

System Verification

Tasks:

Note: all tasks execution time is calculated from the actual implemented tasks using GPIOs and the logic analyzer.

<i>Task Name</i>	<i>Periodicity / Deadline (MS)</i>	<i>Execution Time (MS)</i>
Button_1_Monitor	50	0.0053
Button_2_Monitor	50	0.0053
Periodic Transmitter	100	0.00963
UART Receiver	20	0.0177
Load 1 Simulation	10	5
Load 2 Simulation	100	12

Methods of Verification:

1- Using Analytical Method:

1.1. System Hyper period:

- It's the Least Common Multiple of all task periods
- $H = \text{LCM}(50, 50, 100, 20, 10, 100) = 100$

1.2. CPU Load

- $U = (E1 + E2 + E3 + E4 + E5 + E6) / H$
- where E is the Execution time and H is the Hyper period.
- $U = (0.008*2 + 0.008*2 + 0.0096 + 0.017*5 + 5*10 + 12) / 100 = 0.621$
(62.1%)

1.3. System stimulability check using URM and Time Demand Analysis Techniques:

- $\sum_{i=1}^n \frac{c_i}{p_i} \leq n(2^{\frac{1}{n}} - 1)$
- $L.H.S = \sum_{i=1}^n \frac{c_i}{p_i} = \frac{0.0053}{50} + \frac{0.0053}{50} + \frac{0.00963}{100} + \frac{0.0177}{20} + \frac{5}{10} + \frac{12}{100} = 0.6212$
- $R.H.S = n(2^{\frac{1}{n}} - 1) = 0.7348$
- $L.H.S \leq R.H.S$ so, the system is schedulable.

2- Time Demand Analysis:

a- Sort the tasks making the highest priority at the first:

Task Name	Periodicity / Deadline (MS)	Execution Time (MS)
1- Load 1 Simulation	10	5
2- UART Receiver	20	0.0177
3- Button_1_Monitor	50	0.0053
4- Button_2_Monitor	50	0.0053
5- Periodic Transmitter	100	0.00963
6- Load 2 Simulation	100	12

b- Choose the critical instant 0 then:

$$w_1(10) = 5 + 0 = 5 < \text{deadline} \quad w_2(20) = 0.0177 + 5 * \frac{20}{10} = 5.0177 < \text{deadline}$$

$$w_3(50) = 0.0053 + 0.0177 * \frac{50}{20} + 5 * \frac{50}{10} = 25.049 < \text{deadline}$$

$$w_4(50) = 0.0053 + 0.0053 * \frac{50}{50} + 0.0177 * \frac{50}{20} + 5 * \frac{50}{10} = 25.055 < \text{deadline}$$

$$w_5(100) = 0.00963 + 0.0053 * \frac{100}{50} + 0.0053 * \frac{100}{50} + 0.0177 * \frac{100}{20} + 5 * \frac{100}{10} = 50.1193 < \text{deadline}$$

$$w_6(100) = 12 + 0.0096 * \frac{100}{100} + 0.008 * \frac{100}{50} + 0.008 * \frac{100}{50} + 0.017 * \frac{100}{20} + 5 * \frac{100}{10} = 62.1193 < \text{deadline}$$

As all Tasks are less Than the deadline. So, the system is schedulable.

3- Using SIMSO offline simulator:

Used Scheduler: Fixed priority rate monotonic.

Tasks Simulated:

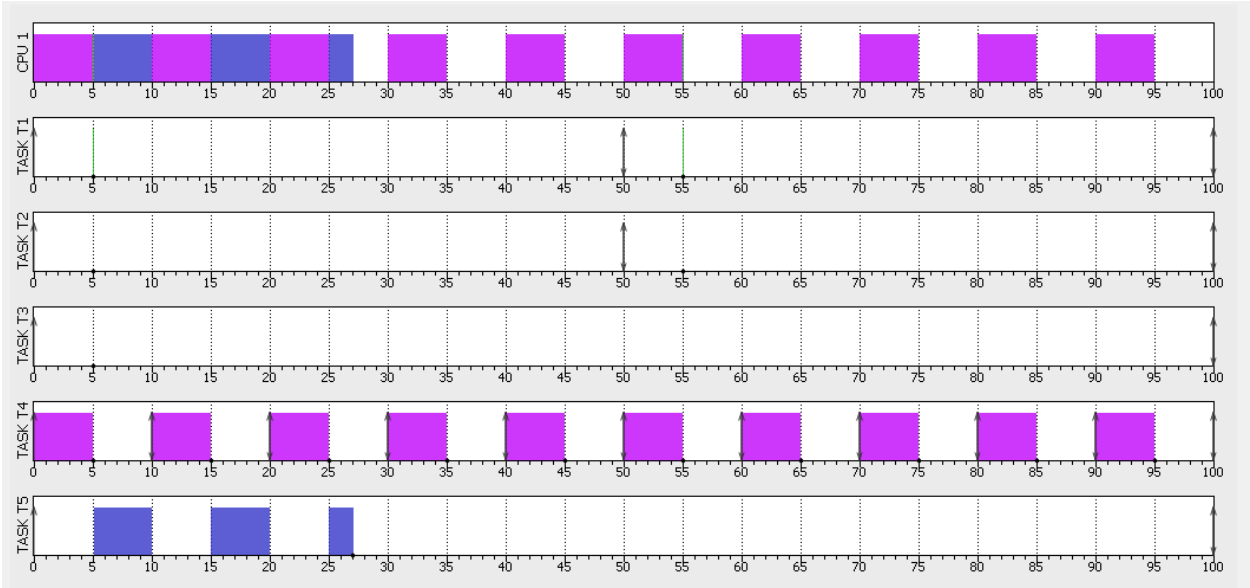
The screenshot shows the 'Qt Model data' window with the 'Tasks' tab selected. It contains a table with 10 columns: id, Name, Task type, Abort on miss, Act. Date (ms), Period (ms), List of Act. dates (ms), Deadline (ms), WCET (ms), and Followed by. There are five tasks listed: TASK T1, TASK T2, TASK T3, TASK T4, and TASK T5. All tasks are 'Periodic' and have 'Abort on miss' set to 'No'. The 'Followed by' column has dropdown menus for each task. Below the table is an 'Edit data fields...' button, and at the bottom are 'Remove selected task(s)', 'Add task', and 'Generate Task Set' buttons.

id	Name	Task type	Abort on miss	Act. Date (ms)	Period (ms)	List of Act. dates (ms)	Deadline (ms)	WCET (ms)	Followed by
1	TASK T1	Periodic	<input type="checkbox"/> No	0	50	-	50	0.0053	▼
2	TASK T2	Periodic	<input type="checkbox"/> No	0	50	-	50	0.0053	▼
3	TASK T3	Periodic	<input type="checkbox"/> No	0	100	-	100	0.00963	▼
4	TASK T4	Periodic	<input type="checkbox"/> No	0	10	-	10	5	▼
5	TASK T5	Periodic	<input type="checkbox"/> No	0	100	-	100	12	▼

For The CPU load the is the same as the analytical mode

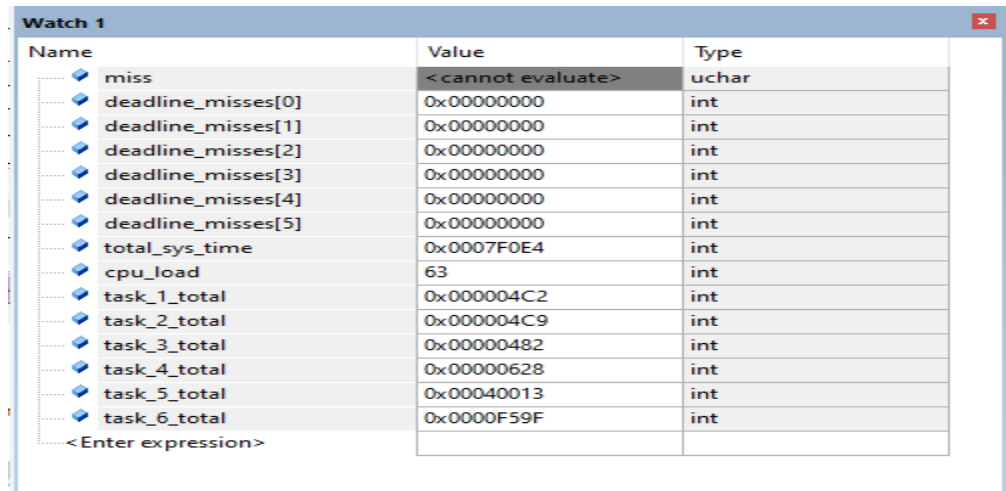
	Total load	Payload	System load
CPU 1	0.6203	0.6203	0.0000
Average	0.6203	0.6203	0.0000

Gantt chart over the Hyper period:



3- Using Keil Simulator at Runtime:

1- Calculate the CPU usage time using timer 1 and trace macros:



Name	Value	Type
miss	<cannot evaluate>	uchar
deadline_misses[0]	0x00000000	int
deadline_misses[1]	0x00000000	int
deadline_misses[2]	0x00000000	int
deadline_misses[3]	0x00000000	int
deadline_misses[4]	0x00000000	int
deadline_misses[5]	0x00000000	int
total_sys_time	0x0007F0E4	int
cpu_load	63	int
task_1_total	0x000004C2	int
task_2_total	0x000004C9	int
task_3_total	0x00000482	int
task_4_total	0x00000628	int
task_5_total	0x00040013	int
task_6_total	0x0000F59F	int
<Enter expression>		

Note:

- 1- The CPU load is the same as the calculated analytically and the obtained using SIMSO offline simulator.
- 2- None of The Tasks Miss the Deadline.

- Using trace macros and GPIOs, plot the execution of all tasks, tick, and the idle task on the logic analyzer:

