A Numerical MBTY-Solution of ARGESIM Comparison C5 'Two State Model'

Oleg Kozlov, Konstantin Timofeev, Slava Petukhov
timofeevka@narod.ru, kozlov7@power.bmstu.ru, petukhov@mbty.biz

Simulator: *MBTY* is software package for graphical modelling, simulating and analysing of dynamic models. It provides a graphical user interface for building block diagrams. MBTY enables to develop new function elements (blocks) using an embedded programming tool (built-in language).

Model. The model uses MBTY's predefined standard blocks. For modelling the differential equations for two *Integrators*, *Cross Detects*, *Relays*, and *Sums* have been used (Figure 1). The initial values and the parameters of the problem have been set by the global parameter editor.

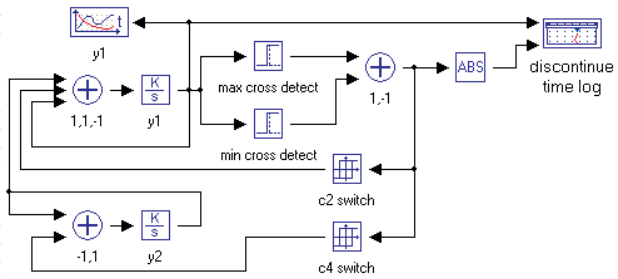

Figure 1: Block diagram model in MBTY.

Two *Cross Detection* blocks have been used to determine a time of input crossing lower and upper limit (*y1_max, y1_min*). Within those time limits the output value of blocks is counted 1, otherwise the output is 0. The user can set an accuracy of the crossing time. Two output values from the *Cross Detection* blocks were summed. Min cross output used again coefficient of -1 in the *Sum* block.
The output from *Sum* becomes 1 when the value of y_1 crosses *y1_max* and -1 when it crosses *y1_min*. The *Relay* c2 switch and c4 switch change the parameters according to the detected events. The *Event log* block is used to log the event times.

Tasks a - c: Time domain simulation and event times for different accuracies. The MBTY allows the user to set up the Max and the Min *time steps* for solvers (here set to 10^{-3} and 10^{-12}, resp.). Accuracy was set at 10^{-12} for the *Cross Detect* block. The MBTY adaptive explicit solver detects if discontinuity has placed with the same result. Figure 2 shows the time domain simulation, Table 1 event times and final value for y_1 for different accuracies.

Rel. tol.	10^{-6}	10^{-10}	10^{-14}
t1	2.46288272933086E-7	2.46288272437342E-7	2.46288273098263E-7
t2	1.1083061677931	1.10830616776826	1.10830616776578
t3	2.12968535517524	2.12968535516337	2.12968535514373
t4	3.05415290714476	3.05415290708184	3.05415290698186
t5	4.07553209453104	4.07553209448122	4.07553209435989
t6	4.99999964651487	4.99999964643625	4.99999964619767
y1(5)	5.36931247360320	5.36931365394820	5.36931409117480

Table 1: Event times and final value y_1.

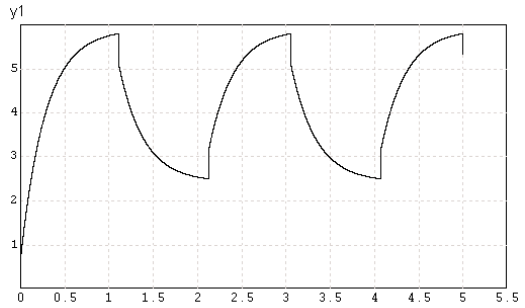

Figure 2: y_1 over time, switching state.

D- Task : Change of State2 behaviour. Changing of the *State 2* parameter value and the switching condition in global parameter editor results in high frequent oscillation behaviour of y_1. All adaptive solvers compute 63 discontinuities. The first and last discontinuities and the final value of y_1 are shown in the Table 2, computed with relative accuracy of 10^{-11}. Figure 3 also reflects the high-frequency oscillations.

	10^{-11}
t1	0.00000000730024
t2	1.10830617053450
t3	1.12172997202320
…	…
t61	4.80930641761650
t62	4.92304042409690
t63	4.93646422553790
y1(5)	5.30470141338140

Table 2: Event times in case of high-frequent *State 2*.

Figure 3: High-frequent oscillations in y_1

Classification: Numerical solution with high accuracy

Corresponding Author: Slava Petukhov,
S. Petukhov, K. Timofeev, S. Petukhov
Moscow State Technical University,
2-nd Baumanskaya, 5, 105005, Moscow, Russia;
petuhoff@mail.ru

Received: February 10, 2006
Reveised: June 10, 2006
Accepted: July 10, 2006