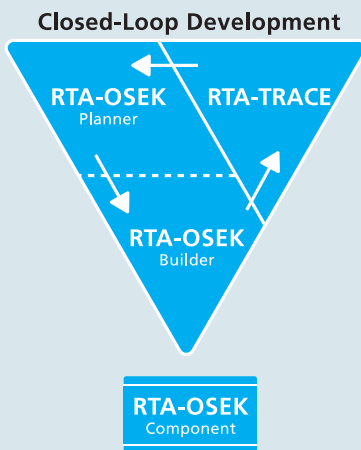


# RTA-OSEK Renesas V850E/ES with the IAR Compiler



## Features at a Glance

- OSEK/VDX OS v2.2 Certified OS
- RTOS overhead: 30 bytes RAM, 152 bytes ROM
- Category 2 interrupt latency: 67 CPU cycles
- Applications include: Engine Management, Chassis Control, Instrumentation Clusters, Industrial Systems



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## RTA-OSEK

RTA-OSEK provides an application design environment that combines the smallest and fastest OSEK RTOS with a unique timing analysis tool.

This datasheet discusses the Renesas V850E/ES port of the RTA-OSEK kernel alone and should be read in conjunction with the Technical Product Overview "Developing Embedded Real-Time Applications with RTA-OSEK" available from ETAS.

The kernel element of RTA-OSEK is a fixed priority, pre-emptive real-time operating system that is compliant to the OSEK/VDX OS standard version 2.3 for all four conformance classes (BCC1, BCC2, ECC1 and ECC2) and intra processor communication using OSEK COM Conformance Classes A and B (CCCA and CCCB).

All CPU overheads of the kernel have low worst case bounds and little variability in execution time. The kernel is particularly suited to systems with very tight constraints on hardware costs and where run-time performance must be guaranteed.

The kernel is configured using an offline tool provided with RTA-OSEK. Determining in advance which features are used allows memory requirements to be minimized and API calls to be optimized for greatest efficiency.

All tasks and ISRs in RTA-OSEK run on a single stack – even extended tasks. This allows dramatic reductions in application stack space requirements.

The RTA-OSEK kernel is designed to be scalable. When a task uses queued activation or waits on events, the additional RTOS overhead required to support these features is paid by the task rather than by the system. This means that a basic single activation task uses the same resources in a BCC1 system as it does in an ECC2 system.

## Compiler/Assembler/Linker

The libraries containing the code for the RTA-OSEK kernel have been built using the following tools:

- IAR iccv850 Version V3.71.1.50017/W32
- IAR av850 Version V3.71.1.50017/W32

- IAR xlink Version V4.61R/W32

### Memory Model

RTA-OSEK supports the normal code and large data model provided by the IAR compiler.

### ORTI Debugger Support

ORTI is the OSEK Run-Time Interface that is supported by RTA-OSEK for the following debuggers:

- Lauterbach Trace32

Further information about ORTI for RTA-OSEK can be found in the *RTA-OSEK ORTI Guide*.

### Hardware Environment

RTA-OSEK supports all variants of the Renesas V850E/ES family including CAG4-M, FG3, FJ3, FK3, PHO3 and JH3-E.

### Interrupt Model

RTA-OSEK supports 8 levels of nested interrupts.

### Floating Point Support

RTA-OSEK is designed to work with fully re-entrant software floating-point libraries supplied by IAR. This allows floating-point to be used in RTA-OSEK tasks and ISRs without the need to save and restore any additional context.

### Evaluation Board Support

RTA-OSEK for the Renesas V850E/ES can be used with any suitable valuation board. An example application is provided to run on the V850ES/Fx3 CAN iT evaluation board. This application can be adapted for other target boards by adjusting the linker command file (to alter the RAM locations) and one source file (if alternative output pins are required).

### Functionality

The table below outlines the restrictions on the maximum number of operating system objects allowed by RTA-OSEK.

	BCC1	BCC2	ECC1	ECC2
Max no of tasks	32 plus an idle task			
Max tasks per priority	1	32	1	32
Max queued activations	1	255	1	255
Max events per task	n/a	n/a	32	32
Max nested resources	255			
Max alarms	Not limited by RTA-OSEK			

	BCC1	BCC2	ECC1	ECC2
Max standard resources	255			
Max internal resources	Not limited by RTA-OSEK			
Max application modes	65535			

Note that OSEK specifies that queued activations in an ECC2 system are only possible for basic tasks. Where tasks share a priority level, the maximum number of queued activations per priority level is 255.

The number of alarms, tasksets, schedules and schedule arrivalpoints is only limited by available hardware resources.

### Memory Usage

The memory overhead of RTA-OSEK is:

Memory Type	Overhead (bytes)
RAM	30
ROM/Flash	152

In addition to the RTOS overhead, each object used by an application has the following memory requirements:

Object	RAM Bytes	ROM Bytes
BCC1 task	0	36
BCC2 task	10	56
ECC1 task	48	60
ECC2 task	50	68
Category 1 ISR	0	0
Category 2 ISR	0	52
Resource	0	20
Internal Resource	0	0
Event	0	4
Alarm	12	42
Counter	4	98
ScheduleTable	16	140
ScheduleTable Expiry	0	12
Taskset (RW)	4	4
Taskset (RO)	0	4
Schedule	16	36
Arrivalpoint (RW)	12	12
Arrivalpoint (RO)	0	12

In addition to these static memory requirements each task priority and Category 2 interrupt has a stack overhead (in addition to application stack usage). The single

stack model means that this overhead applies to each priority level rather than to each task. Similarly, for Category 2 interrupts this overhead applies for each unique interrupt priority. The table below shows stack usage for these objects.

Object	Stack Bytes
Task priority level	68
Category 2 interrupt	56

RTA-OSEK provides an optimization for task termination if the user can guarantee that tasks only terminate from their entry function. Tasks that terminate from elsewhere are not eligible for this optimization and duly require 40 more stack bytes per priority level than indicated in the table above.

### Performance

The following table gives the key kernel timings for operating system behavior in CPU cycles.

Task Type	Basic	Extended	Ref
Category 1 ISR Latency	41	41	K
Category 2 ISR Entry Latency	67	67	A
Category 2 ISR Exit Latency	255	369	E
Normal Termination	133	251	D
ChainTask	307	609	J
Pre-emption	247	359	C
Triggered by alarm	383	497	F
Schedule	235	349	Q
ReleaseResource	247	361	M
SetEvent	n/a	559	S

All performance figures are for the non-optimized interface to RTA-OSEK. Using the optimized interface will result in shorter execution times for some operations. All tasks use lightweight termination and no pre or post task hooks were specified.

The execution time for every kernel API call is available on request from ETAS.

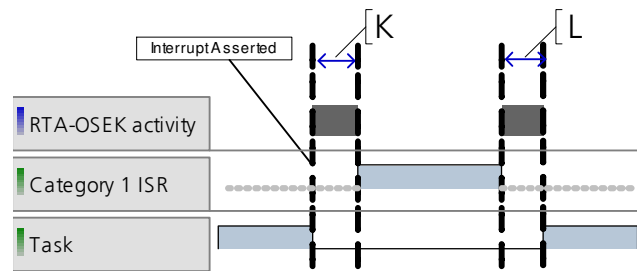


Figure 1 - Category 1 interrupt with return to interrupted task

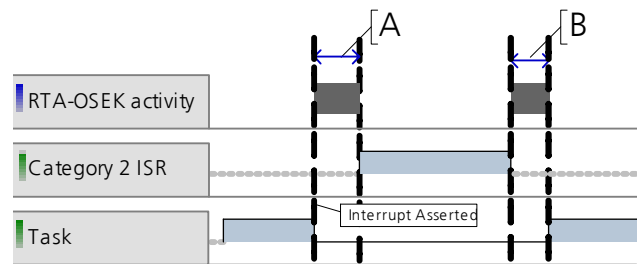


Figure 2 - Category 2 interrupt with return to interrupted task

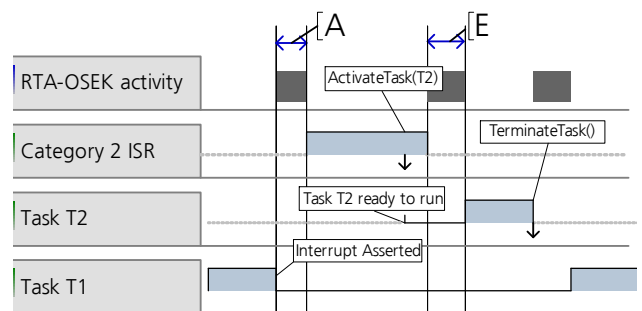


Figure 3 - Category 2 interrupt activates a higher priority task

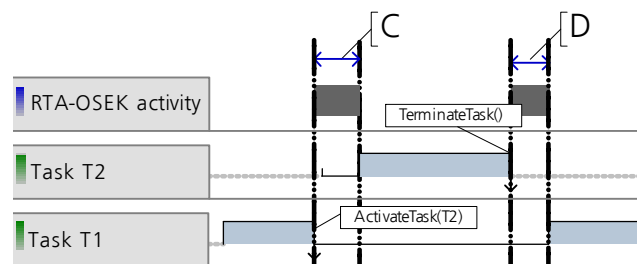


Figure 4 - Task activates a higher priority task

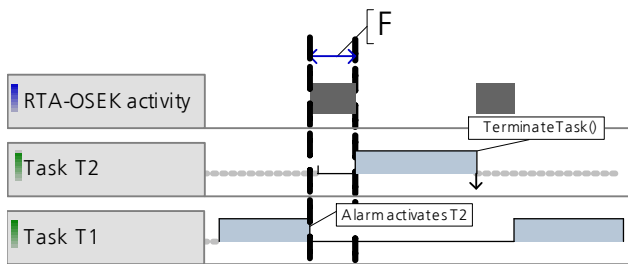


Figure 5 - Alarm activates task

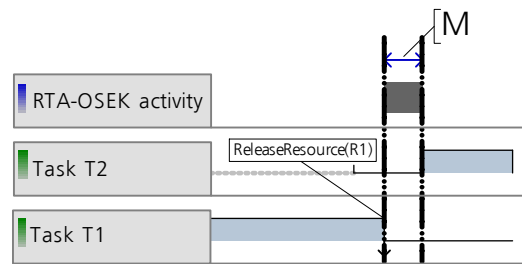


Figure 9 - ReleaseResource()

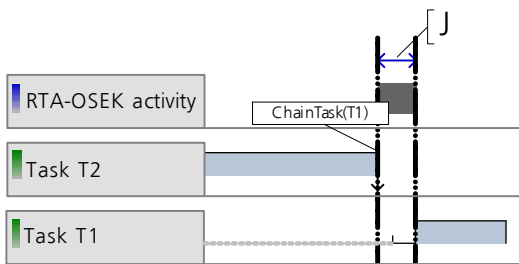


Figure 6 - Task chaining

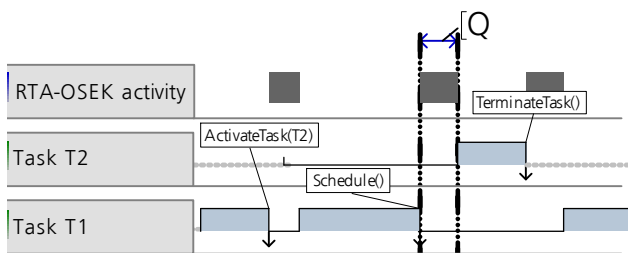


Figure 7 - Schedule() call

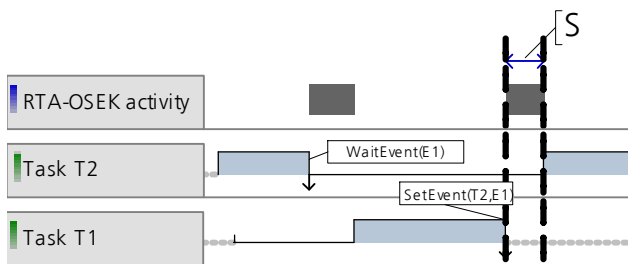


Figure 8 - Activation by SetEvent()

### Benchmarks

The following sections shows benchmarks for RTA-OSEK memory usage for BCC1, BCC2, ECC1 and ECC2 conformant applications. The applications have the following framework:

- 8 tasks plus the idle task
- All basic tasks are lightweight tasks
- 1 Category 2 ISR with a 10ms minimum inter-arrival time
- 1 Counter
- 7 or 8 alarms, all attached to the same counter
- No resources or internal resources
- No hooks
- No schedules
- No tasksets
- Built using standard status

The following table shows the task priority configuration for each benchmark application:

Task/ISR	Stack (bytes)	Period (ms)	BCC1	BCC2	ECC1	ECC2
ISR1	10	10	IPL1	IPL1	IPL1	IPL1
A	10	10	8	8	8	8
B	20	20	7	7	7	7
C	30	20	6	6	6	6
D	40	30	5	5	5	5
E	50	50	4	4	4	4
F	60	80	3	3	3	3

Task/ISR	Stack (bytes)	Period (ms)	BCC1	BCC2	ECC1	ECC2
G	70	100	2	2	2	2
H	80	150	1	1	1	2
Idle	10	-	idle	idle	idle	idle

The overhead figures give the ROM and RAM required for RTA-OSEK in addition to that required by the application. The RAM figure is shown split into RAM data and RAM stack.

### BCC1

The BCC1 application uses 8 basic tasks with unique priorities.

This application has the following overheads:

Memory Usage	Bytes
<b>OS ROM</b>	<b>3138</b>
<b>OS RAM</b>	<b>762</b>
comprising RAM data	146
comprising RAM stack	616

### BCC2

The BCC2 application uses 8 basic tasks with unique priorities.

Tasks A-G are attached to 7 alarms. Task H is activated multiple times from Task A and has maximum queued activation count of 255.

This application has the following overheads:

Memory Usage	Bytes
<b>OS ROM</b>	<b>3686</b>
<b>OS RAM</b>	<b>762</b>
comprising RAM data	142
comprising RAM stack	620

### ECC1

The ECC1 application uses 7 basic tasks and 1 extended task with unique priorities. Task H is the extended task and it waits on a single event that is set by basic tasks A-G.

This application has the following overheads:

Memory Usage	Bytes
<b>OS ROM</b>	<b>4735</b>
<b>OS RAM</b>	<b>862</b>
comprising RAM data	194
comprising RAM stack	668

### ECC2

The ECC2 application uses 6 basic tasks and 2 extended tasks. Tasks G and H are the extended tasks and share a priority. The extended tasks wait on a single event that is set by tasks A-F.

This application has the following overheads:

Memory Usage	Bytes
<b>OS ROM</b>	<b>5835</b>
<b>OS RAM</b>	<b>948</b>
comprising RAM data	252
comprising RAM stack	696

### Stack Optimization

Using stack optimization with the benchmark example identifies that the following tasks can share internal resources:

- Tasks A, B and C
- Tasks D, E and F
- Tasks G and H

The benefit of this optimization is shown in the following table:

Total Stack Space (bytes)	BCC1	BCC2	ECC1	ECC2
<b>Non-optimized</b>	<b>996</b>	<b>1000</b>	<b>1048</b>	<b>1076</b>
OS Overhead	616	620	668	696
Application Overhead	380	380	380	380
<b>Optimized</b>	<b>456</b>	<b>456</b>	<b>508</b>	<b>508</b>
OS Overhead	276	276	328	328
Application Overhead	180	180	180	180

## Notes

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