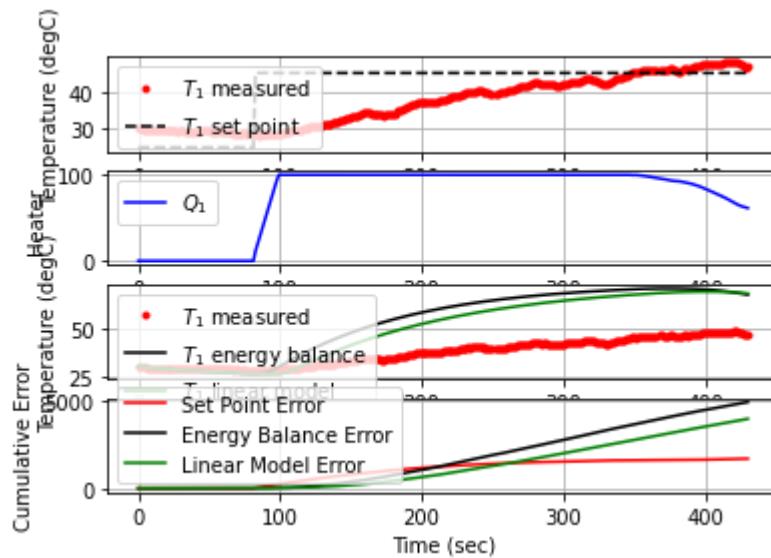
428.6 45.00 46.55 61.99 -0.31 62.30 0.01



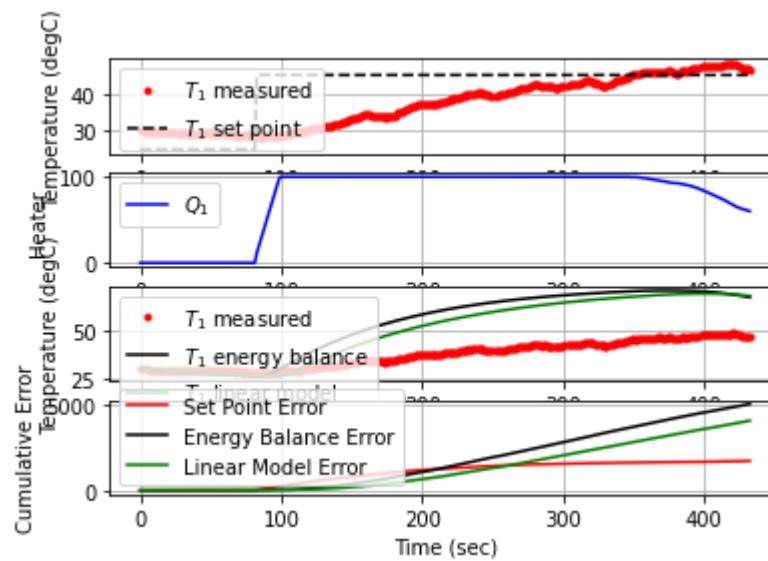
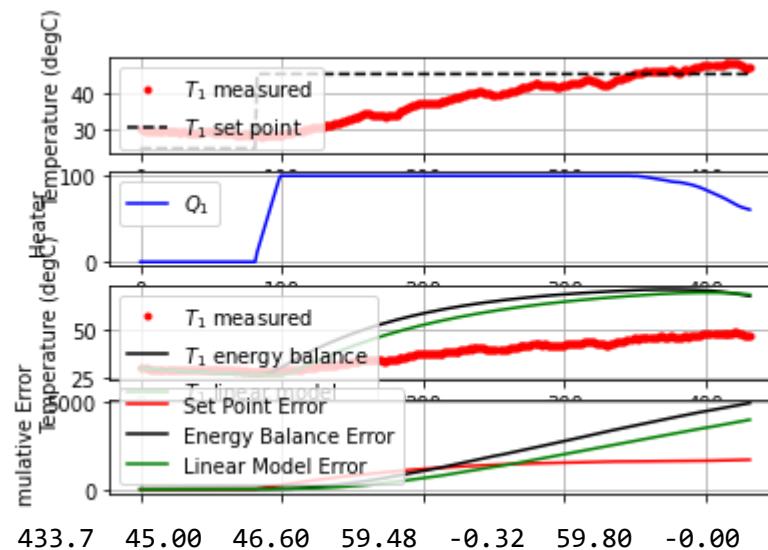
429.9 45.00 46.68 61.31 -0.33 61.65 -0.00



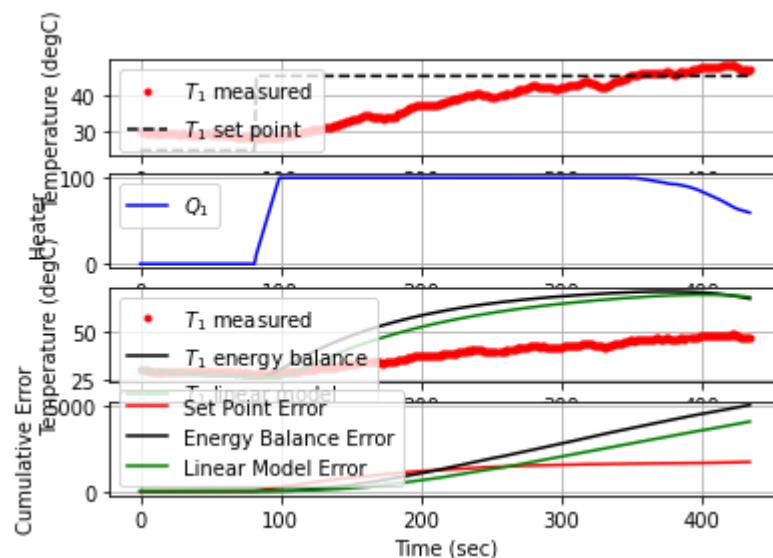
431.1 45.00 46.74 60.66 -0.34 61.00 -0.00



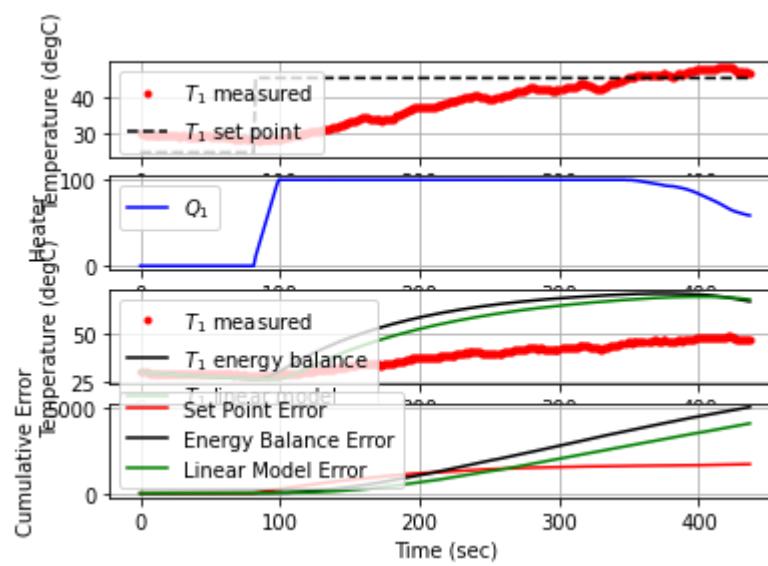
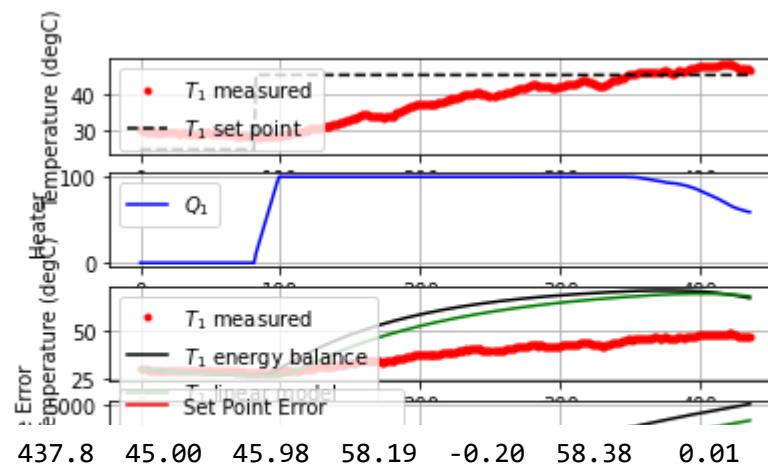
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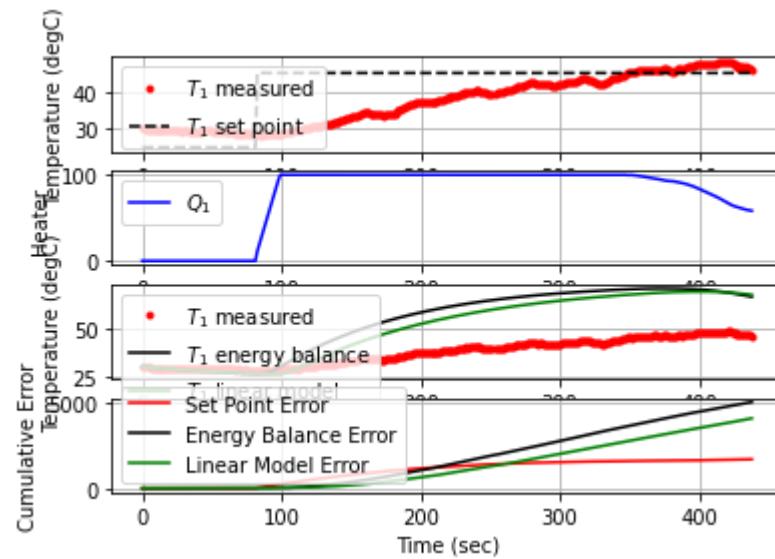
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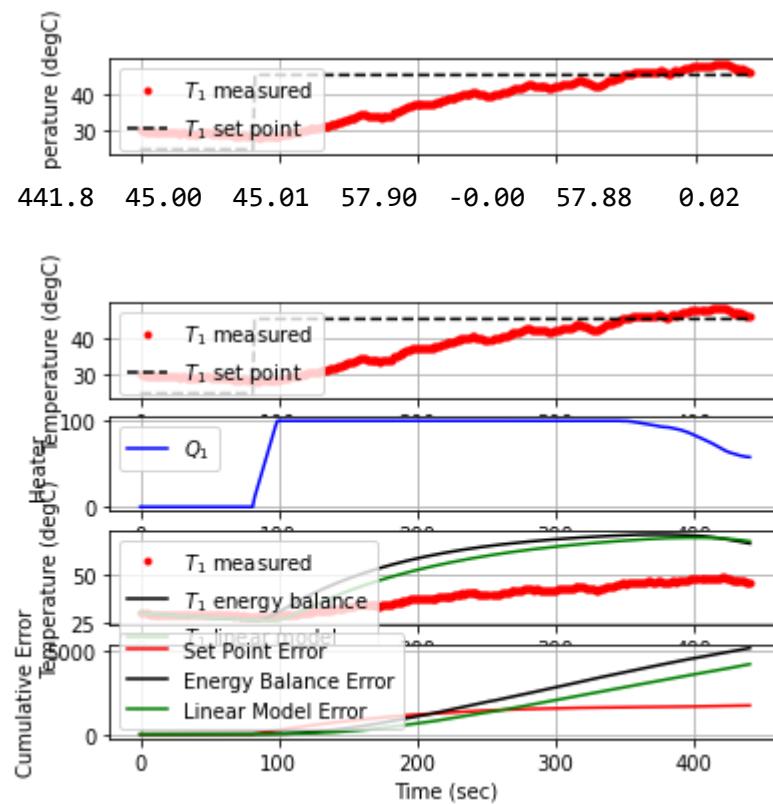
436.5 45.00 46.12 58.57 -0.23 58.79 0.00



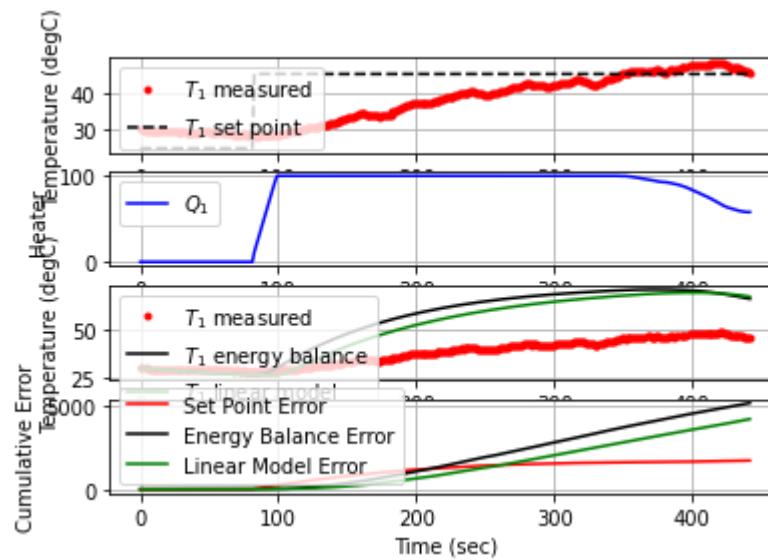
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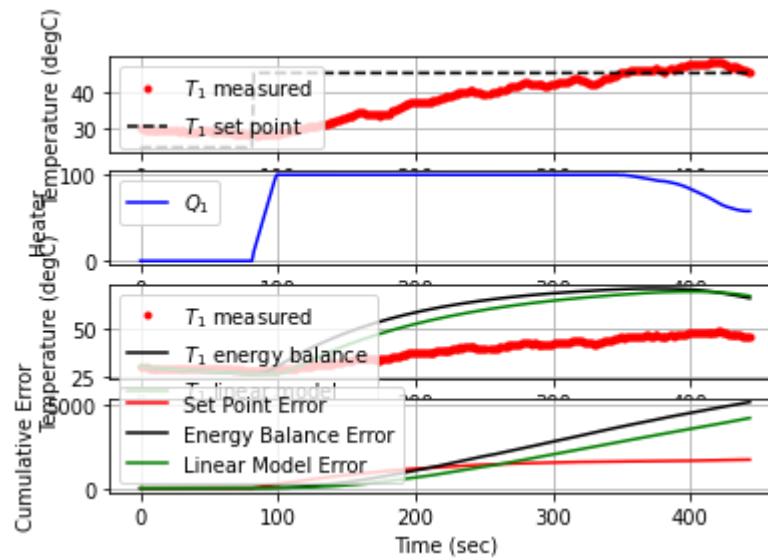
440.5 45.00 45.53 57.78 -0.11 57.89 0.01



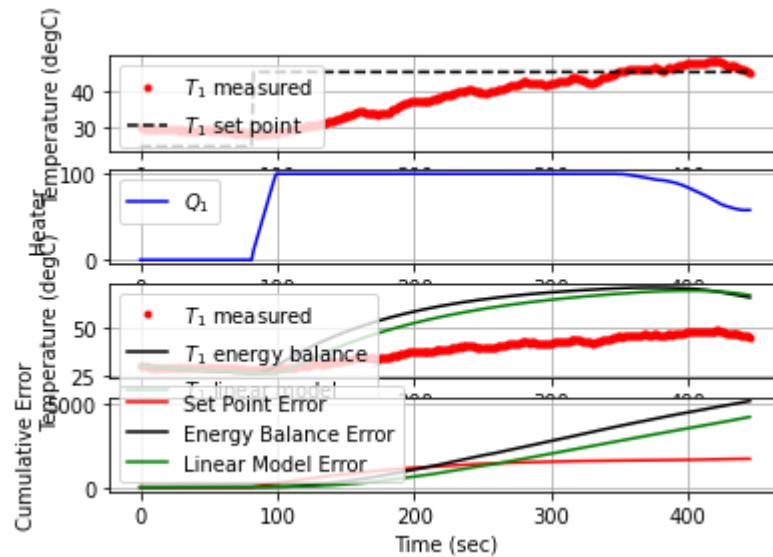
443.3 45.00 45.04 57.86 -0.01 57.87 -0.00



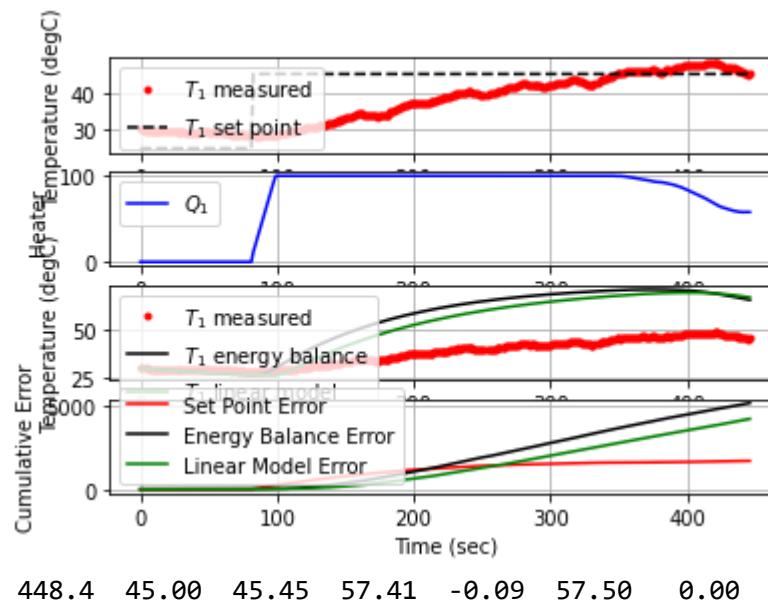
444.5 45.00 44.88 57.94 0.02 57.91 0.01



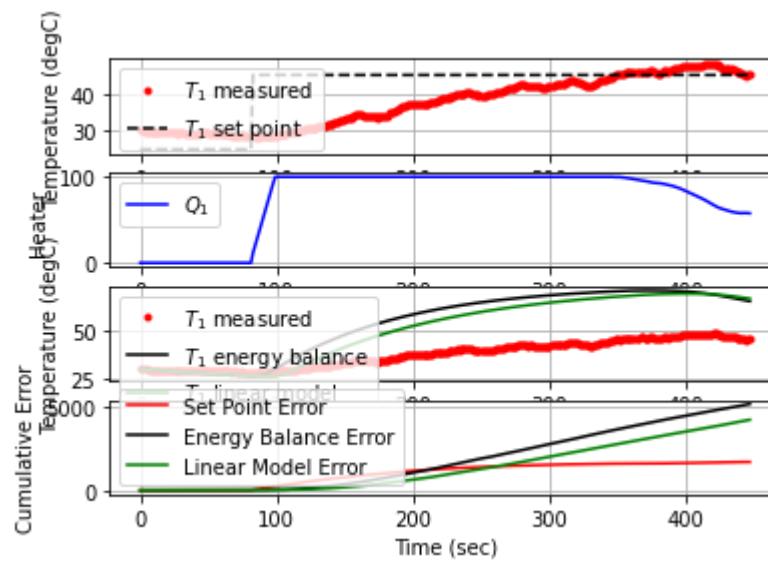
445.8 45.00 45.14 57.82 -0.03 57.86 -0.01



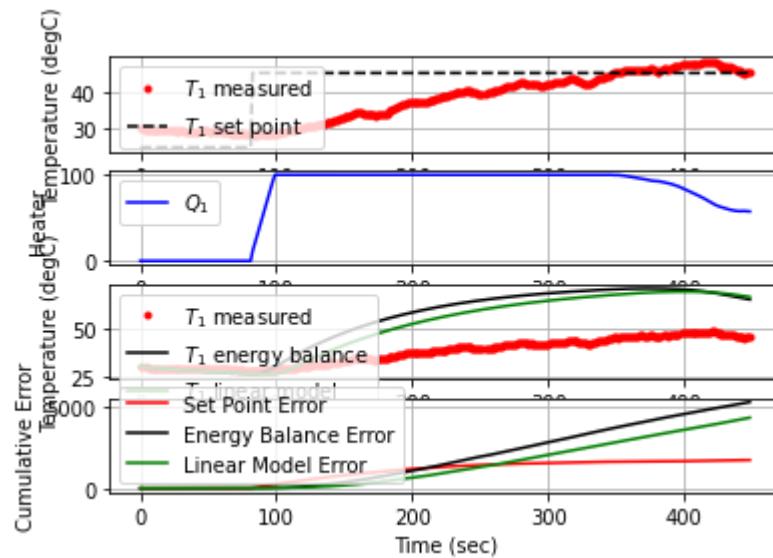
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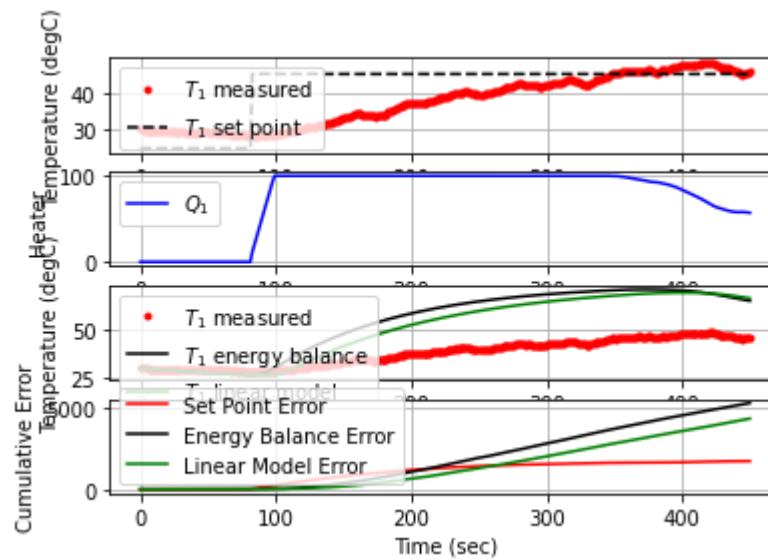
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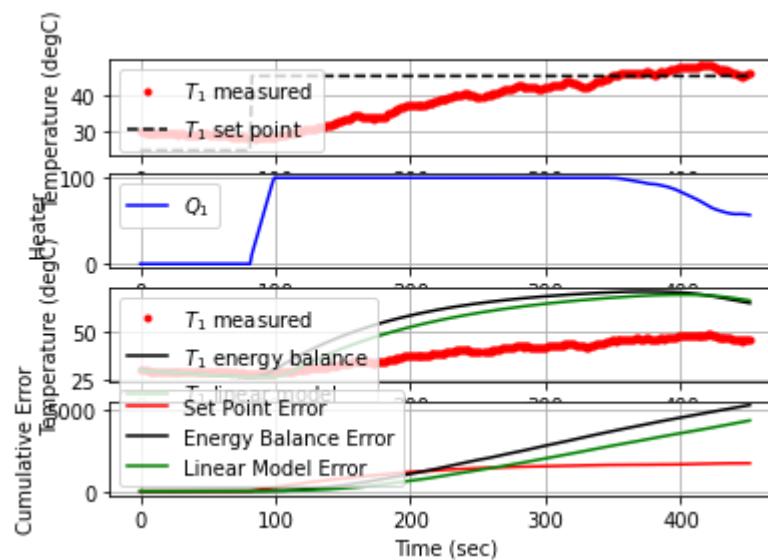
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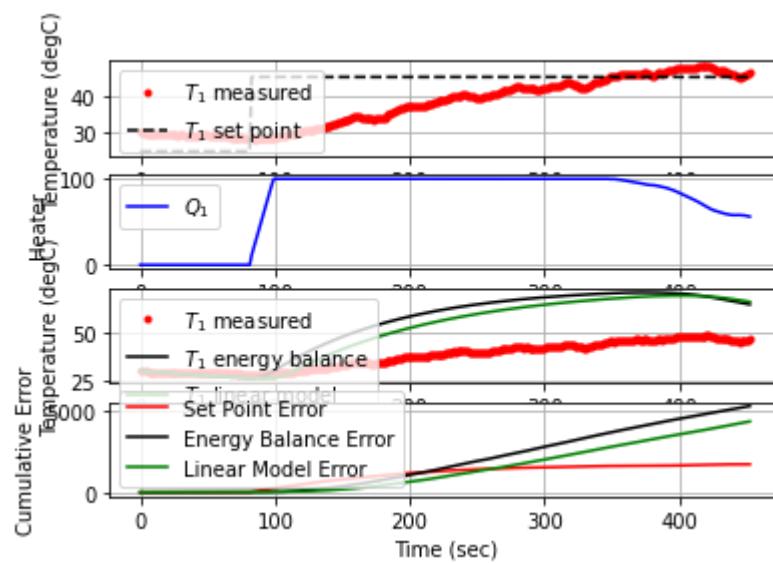
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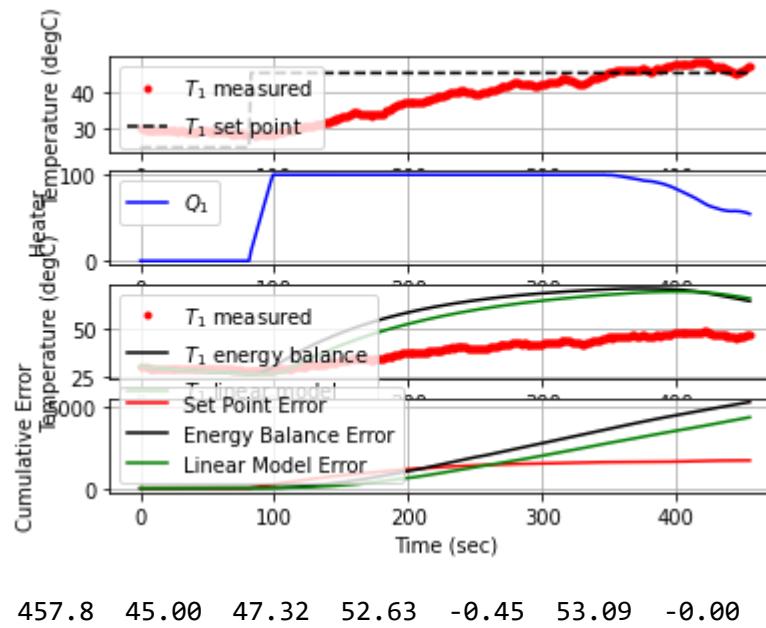
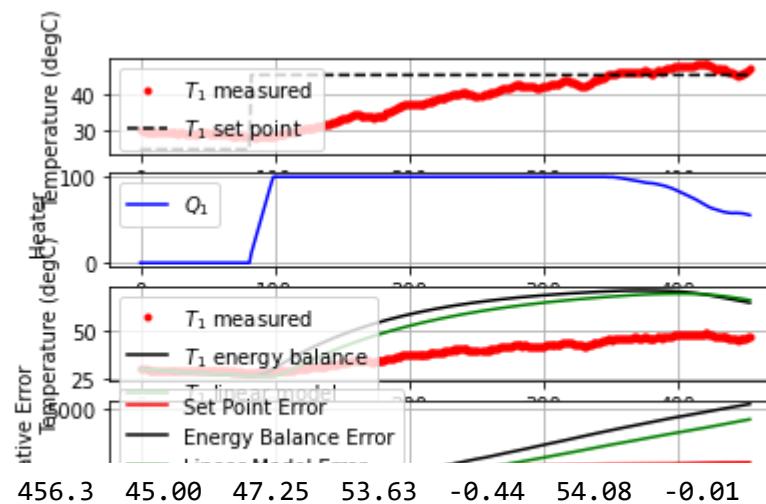
452.3 45.00 46.42 56.08 -0.27 56.37 -0.02

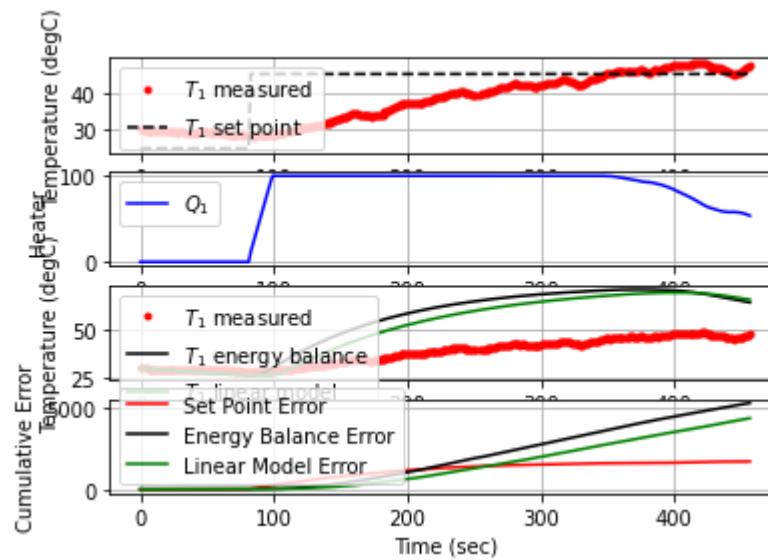


453.6 45.00 46.63 55.40 -0.32 55.73 -0.01

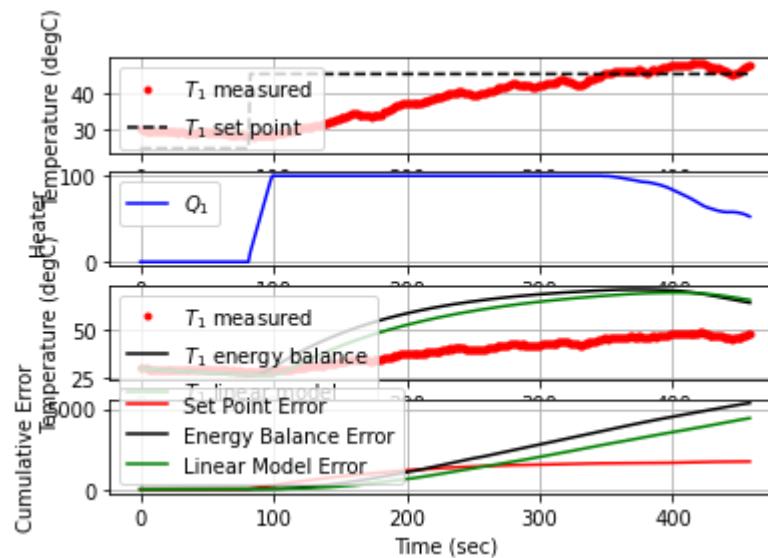


455.0 45.00 47.00 54.53 -0.39 54.93 -0.01

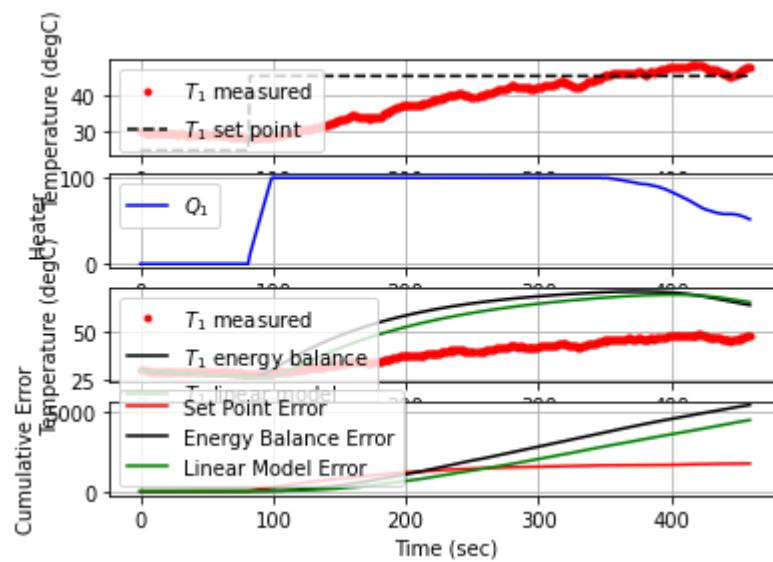




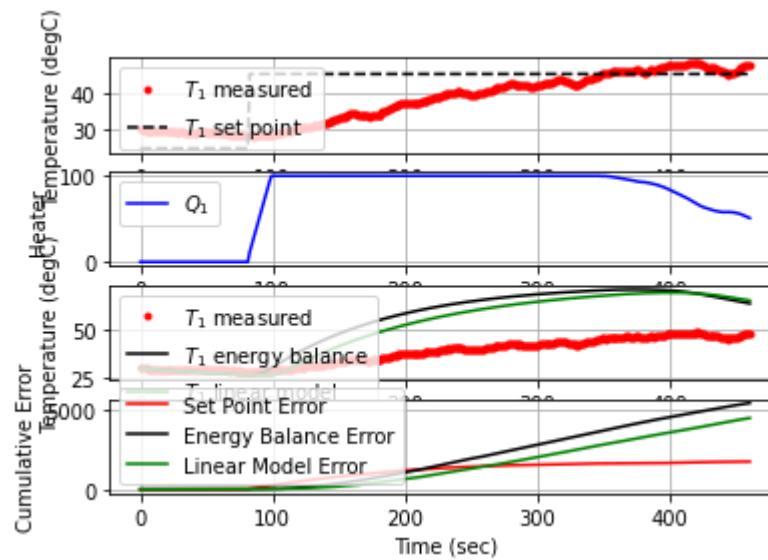
459.1 45.00 47.17 51.82 -0.43 52.25 0.01



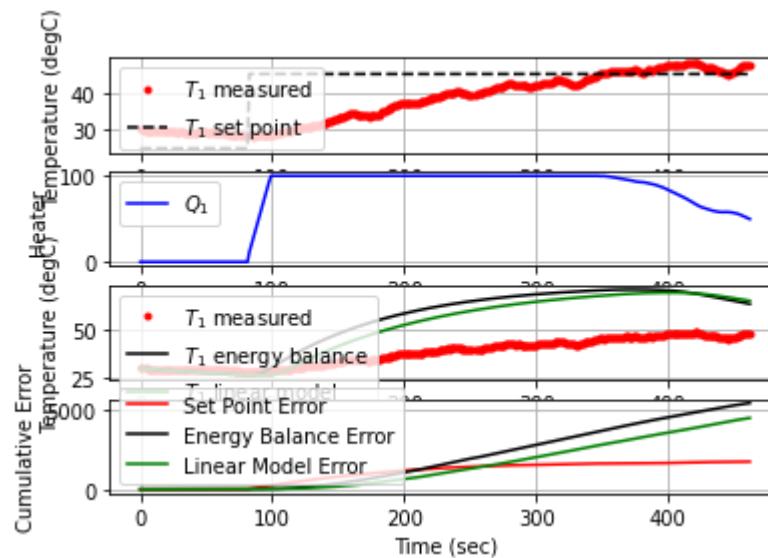
460.4 45.00 47.39 50.86 -0.46 51.34 -0.01



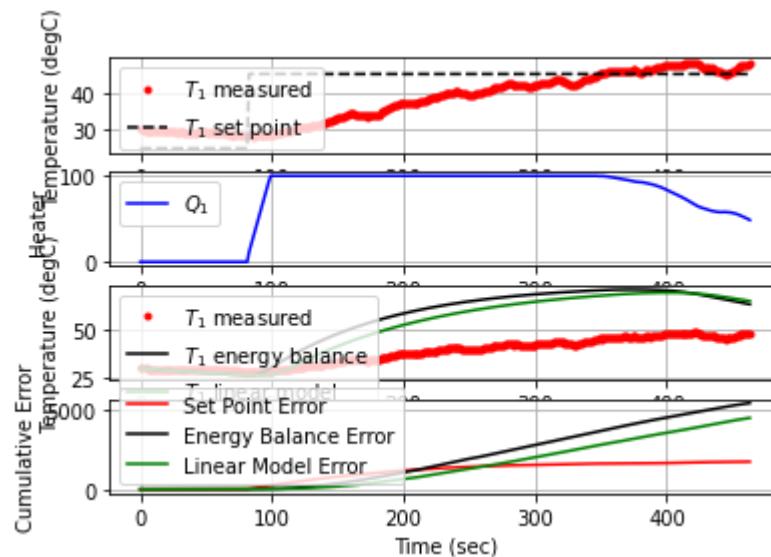
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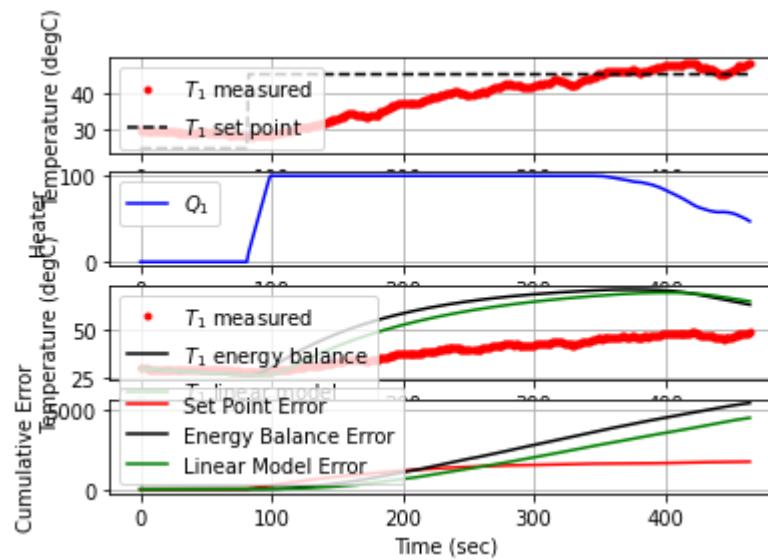
463.1 45.00 47.96 48.61 -0.56 49.19 -0.01



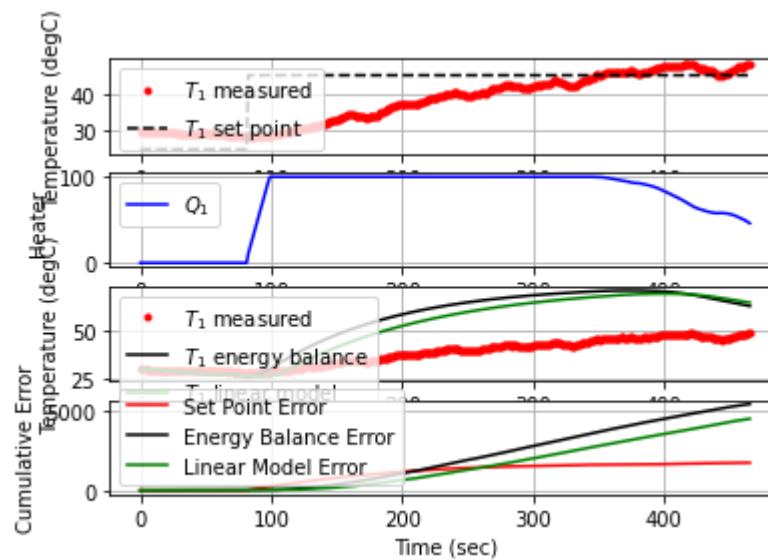
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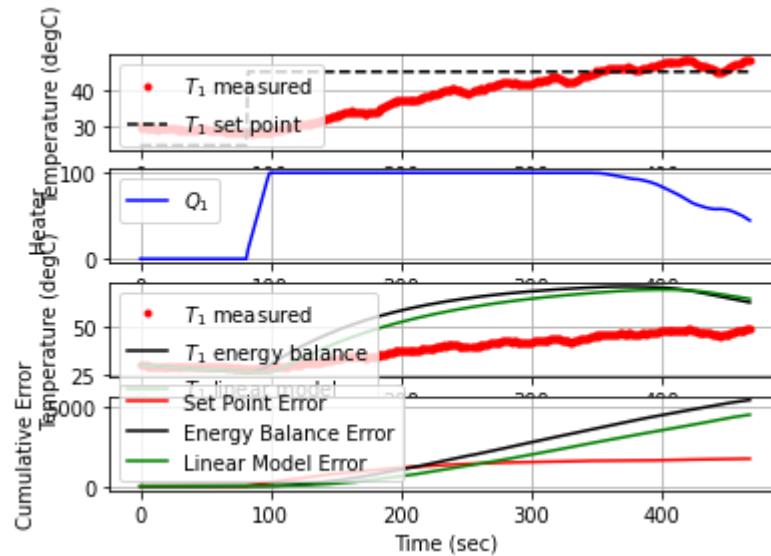
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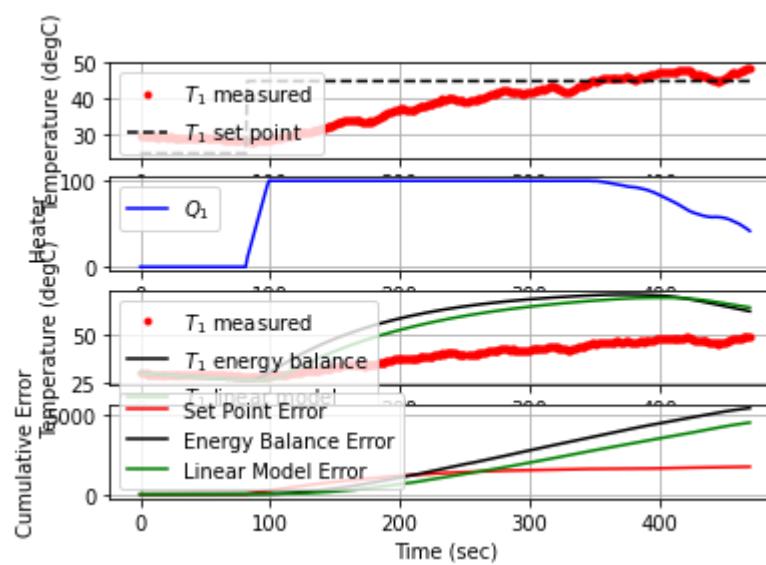
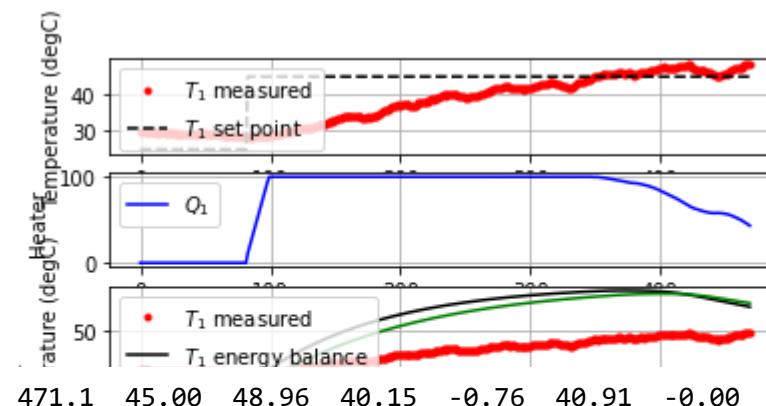
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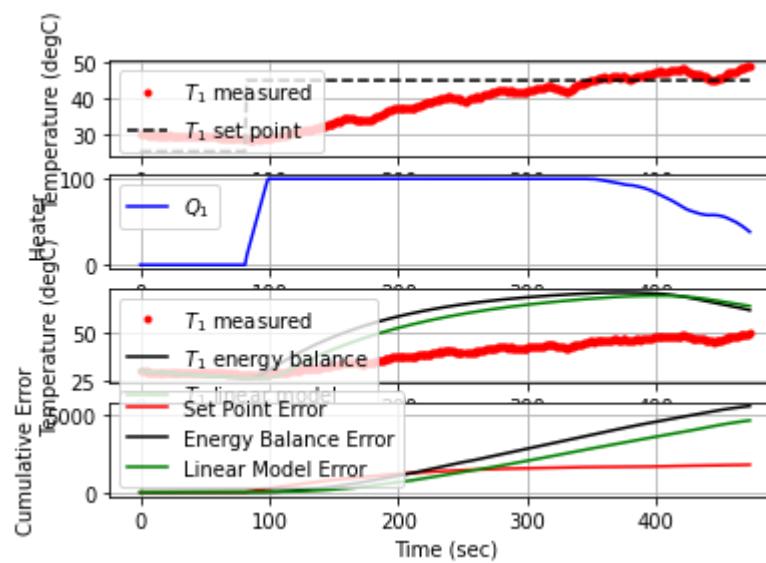
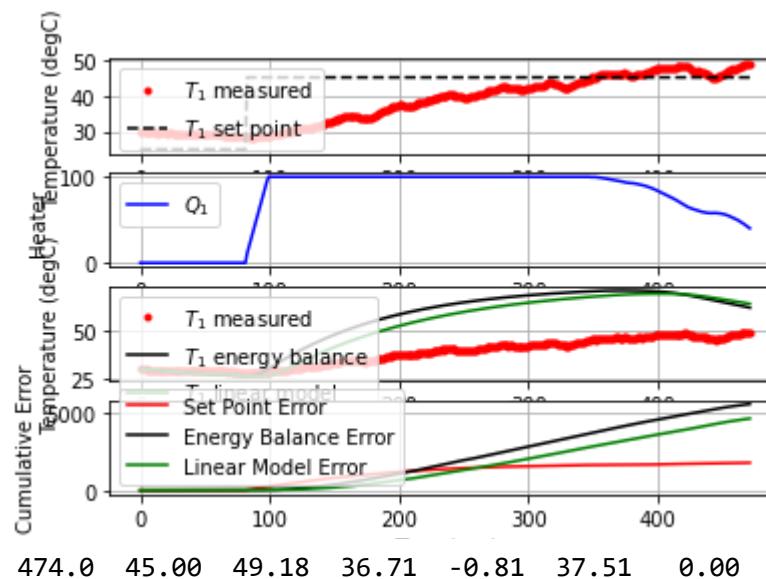


468.5 45.00 48.71 43.22 -0.70 43.93 -0.01

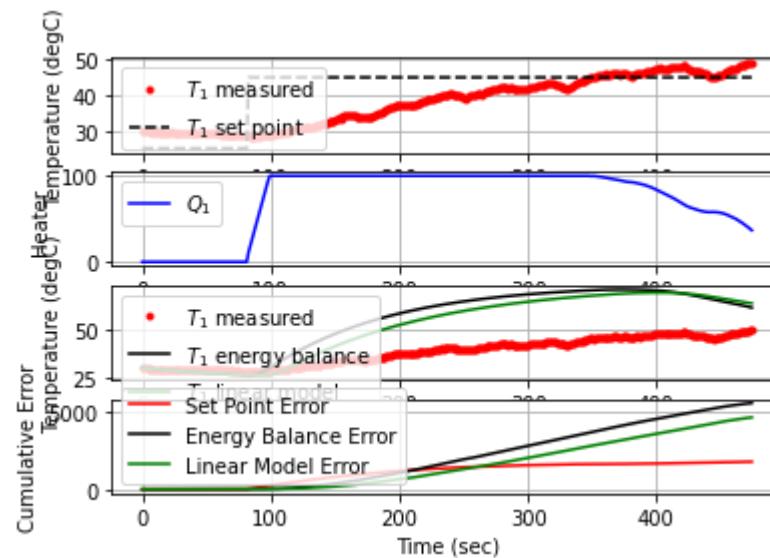


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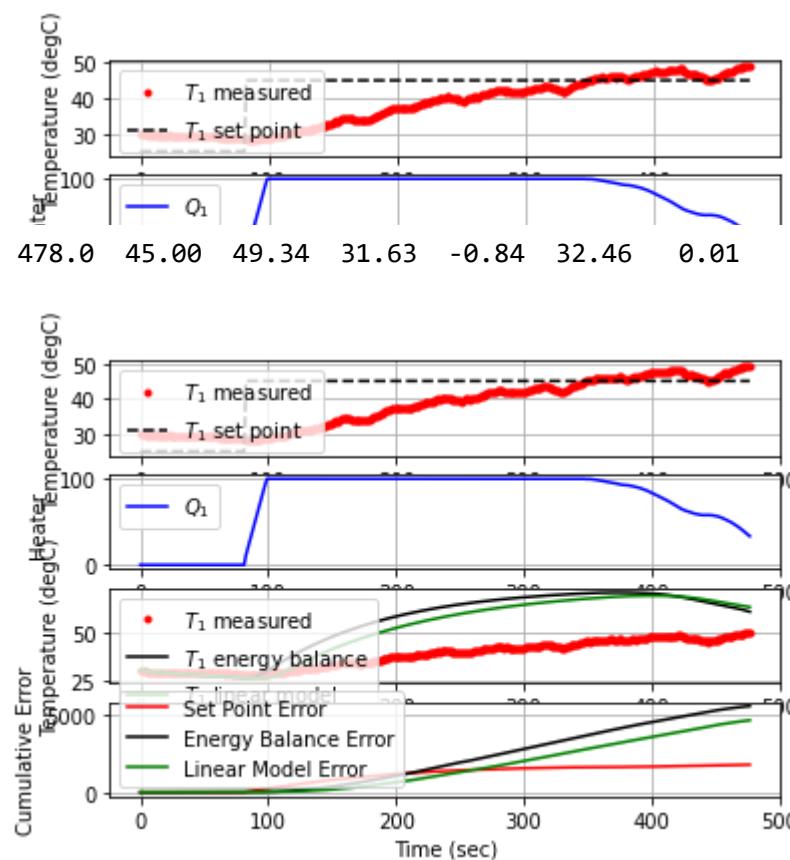




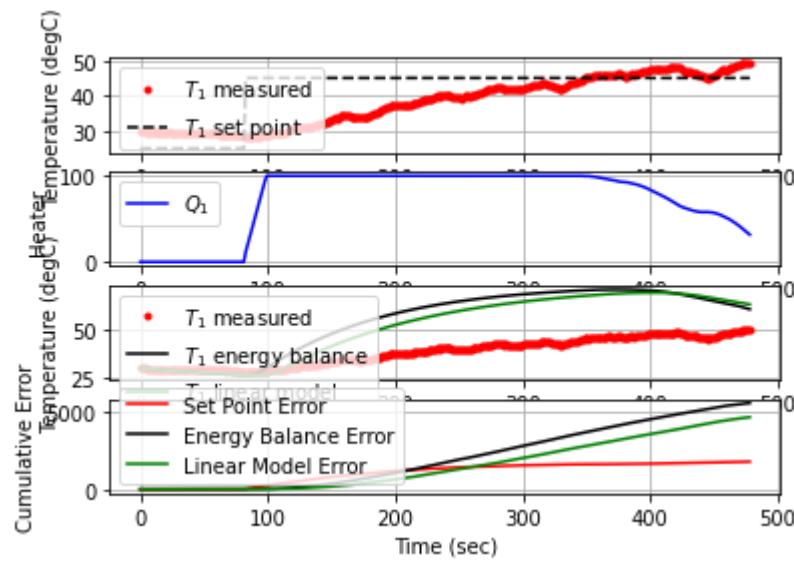
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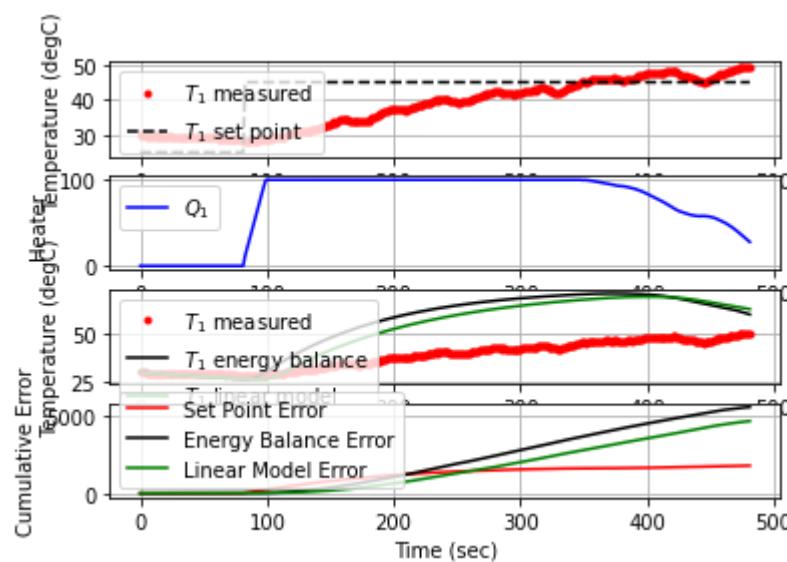
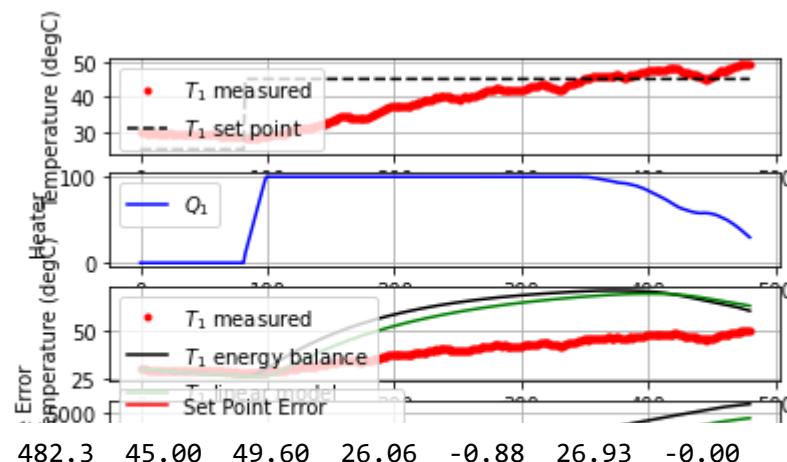
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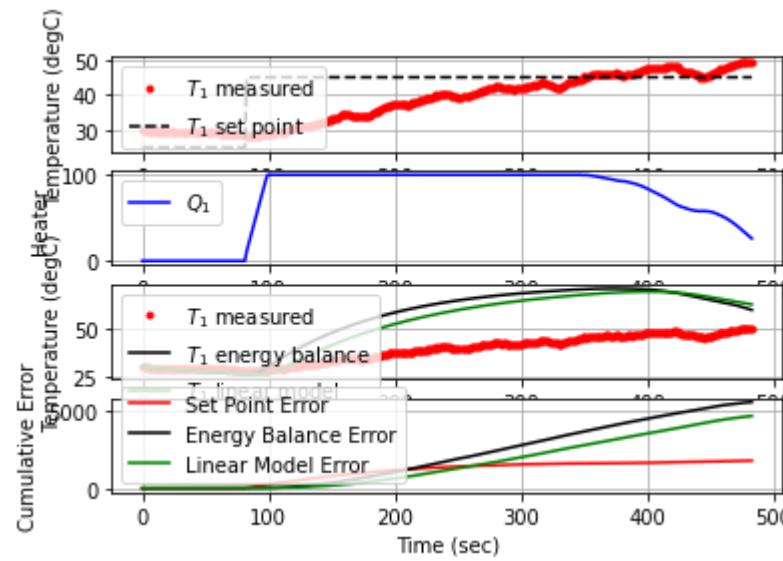
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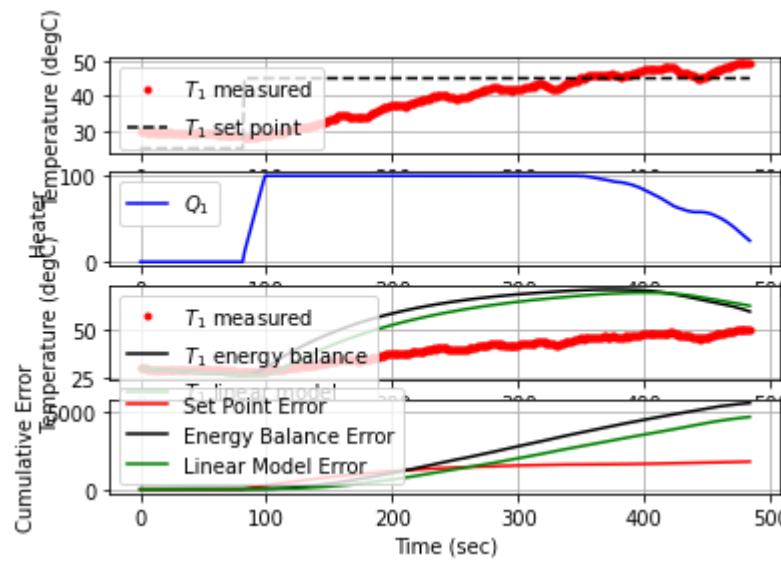
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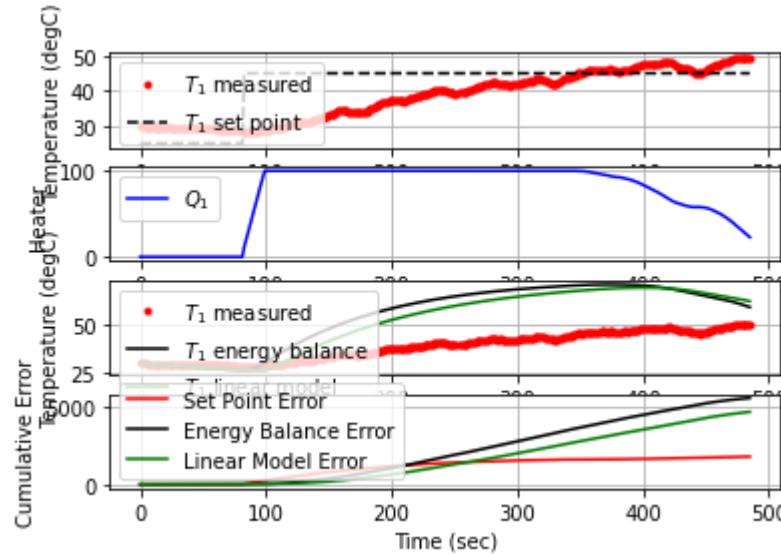
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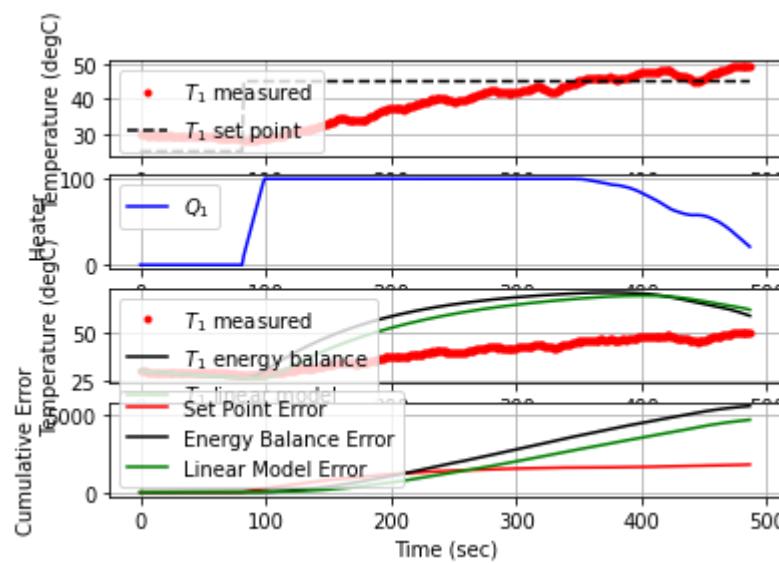
484.9 45.00 49.35 22.92 -0.82 23.75 -0.01



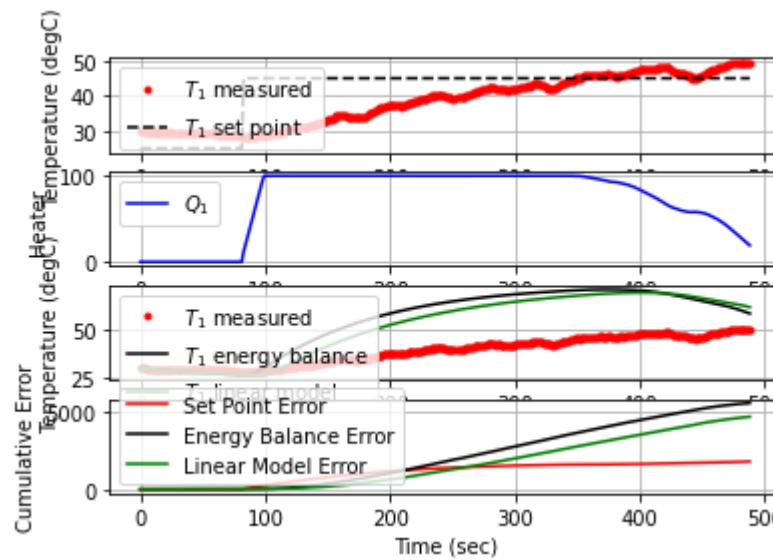
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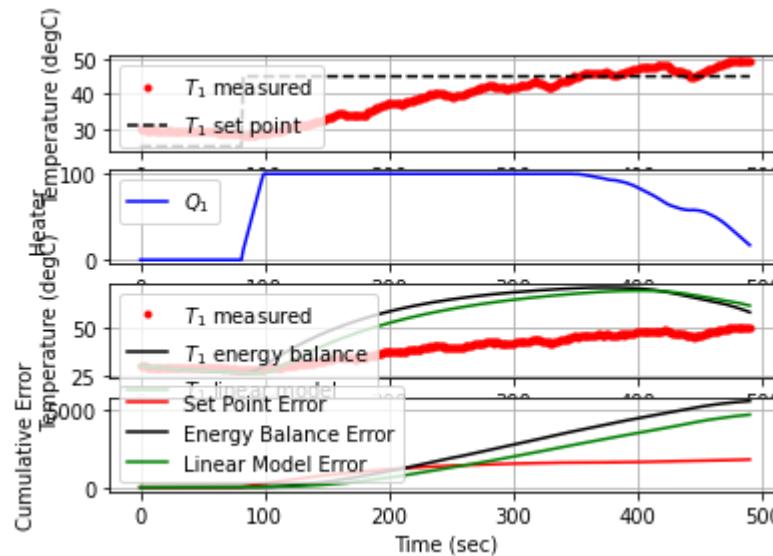
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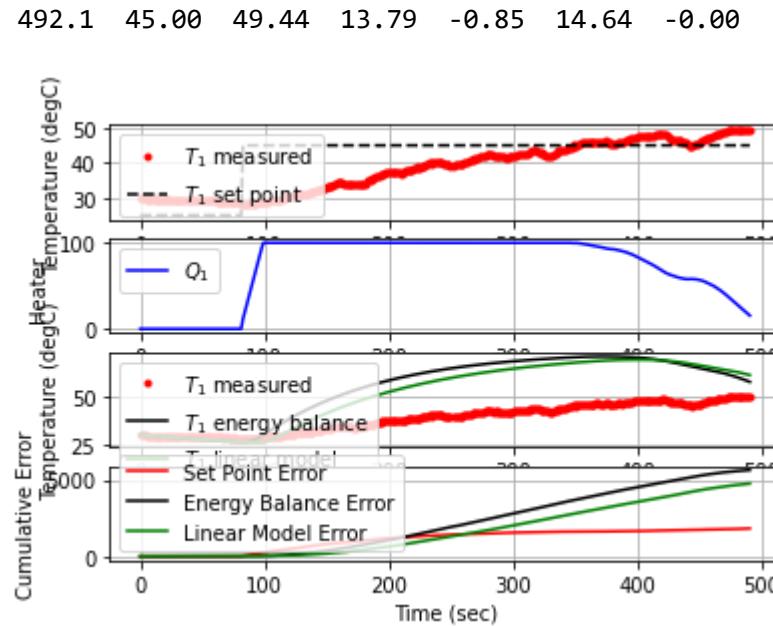


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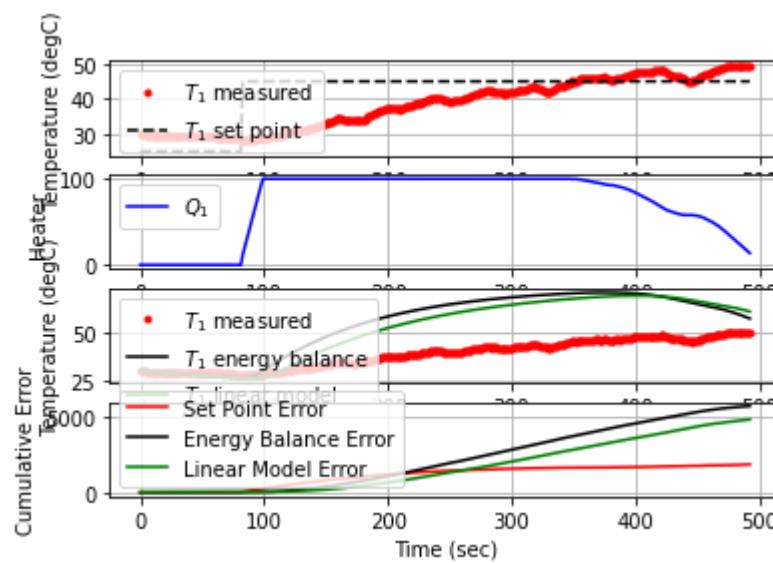


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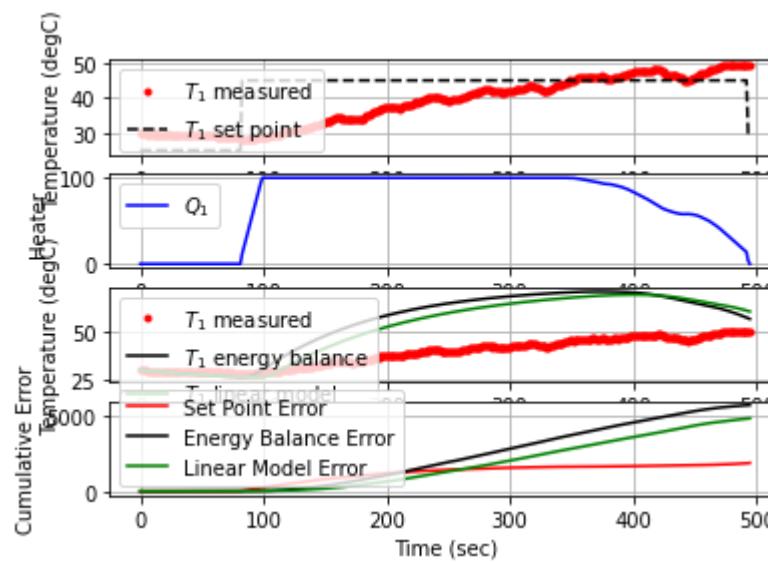
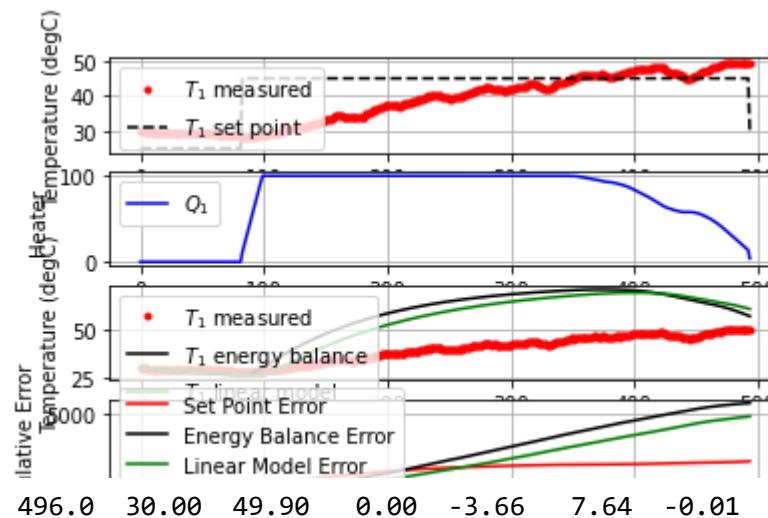


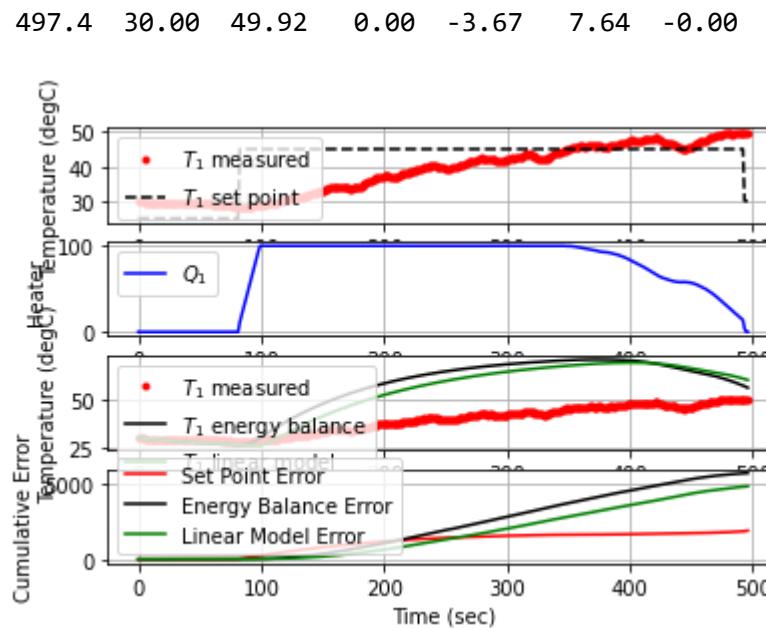
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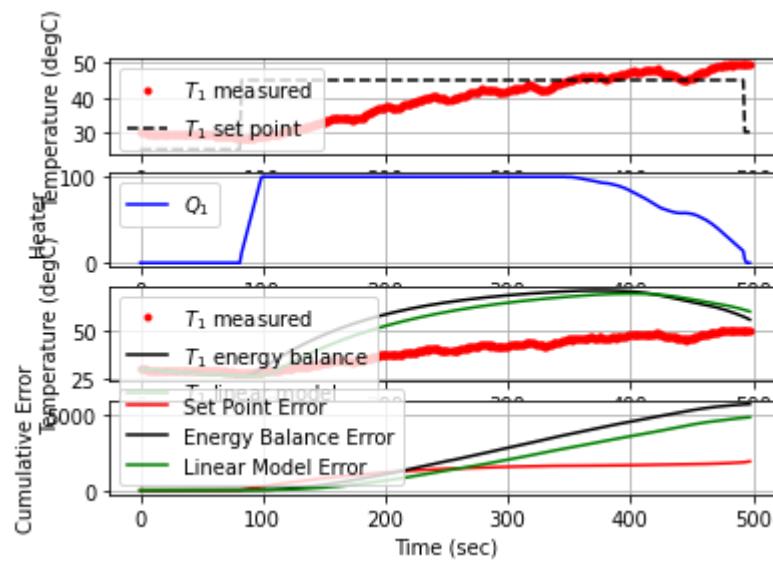
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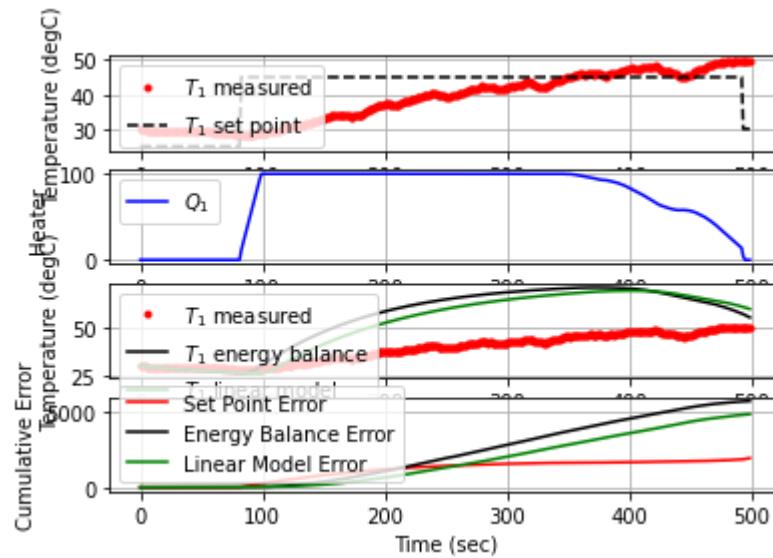


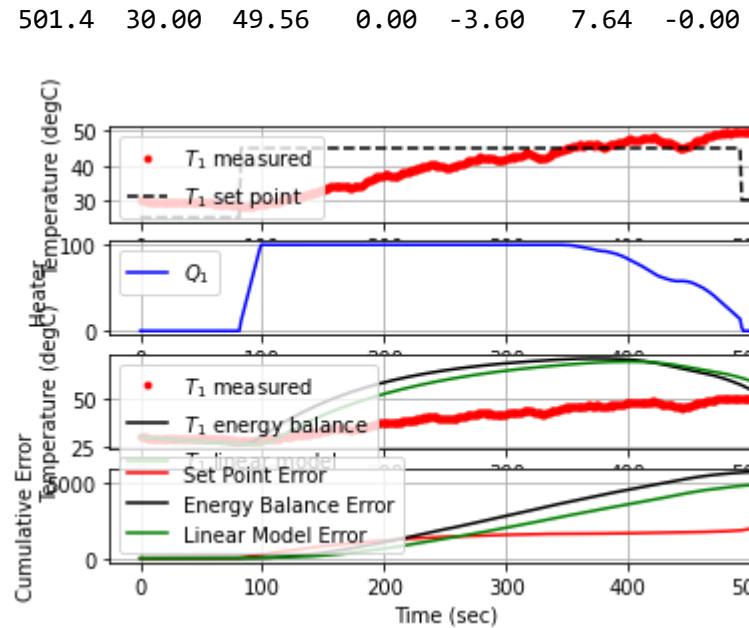


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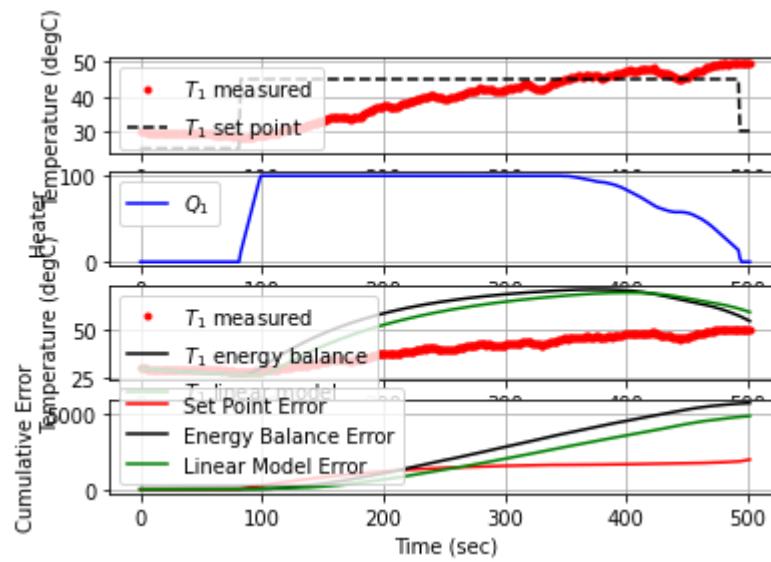


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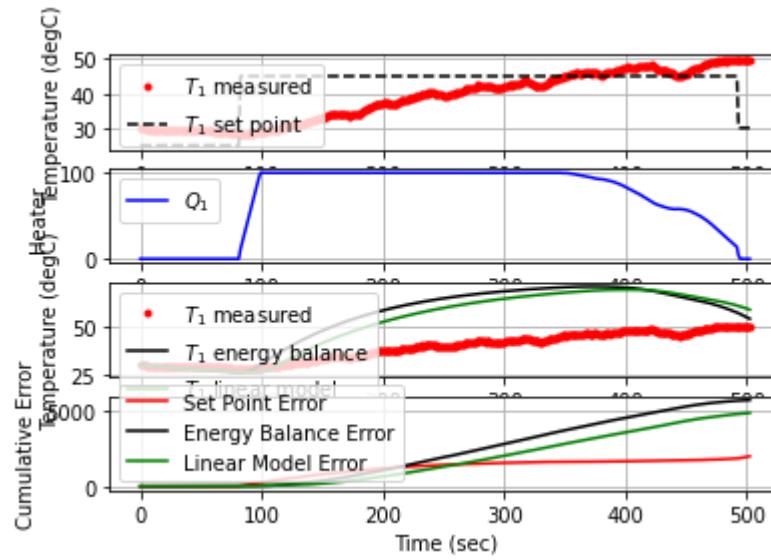




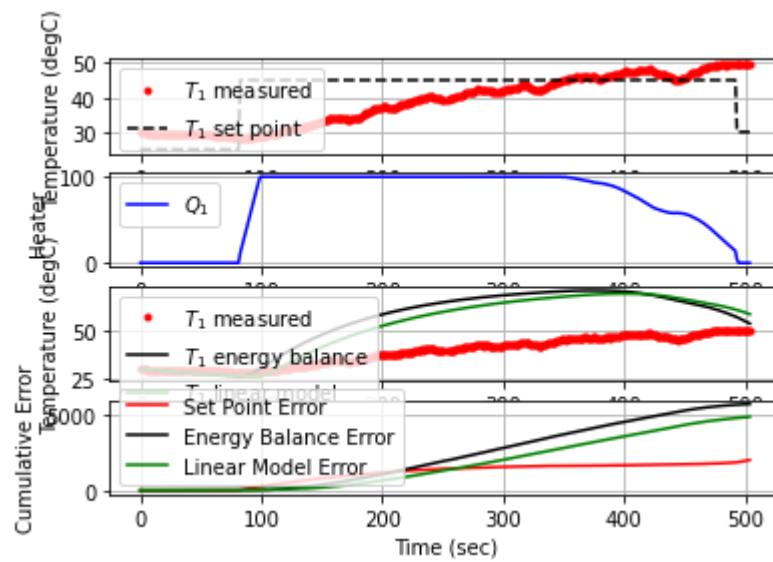
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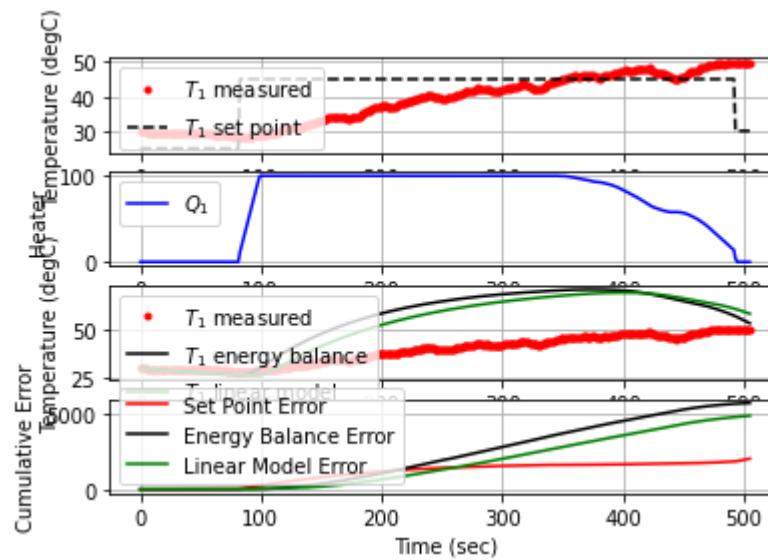
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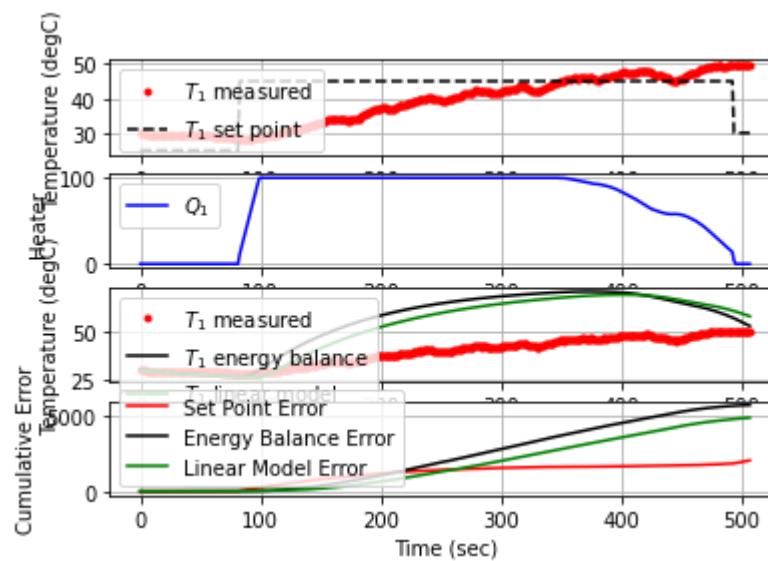
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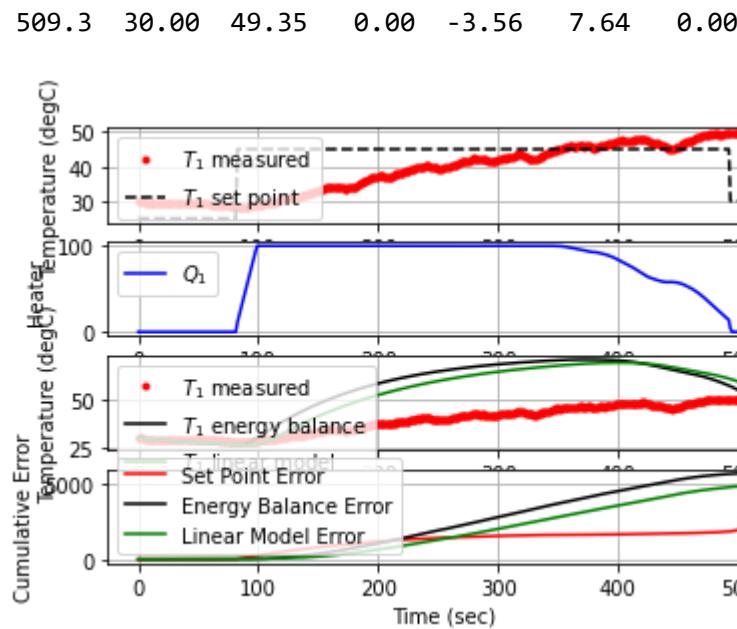


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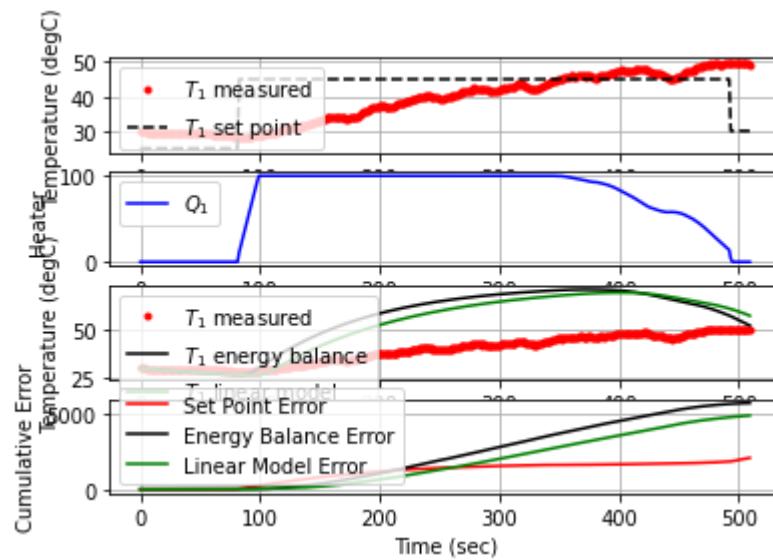


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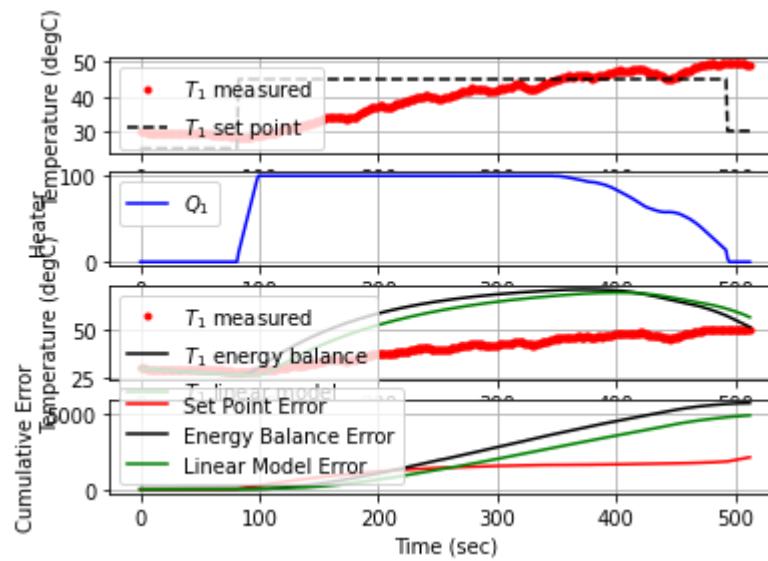
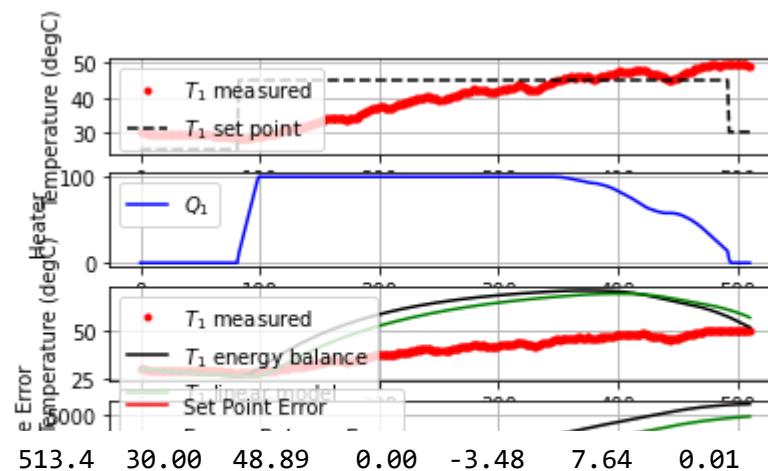




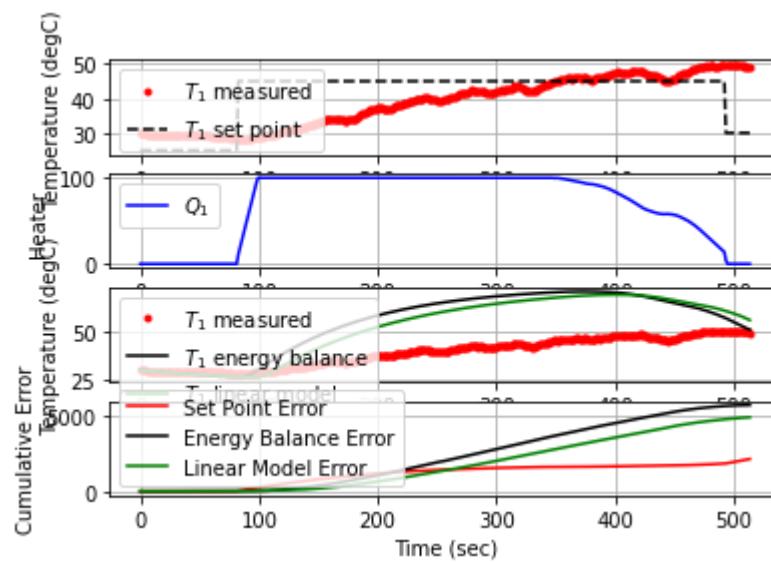
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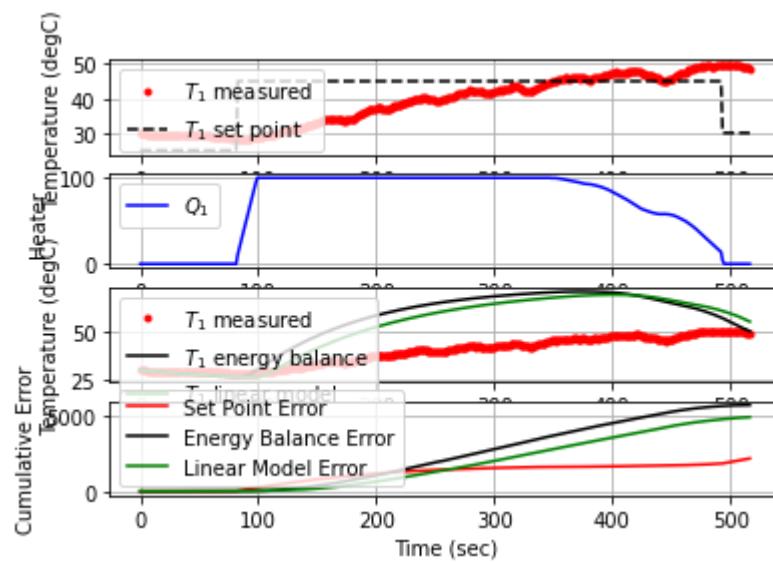
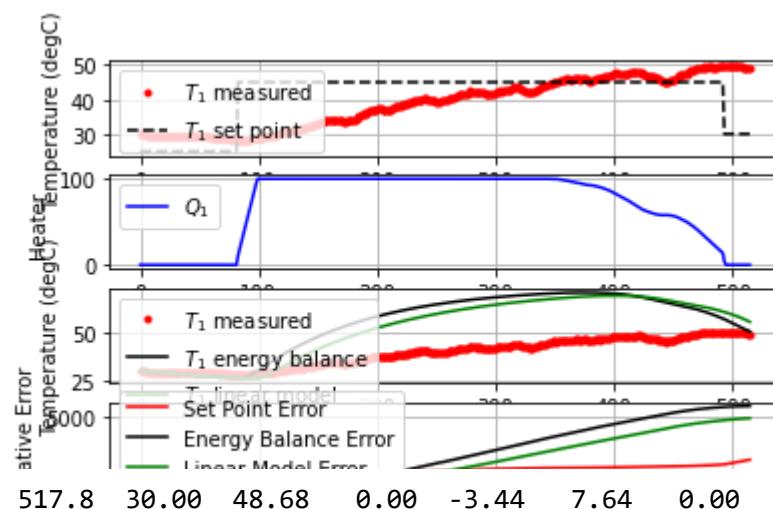
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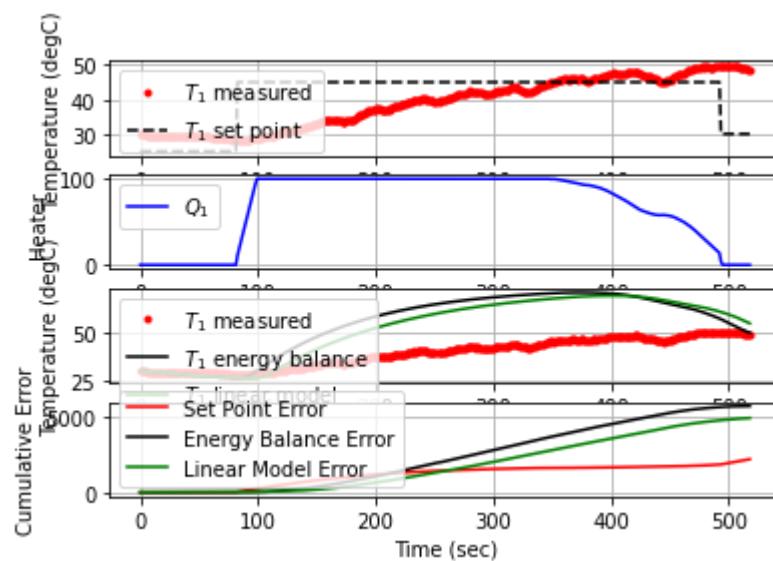
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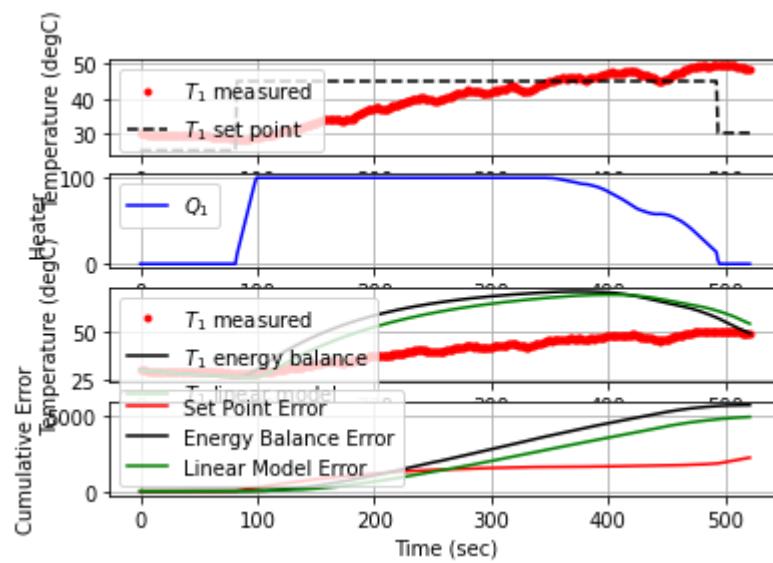
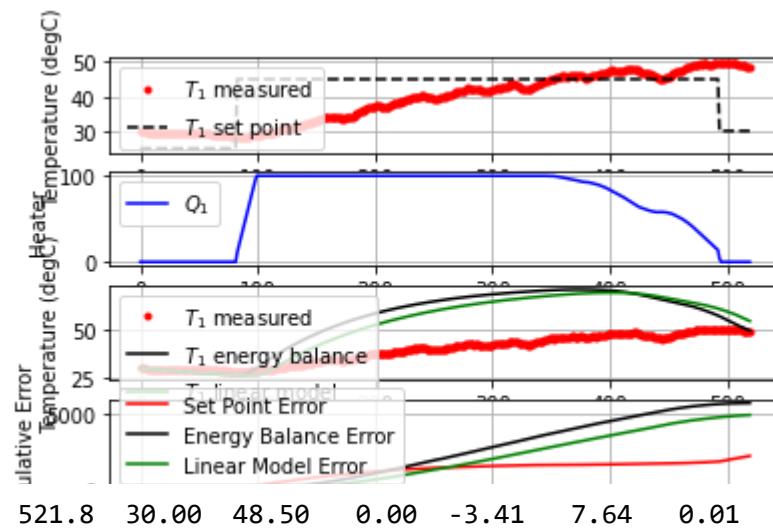
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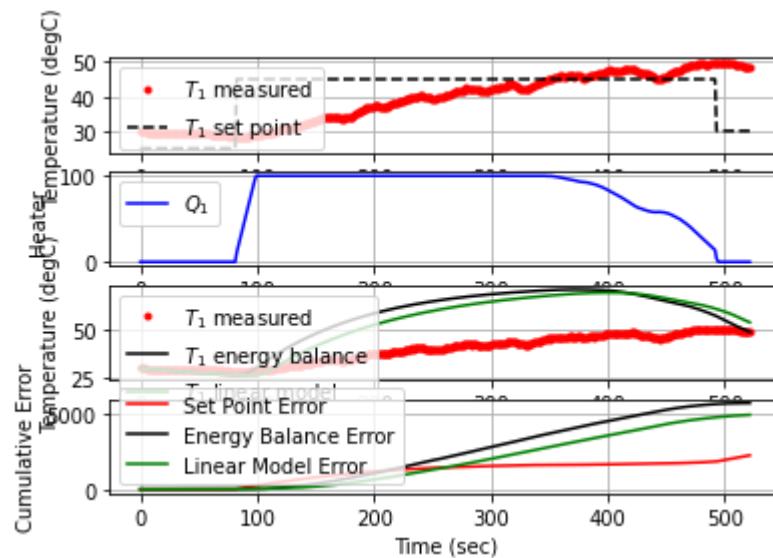
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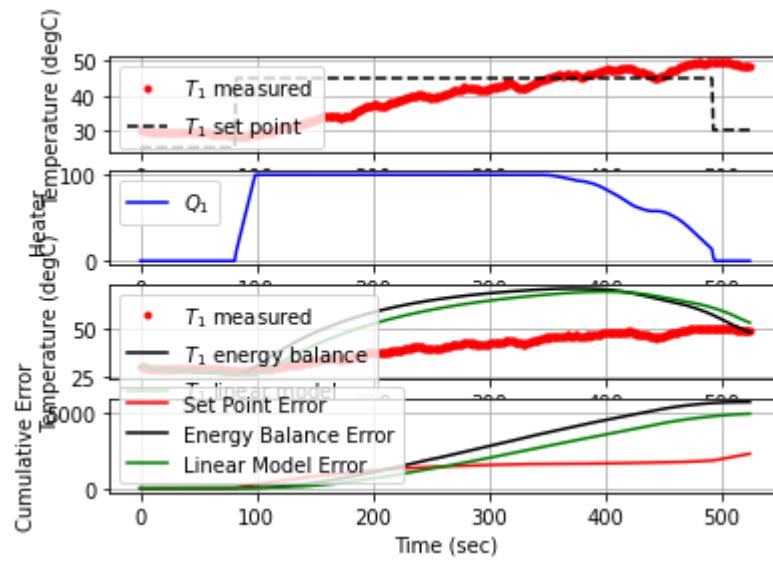
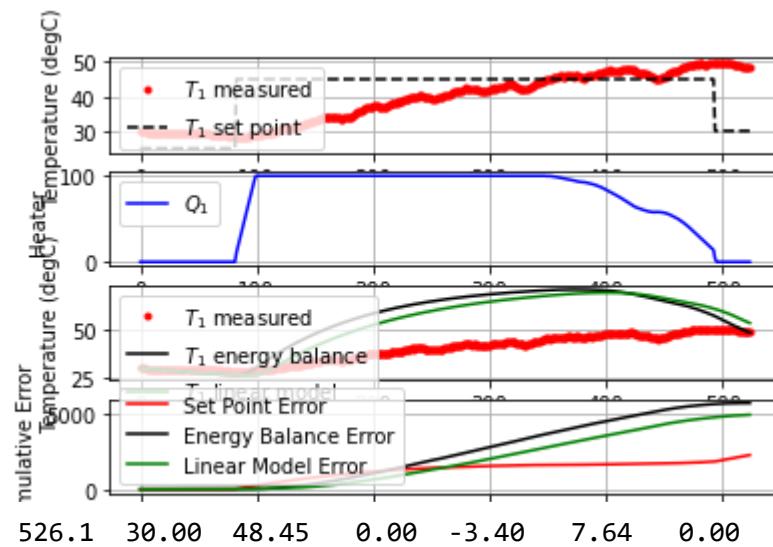
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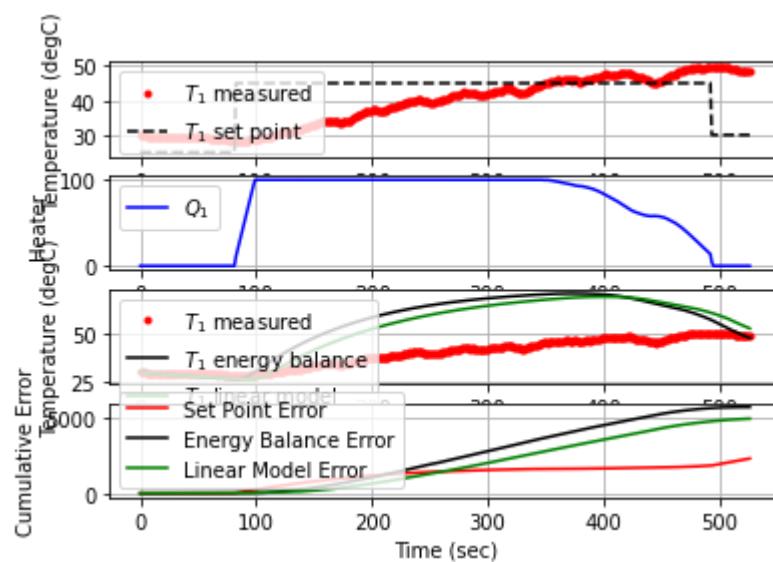
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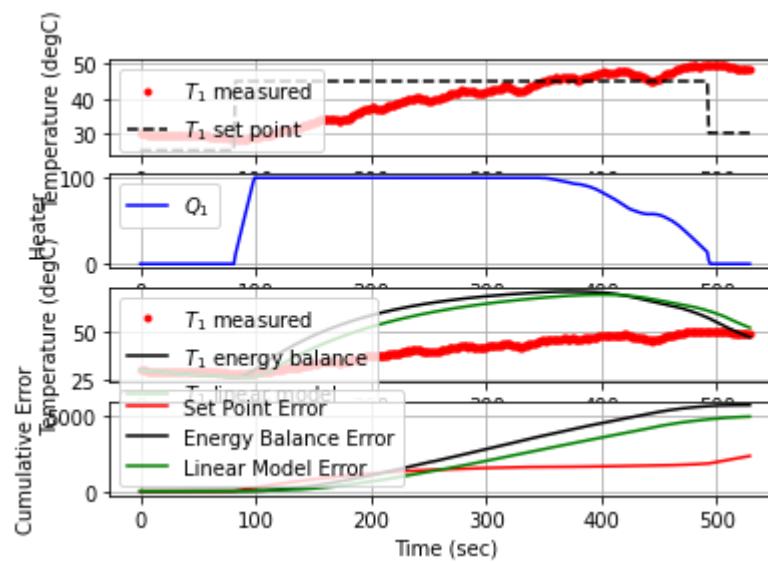
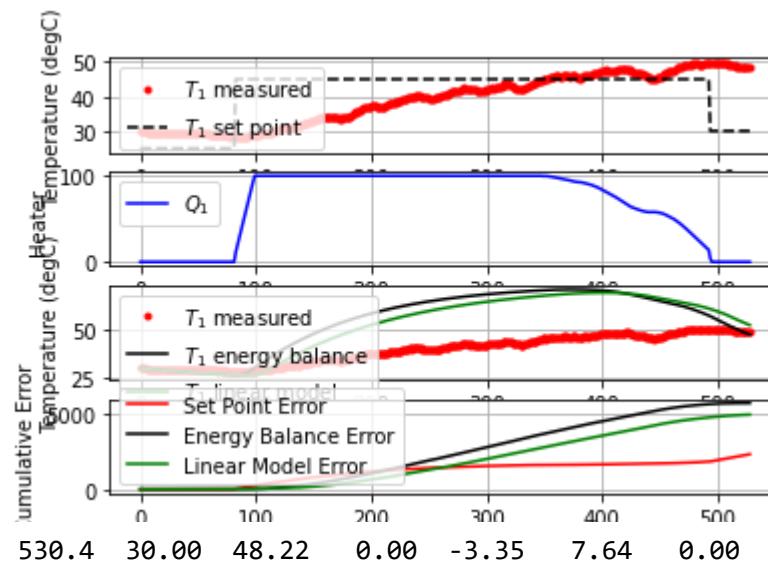
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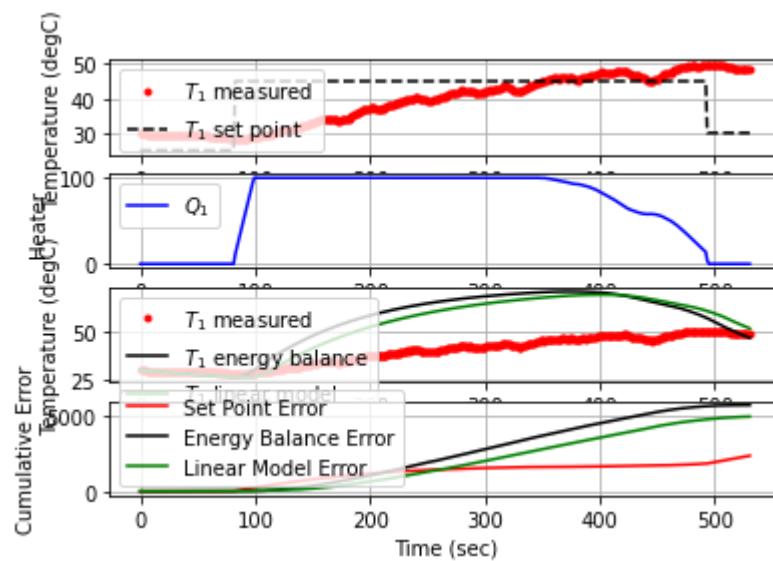
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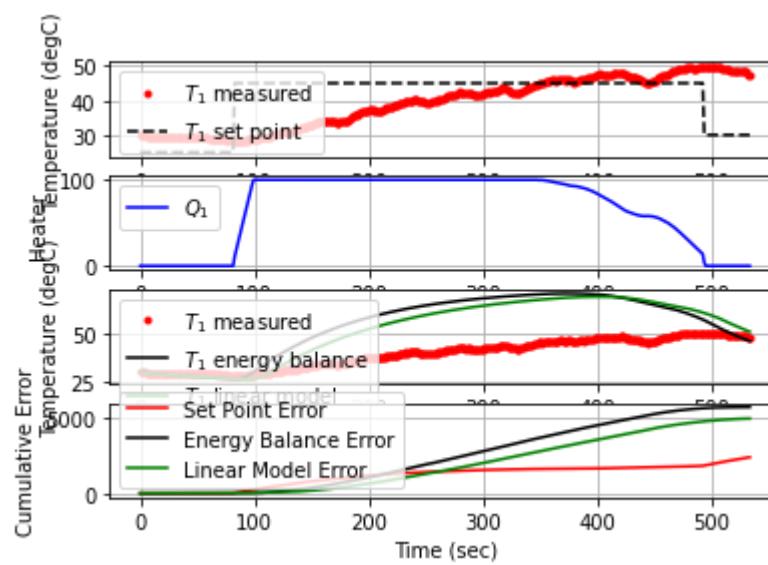
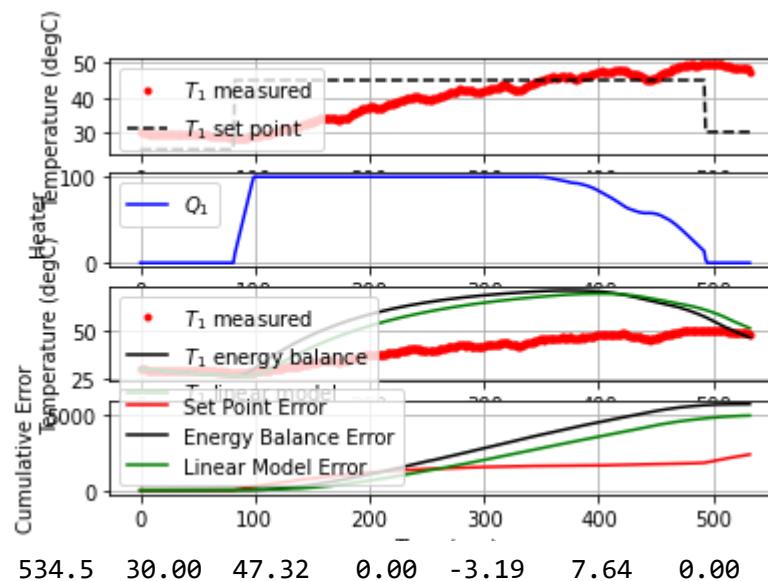
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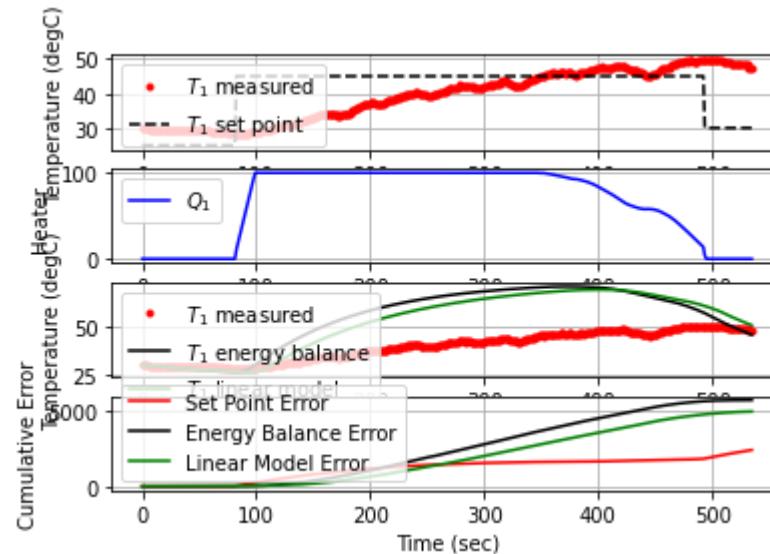
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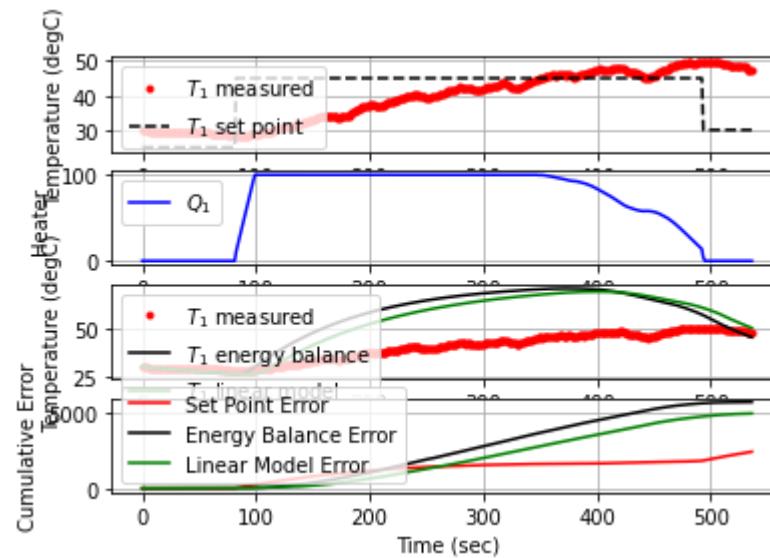
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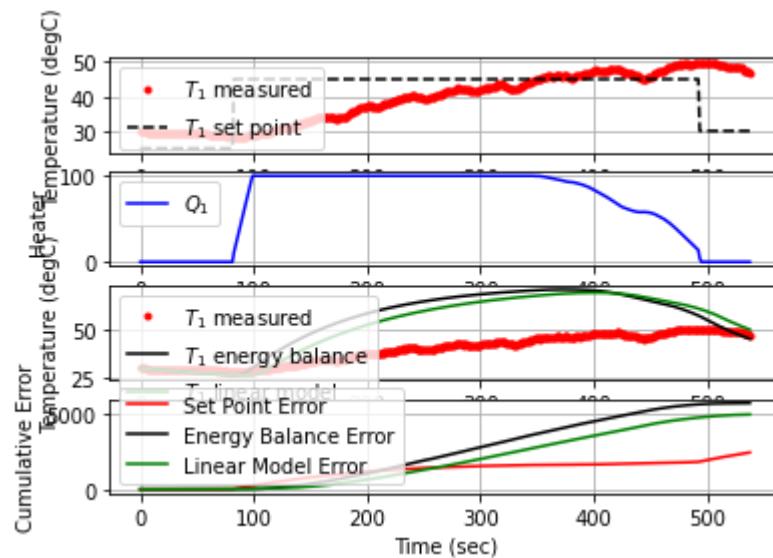
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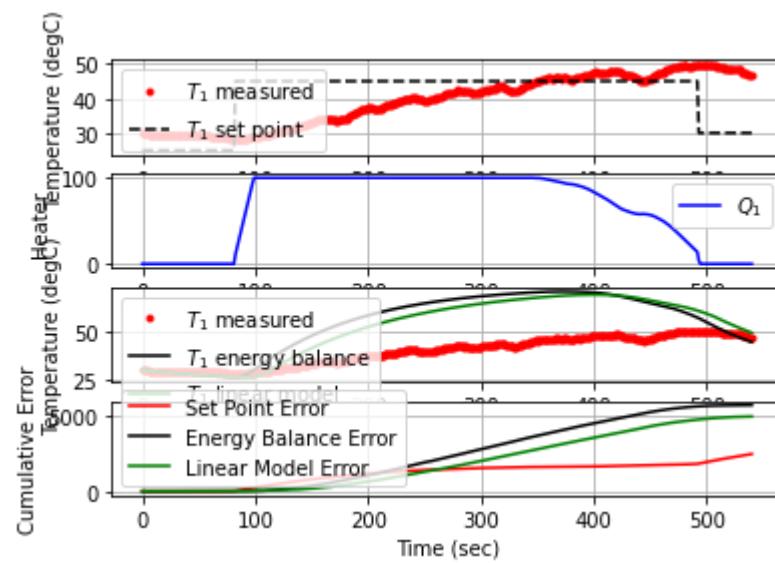
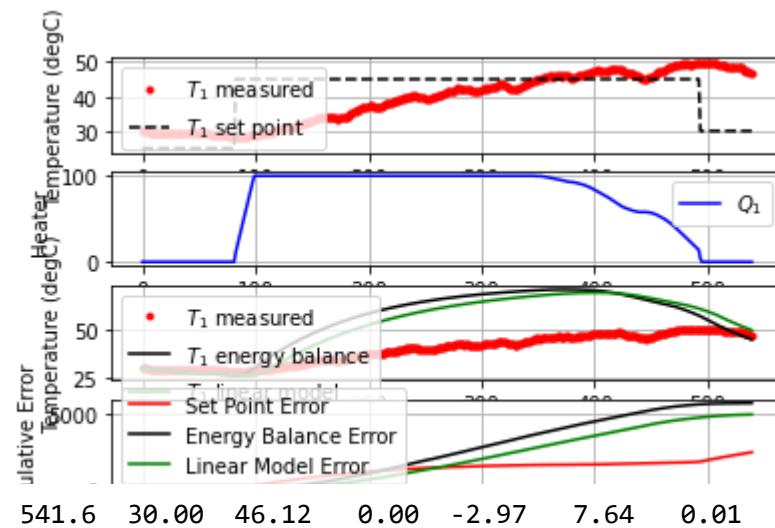
537.4 30.00 46.94 0.00 -3.12 7.64 0.01



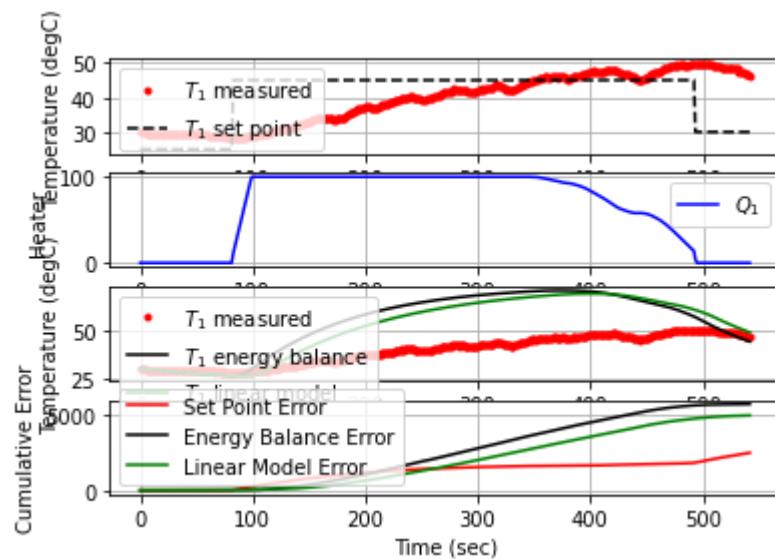
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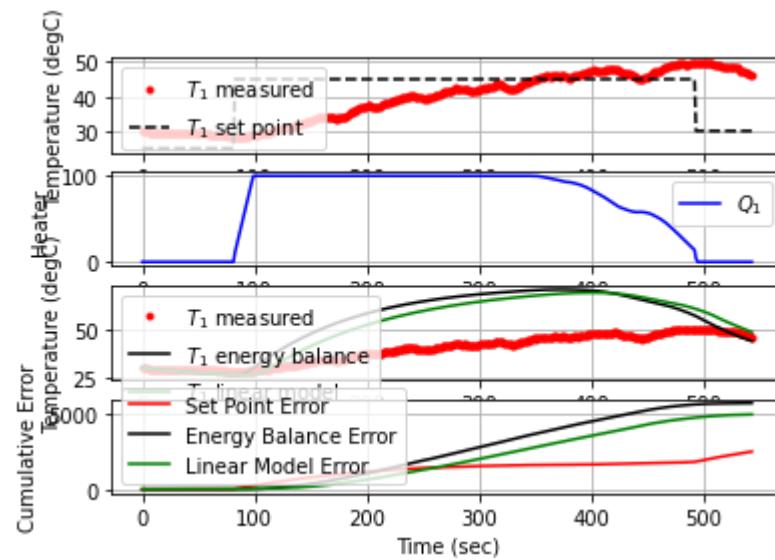
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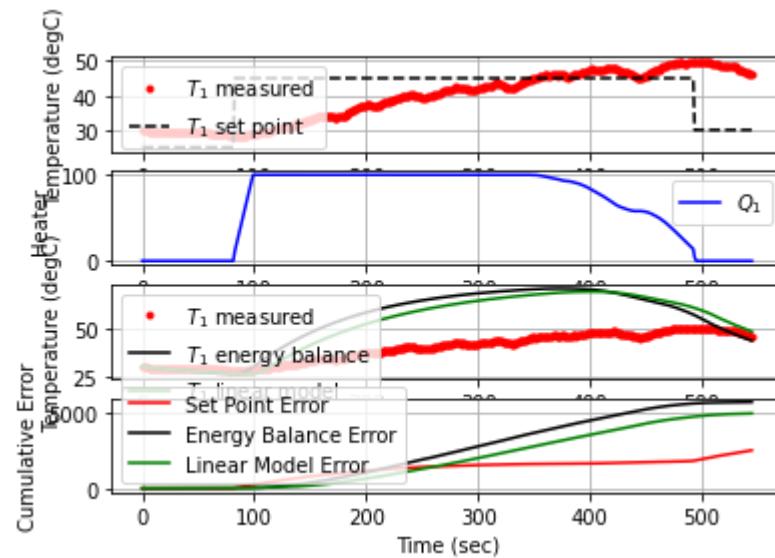
543.0 30.00 45.98 0.00 -2.94 7.64 0.00



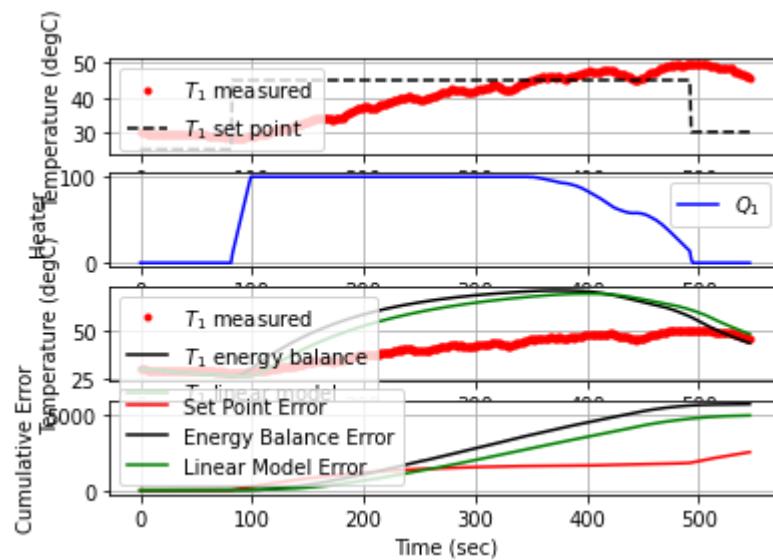
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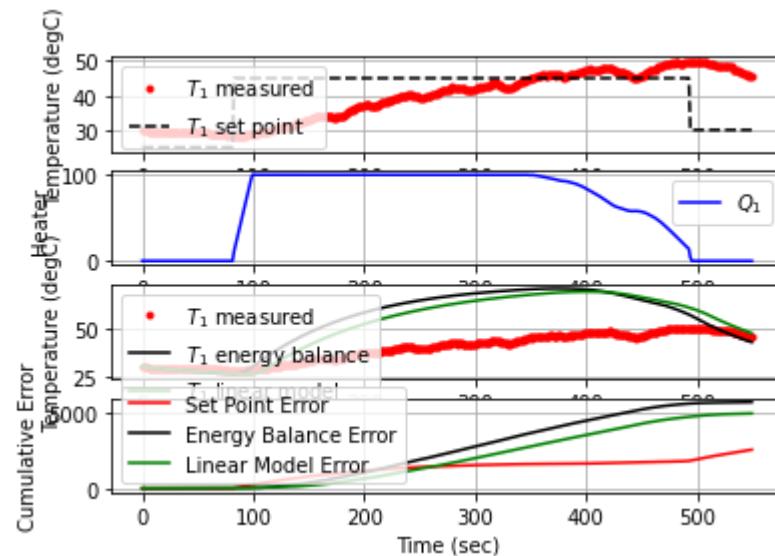
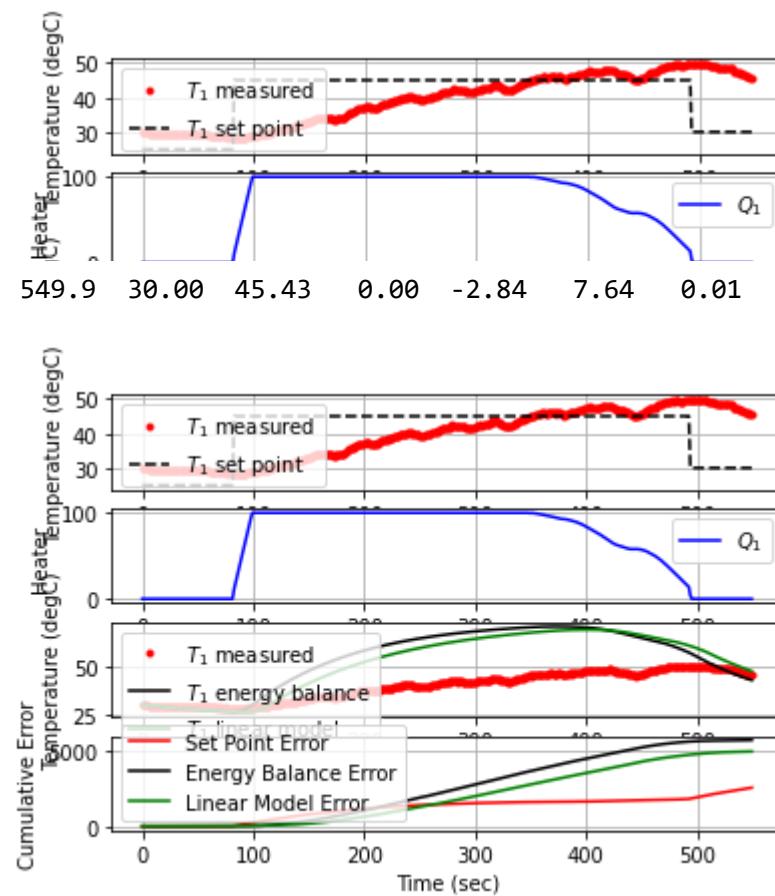
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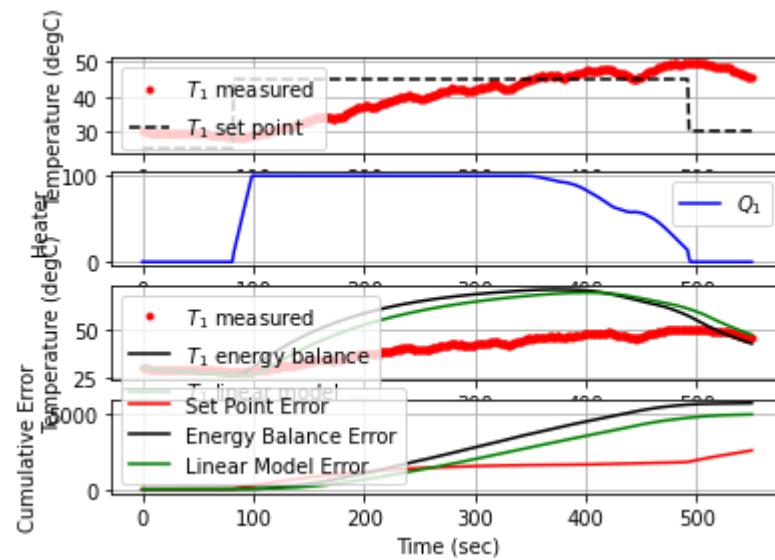
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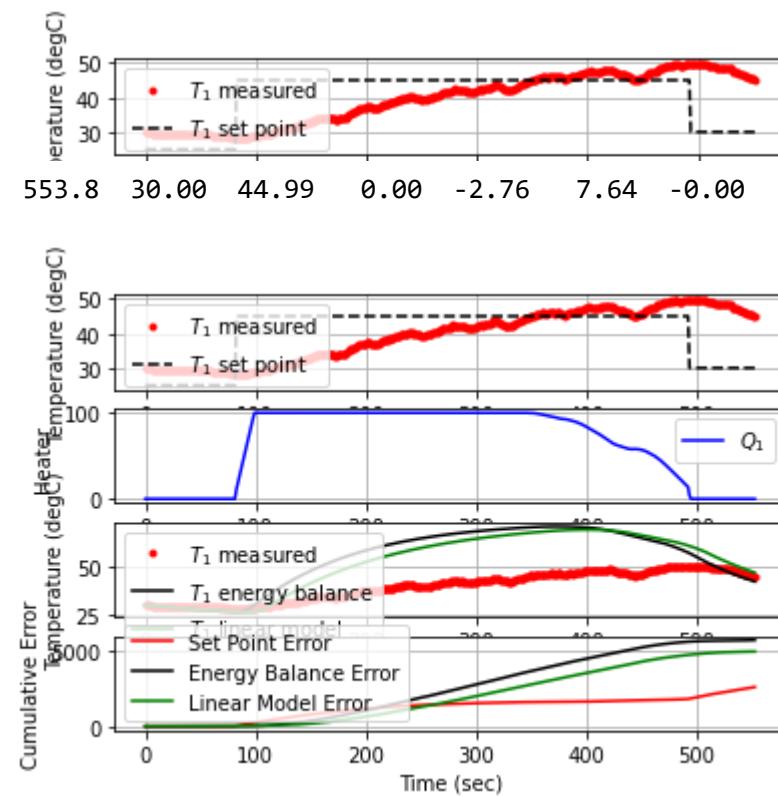
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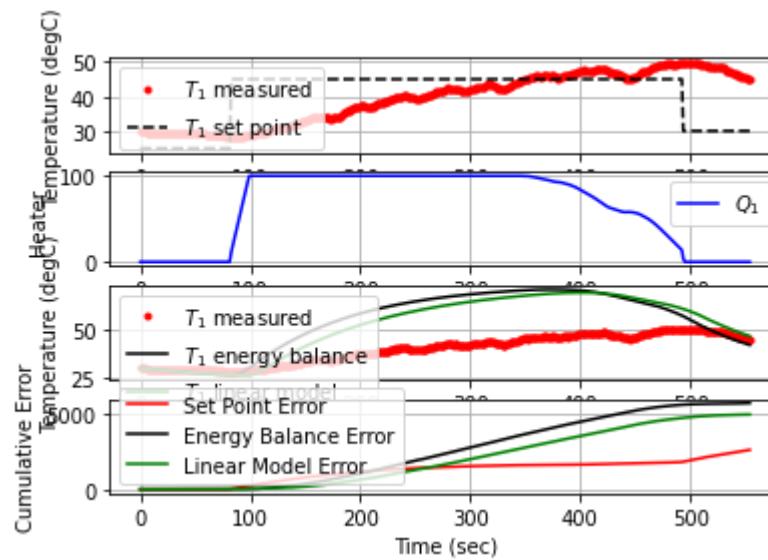
551.2 30.00 44.96 0.00 -2.76 7.64 0.02



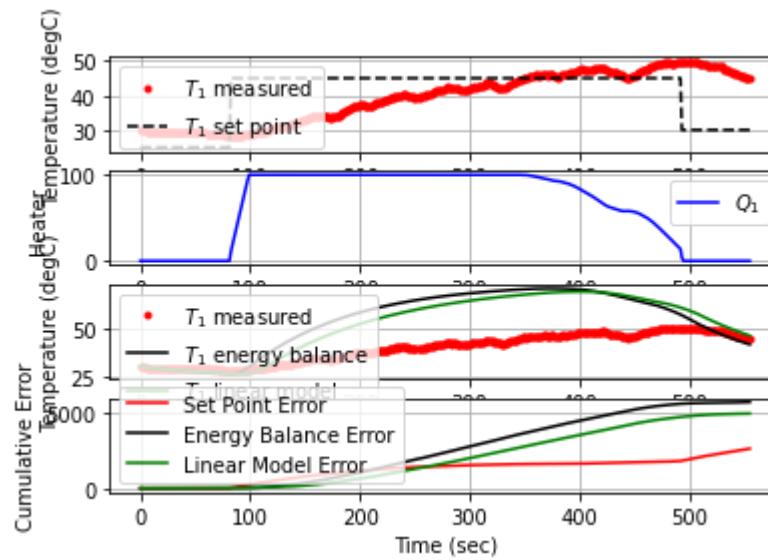
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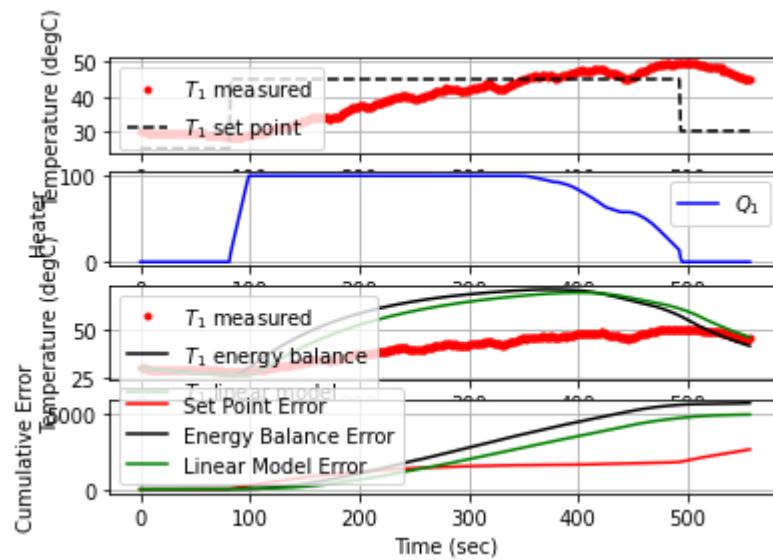
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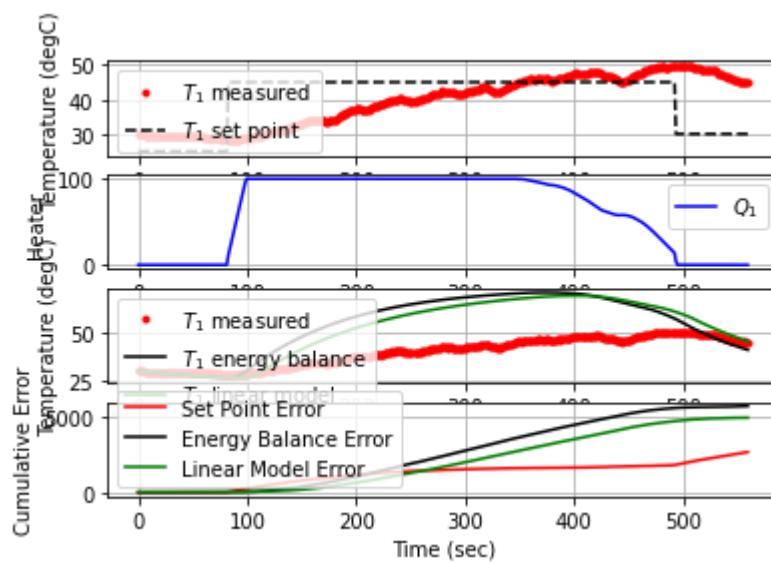
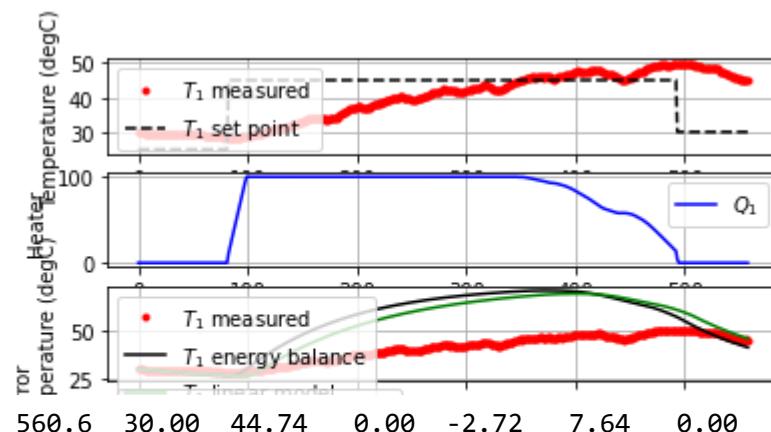
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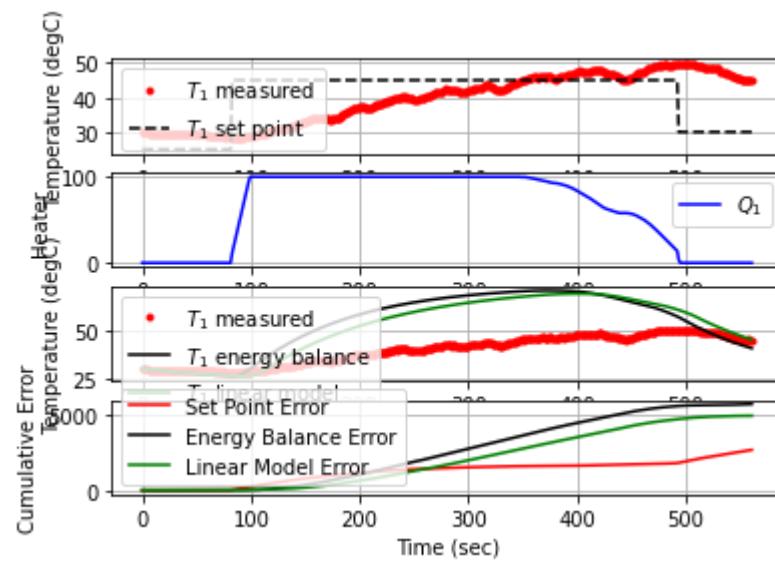
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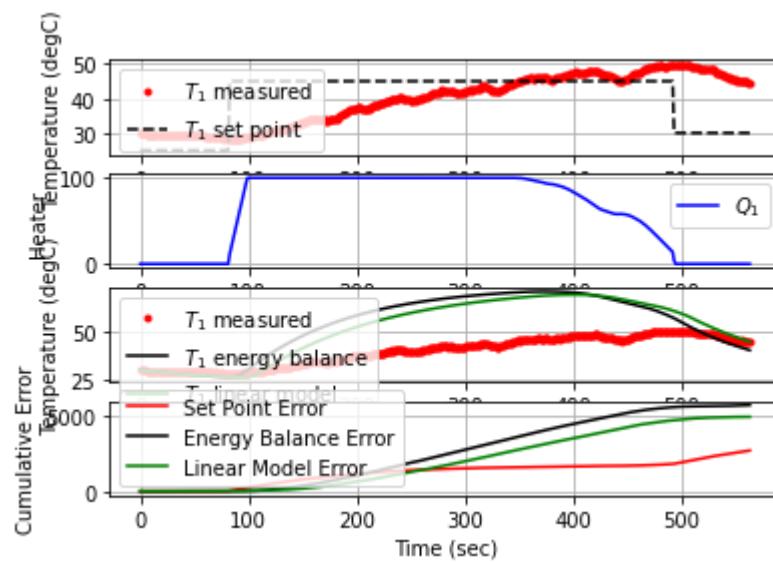
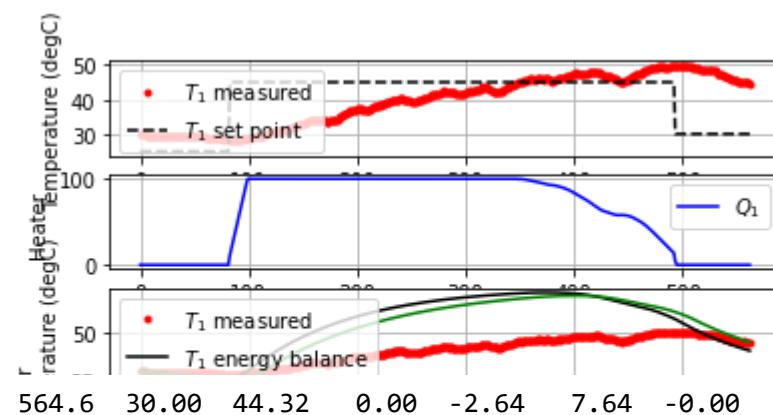
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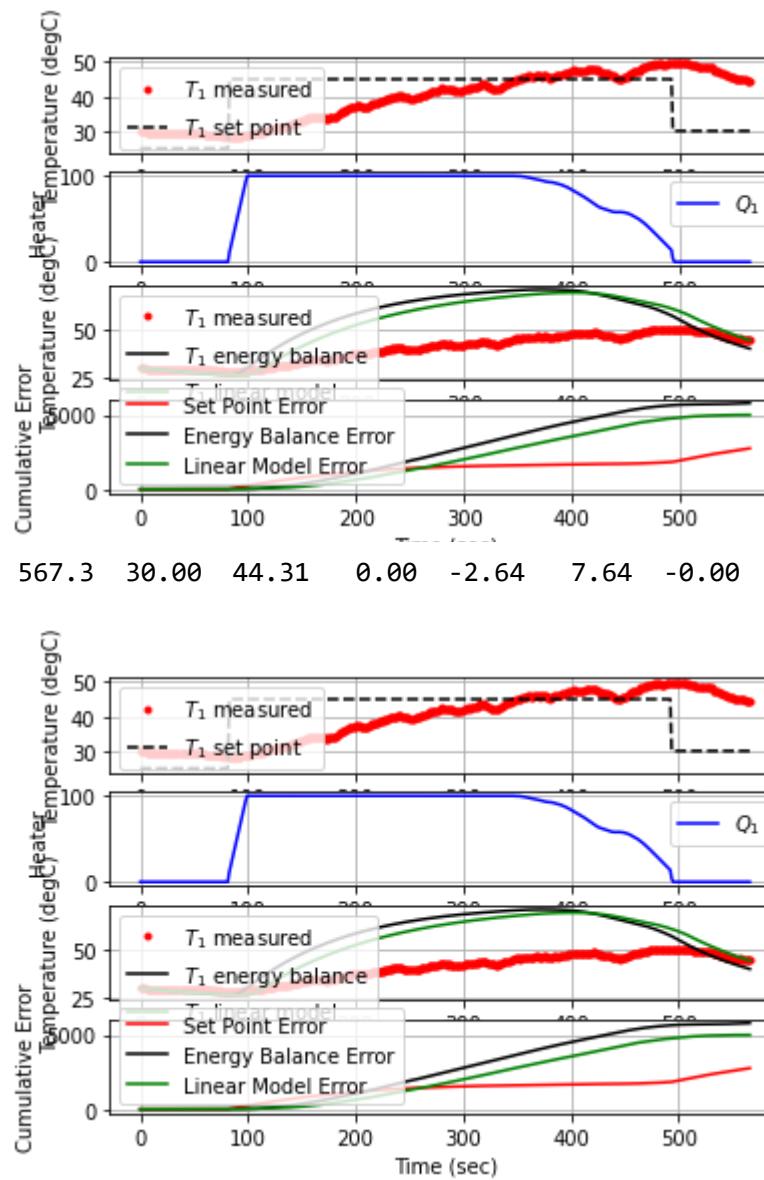
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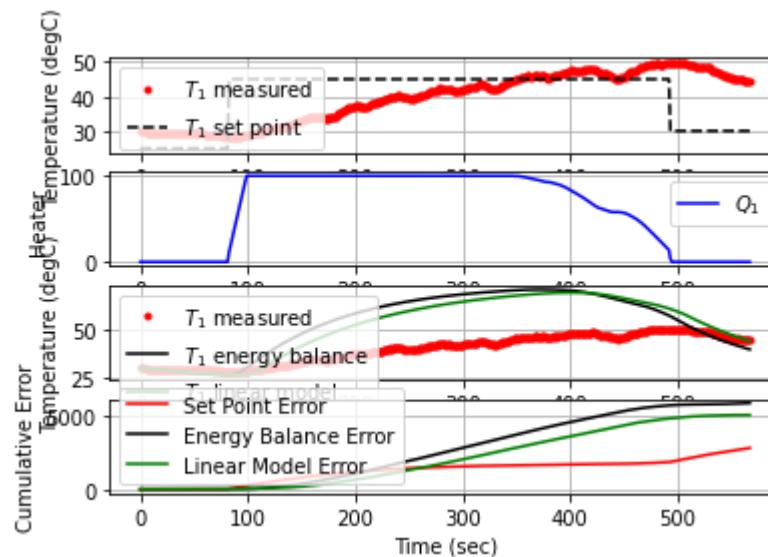
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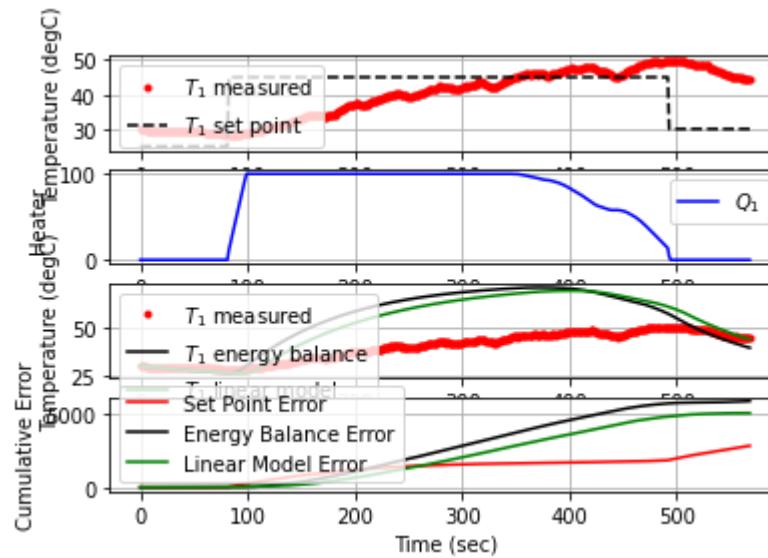
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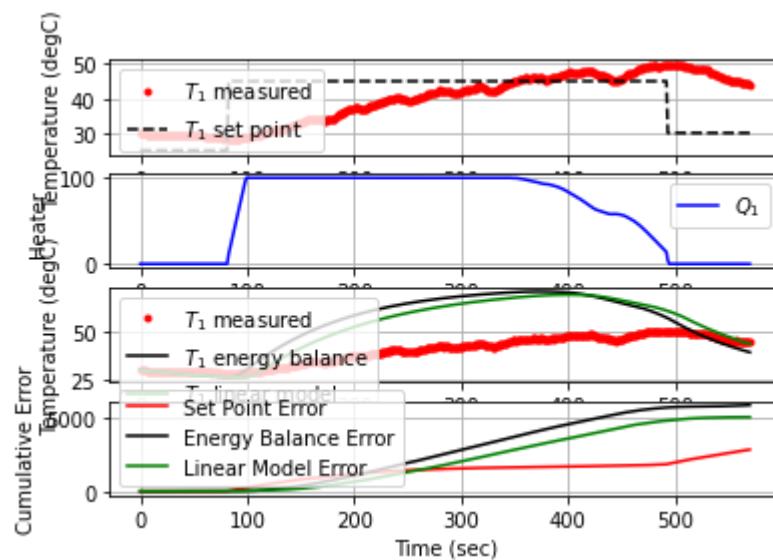
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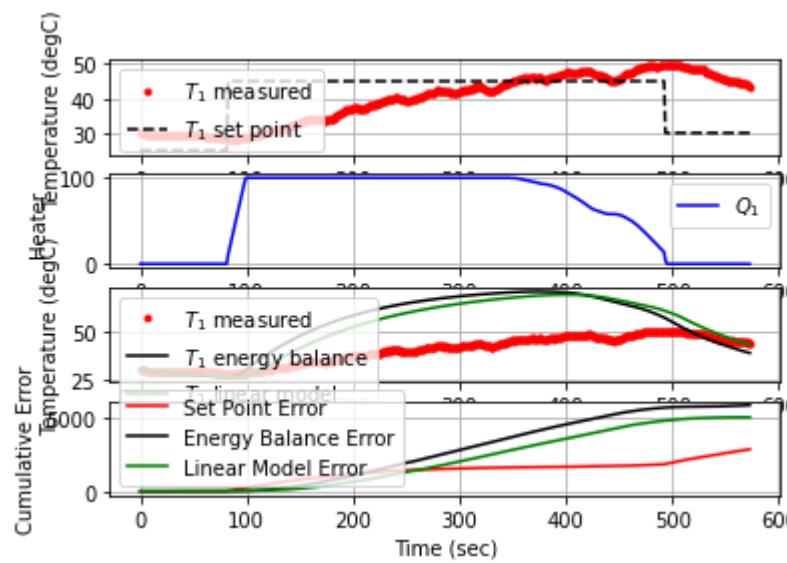
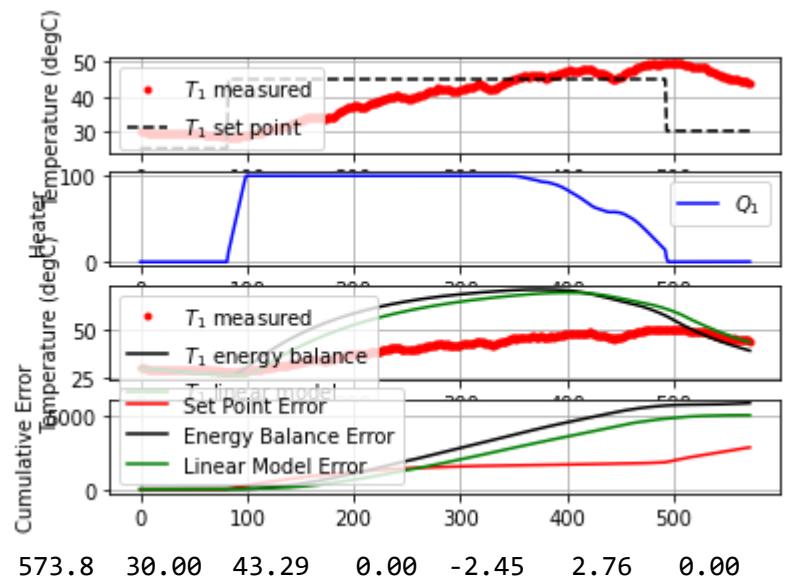
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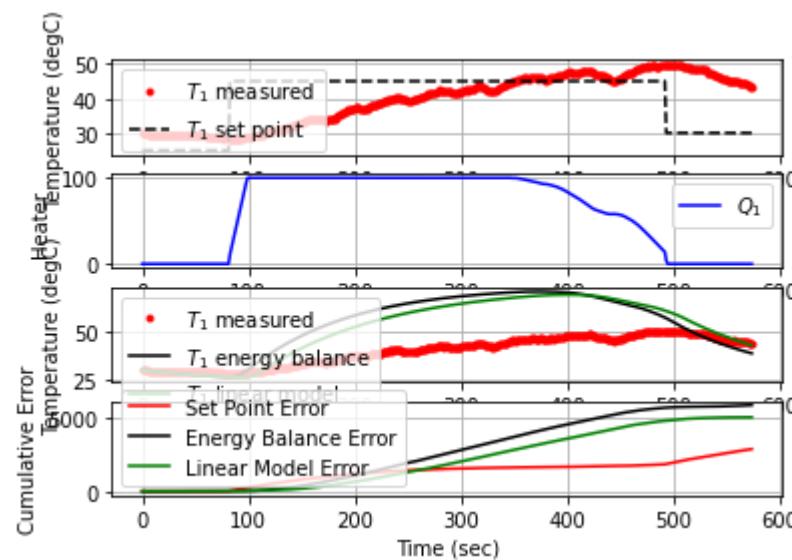
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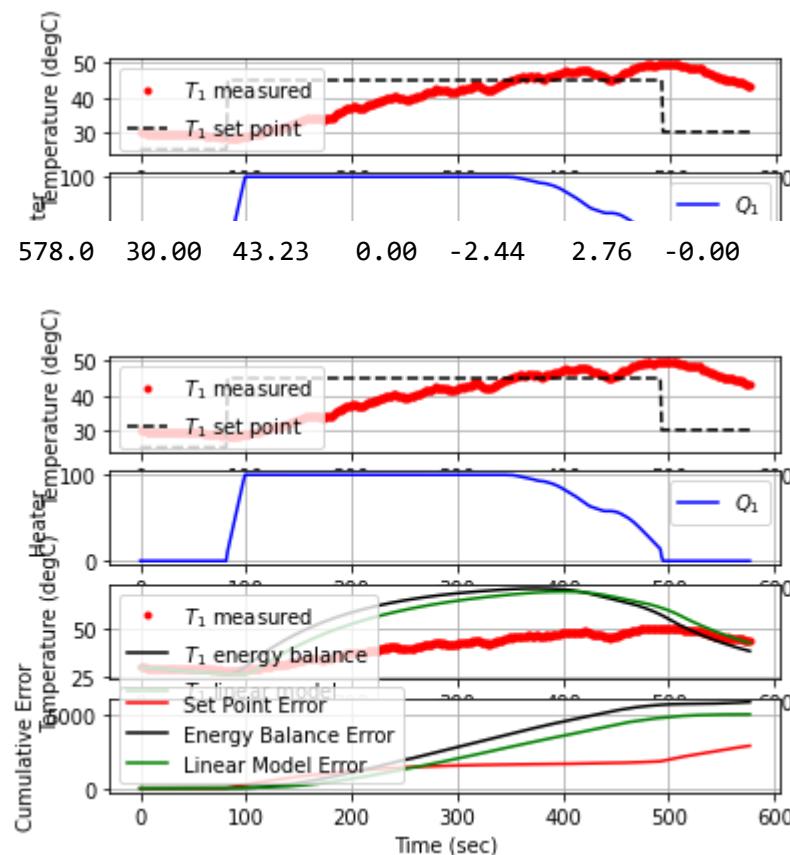
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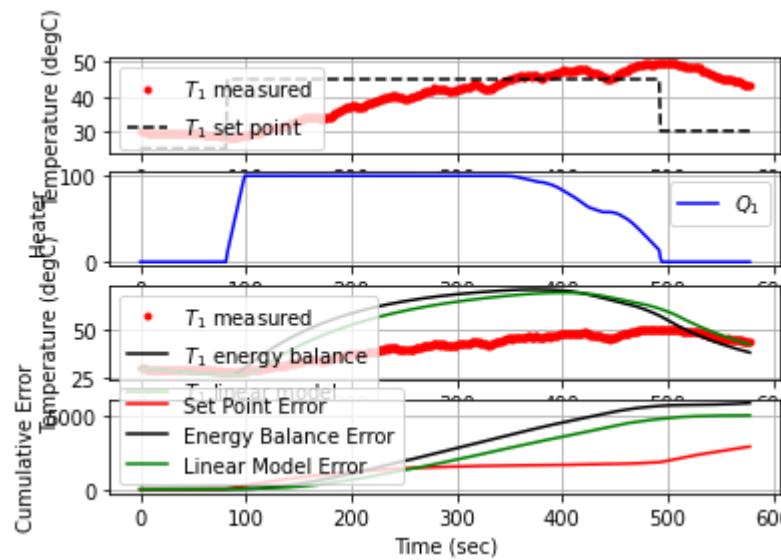
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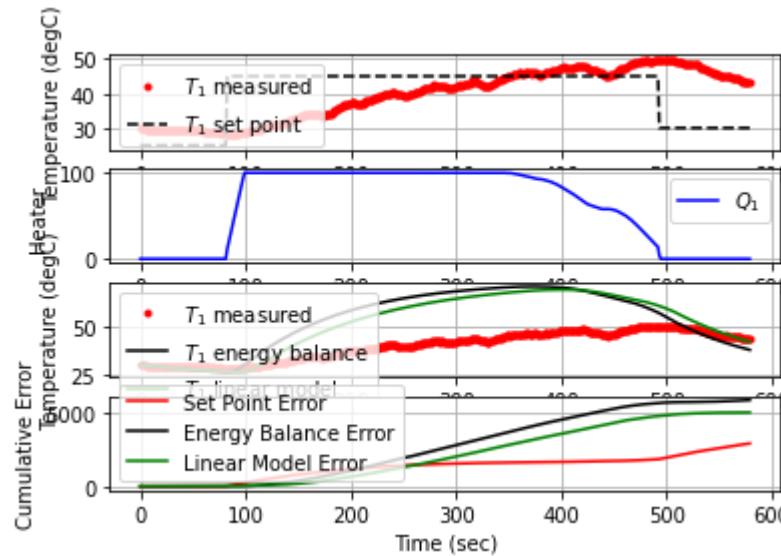
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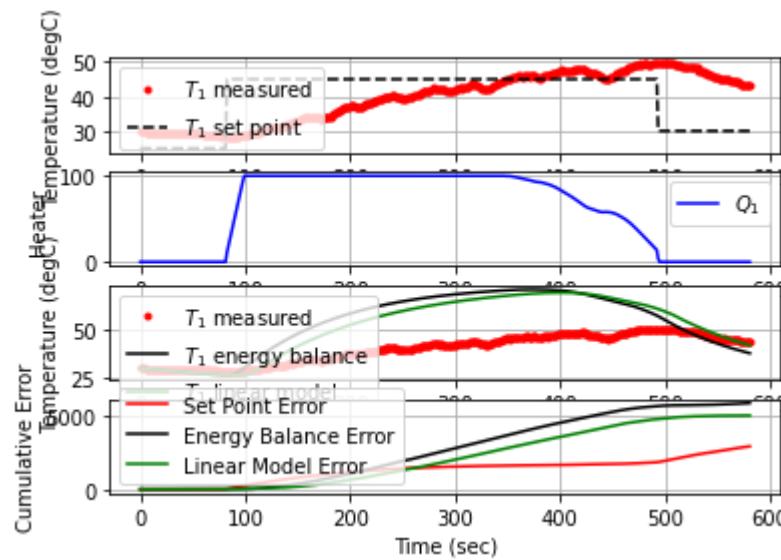
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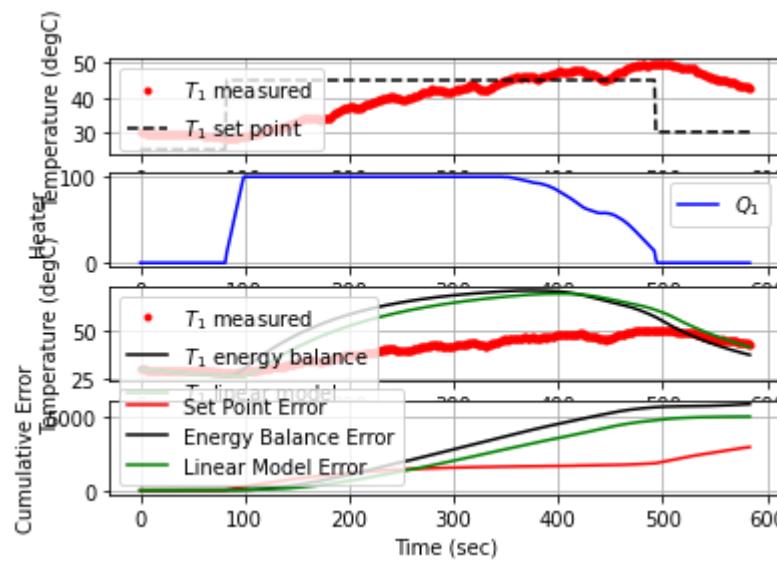
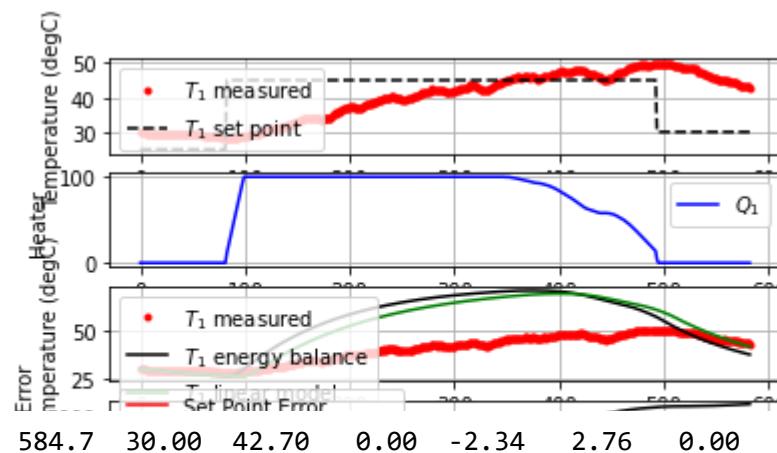
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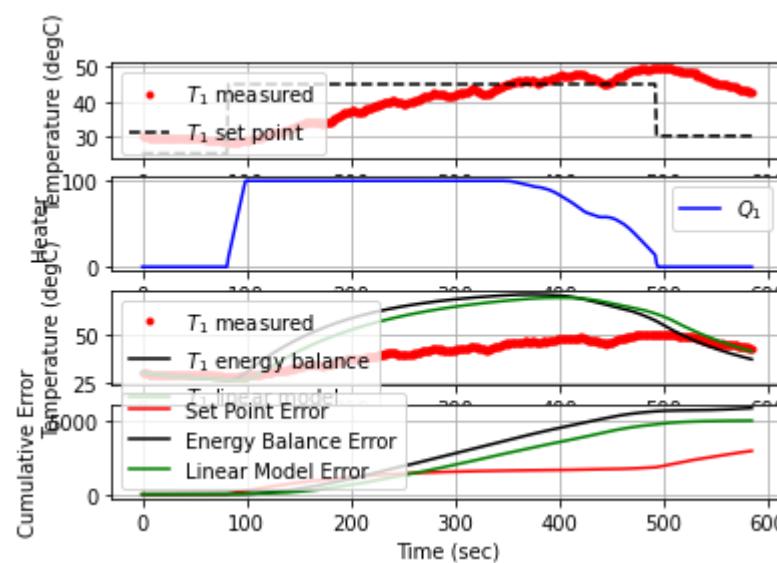
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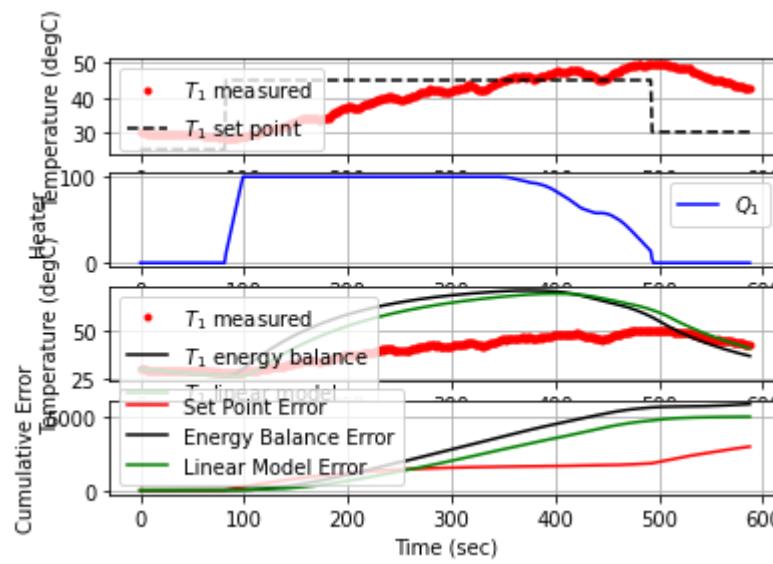
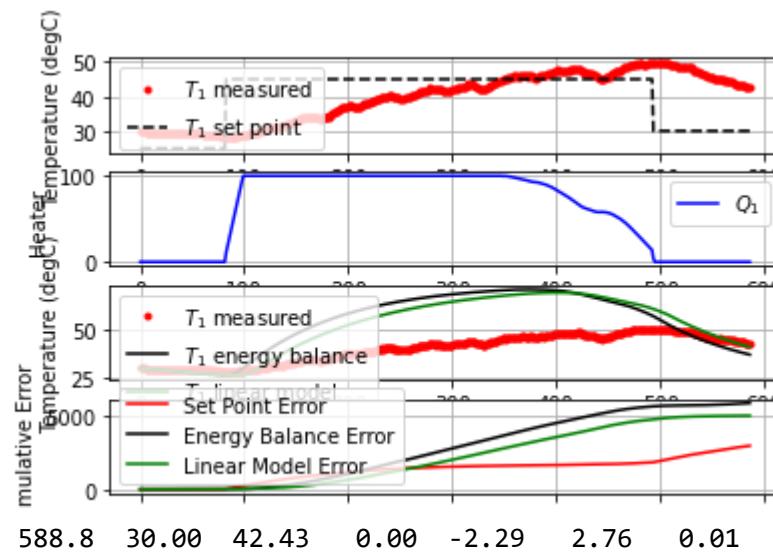
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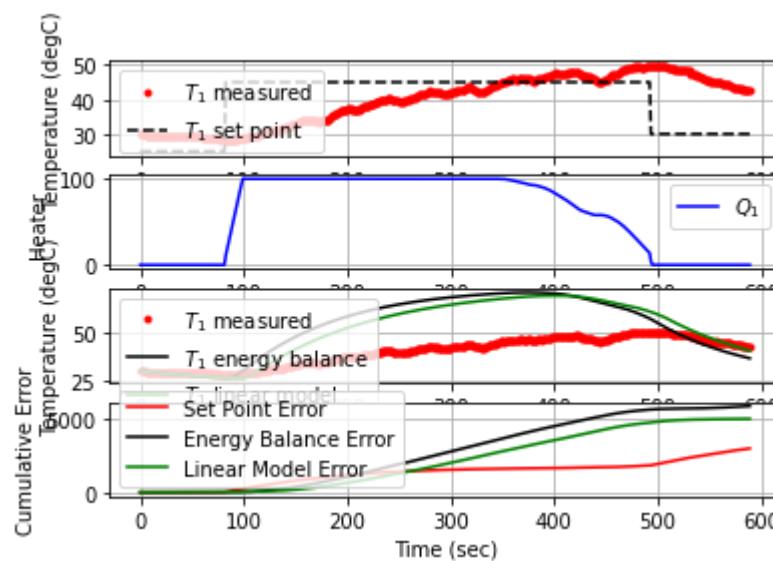
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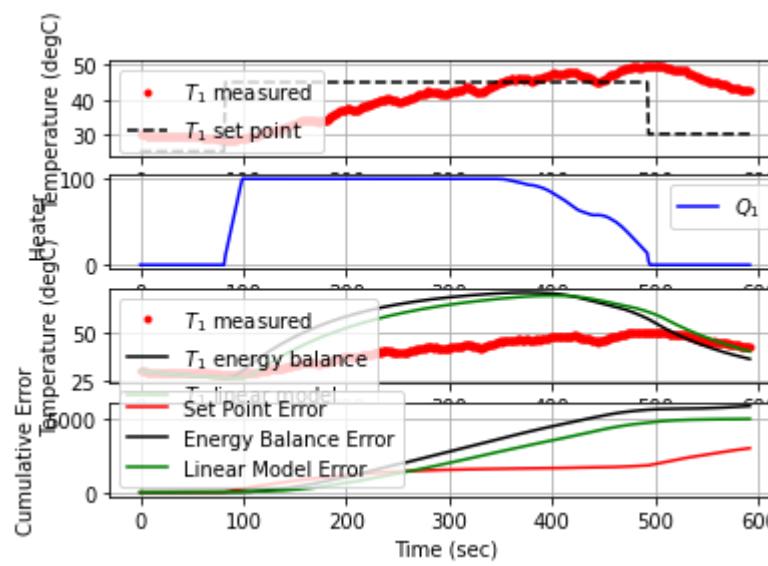
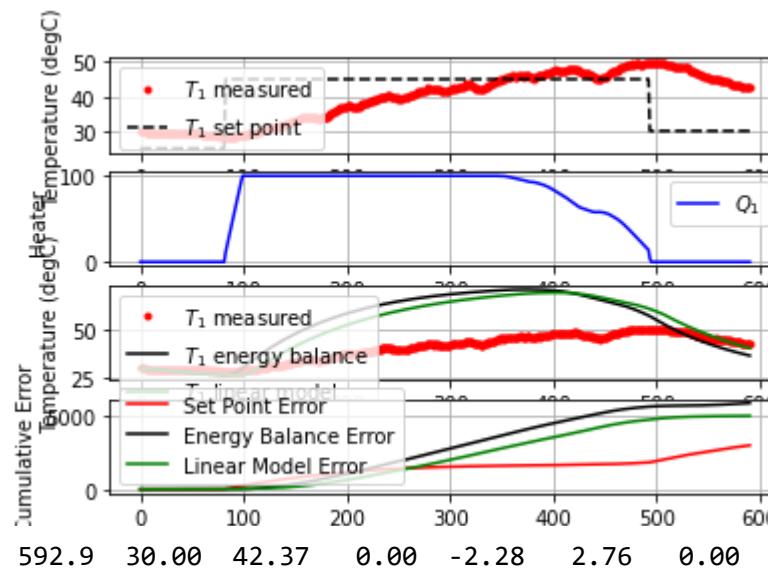
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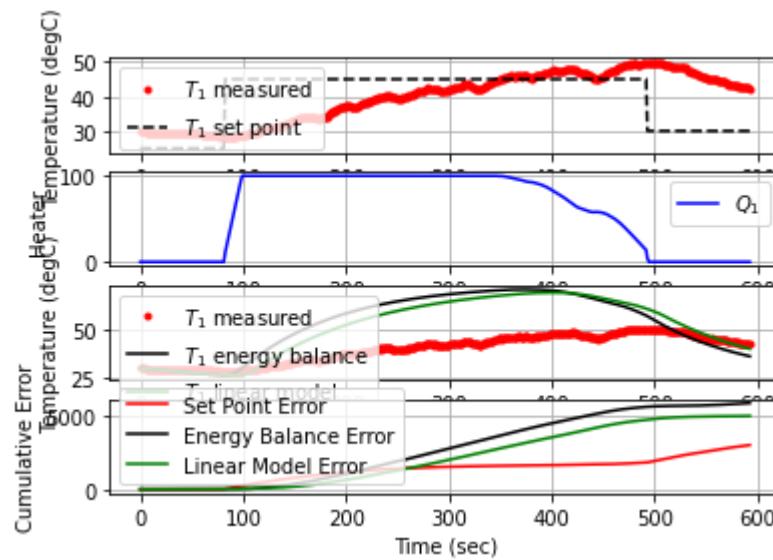
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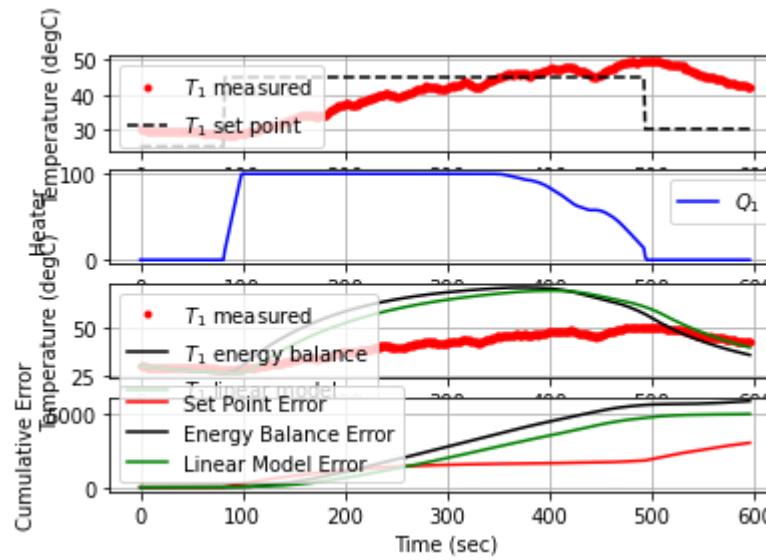
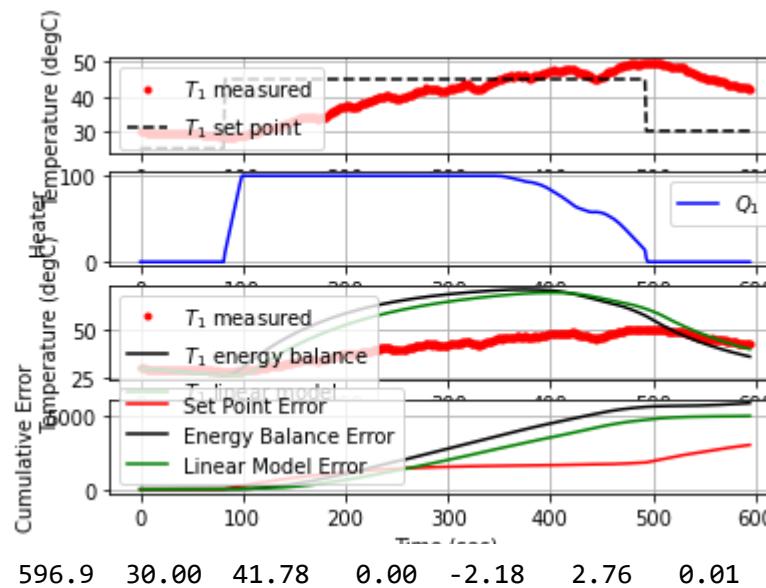
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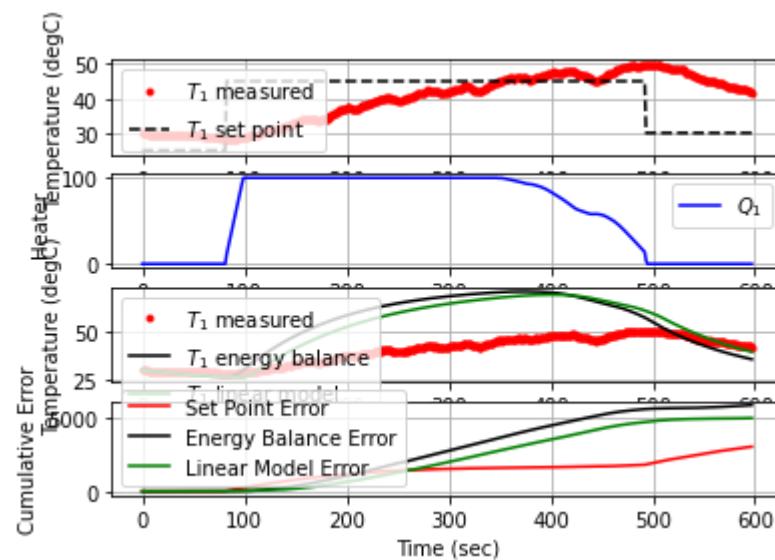
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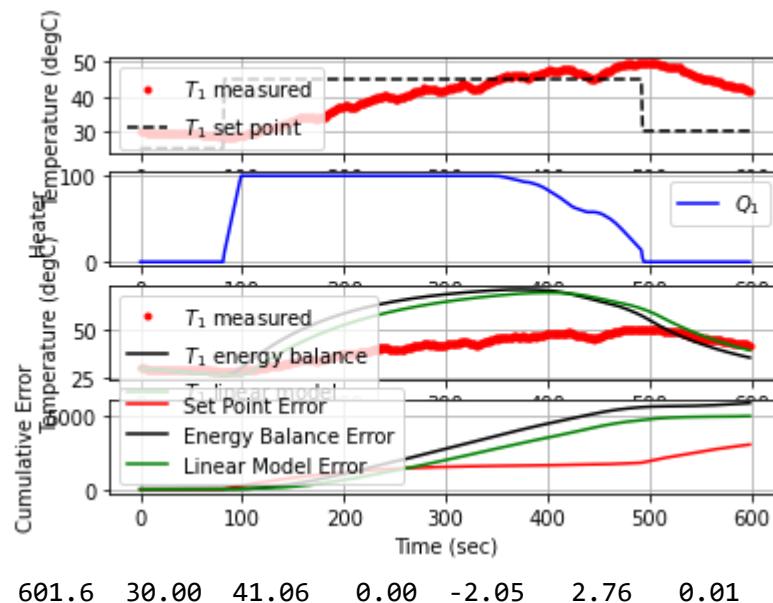
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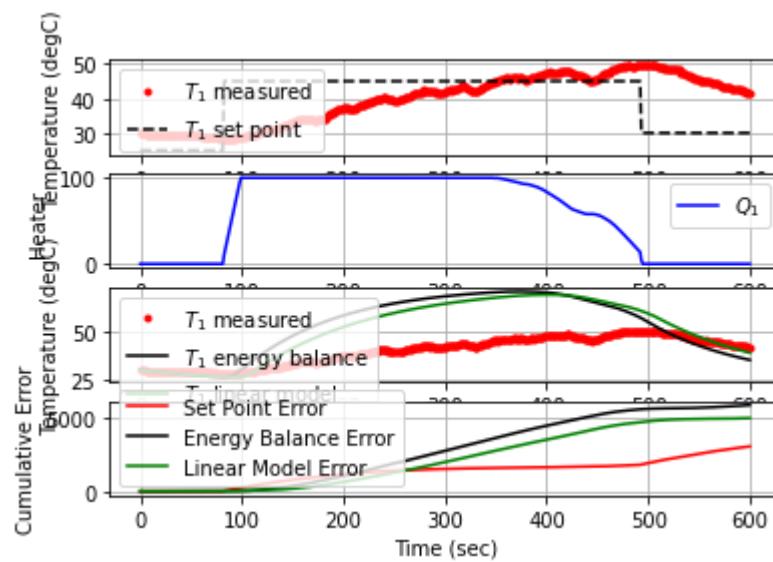
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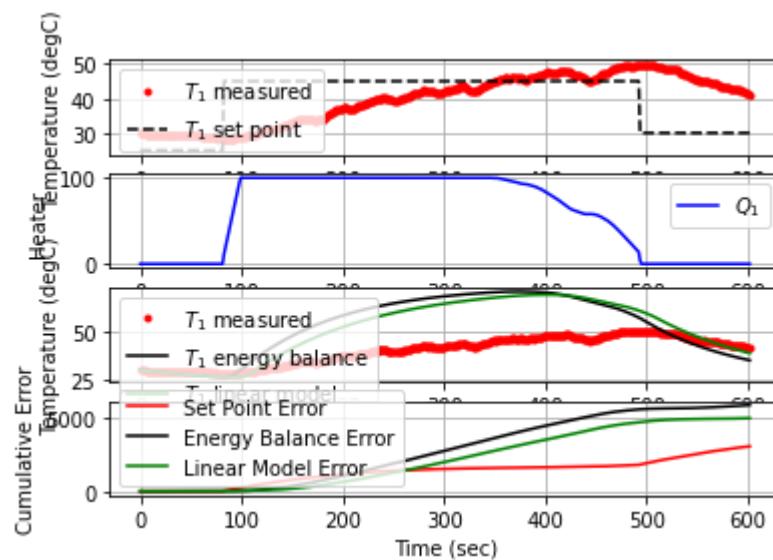
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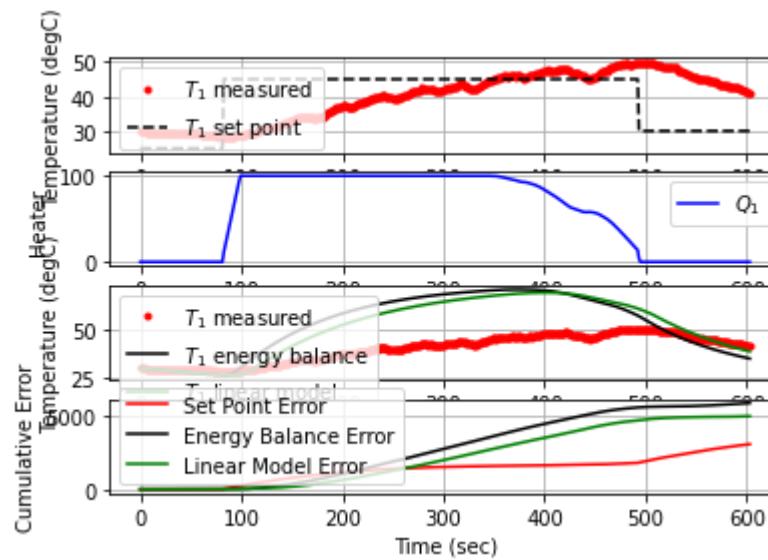
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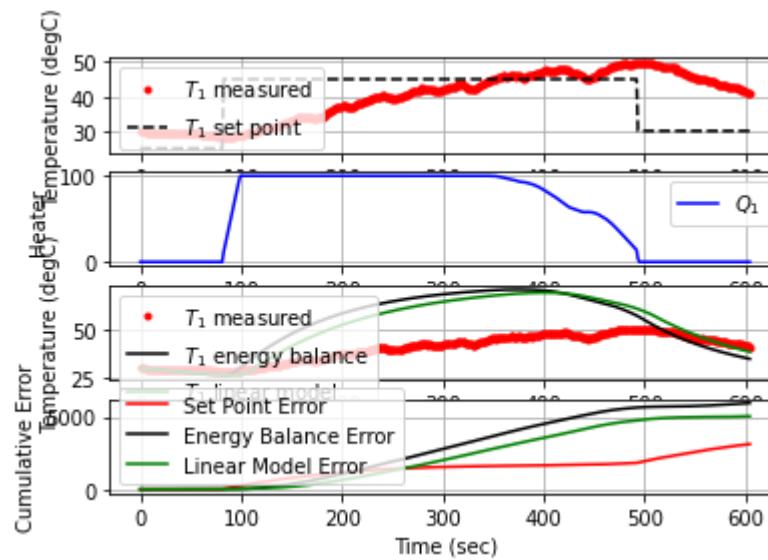
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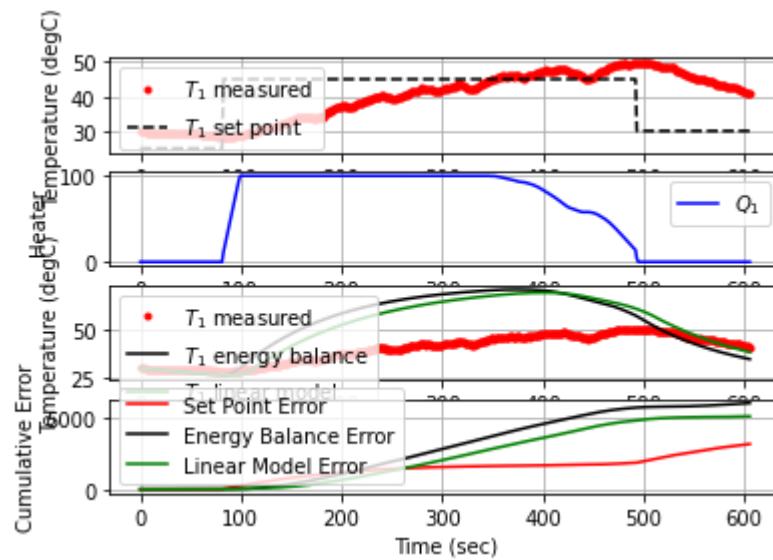
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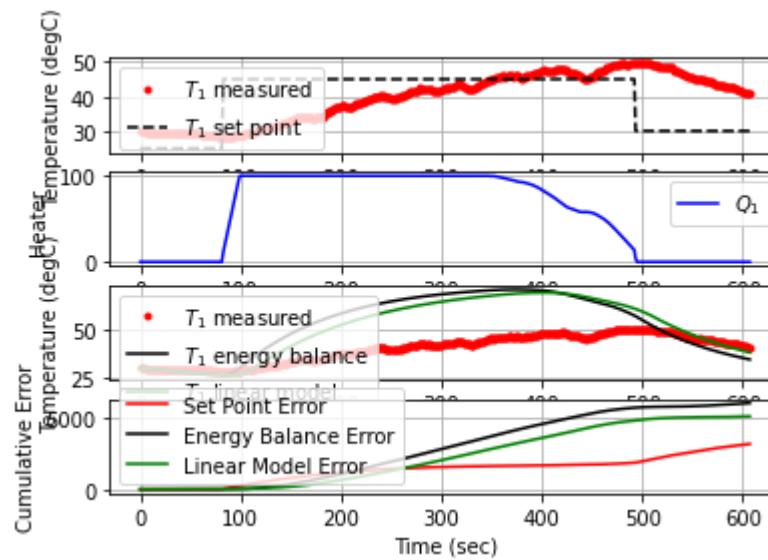
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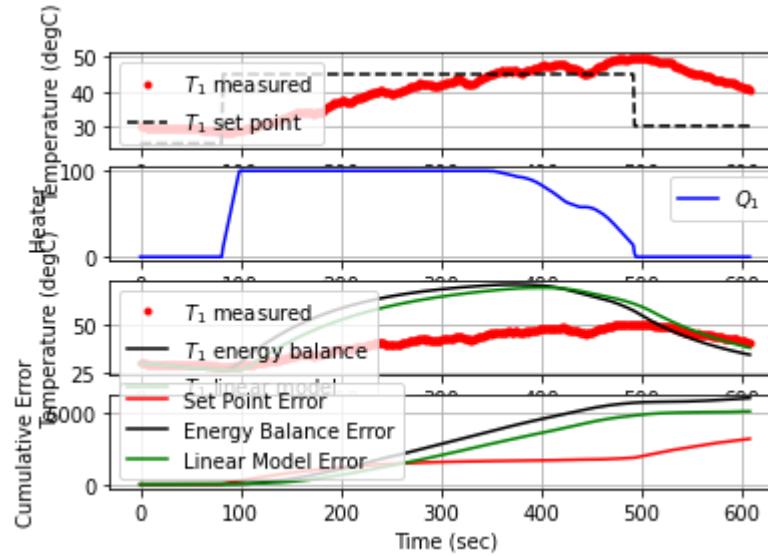
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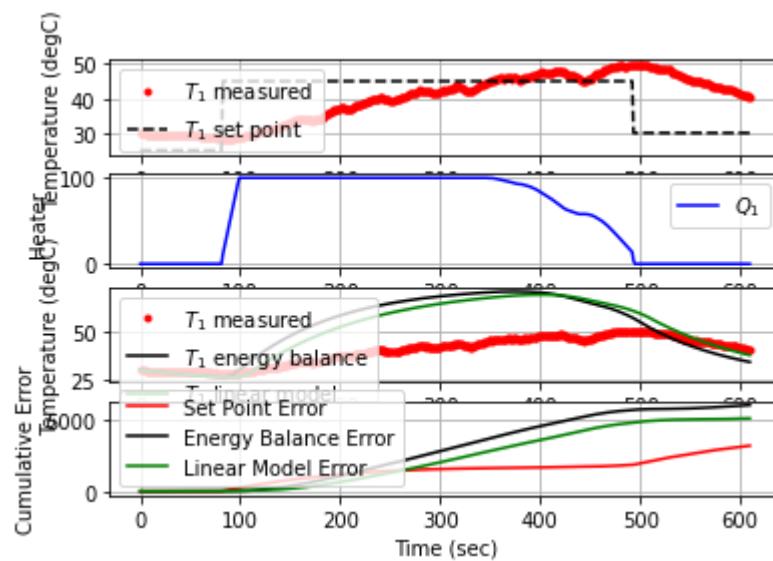
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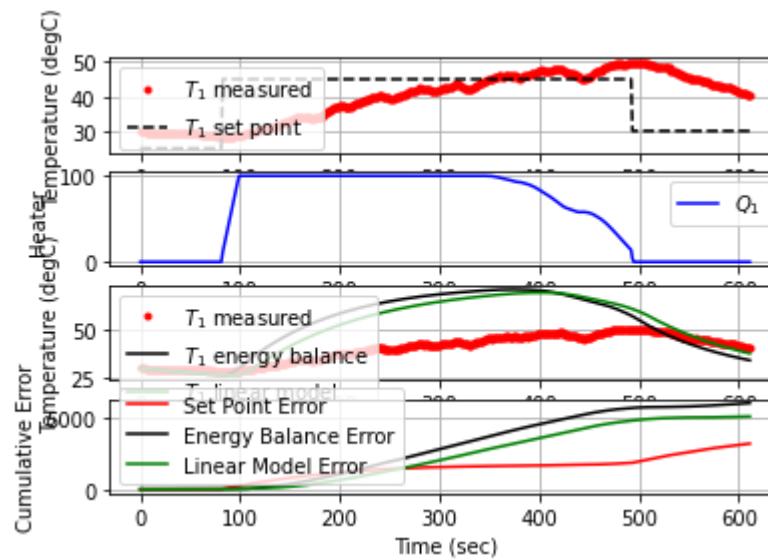
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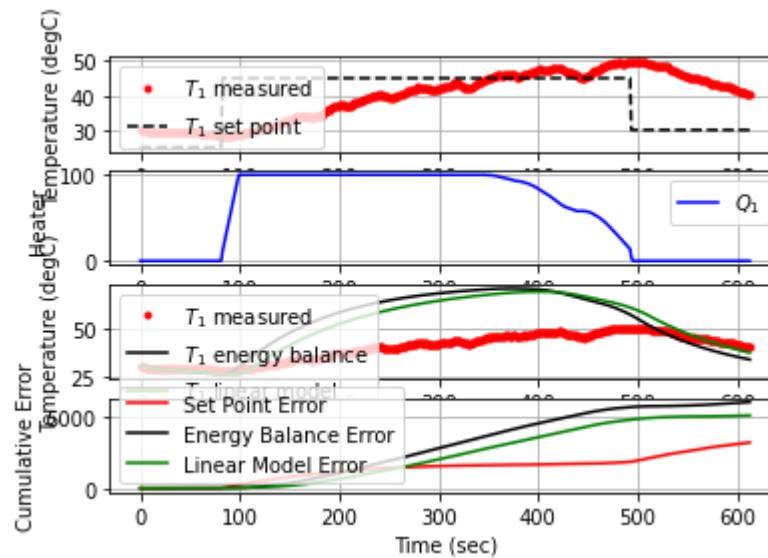
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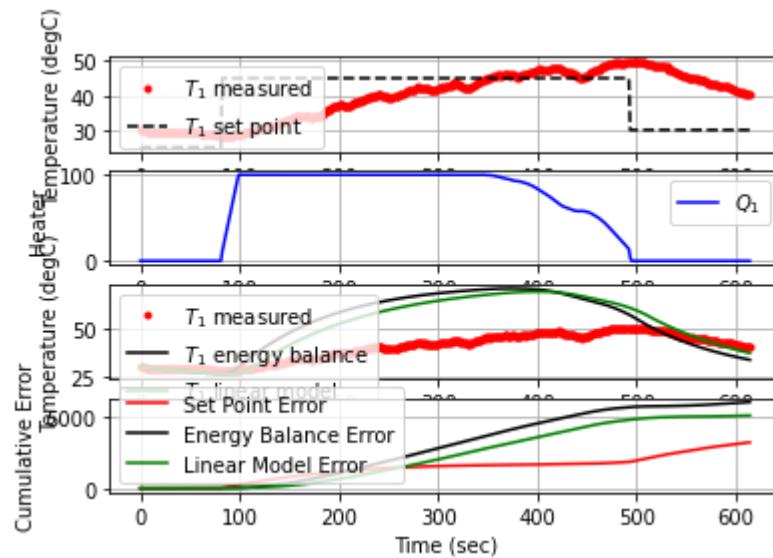
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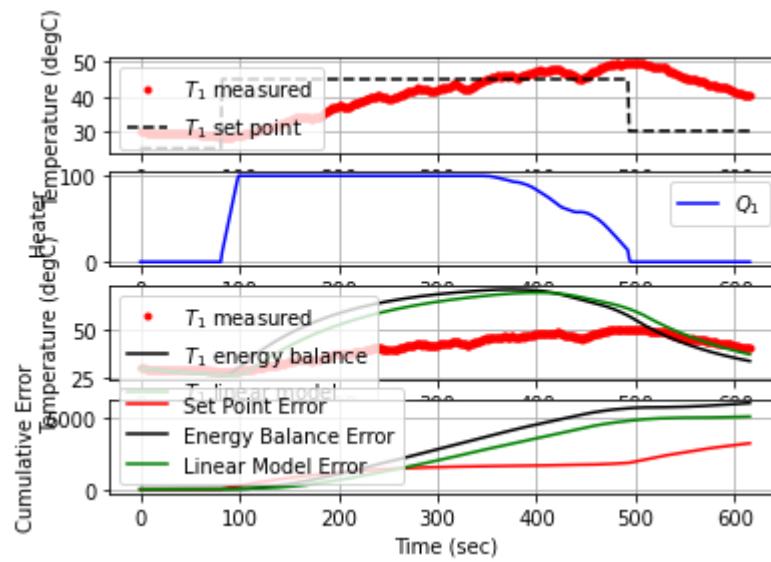
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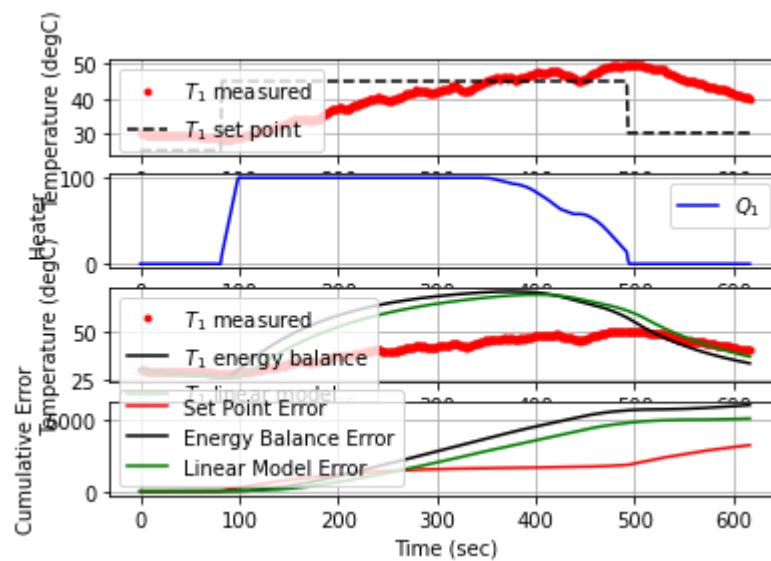
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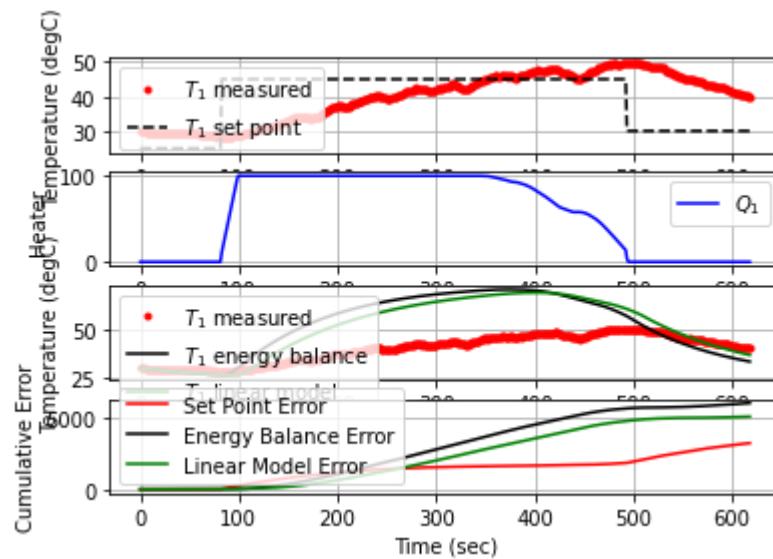
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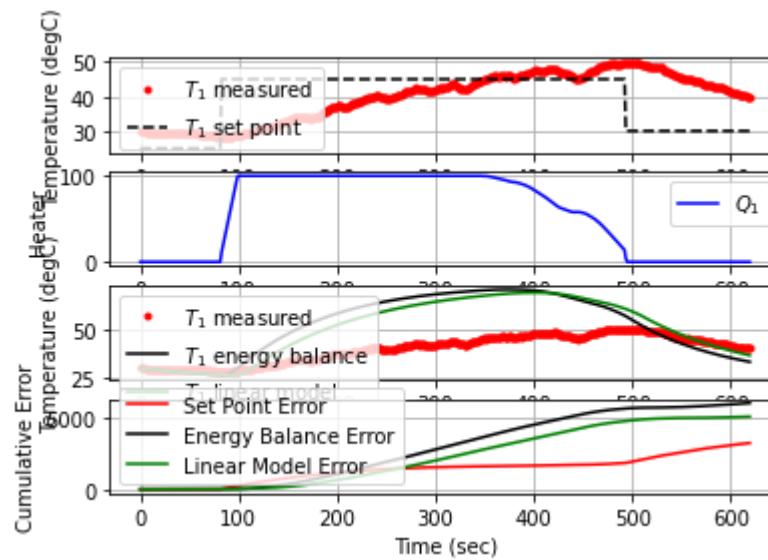
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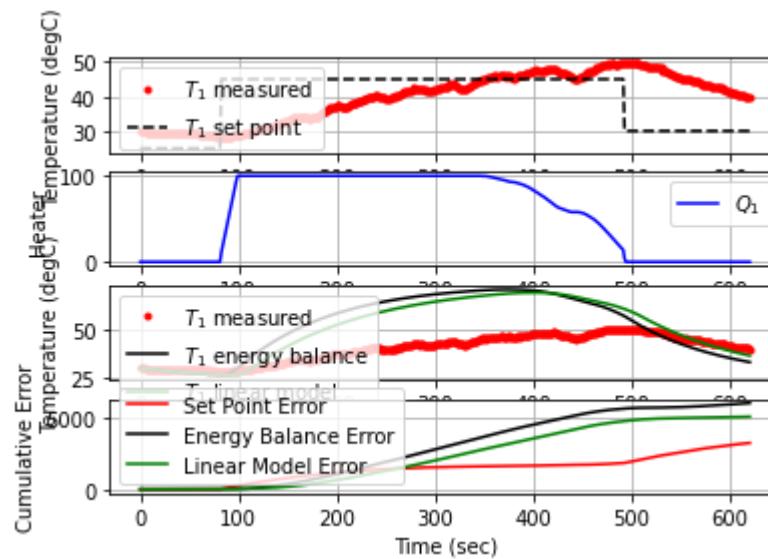
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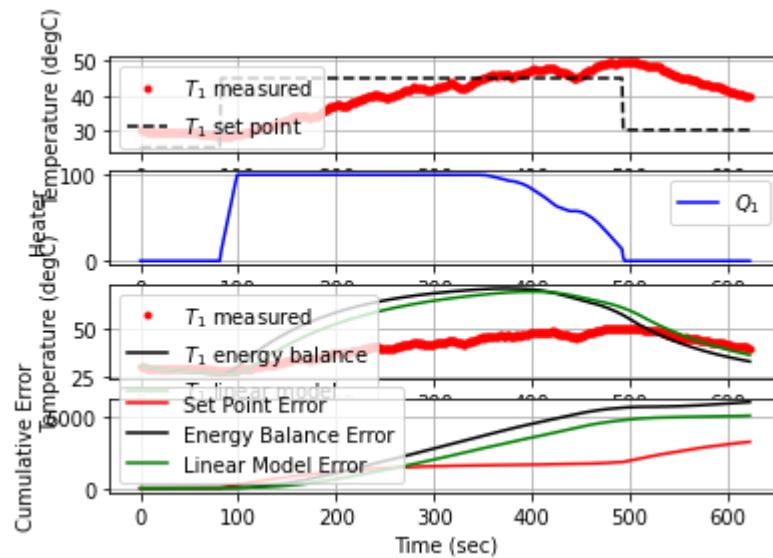
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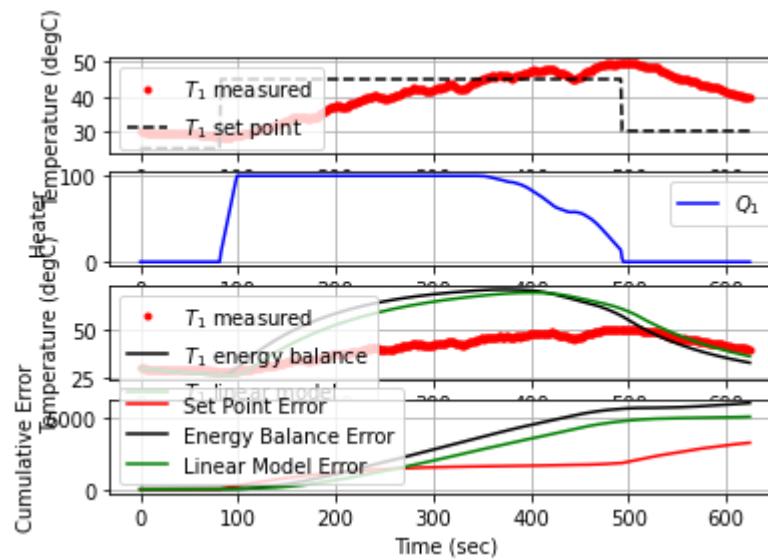
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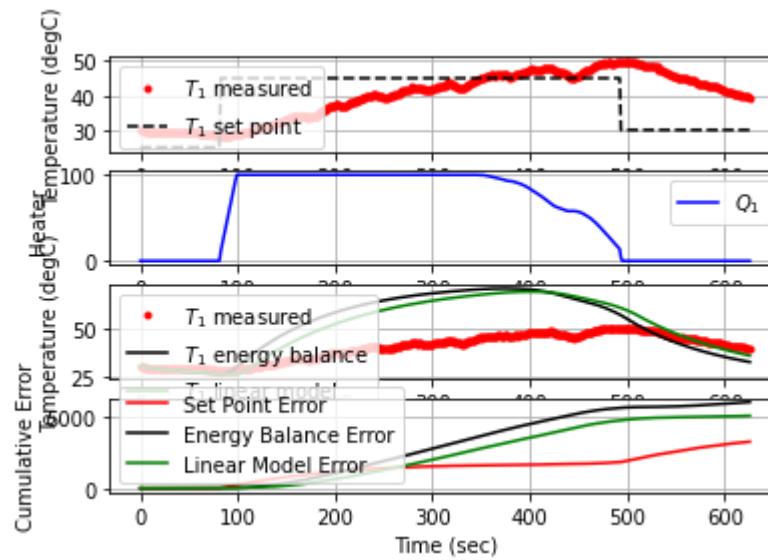
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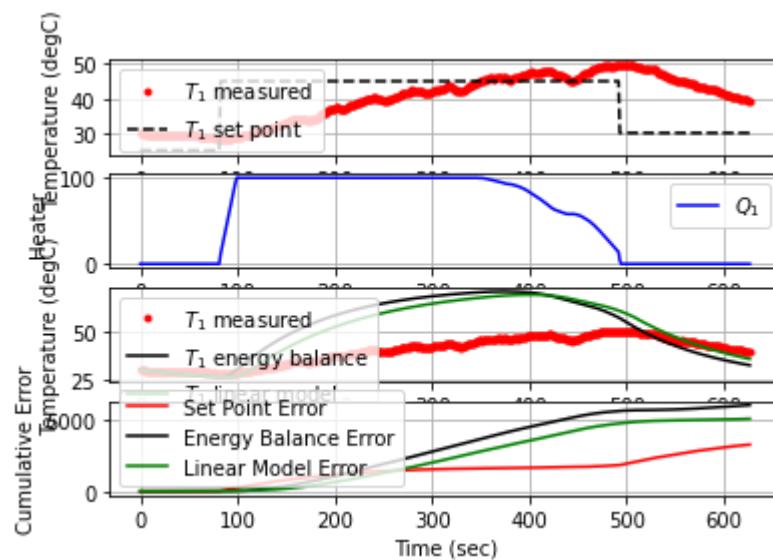
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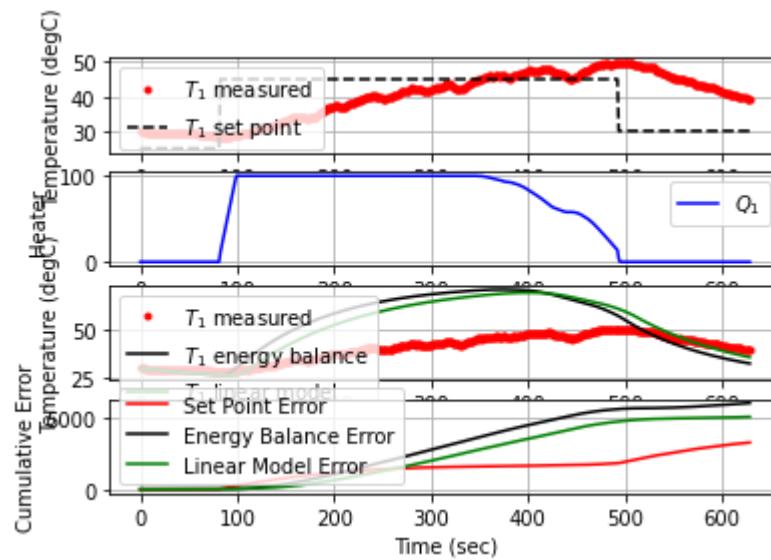
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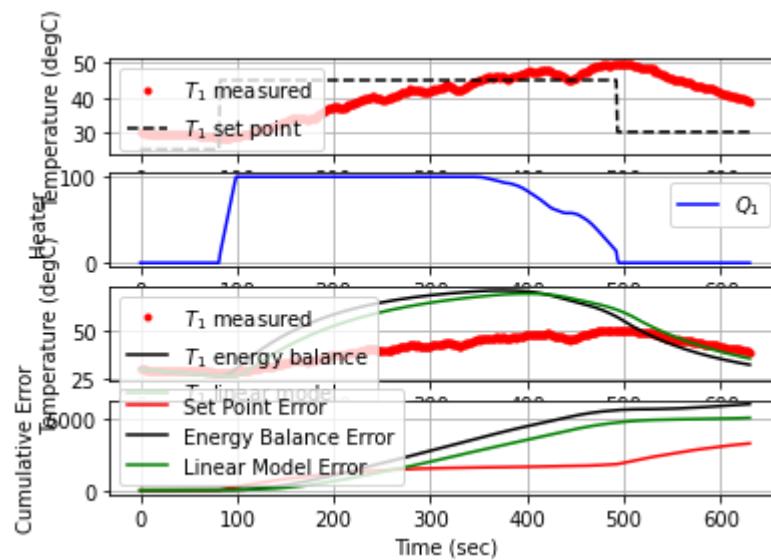
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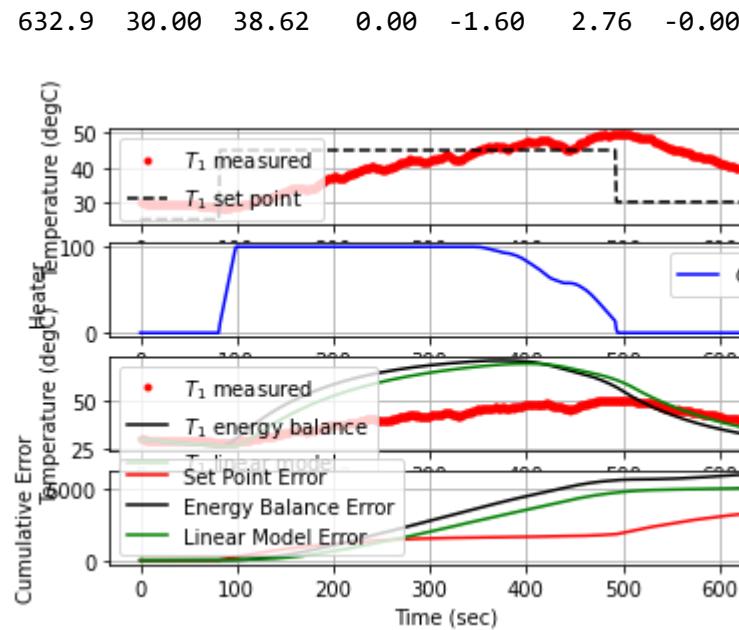


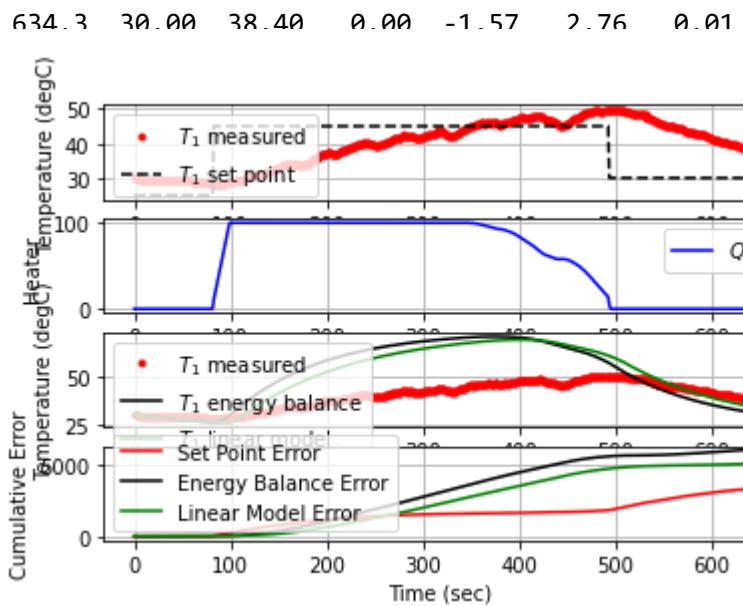
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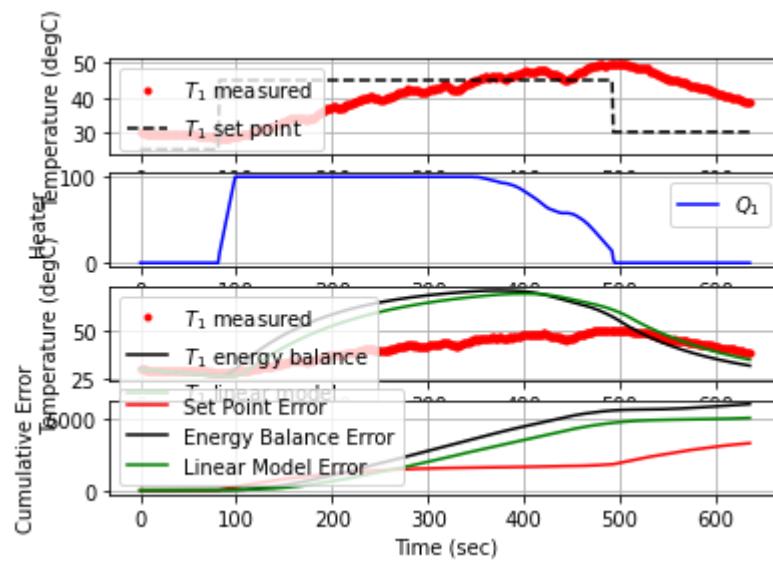
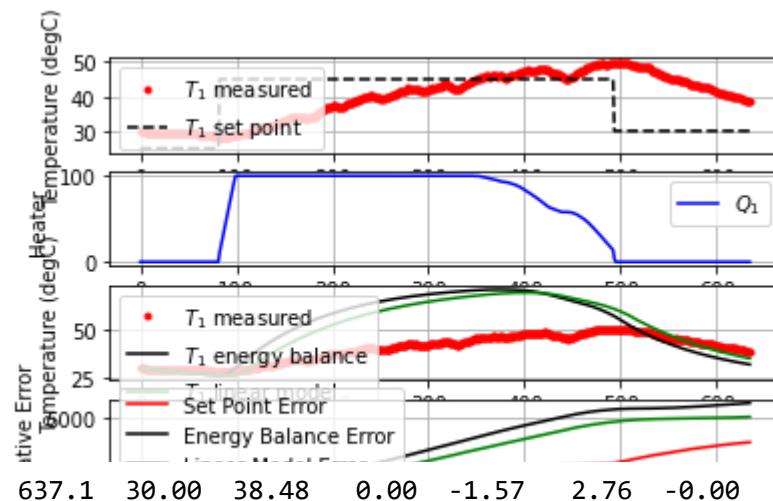
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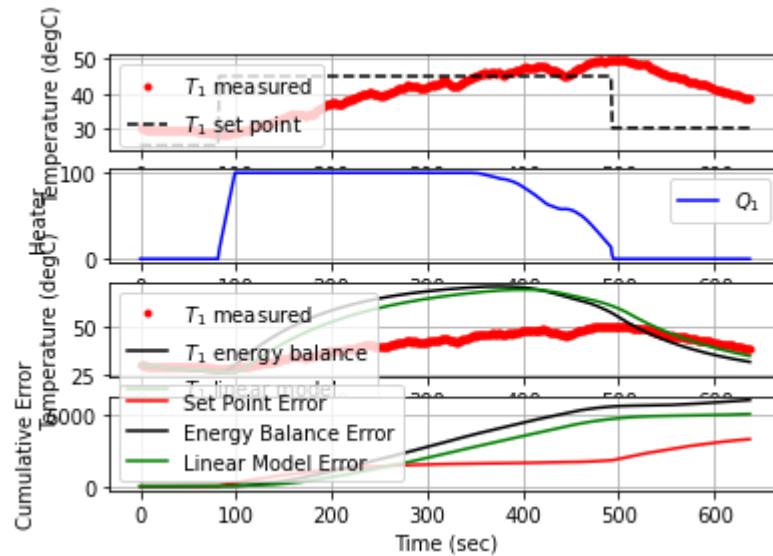




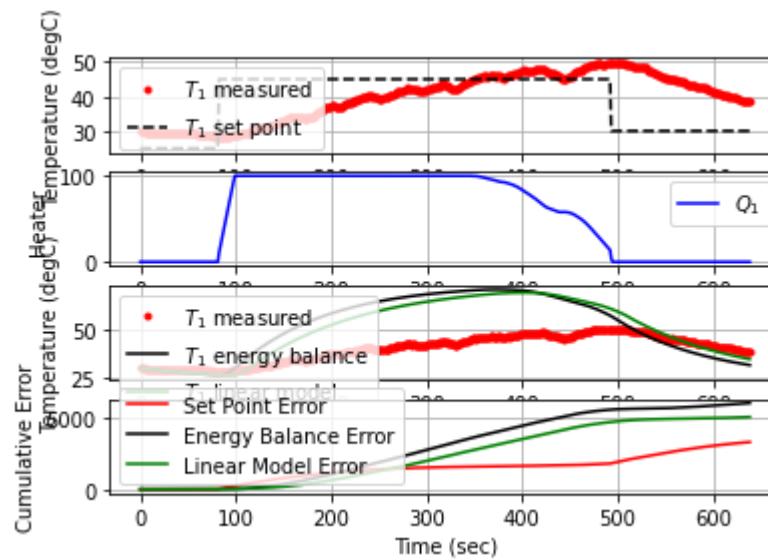
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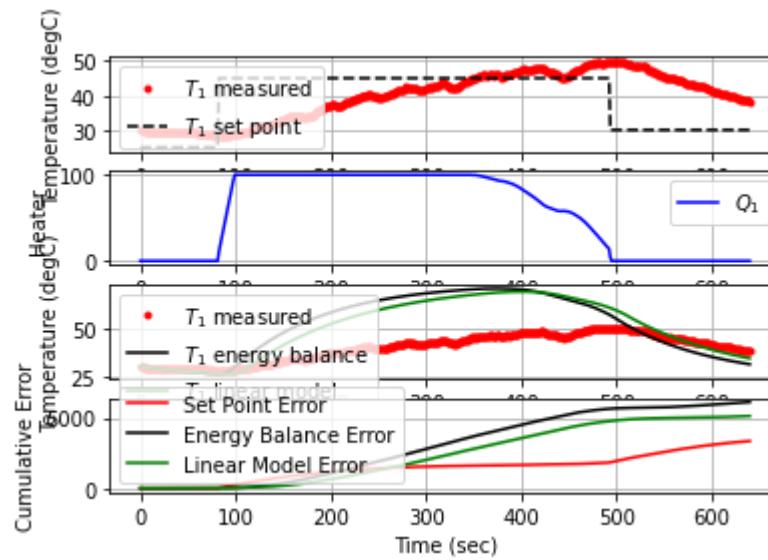
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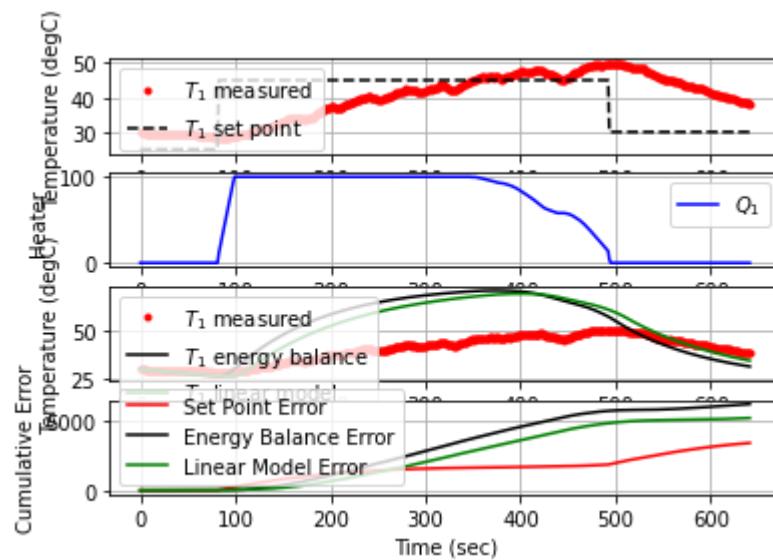
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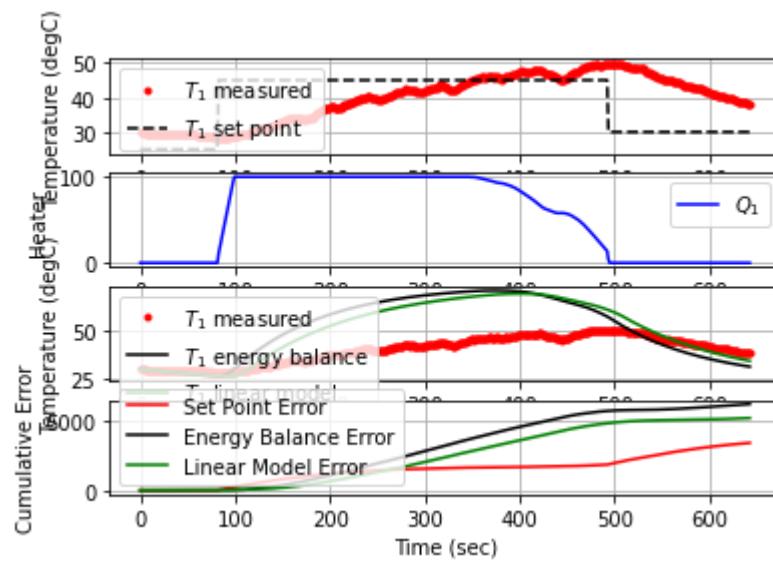
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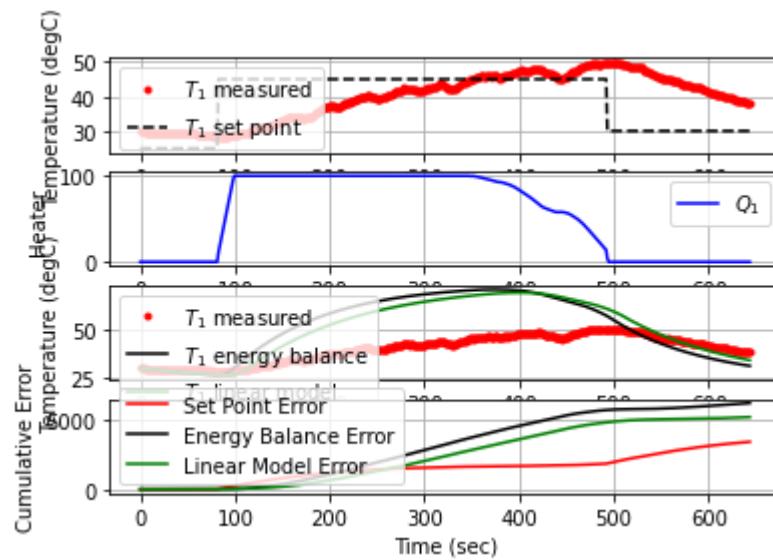
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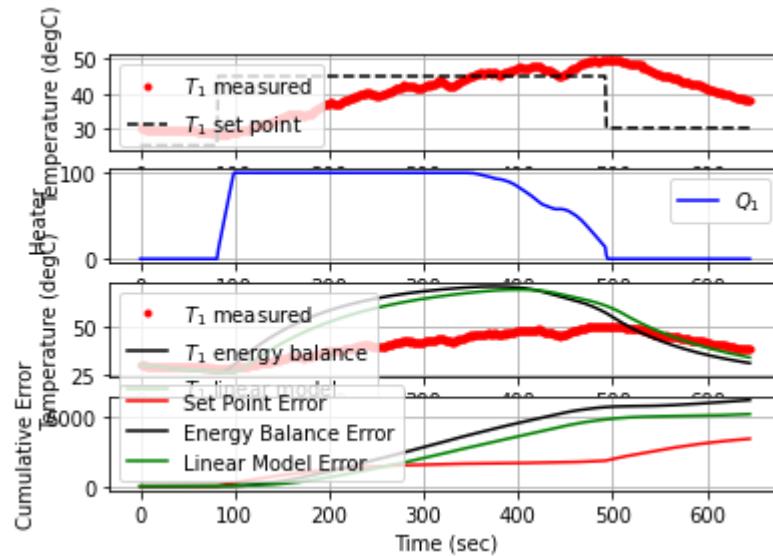
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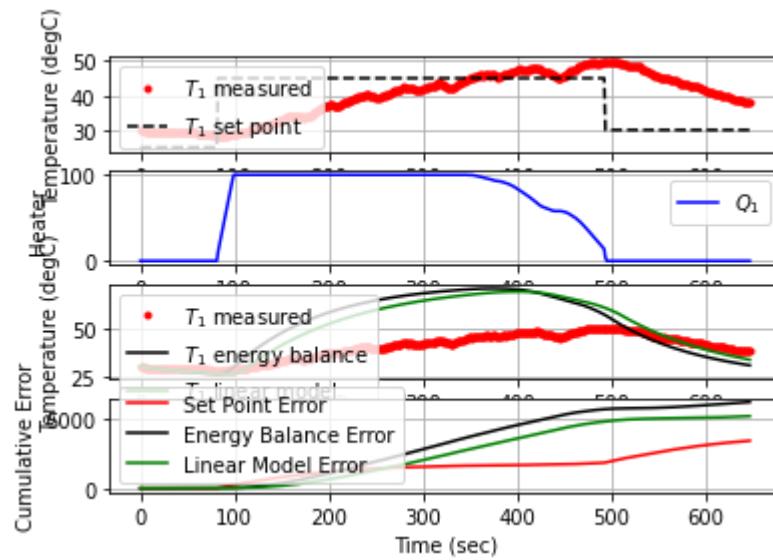
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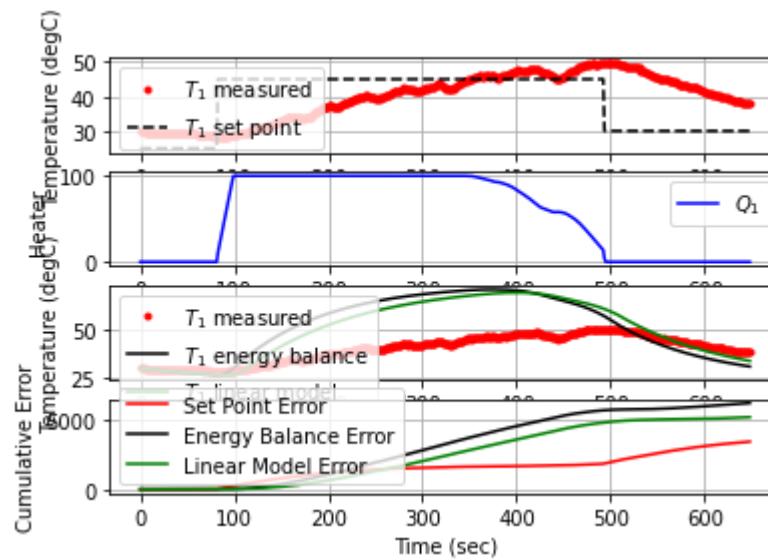
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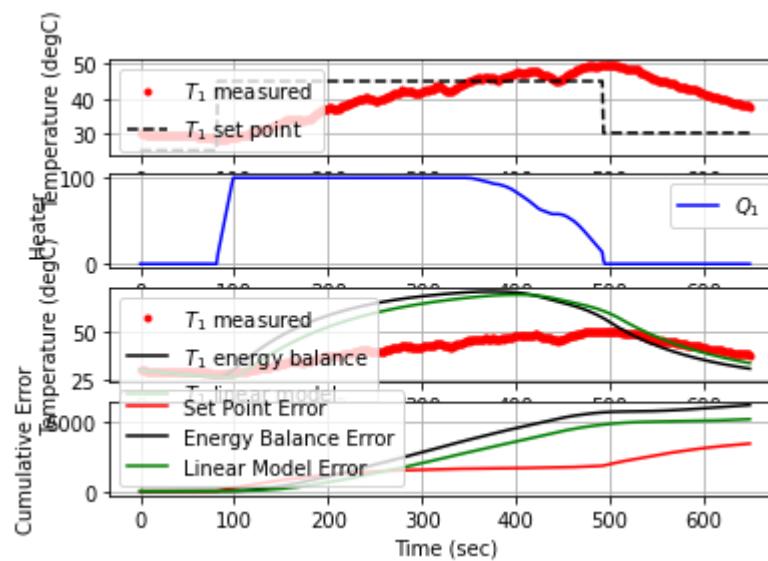
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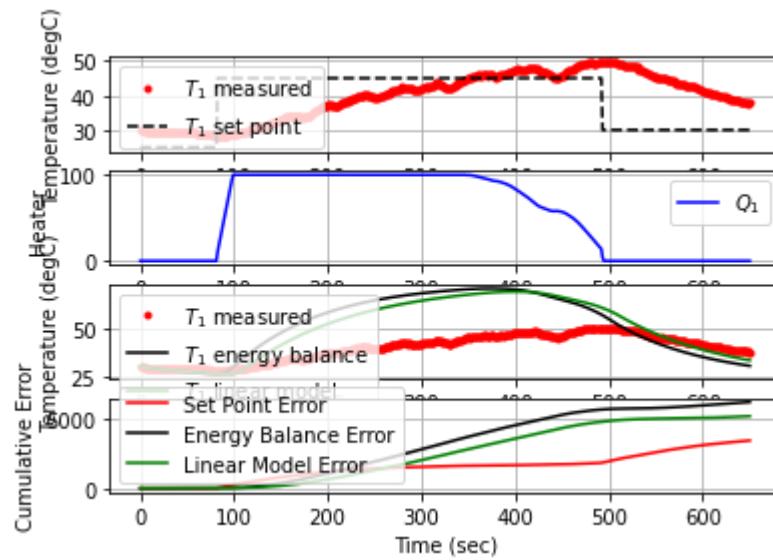
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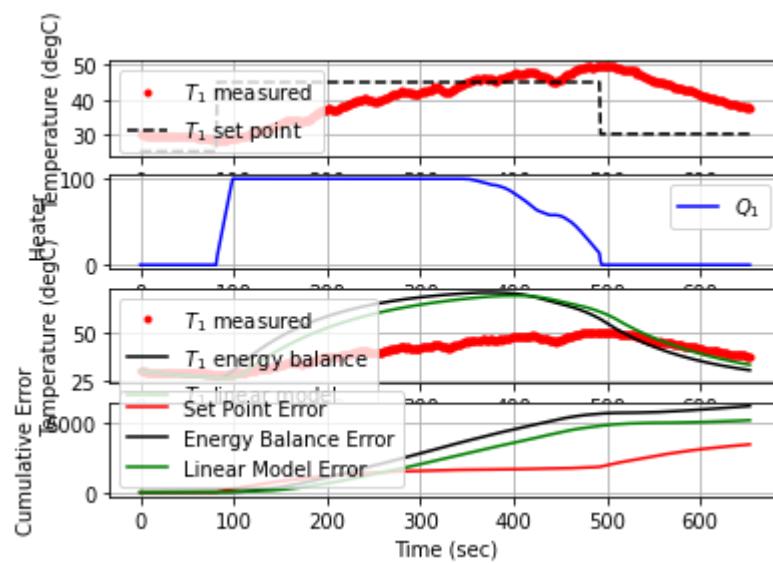
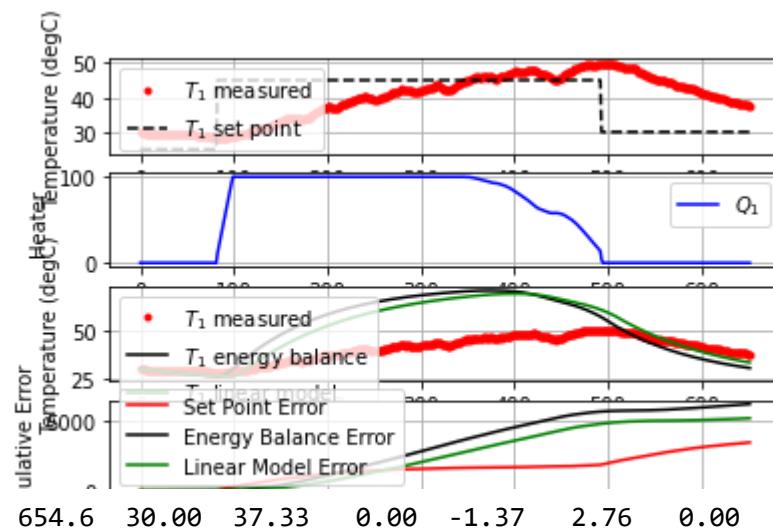
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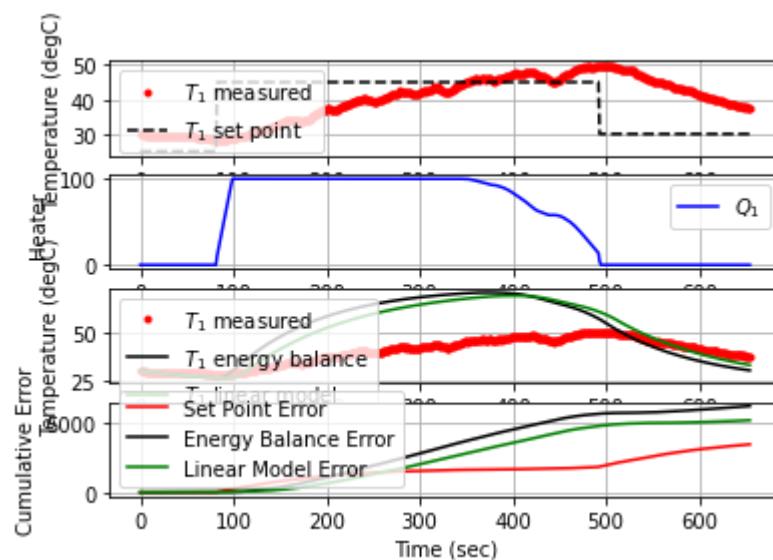
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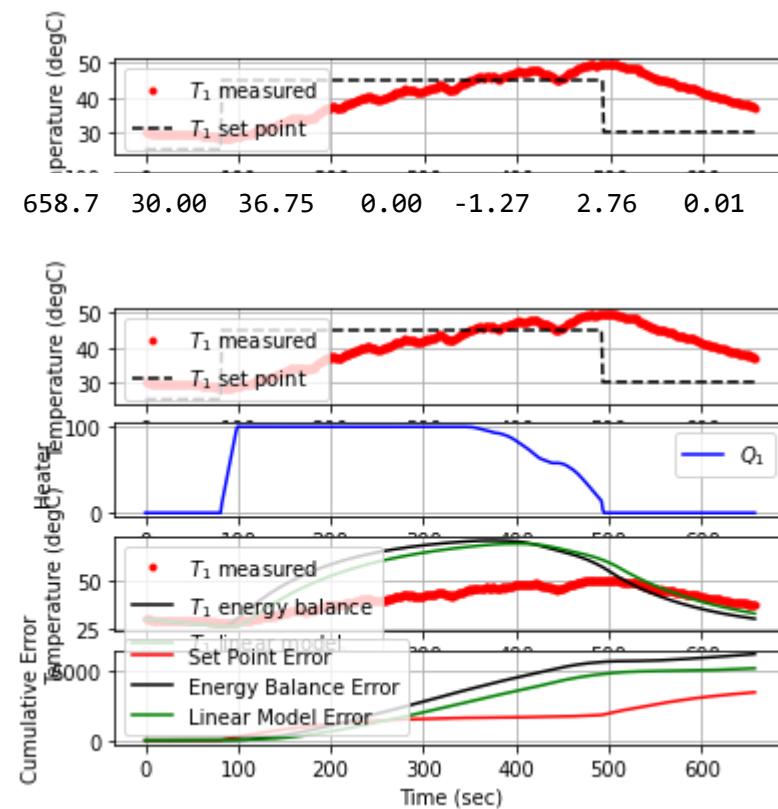
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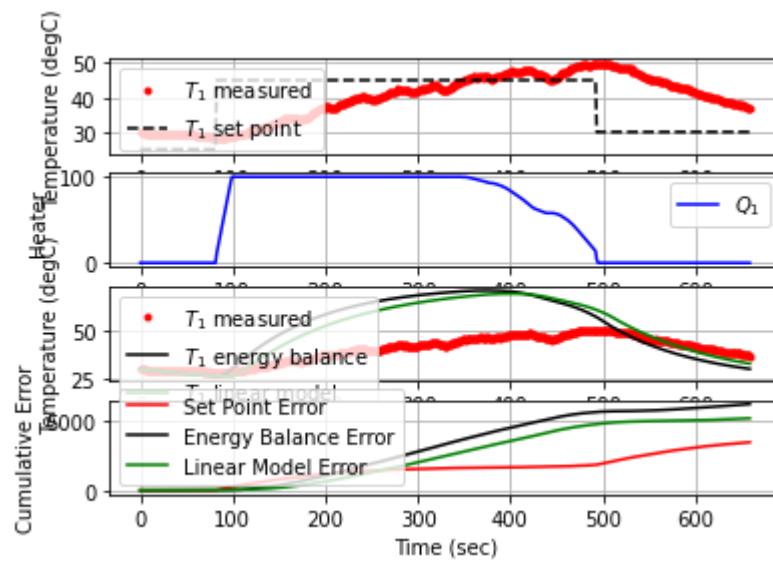
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657.3 30.00 37.00 0.00 -1.31 2.76 0.00

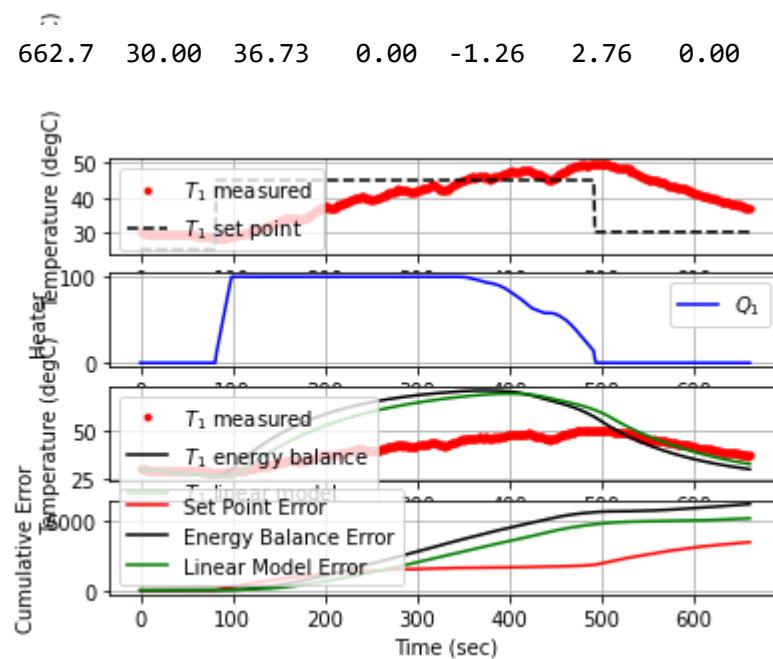


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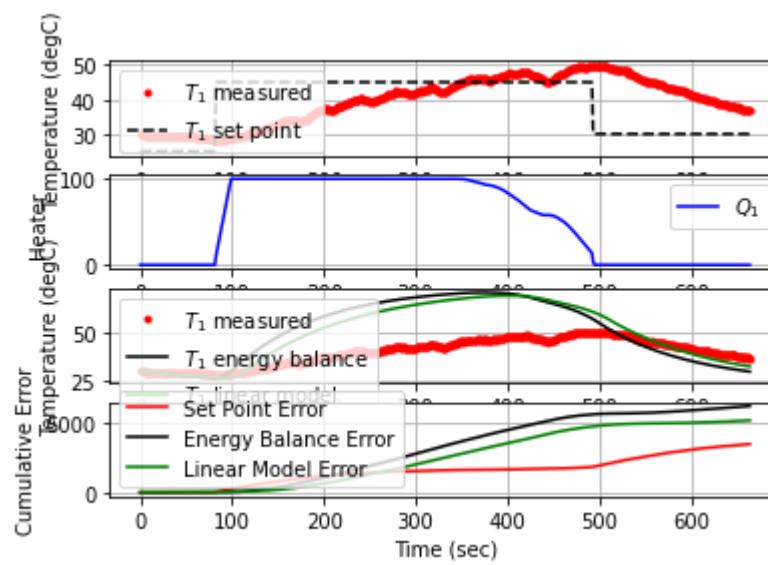
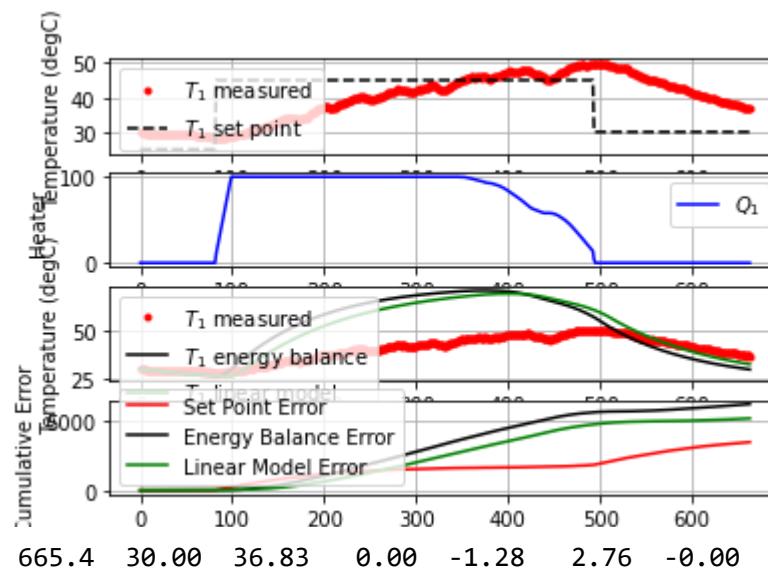


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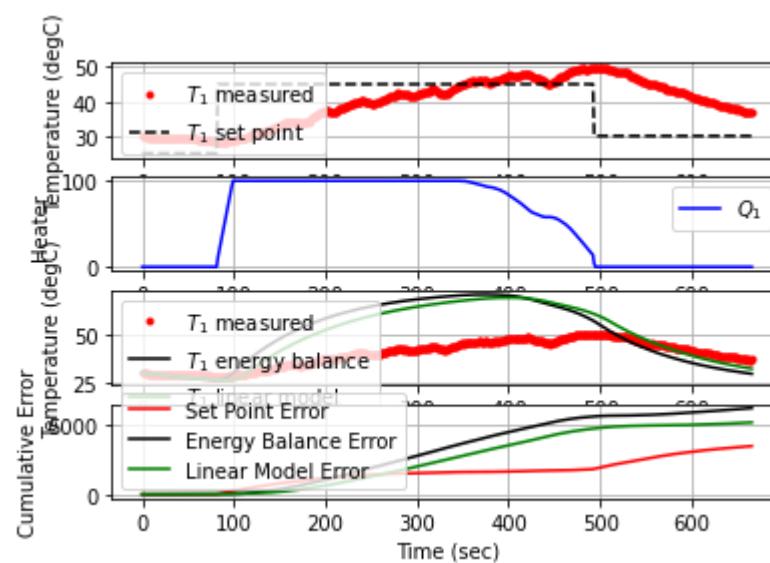




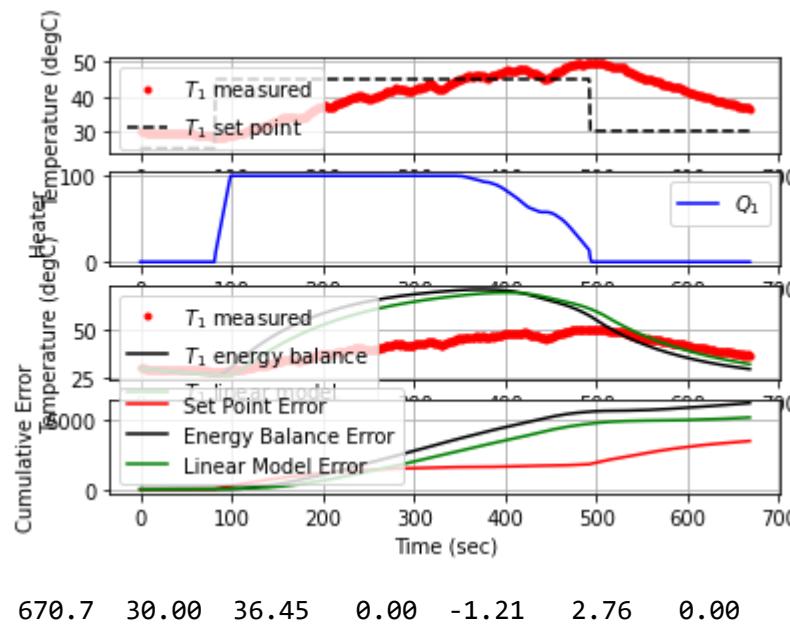
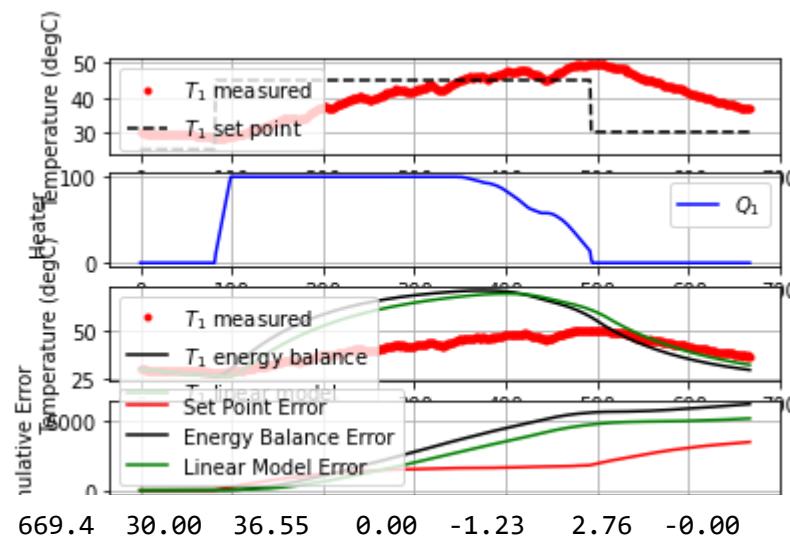
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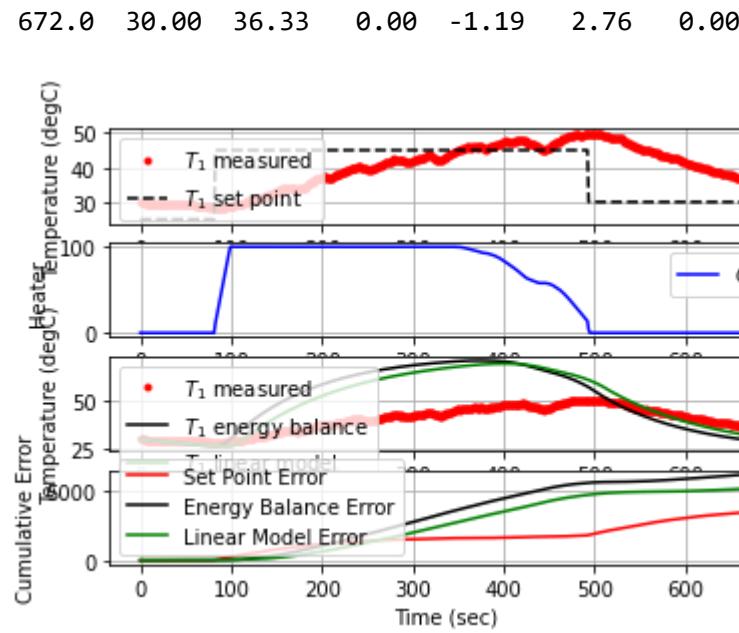
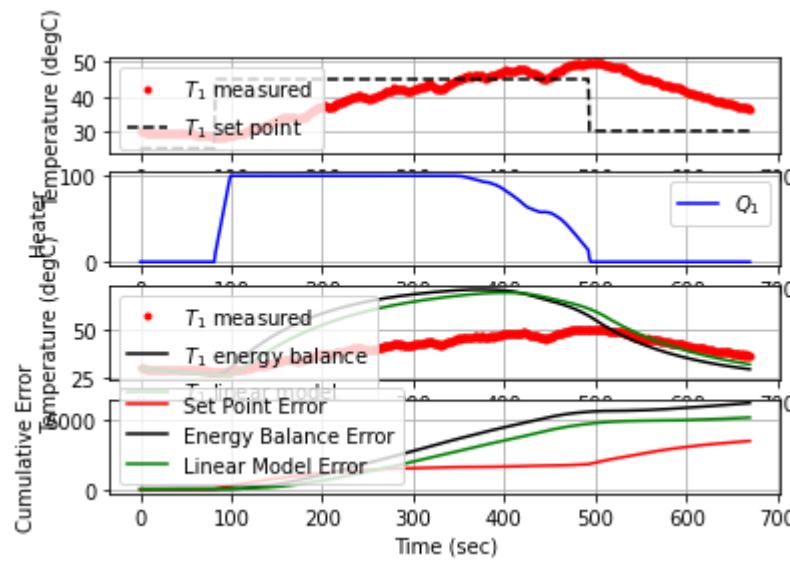


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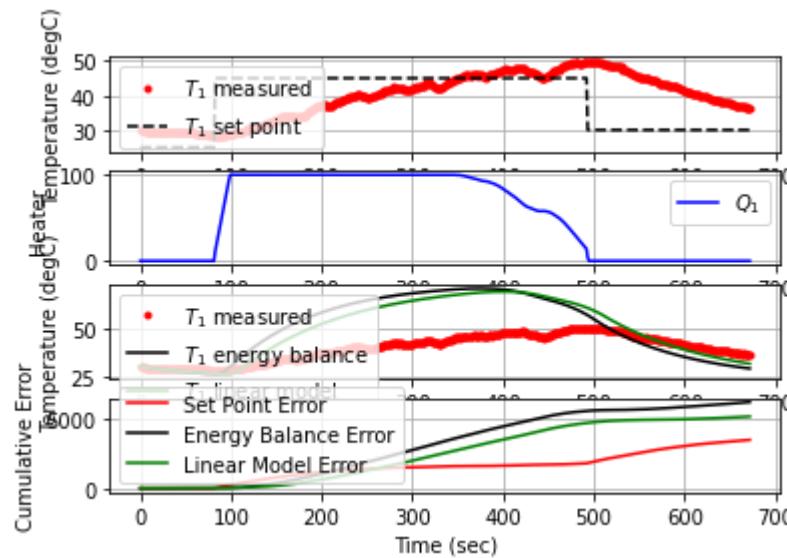


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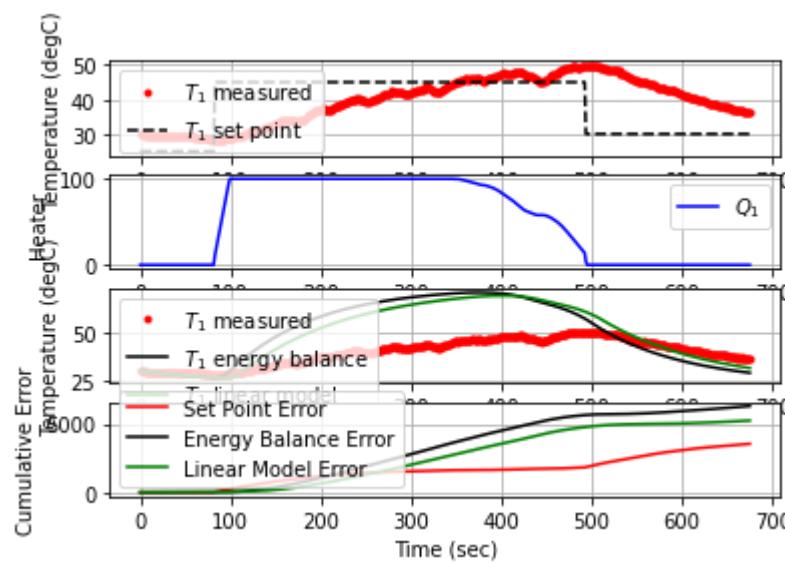
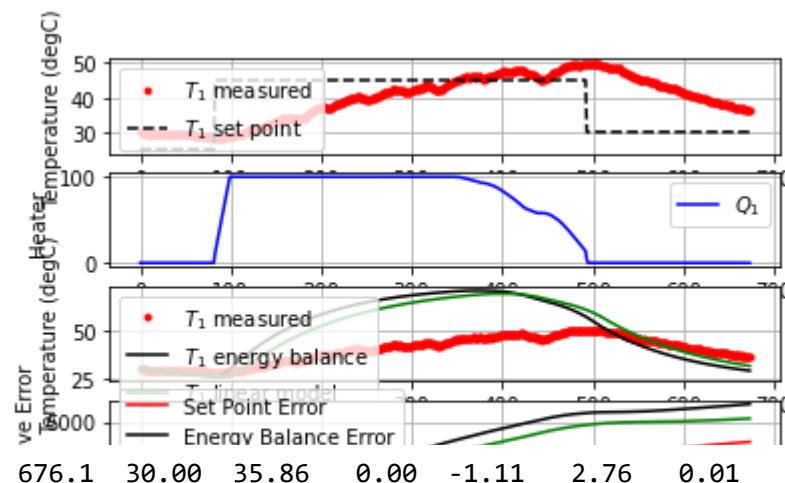


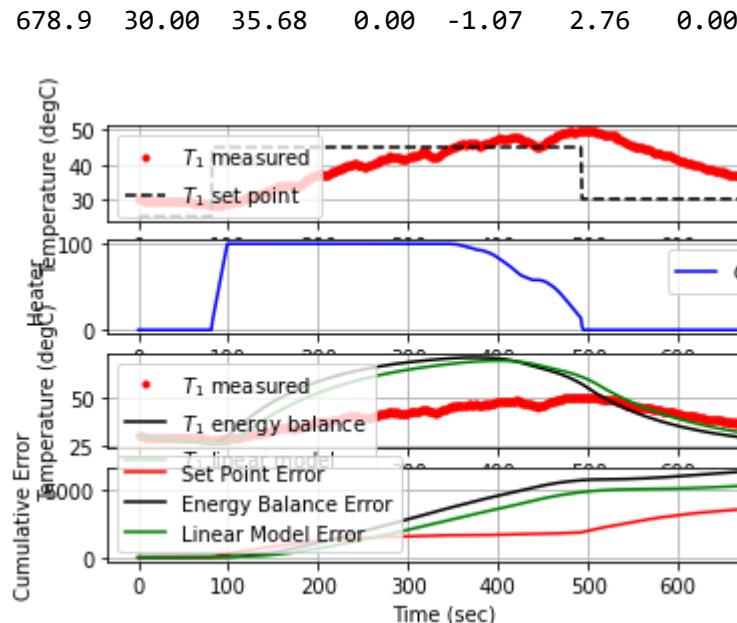
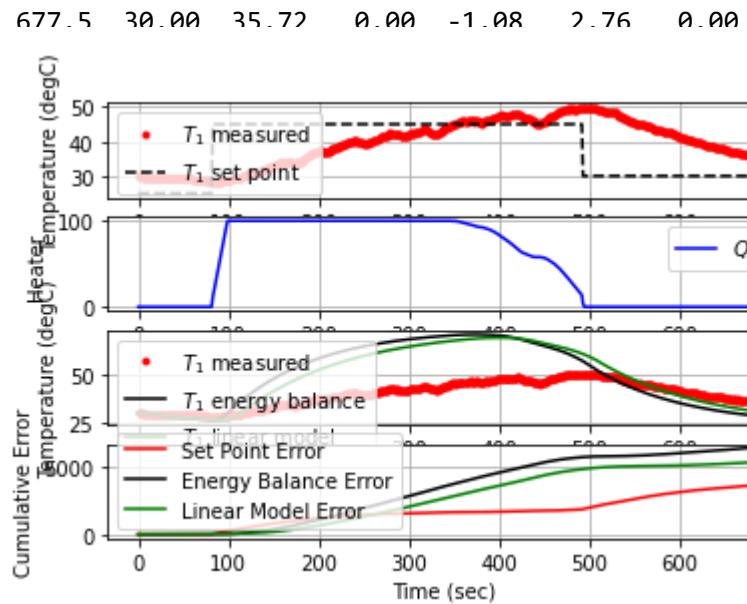


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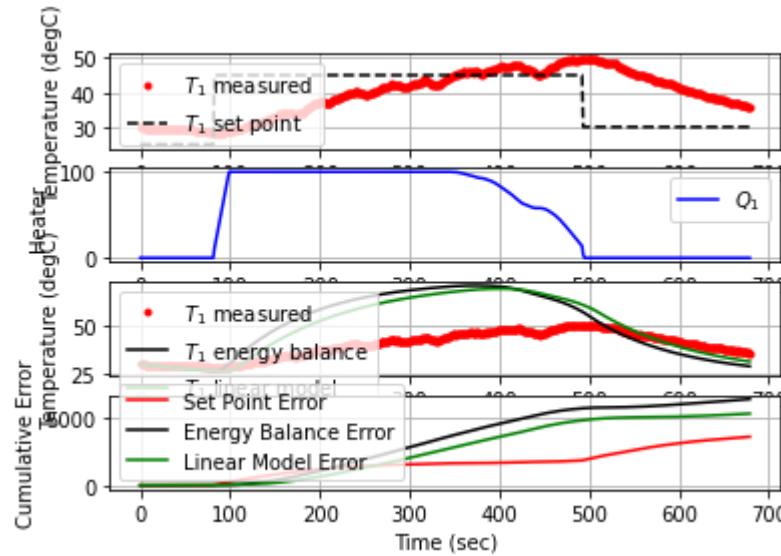


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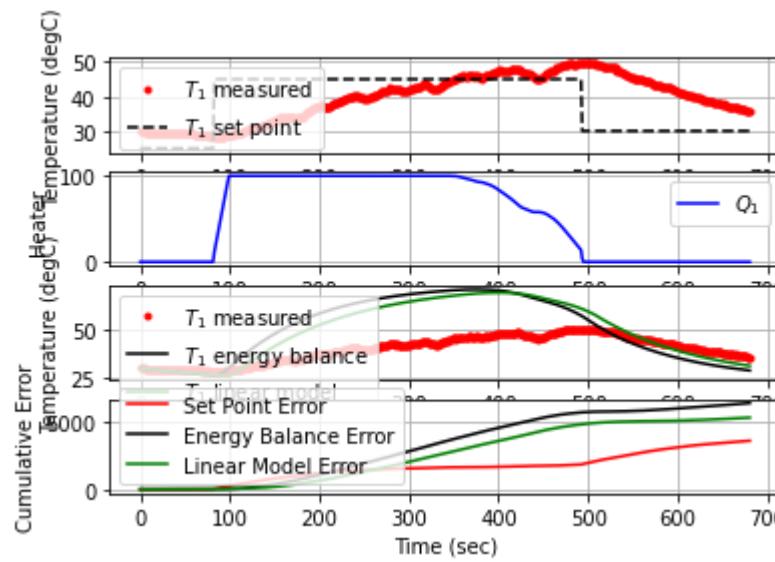




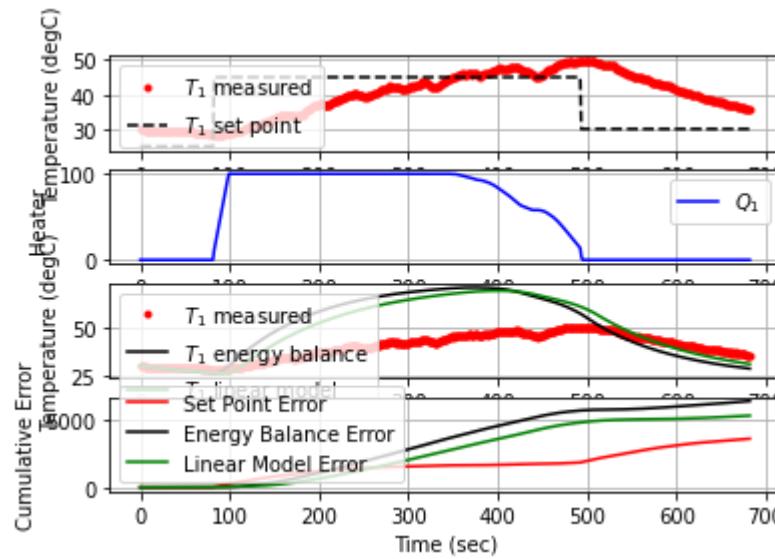
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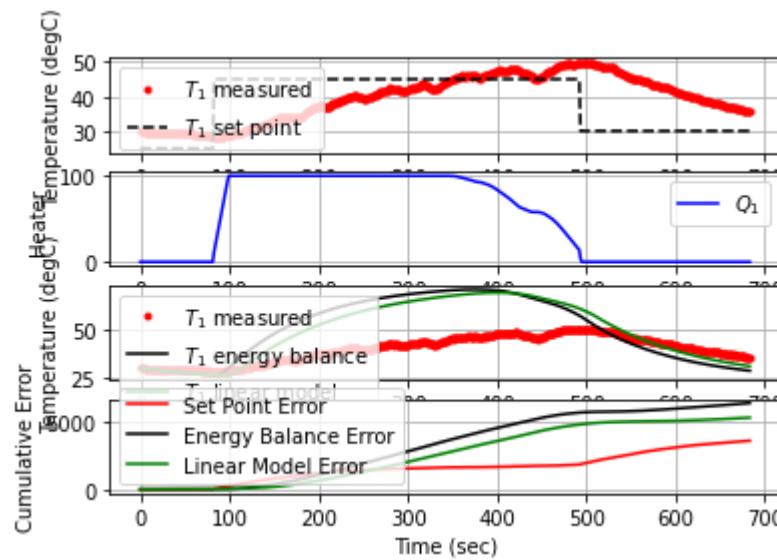
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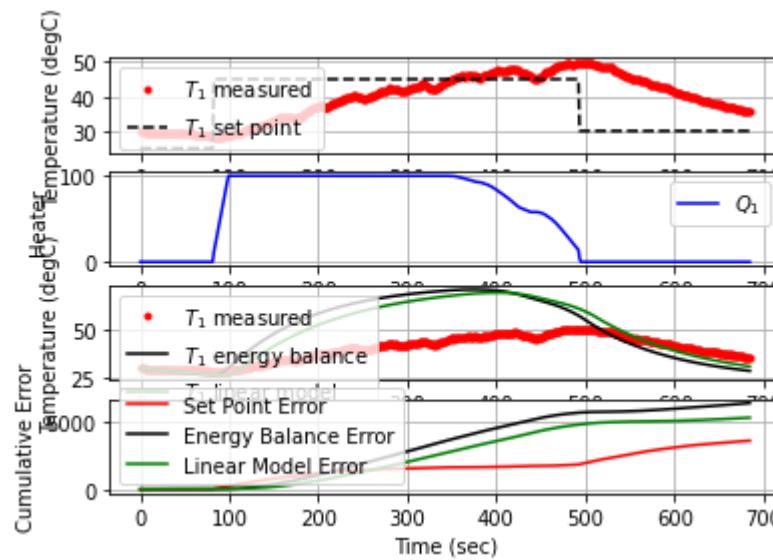
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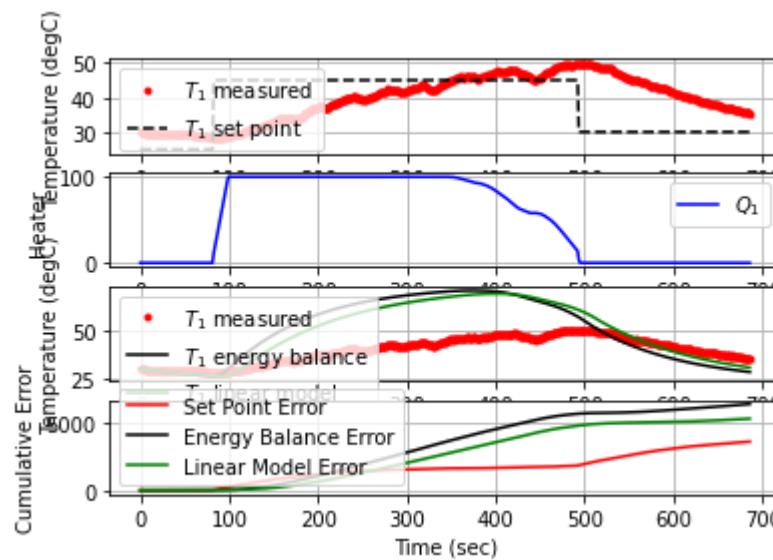
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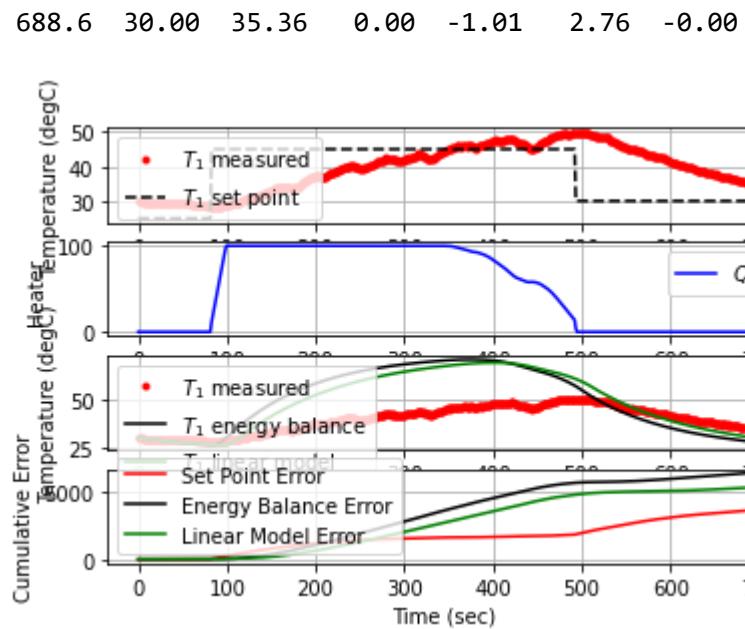


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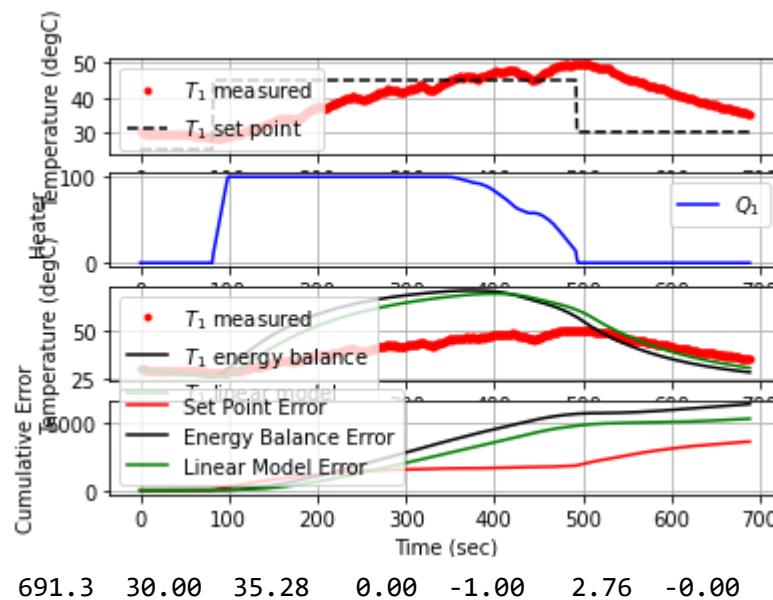


687.2 30.00 35.23 0.00 -1.00 2.76 0.00

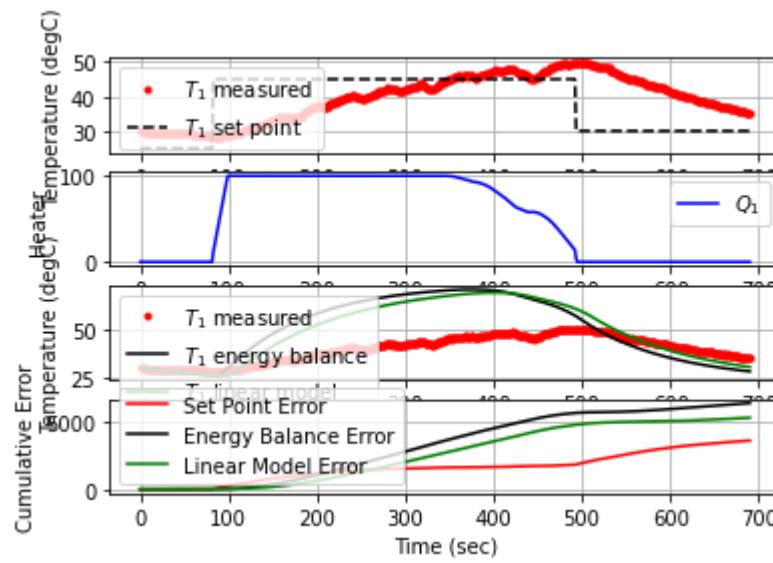




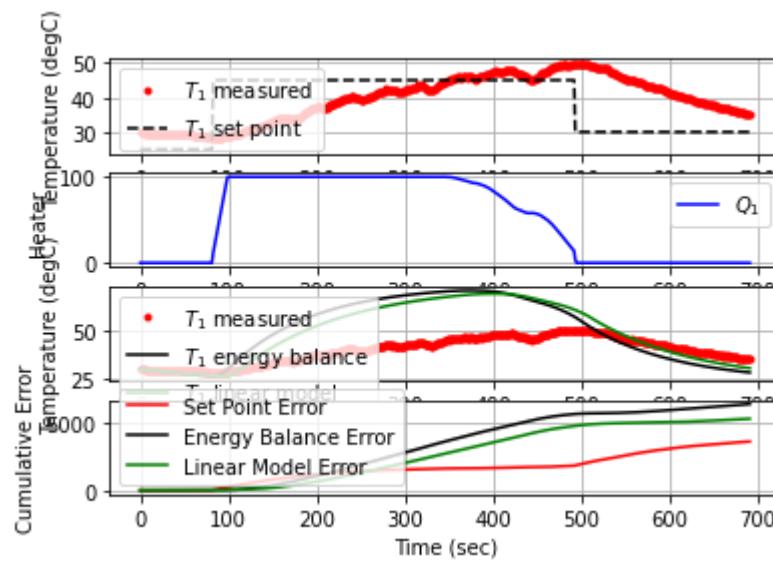
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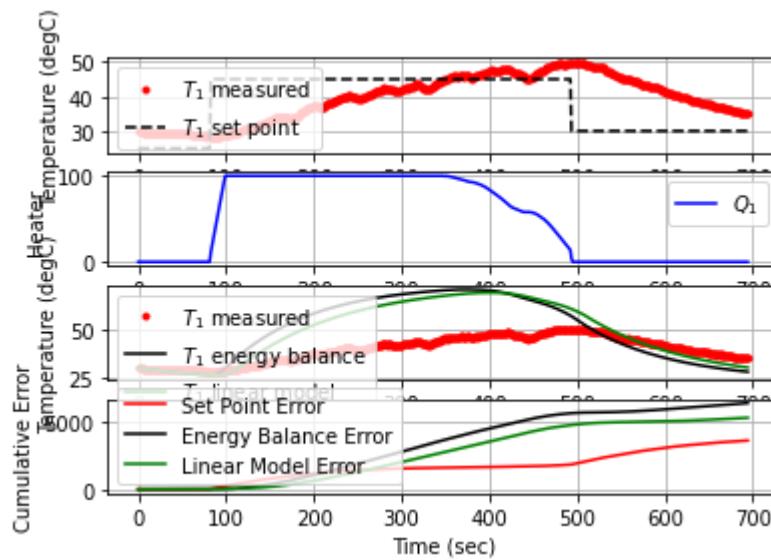
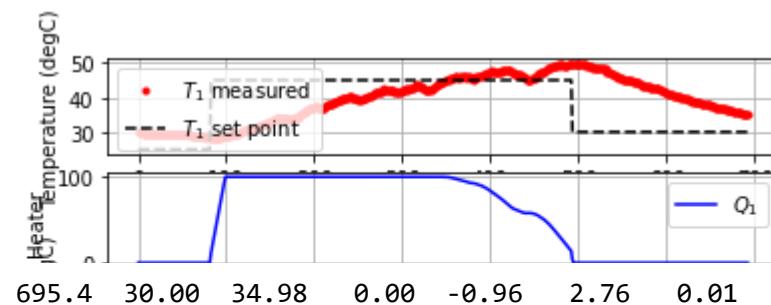
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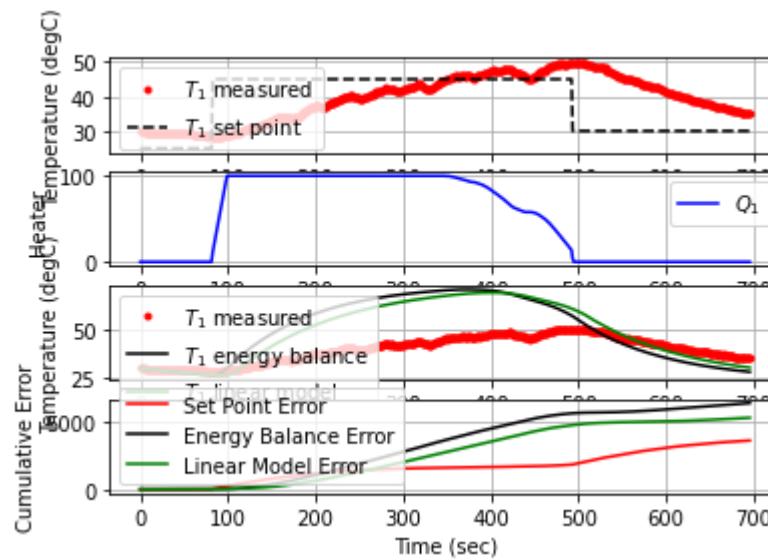
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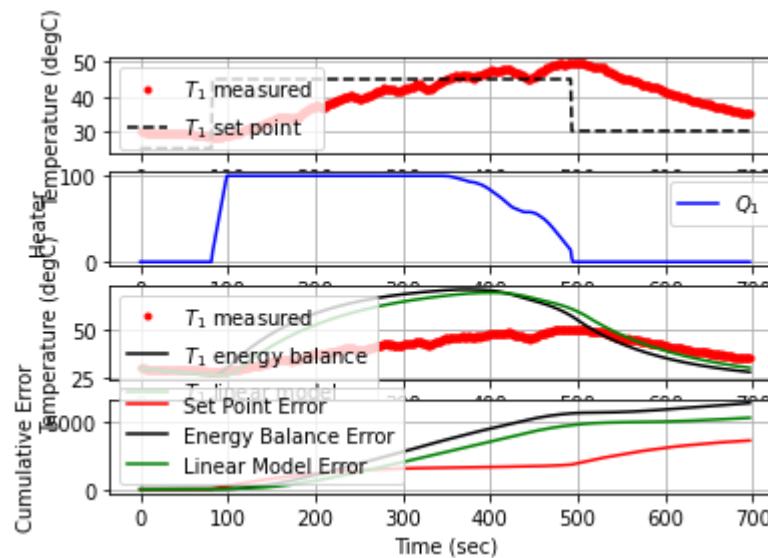
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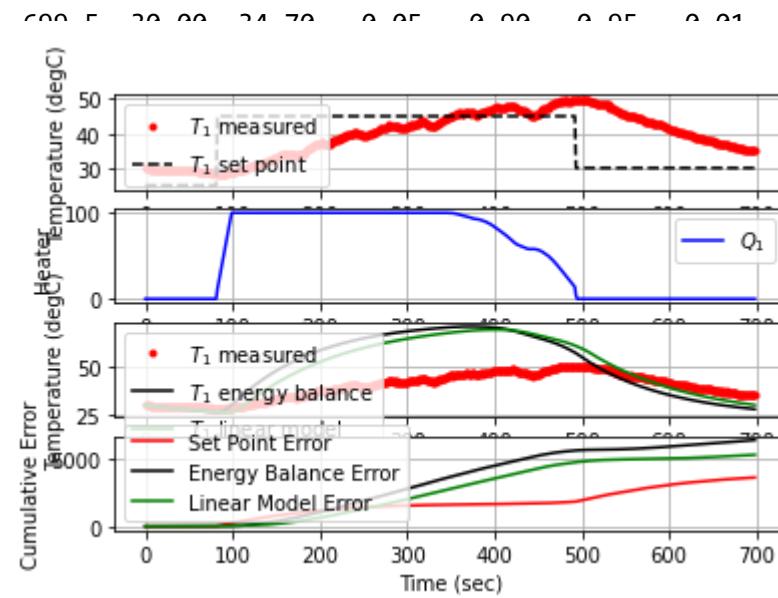


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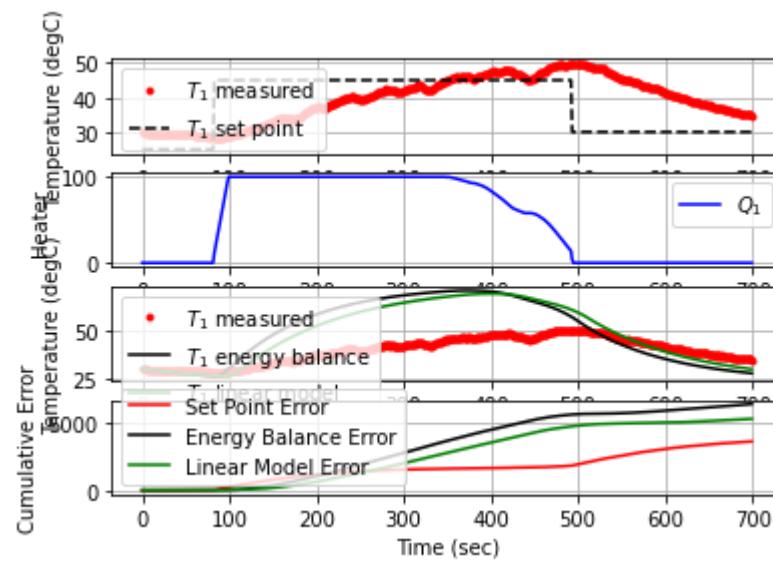


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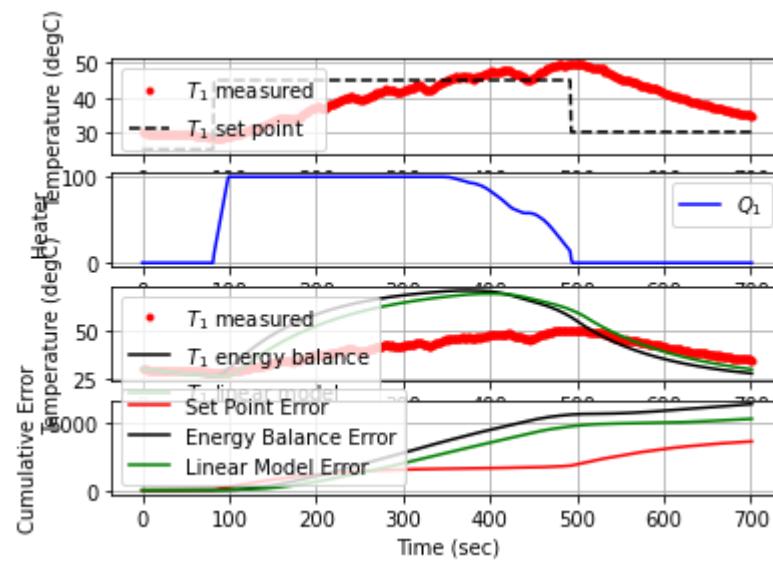




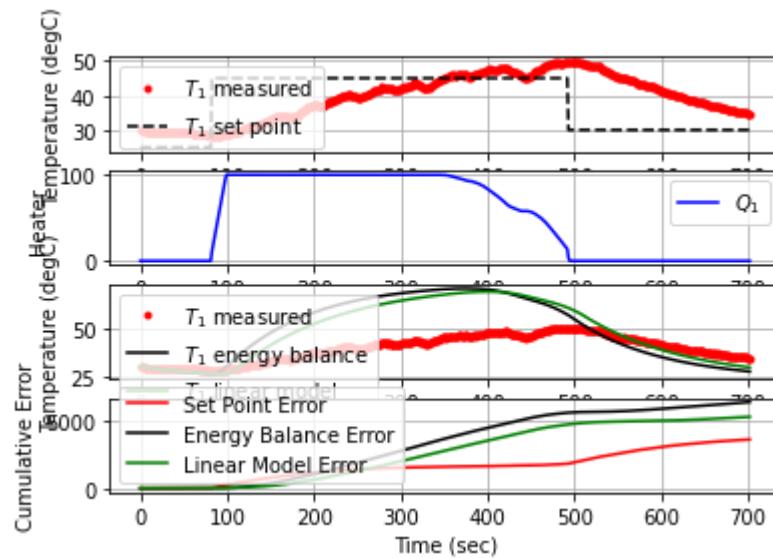
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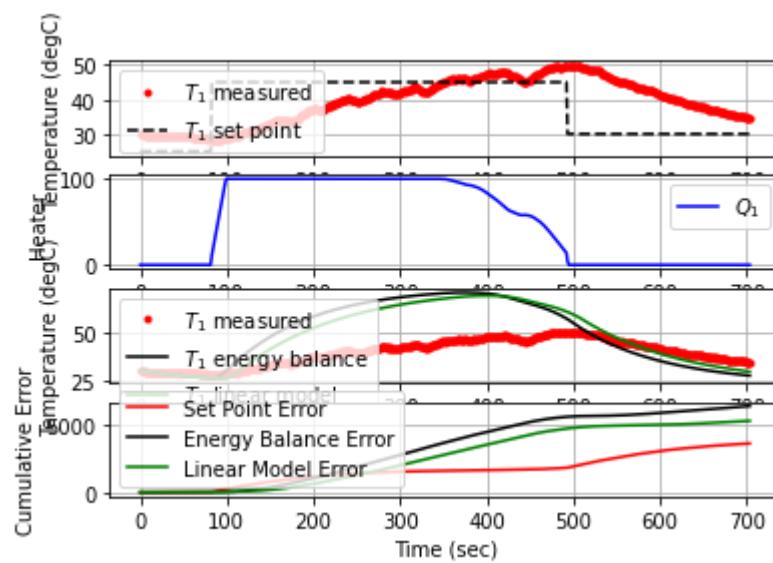
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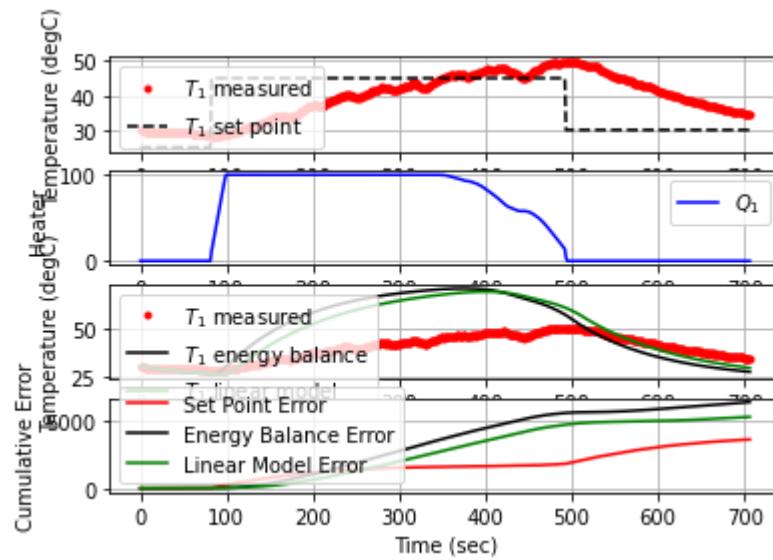
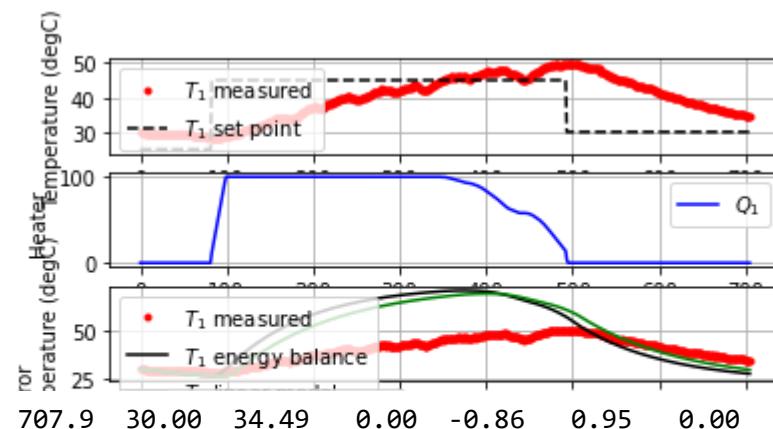
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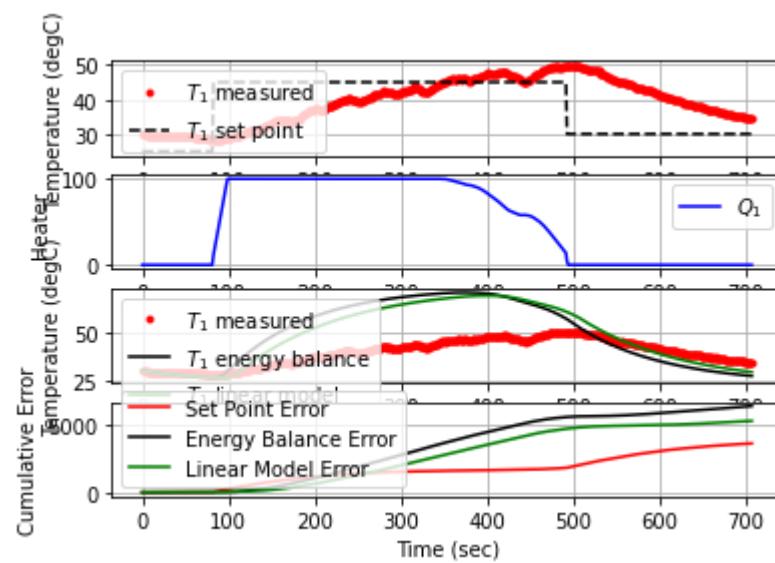
705.0 30.00 34.53 0.00 -0.87 0.95 0.00



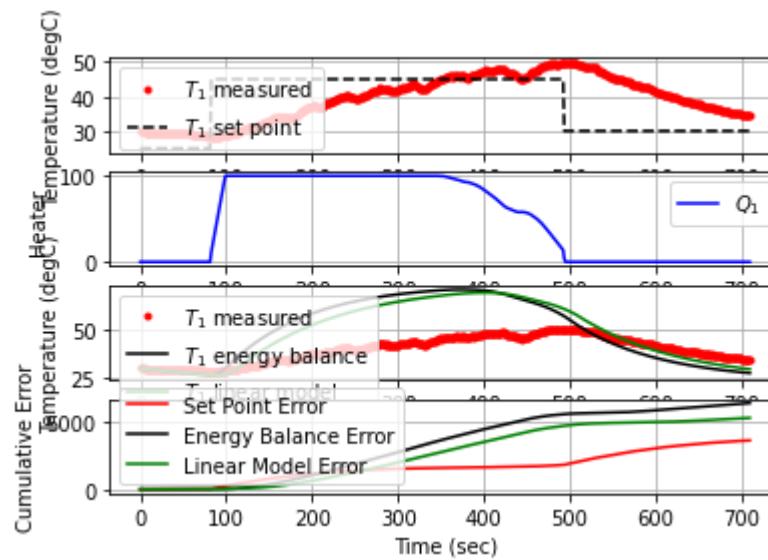
706.3 30.00 34.54 0.00 -0.87 0.95 -0.00



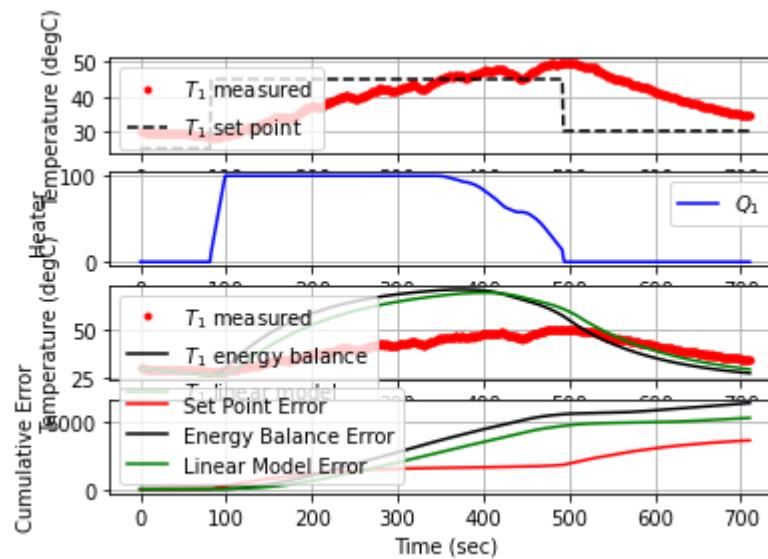
709.2 30.00 34.38 0.00 -0.84 0.95 0.00



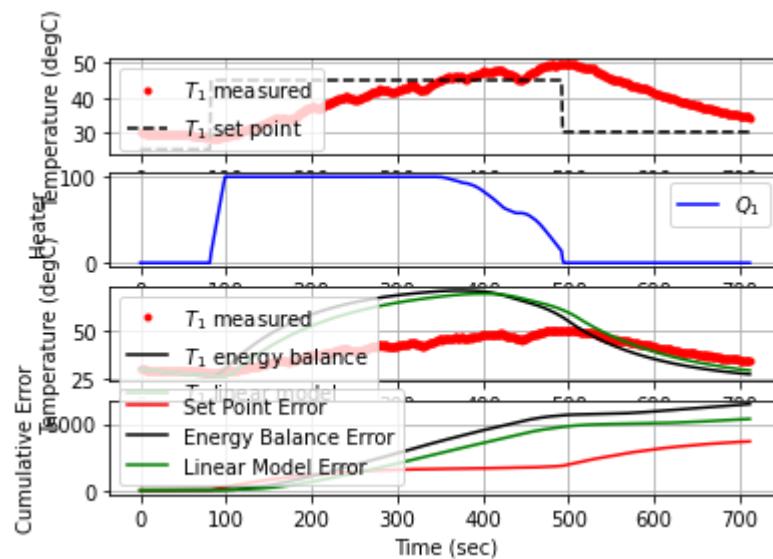
710.6 30.00 34.29 0.00 -0.82 0.95 0.00



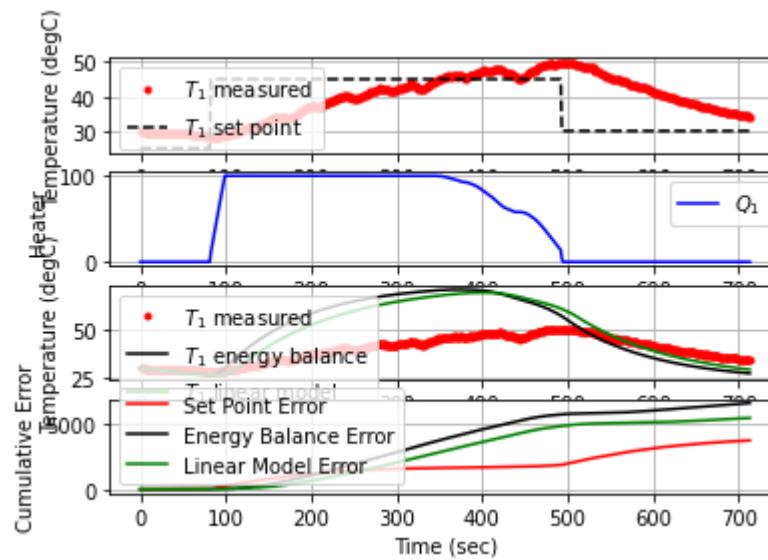
711.9 30.00 34.26 0.00 -0.82 0.95 0.00



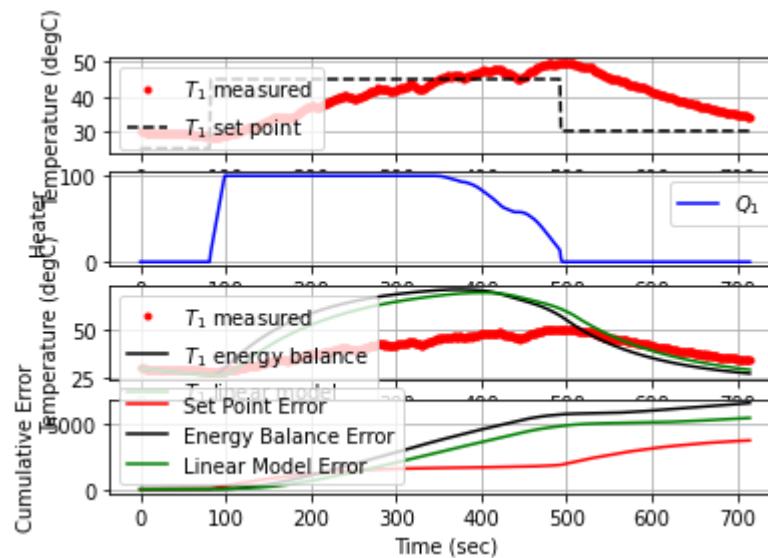
713.3 30.00 34.20 0.00 -0.81 0.95 0.00



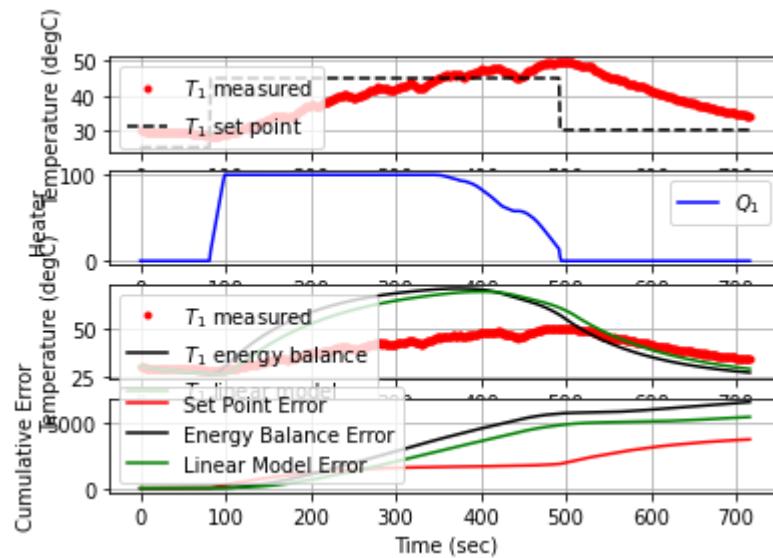
714.8 30.00 34.20 0.00 -0.80 0.95 -0.00



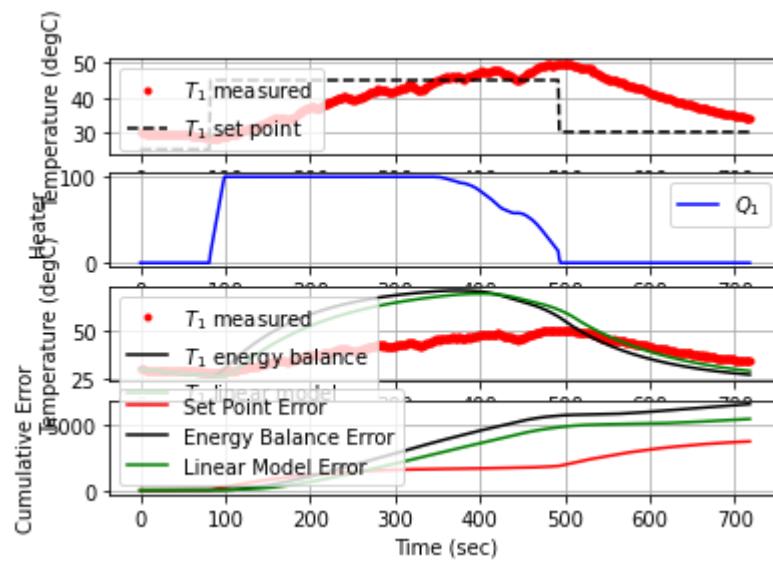
716.1 30.00 34.12 0.00 -0.79 0.95 0.00



717.5 30.00 34.08 0.00 -0.78 0.95 0.00

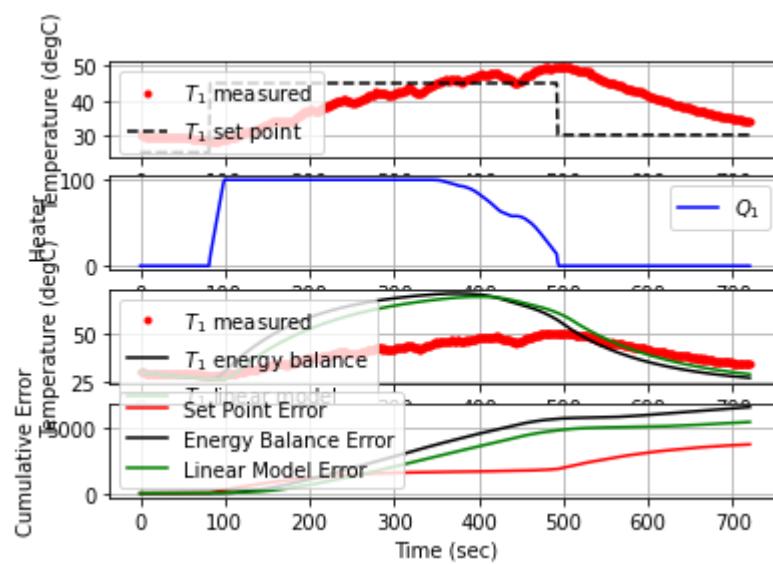
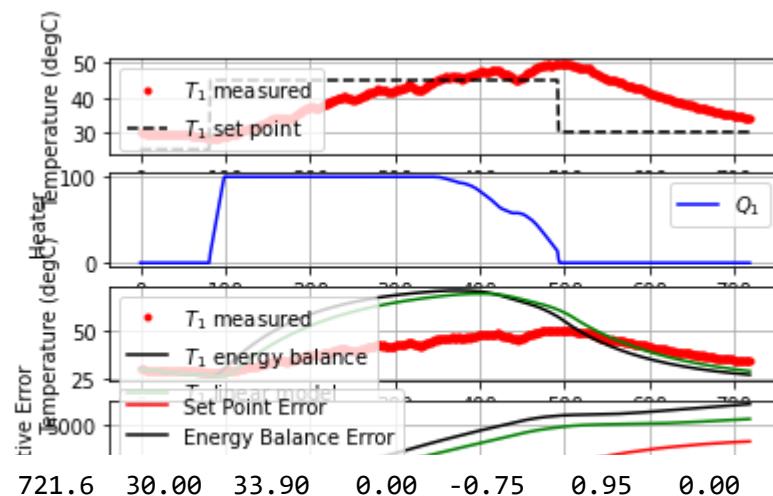


718.8 30.00 34.04 0.00 -0.78 0.95 0.00

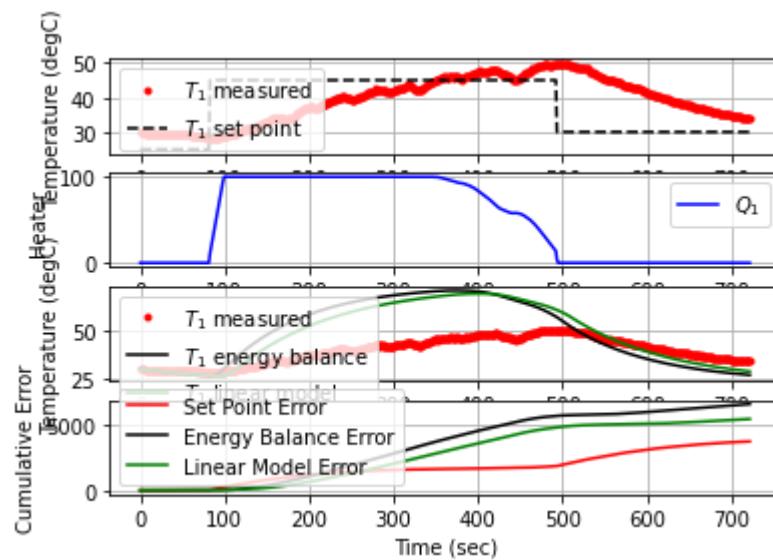


720.2 30.00 34.02 0.00 -0.77 0.95 0.00

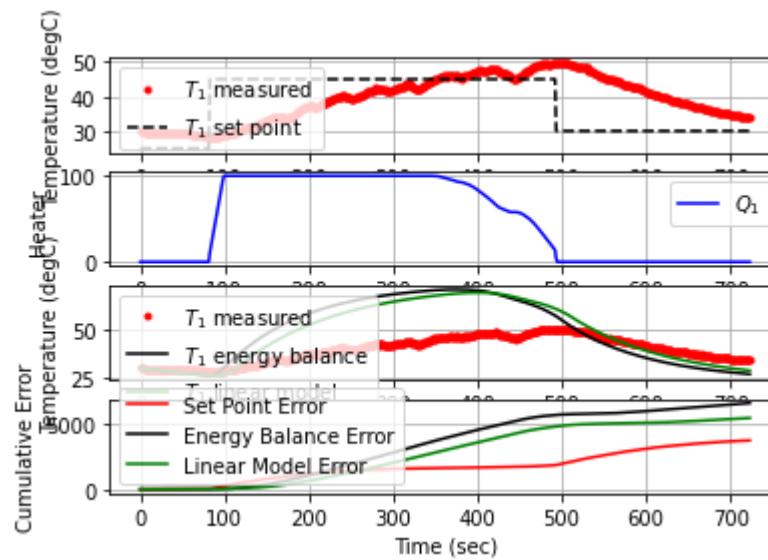




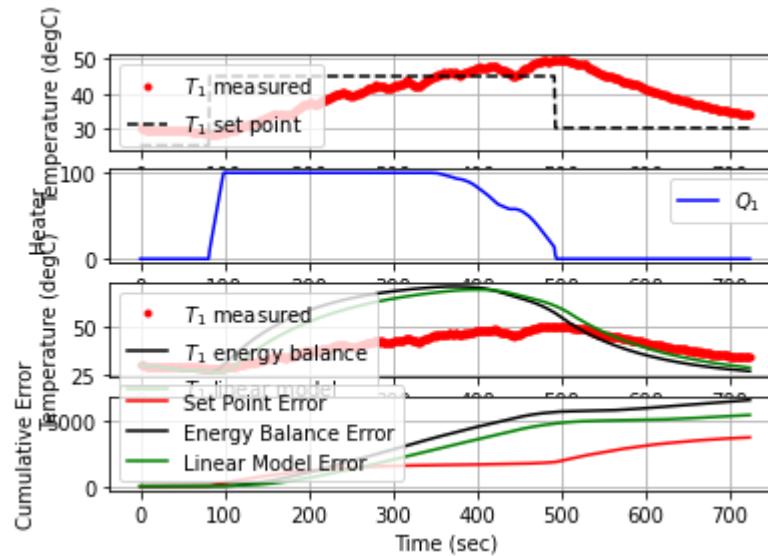
723.0 30.00 33.89 0.00 -0.75 0.95 0.00

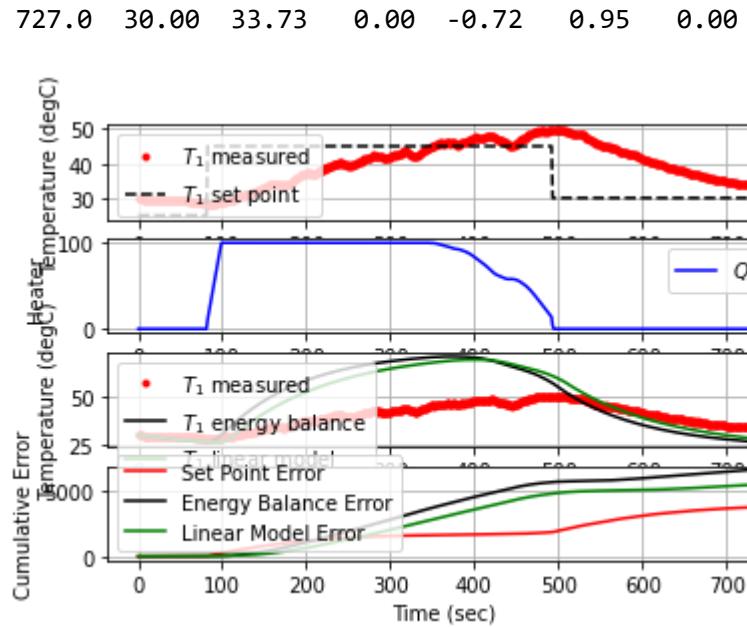


724.3 30.00 33.86 0.00 -0.74 0.95 0.00

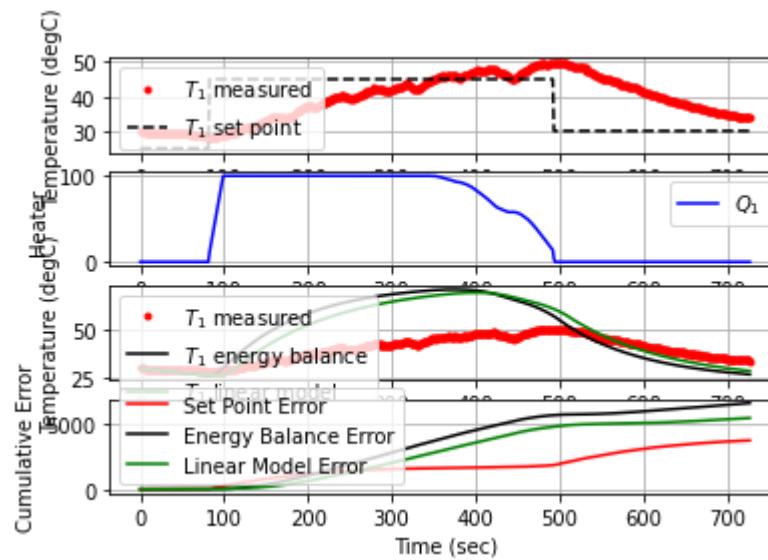


725.7 30.00 33.80 0.00 -0.73 0.95 0.00

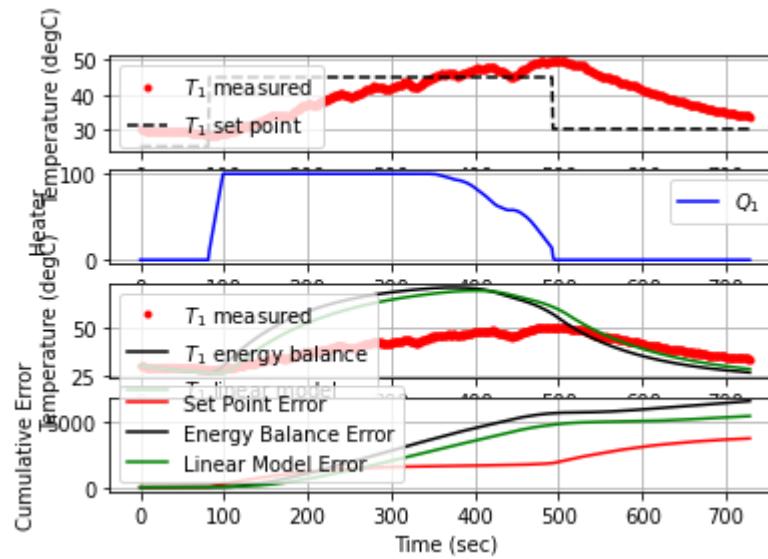


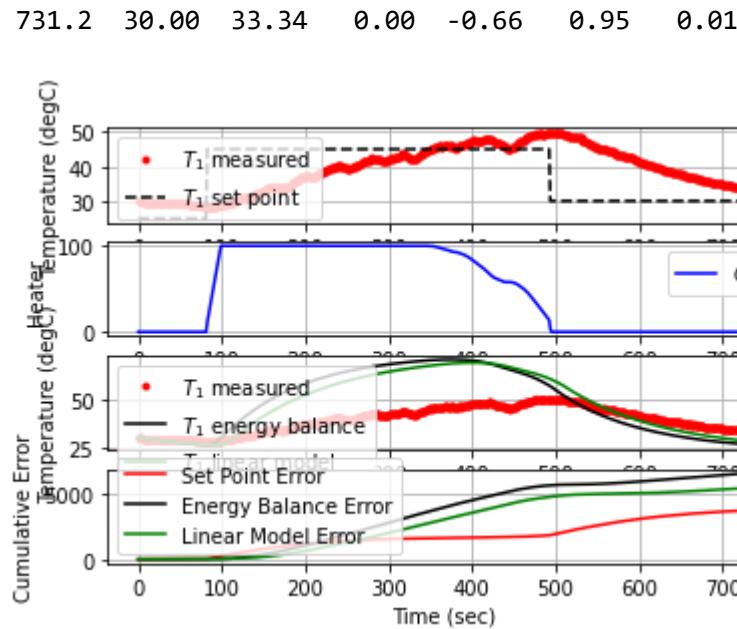


728.5 30.00 33.66 0.00 -0.71 0.95 0.00

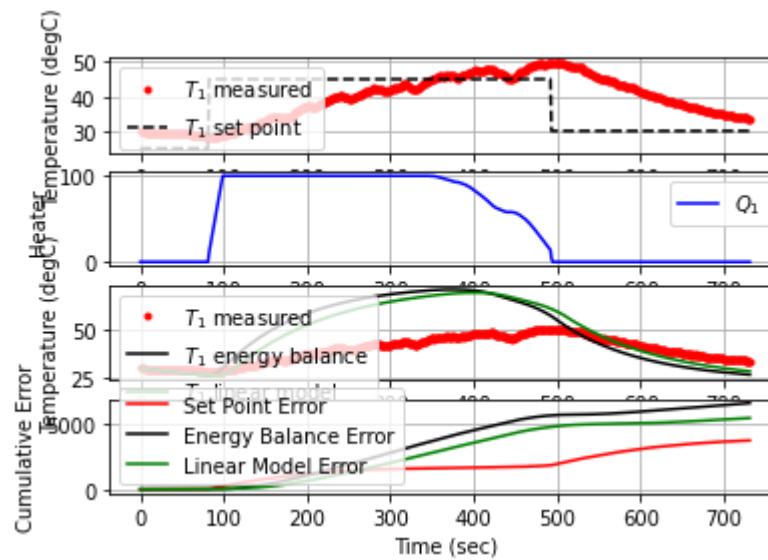


729.8 30.00 33.66 0.00 -0.71 0.95 -0.00

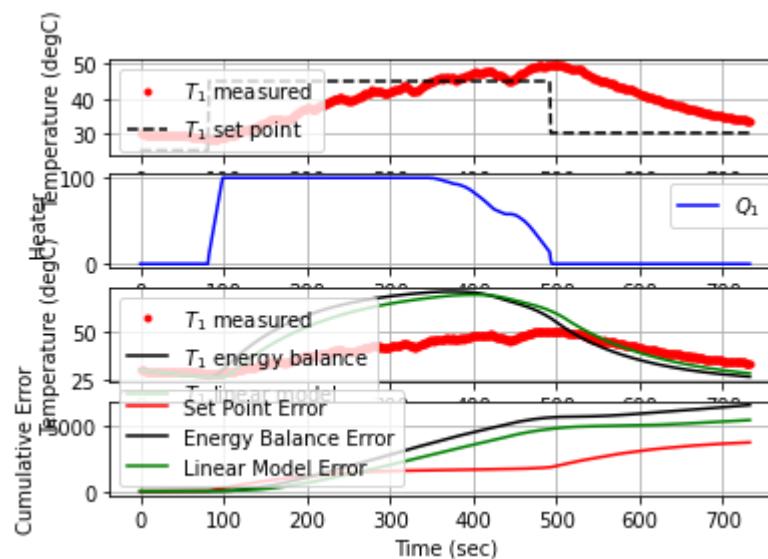




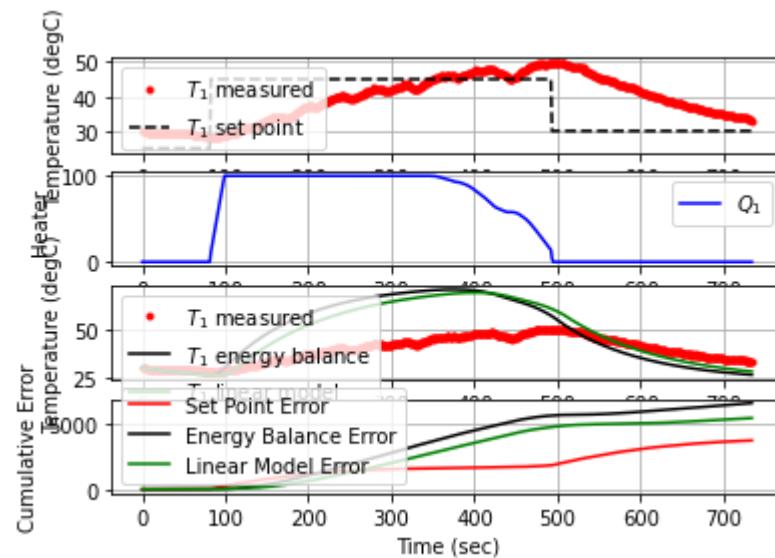
732.5 30.00 33.42 0.00 -0.66 0.95 -0.00



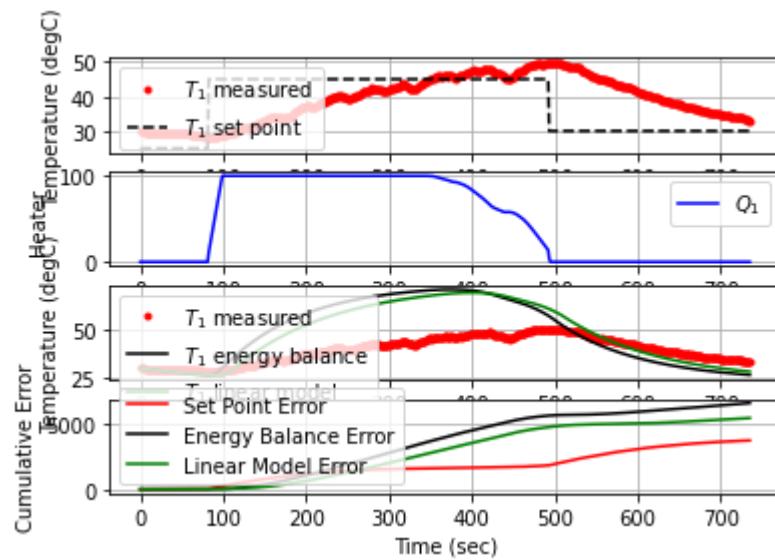
733.8 30.00 32.90 0.00 -0.59 0.95 0.02



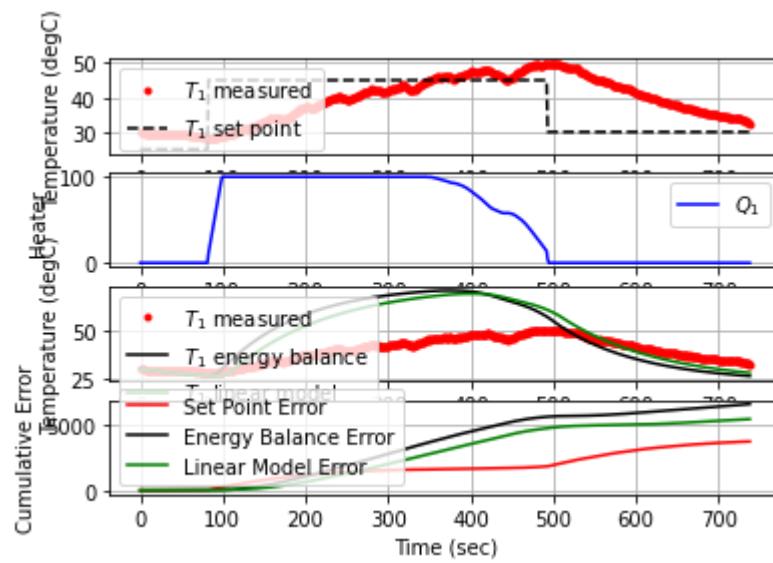
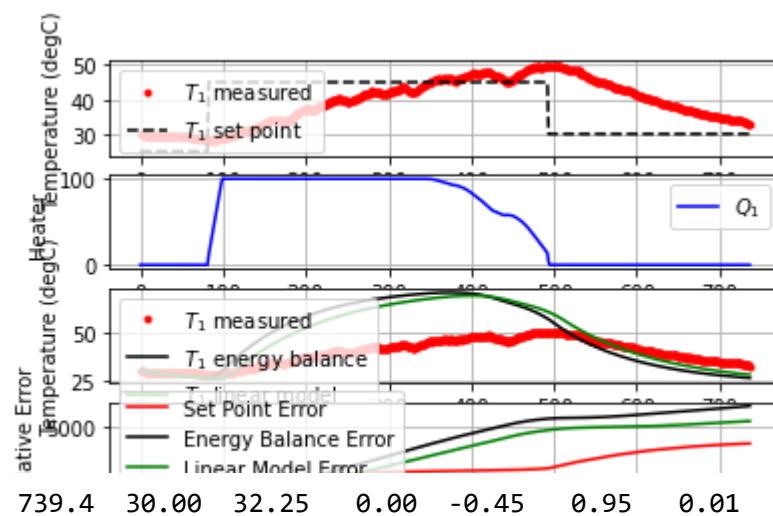
735.3 30.00 32.85 0.00 -0.56 0.95 0.00



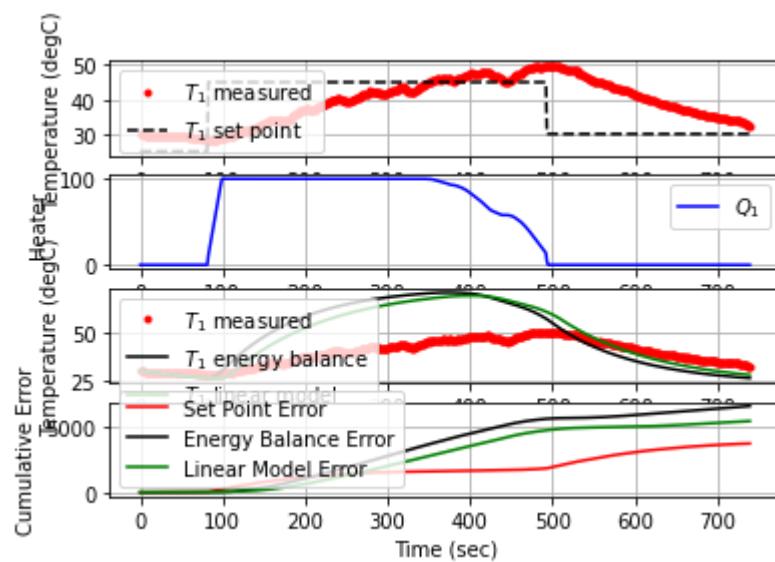
736.6 30.00 32.58 0.00 -0.51 0.95 0.01



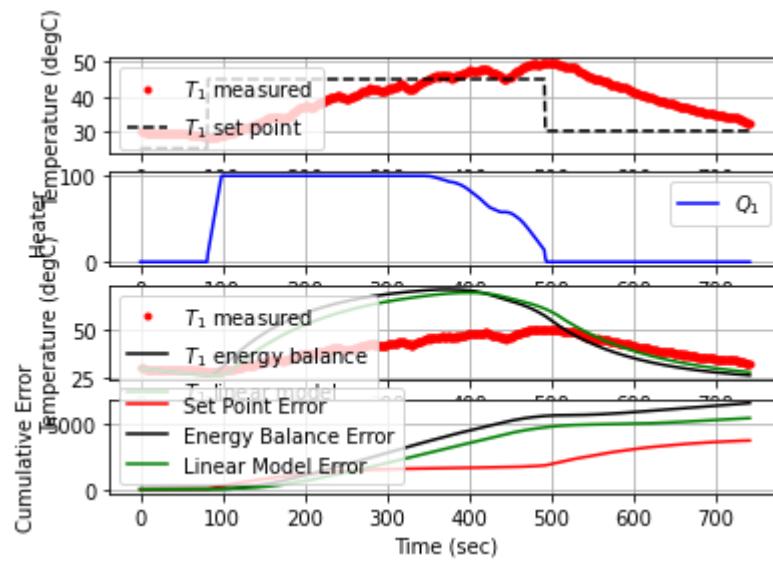
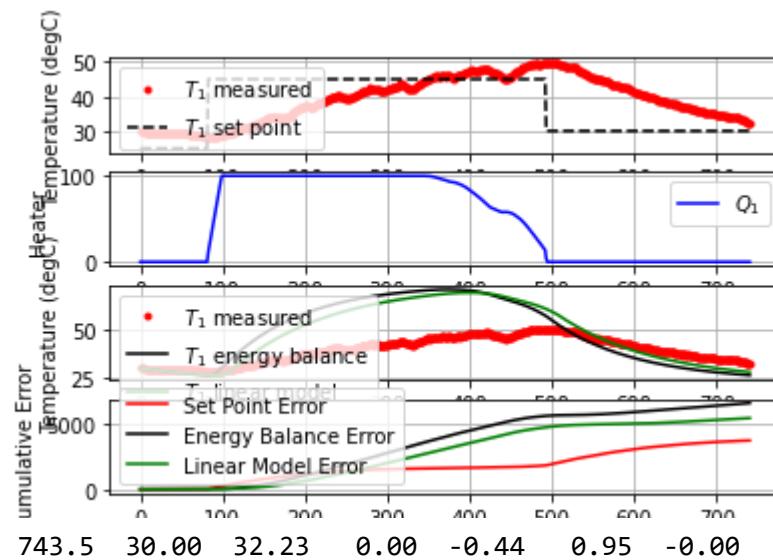
738.0 30.00 32.47 0.00 -0.49 0.95 0.00



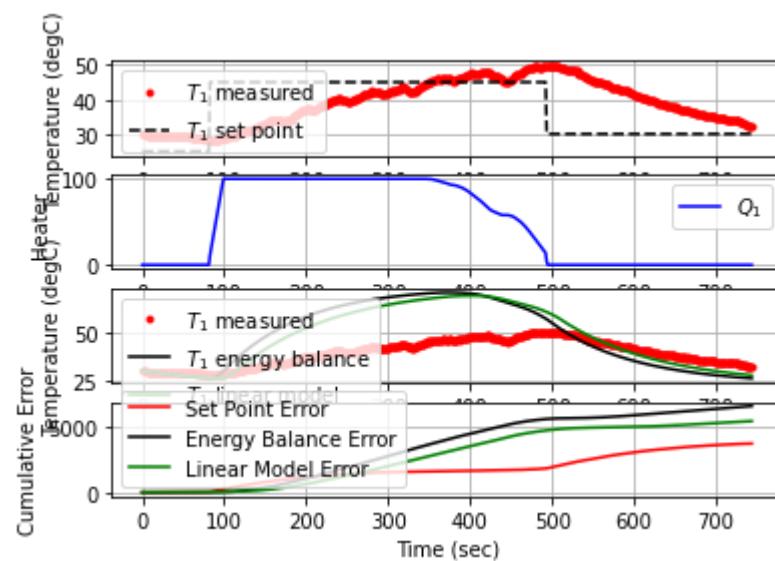
740.7 30.00 32.26 0.00 -0.44 0.95 -0.00



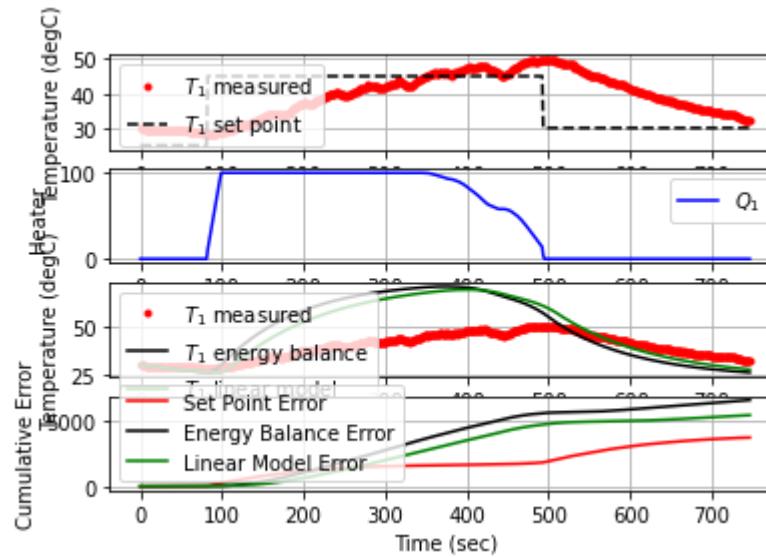
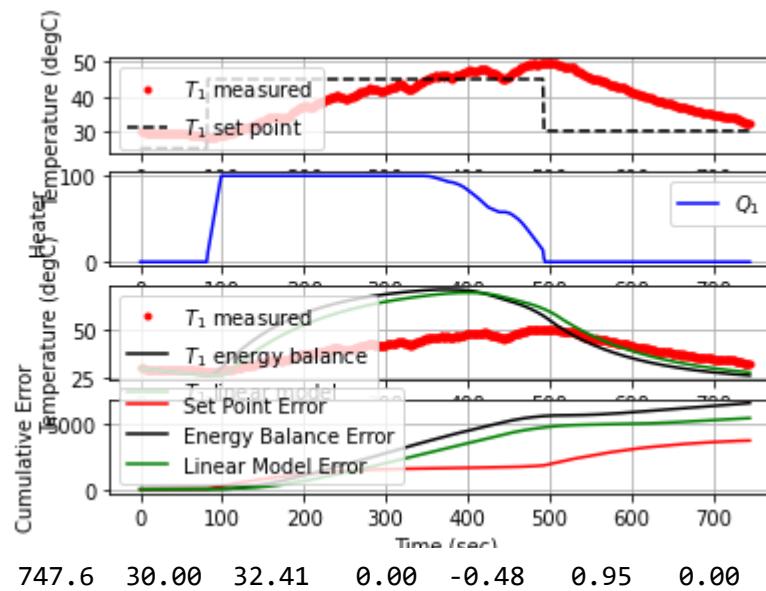
742.2 30.00 32.18 0.00 -0.43 0.95 0.00



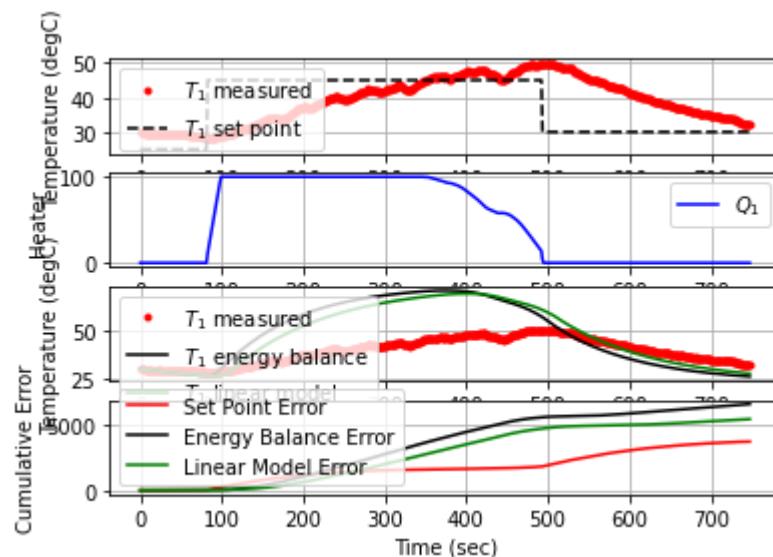
744.8 30.00 32.16 0.00 -0.43 0.95 0.00



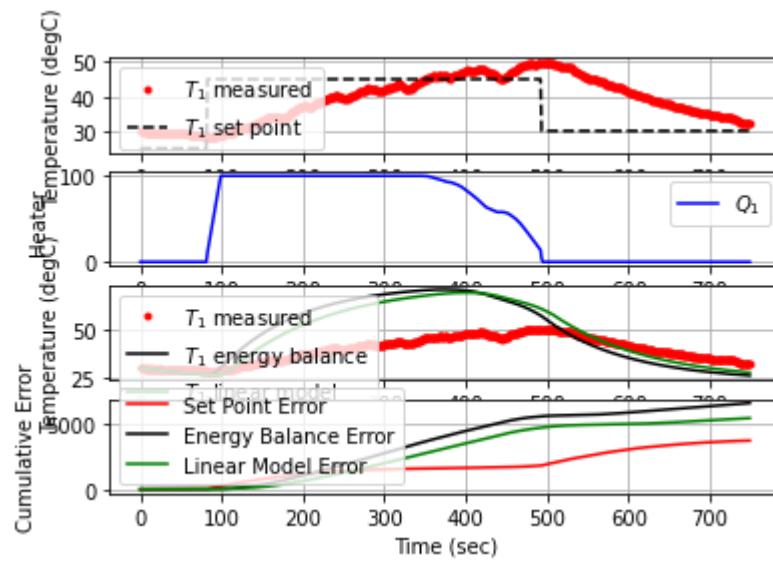
746.2 30.00 32.48 0.00 -0.48 0.95 -0.01



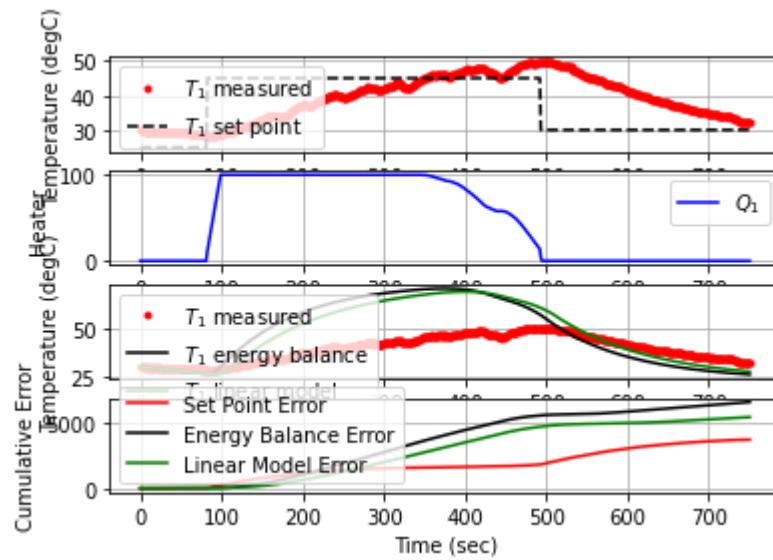
749.3 30.00 32.32 0.00 -0.46 0.95 0.00



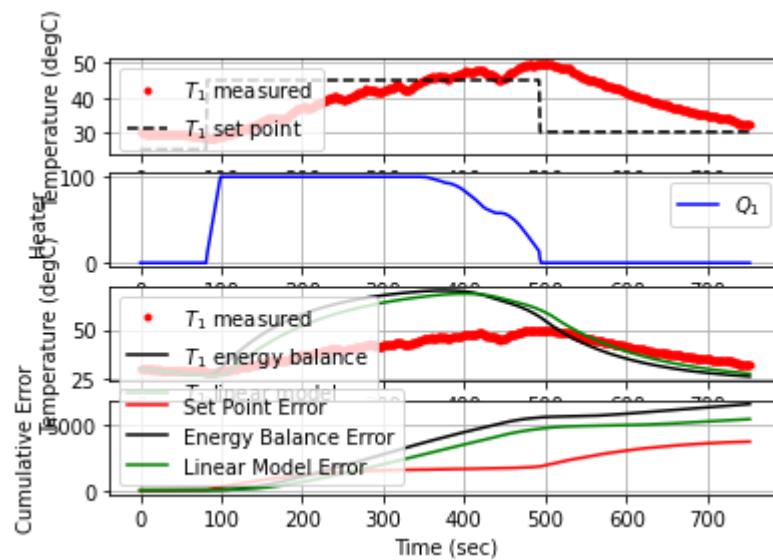
750.7 30.00 32.30 0.00 -0.45 0.95 0.00



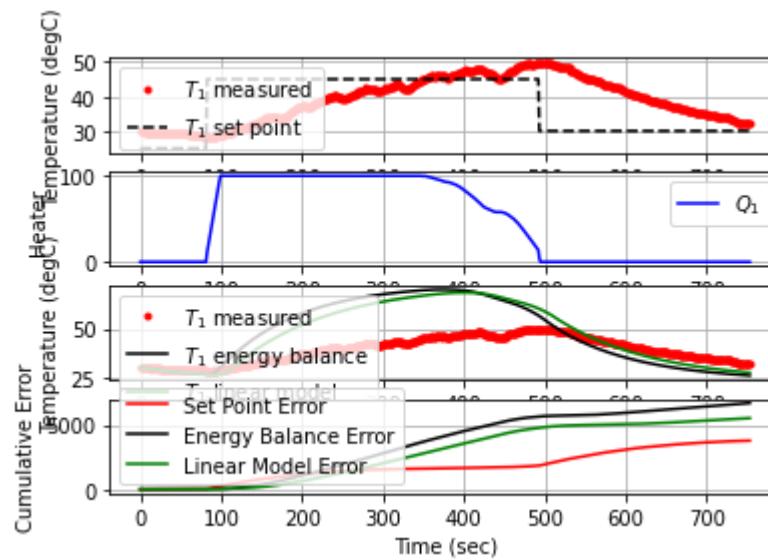
752.1 30.00 32.48 0.00 -0.48 0.95 -0.01



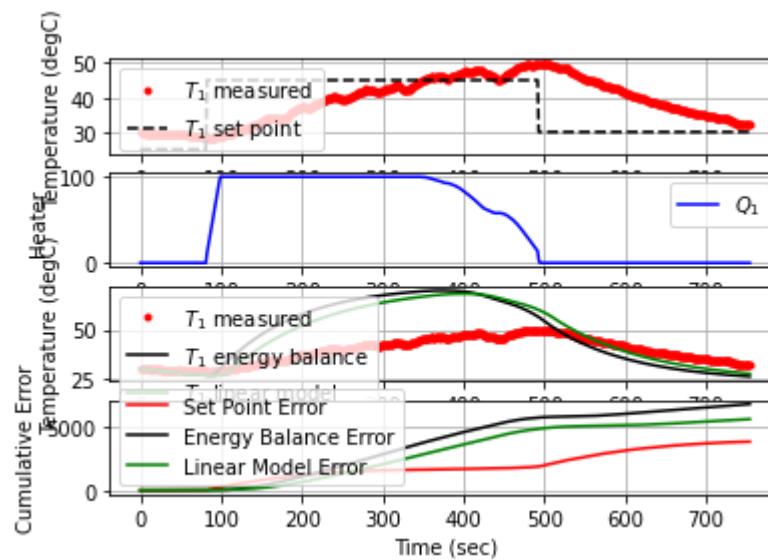
753.4 30.00 32.34 0.00 -0.46 0.95 0.01



754.7 30.00 32.29 0.00 -0.45 0.95 0.00



756.3 30.00 32.04 0.00 -0.41 0.95 0.01



```
757.8 30.00 32.09  0.00  -0.41   0.95  -0.00
Shutting down
Arduino disconnected successfully
Arduino disconnected successfully
```

Out[24]: True

```
<Figure size 432x288 with 0 Axes>
```


In [25]: `a.close()`

Arduino disconnected successfully

Out[25]: True

In []: