Step of a 3rd Order State Space System

The previous ODE45 comparison study of a step input to a PSS model was altered to test a variety of variable step MATLAB ode solvers. Simulation time was set to one minute so that step time variations could be observed after a disturbance. It should be noted that maximum step size was limited to 20 seconds (20,000 ms).

Summary

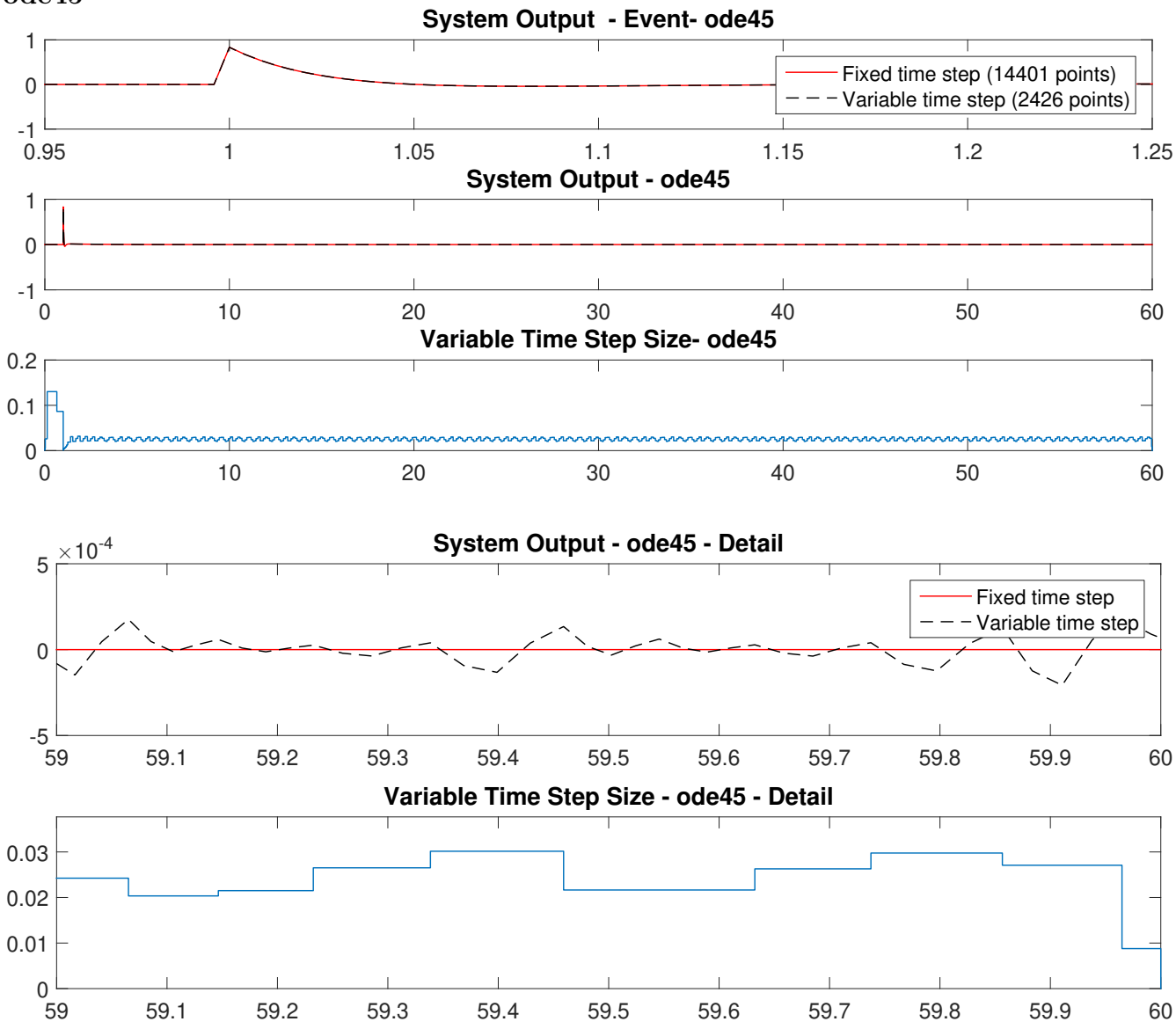
The table below shows the number of steps each method took for a 60 second simulation, the maximum step size post-step event, the magnitude of the steady state error, and if the method is Octave compatible. Full result plots are presented in the following pages.

Method	Number of Steps	Max Step Post Disturbance [ms]	SS Error Magnitude	Octave compatible
Fixed	14,401	≈4	-	*
ODE45	2,426	30	10^{-4}	*
ODE23	803	75	10^{-4}	*
ODE113	1,298	75	10^{-4}	
ODE15s	71	20,000	10^{-8}	*
ODE23s	45	20,000	10^{-9}	
ODE23t	72	≈17,000	10^{-9}	
ODE23tb	49	20,000	10^{-8}	

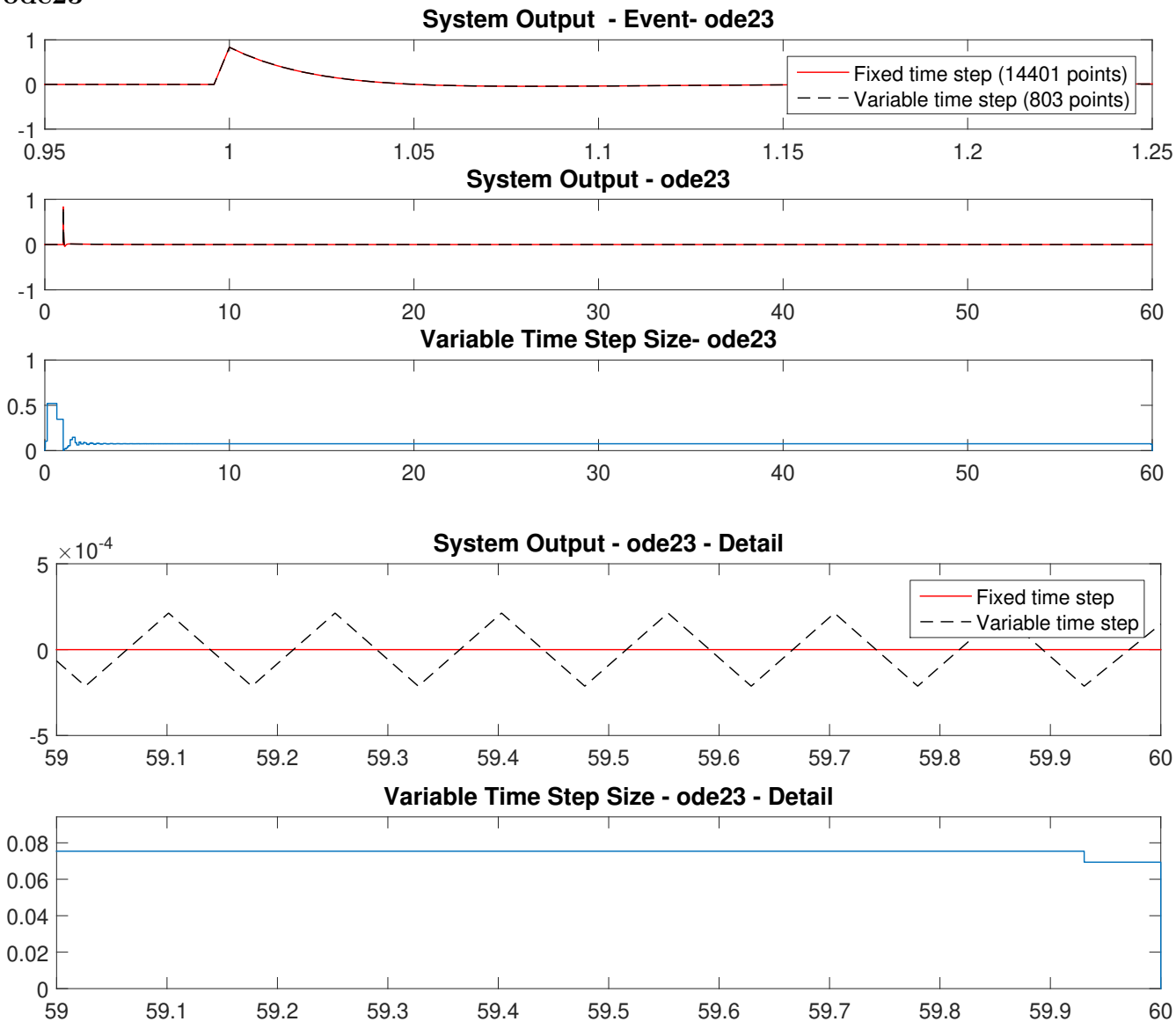
Observations of Note

1. All ODE methods greatly reduce the number of required steps.
2. ODE15s, ODE23s, and ODE23tb reached the maximum allowed step size of 20 seconds.
3. Steady state error for ODE45, ODE23, and ODE113 was approximately 4 orders of magnitude larger than all other methods and step size stayed below 75 ms.
4. ODE23s used the least amount of steps and had one of the smallest steady state errors.
5. ODE15s appears to be the most appropriate Octave compatible solver.

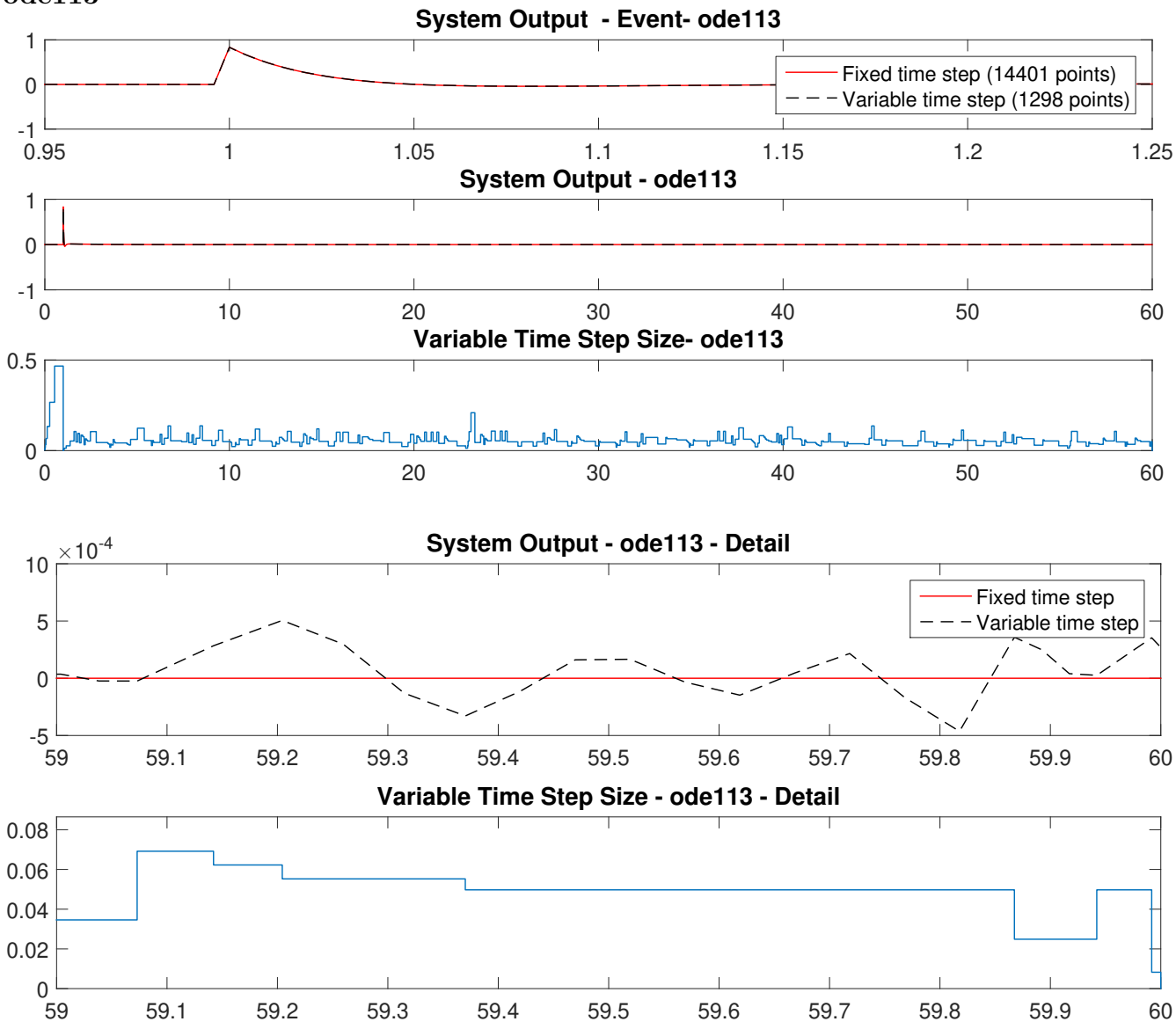
ode45


System Output - Event- ode45
Fixed time step (14401 points)
Variable time step (2426 points)
System Output - ode45
Variable Time Step Size- ode45
System Output - ode45 - Detail
×10^-4
Fixed time step
Variable time step
Variable Time Step Size - ode45 - Detail

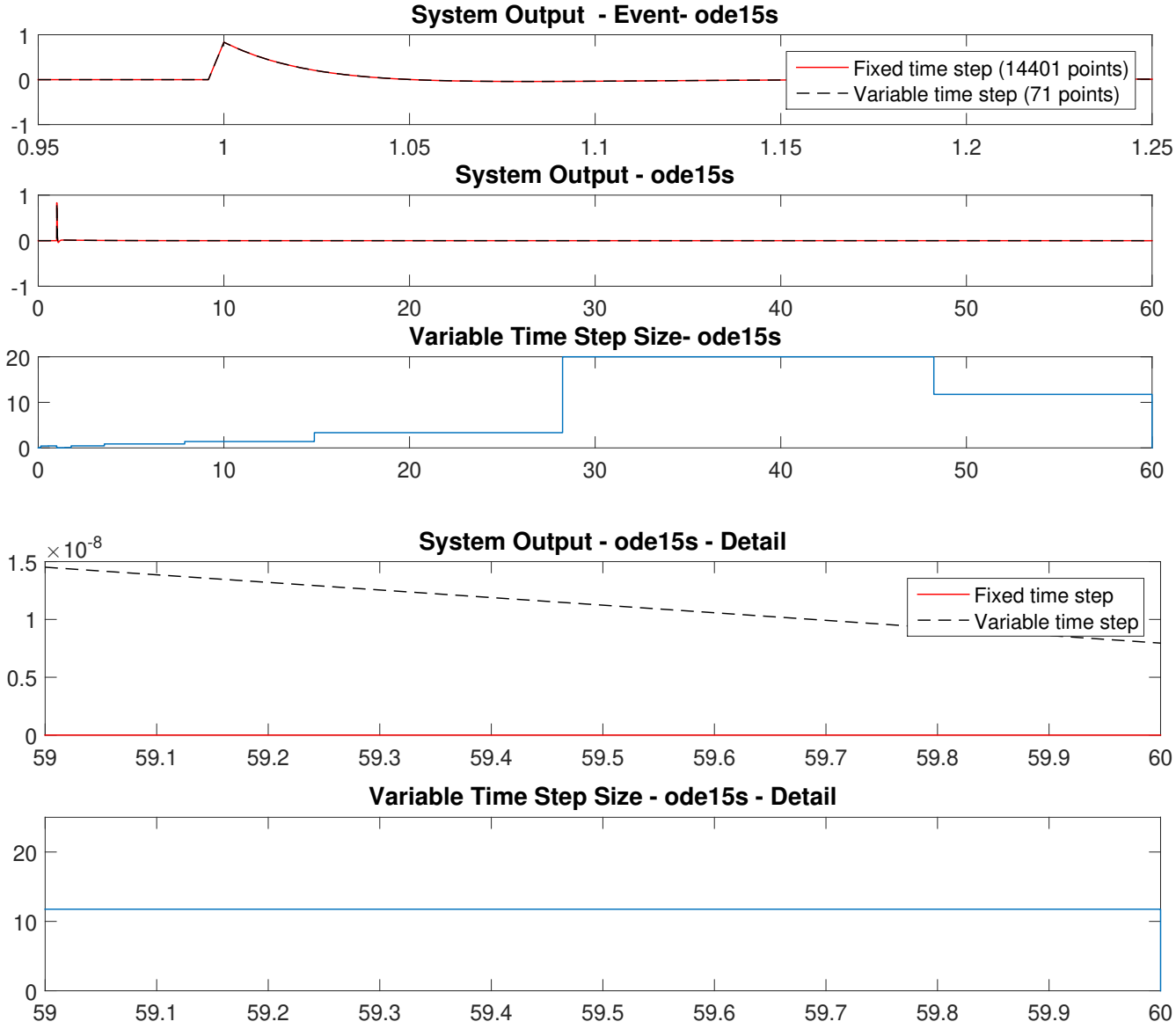
ode23


System Output - Event- ode23
Fixed time step (14401 points)
Variable time step (803 points)
System Output - ode23
Variable Time Step Size- ode23
System Output - ode23 - Detail
×10^-4
Fixed time step
Variable time step
Variable Time Step Size - ode23 - Detail

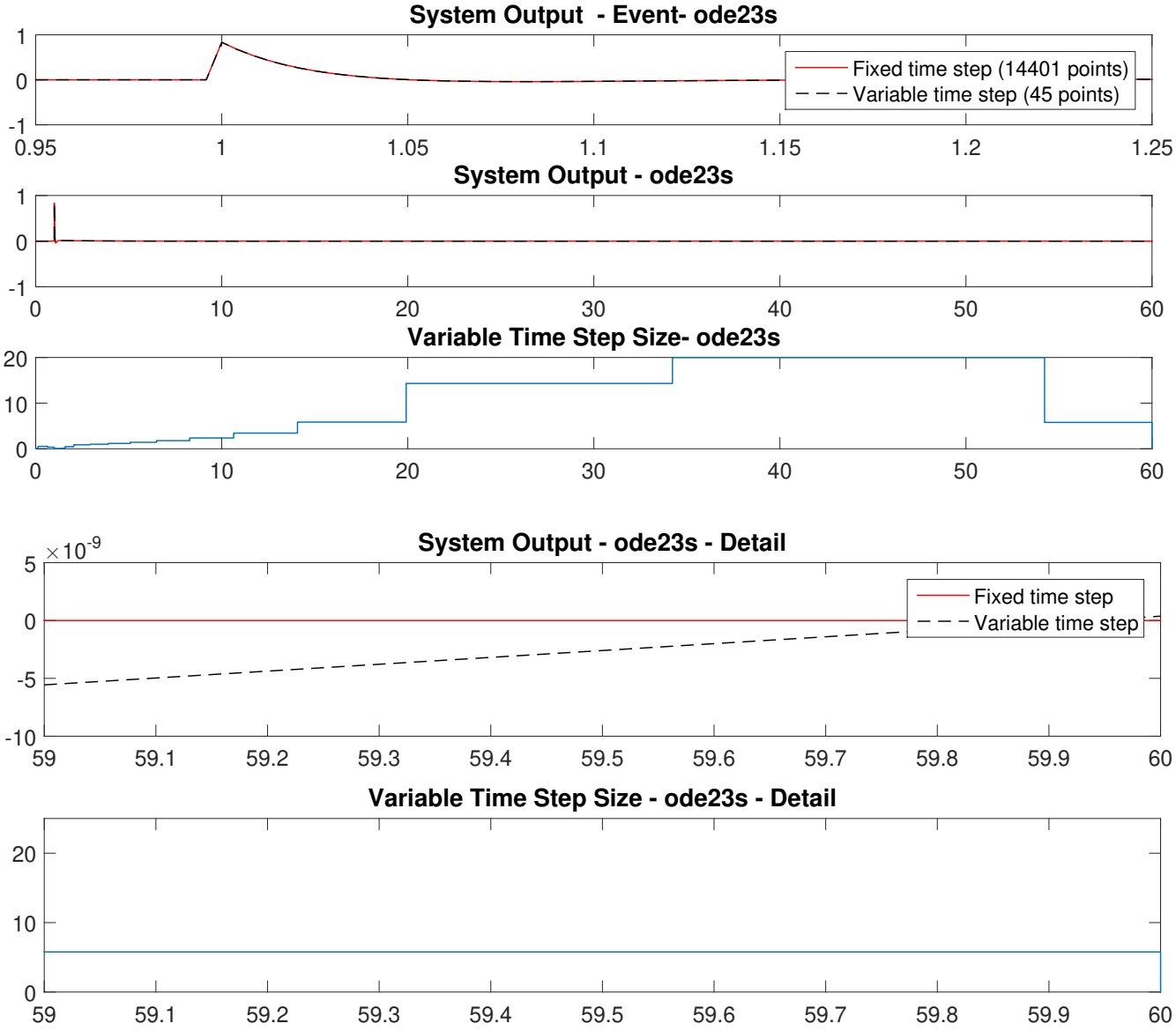
ode113


System Output - Event- ode113
Fixed time step (14401 points)
Variable time step (1298 points)
System Output - ode113
Variable Time Step Size- ode113
System Output - ode113 - Detail
×10^-4
Fixed time step
Variable time step
Variable Time Step Size - ode113 - Detail

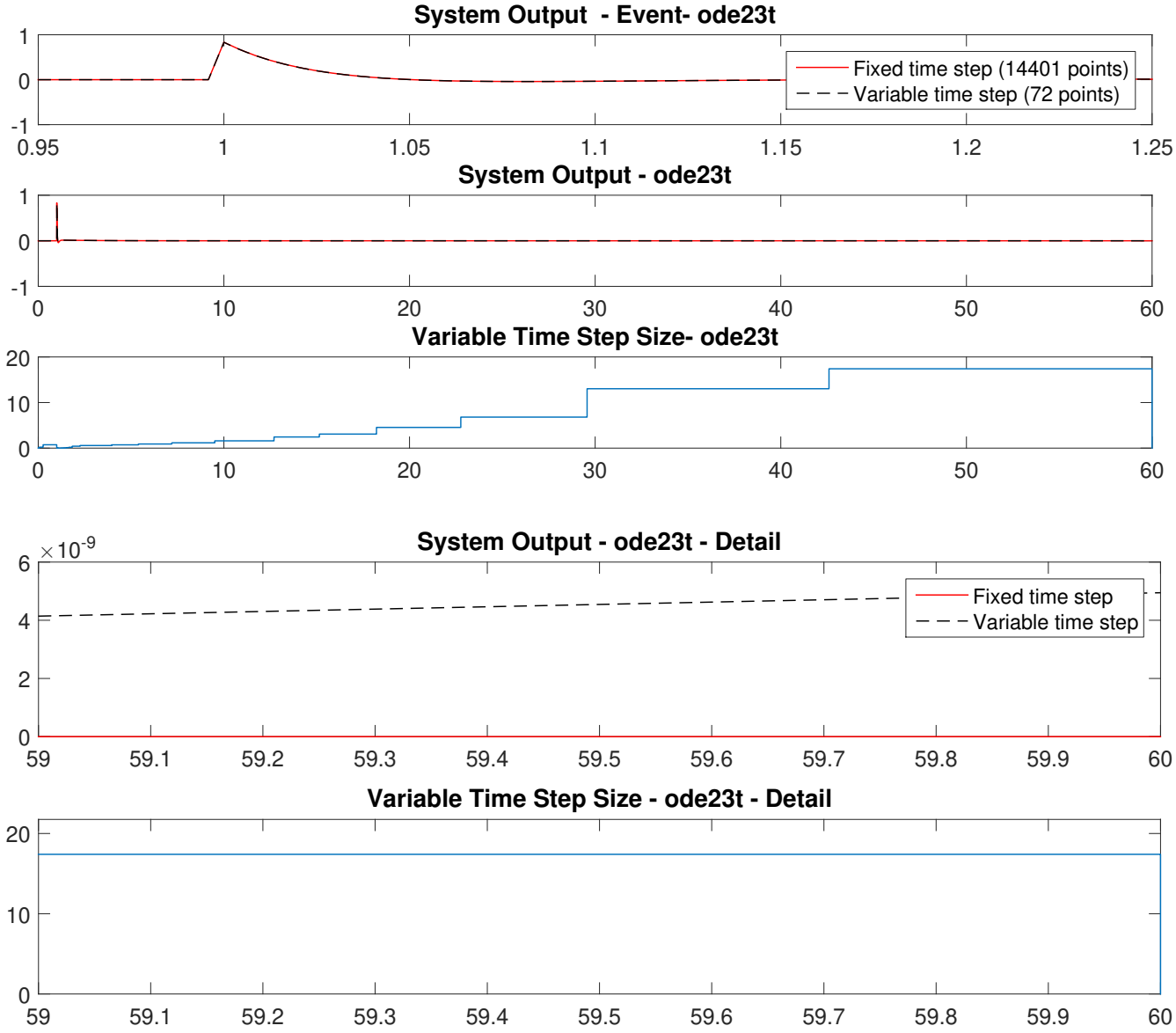
ode15s


System Output - Event- ode15s
Fixed time step (14401 points)
Variable time step (71 points)
System Output - ode15s
Variable Time Step Size- ode15s
System Output - ode15s - Detail
×10^-8
Fixed time step
Variable time step
Variable Time Step Size - ode15s - Detail

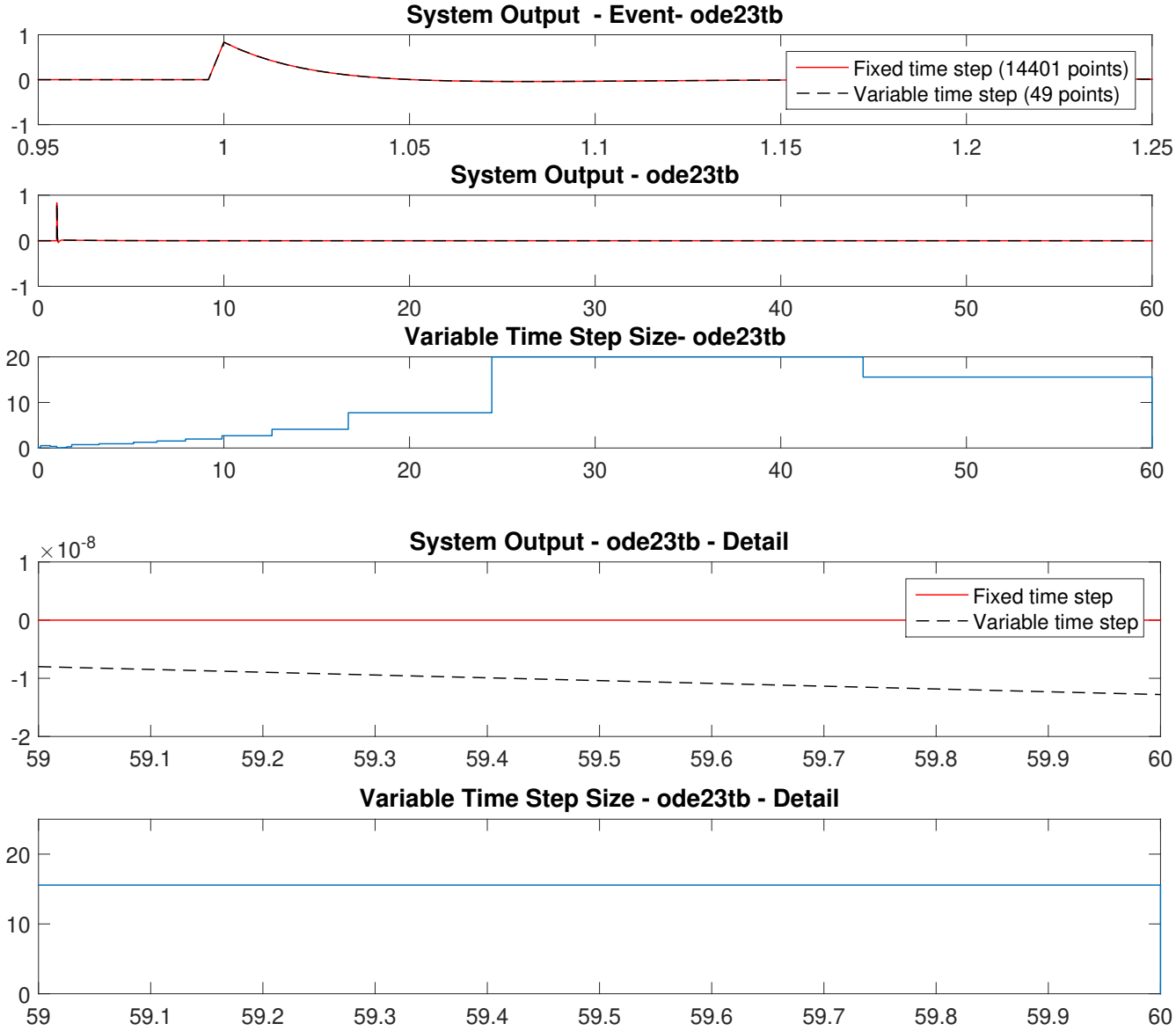
ode23s


System Output - Event- ode23s
Fixed time step (14401 points)
Variable time step (45 points)
System Output - ode23s
Variable Time Step Size- ode23s
System Output - ode23s - Detail
×10-9
Fixed time step
Variable time step
Variable Time Step Size - ode23s - Detail

ode23t


System Output - Event- ode23t
Fixed time step (14401 points)
Variable time step (72 points)
System Output - ode23t
Variable Time Step Size- ode23t
System Output - ode23t - Detail
×10-9
Fixed time step
Variable time step
Variable Time Step Size - ode23t - Detail

ode23tb


System Output - Event- ode23tb
Fixed time step (14401 points)
Variable time step (49 points)
System Output - ode23tb
Variable Time Step Size- ode23tb
System Output - ode23tb - Detail
×10-8
Fixed time step
Variable time step
Variable Time Step Size - ode23tb - Detail