LAUTERBACH
DEVELOPMENT TOOLS

OS Awareness Manual
MicroC3/Standard

MANUAL

OS Awareness Manual MicroC3/Standard

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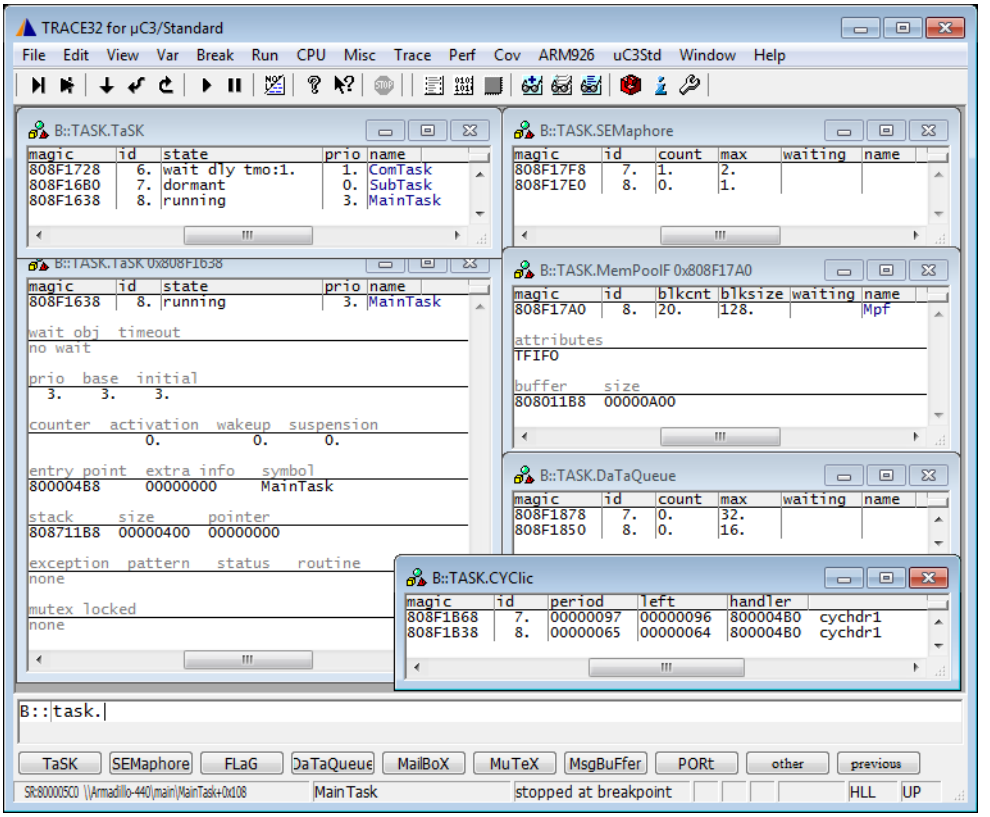
Version 06-Jun-2024

History

28-Aug-18 The title of the manual was changed from “RTOS Debugger for *<x>*” to “OS Awareness Manual *<x>*”.

Overview



The OS Awareness for µC3/Standard contains special extensions to the TRACE32 Debugger. This manual describes the additional features, such as additional commands and statistic evaluations.

Architecture-independent information:

- **"Training Basic Debugging"** (training_debugger.pdf): Get familiar with the basic features of a TRACE32 debugger.
- **"T32Start"** (app_t32start.pdf): T32Start assists you in starting TRACE32 PowerView instances for different configurations of the debugger. T32Start is only available for Windows.
- **"General Commands"** (general_ref_*<x>*.pdf): Alphabetic list of debug commands.

Architecture-specific information:

- **"Processor Architecture Manuals"**: These manuals describe commands that are specific for the processor architecture supported by your Debug Cable. To access the manual for your processor architecture, proceed as follows:
  - Choose **Help** menu > **Processor Architecture Manual**.
- **"OS Awareness Manuals"** (rtos_*<os>*.pdf): TRACE32 PowerView can be extended for operating system-aware debugging. The appropriate OS Awareness manual informs you how to enable the OS-aware debugging.

Supported Versions

Currently µC3/Standard is supported for the following versions:

- µC3/Standard on ARM architecture.

The **TASK.CONFIG** command loads an extension definition file called “uc3std.t32” (directory “~~/demo/<*processor*>/kernel/uc3std”). It contains all necessary extensions.

Automatic configuration tries to locate the µC3/Std internals automatically. For this purpose all symbol tables must be loaded and accessible at any time the OS Awareness is used.

If you want to display the OS objects “On The Fly” while the target is running, you need to have access to memory while the target is running. In case of ICD, you have to enable **SYStem.MemAccess** or **SYStem.CpuAccess** (CPU dependent).

For system resource display and trace functionality, you can do an automatic configuration of the OS Awareness. For this purpose it is necessary that all system internal symbols are loaded and accessible at any time, the OS Awareness is used. Each of the **TASK.CONFIG** arguments can be substituted by '0', which means that this argument will be searched and configured automatically. For a fully automatic configuration omit all arguments:

Format:	**TASK.CONFIG uc3std**

See also “**Hooks & Internals**” for details on the used symbols.

Quick Configuration Guide

To get a quick access to the features of the µC3/Std OS Awareness with your application, follow the following roadmap:

1. Start the TRACE32 Debugger.
2. Load your application as normal.
3. Execute the command "`TASK.CONFIG ~~/demo/<cpu>/kernel/uc3std/uc3std.t32`" (See "**Configuration**").
4. Execute the command "`MENU.ReProgram ~~/demo/<cpu>/kernel/uc3std/uc3std.men`" (See "**RTOS Specific Menu**").
5. Start your application.

Now you can access the µC3/Std extensions through the menu.

In case of any problems, please carefully read the previous Configuration chapter.

Hooks & Internals in MicroC3/Std

No hooks are used in the kernel.

For retrieving the kernel data structures, the OS Awareness uses the global kernel symbols and structure definitions. Ensure that access to those structures is possible every time when features of the OS Awareness are used. The µC3/Std kernel must be compiled with debug information.

Features

The OS Awareness for µC3/Std supports the following features.

Display of Kernel Resources

The extension defines new commands to display various kernel resources. Information on the following µC3/Std components can be displayed:

TASK.TaSK	Tasks
TASK.SEMaphore	Semaphores
TASK.FLaG	Event flags
TASK.DaTaQueue	Data queues
TASK.MailBoX	Mailboxes
TASK.MsgBuFfer	Message buffers
TASK.MuTeX	Mutexes
TASK.PORt	Rendezvous ports
TASK.MemPoolF	Fixed sized memory pools
TASK.MemPoolL	Variable sized memory pools
TASK.CYClic	Cyclic handlers
TASK.ALarM	Alarm handlers
TASK.ISR	Interrupt service routines

For a description of the commands, refer to chapter "**MicorC3/Std Commands**".

If your hardware allows memory access while the target is running, these resources can be displayed "On The Fly", i.e. while the application is running, without any intrusion to the application.

Without this capability, the information will only be displayed if the target application is stopped.

Task-Related Breakpoints

Any breakpoint set in the debugger can be restricted to fire only if a specific task hits that breakpoint. This is especially useful when debugging code which is shared between several tasks. To set a task-related breakpoint, use the command:

Break.Set *<address>*|*<range>* [**/***<option>*] **/TASK** *<task>*	Set task-related breakpoint.

- Use a magic number, task ID, or task name for *<task>*. For information about the parameters, see **"What to know about the Task Parameters"** (general_ref_t.pdf).
- For a general description of the **Break.Set** command, please see its documentation.

By default, the task-related breakpoint will be implemented by a conditional breakpoint inside the debugger. This means that the target will *always* halt at that breakpoint, but the debugger immediately resumes execution if the current running task is not equal to the specified task.

NOTE:	Task-related breakpoints impact the real-time behavior of the application.

On some architectures, however, it is possible to set a task-related breakpoint with *on-chip* debug logic that is less intrusive. To do this, include the option **/Onchip** in the **Break.Set** command. The debugger then uses the on-chip resources to reduce the number of breaks to the minimum by pre-filtering the tasks.

For example, on ARM architectures: *If* the RTOS serves the Context ID register at task switches, and *if* the debug logic provides the Context ID comparison, you may use Context ID register for less intrusive task-related breakpoints:

Break.CONFIG.UseContextID ON	Enables the comparison to the whole Context ID register.
Break.CONFIG.MatchASID ON	Enables the comparison to the ASID part only.
TASK.List.tasks	If **TASK.List.tasks** provides a trace ID (**traceid** column), the debugger will use this ID for comparison. Without the trace ID, it uses the magic number (**magic** column) for comparison.

When single stepping, the debugger halts at the next instruction, regardless of which task hits this breakpoint. When debugging shared code, stepping over an OS function may cause a task switch and coming back to the same place - but with a different task. If you want to restrict debugging to the current task, you can set up the debugger with **SETUP.StepWithinTask ON** to use task-related breakpoints for single stepping. In this case, single stepping will always stay within the current task. Other tasks using the same code will not be halted on these breakpoints.

If you want to halt program execution as soon as a specific task is scheduled to run by the OS, you can use the **Break.SetTask** command.

Dynamic Task Performance Measurement

The debugger can execute a dynamic performance measurement by evaluating the current running task in changing time intervals. Start the measurement with the commands **PERF.Mode TASK** and **PERF.Arm**, and view the contents with **PERF.ListTASK**. The evaluation is done by reading the 'magic' location (= current running task) in memory. This memory read may be non-intrusive or intrusive, depending on the **PERF.METHOD** used.

If **PERF** collects the PC for function profiling of processes in MMU-based operating systems (**SYStem.Option.MMUSPACES ON**), then you need to set **PERF.MMUSPACES**, too.

For a general description of the **PERF** command group, refer to **"General Commands Reference Guide P"** (general_ref_p.pdf).

Task Runtime Statistics

NOTE:	This feature is *only* available, if your debug environment is able to trace task switches (program flow trace is not sufficient). It requires either an on-chip trace logic that is able to generate task information (eg. data trace), or a software instrumentation feeding one of TRACE32 software based traces (e.g. **FDX** or **Logger**). For details, refer to **"OS-aware Tracing"** (glossary.pdf).

Based on the recordings made by the **Trace** (if available), the debugger is able to evaluate the time spent in a task and display it statistically and graphically.

To evaluate the contents of the trace buffer, use these commands:

Trace.List List.TASK DEFault	Display trace buffer and task switches
Trace.STATistic.TASK	Display task runtime statistic evaluation
Trace.Chart.TASK	Display task runtime timechart
Trace.PROfileSTATistic.TASK	Display task runtime within fixed time intervals statistically
Trace.PROfileChart.TASK	Display task runtime within fixed time intervals as colored graph
Trace.FindAll Address TASK.CONFIG(magic)	Display all data access records to the "magic" location
Trace.FindAll CYcle owner OR CYcle context	Display all context ID records

The start of the recording time, when the calculation doesn't know which task is running, is calculated as "(unknown)".

NOTE:	This feature is *only* available, if your debug environment is able to trace task switches (program flow trace is not sufficient). It requires either an on-chip trace logic that is able to generate task information (eg. data trace), or a software instrumentation feeding one of TRACE32 software based traces (e.g. **FDX** or **Logger**). For details, refer to **"OS-aware Tracing"** (glossary.pdf).

All function-related statistic and time chart evaluations can be used with task-specific information. The function timings will be calculated dependent on the task that called this function. To do this, in addition to the function entries and exits, the task switches must be recorded.

To do a selective recording on task-related function runtimes based on the data accesses, use the following command:

```
; Enable flow trace and accesses to the magic location
Break.Set TASK.CONFIG(magic) /TraceData
```

To do a selective recording on task-related function runtimes, based on the Arm Context ID, use the following command:

```
; Enable flow trace with Arm Context ID (e.g. 32bit)
ETM.ContextID 32
```

To evaluate the contents of the trace buffer, use these commands:

Trace.ListNesting	Display function nesting
Trace.STATistic.Func	Display function runtime statistic
Trace.STATistic.TREE	Display functions as call tree
Trace.STATistic.sYmbol /SplitTASK	Display flat runtime analysis
Trace.Chart.Func	Display function timechart
Trace.Chart.sYmbol /SplitTASK	Display flat runtime timechart

The start of the recording time, when the calculation doesn't know which task is running, is calculated as "(unknown)".

MicroC3/Std specific Menu

The menu file “uc3std.men” contains a menu with µC3/Std specific menu items. Load this menu with the **MENU.ReProgram** command.

You will find a new menu called **uC3Stc**.

- The **Display** menu items launch the kernel resource display windows.

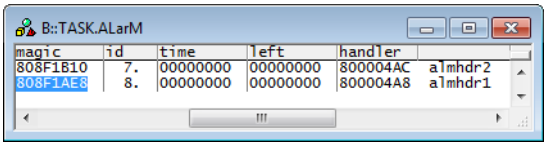
In addition, the menu file (*.men) modifies these menus on the TRACE32 main menu bar:

- The **Trace** menu is extended. In the **List** submenu, you can choose if you want a trace list window to show only task switches (if any) or task switches together with the default display.
- The **Perf** menu contains additional submenus for task runtime statistics.

TASK.ALarM — Display alarm handlers

Format: **TASK.ALarM**

Displays the table of installed alarm handlers.

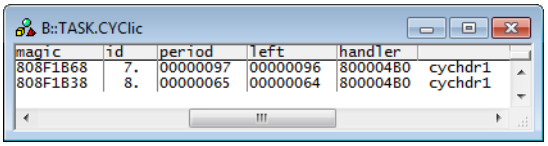


The fields “id” and “handler” are mouse sensitive. Double-clicking on them open appropriate windows. Right clicking on them will show local menu.

TASK.CYClic — Display cyclic handlers

Format: **TASK.CYClic**

Displays the table of installed cyclic handlers.

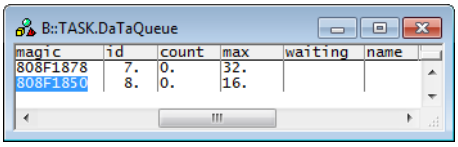


The fields “id” and “handler” are mouse sensitive. Double-clicking on them open appropriate windows. Right clicking on them will show local menu.

Format: **TASK.DaTaQueue** [<*queue*>]

Displays the data queue table of µC3/Std or detailed information about one specific data queue.

Without any arguments, a table with all created data queues will be shown. Specify a data queue ID or name to display detailed information on that data queue.



The “waiting” column shows the task IDs waiting.

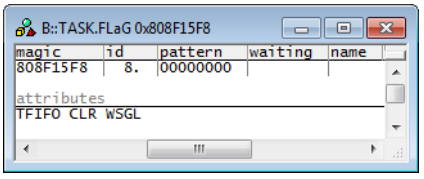
The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

TASK.FLaG Display event flags

Format: **TASK.FLaG** [<*flag*>]

Displays the event flag table of µC3/Std or detailed information about one specific event flag.

Without any arguments, a table with all created event flags will be shown. Specify a flag ID or name to display detailed information on that flag.

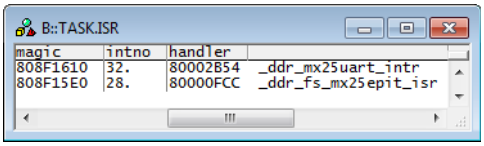


The “waiting” column shows the task IDs waiting.

The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

Format: **TASK.ISR**

Displays the table of installed interrupt service routines.



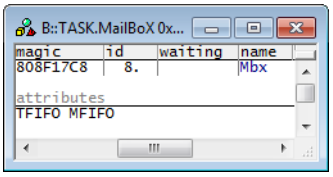
The fields “id” and “handler” are mouse sensitive. Double-clicking on them open appropriate windows. Right clicking on them will show local menu.

TASK.MailBoX Display mailboxes

Format: **TASK.MailBoX** [<*mailbox*>]

Displays the mailbox table of µC3/Std or detailed information about one specific mailbox.

Without any arguments, a table with all created mailboxes will be shown.
Specify a mailbox ID or name to display detailed information on that mailbox.



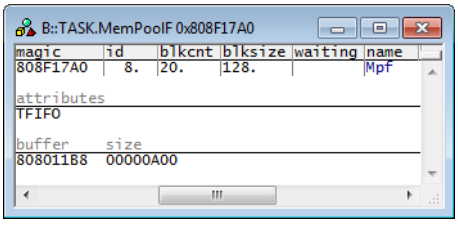
The “waiting” column shows the task IDs waiting.

The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

Format: **TASK.MemPoolF** [<*mempool*>]

Displays the fixed size memory pool table of µC3/Std or detailed information about one specific memory pool.

Without any arguments, a table with all created memory pools will be shown.
Specify a pool ID or name to display detailed information on that memory pool.



The “waiting” column shows the task IDs waiting.

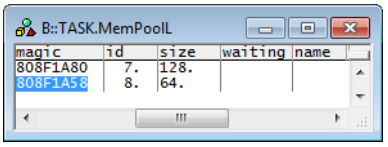
The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

TASK.MemPoolL Display variable memory pools

Format: **TASK.MemPoolL** [<*mempool*>]

Displays the variable size memory pool table of µC3/Std or detailed information about one specific memory pool.

Without any arguments, a table with all created memory pools will be shown.
Specify a pool ID or name to display detailed information on that memory pool.



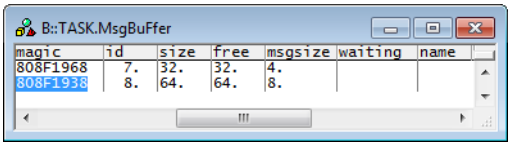
The “waiting” column shows the task IDs waiting.

The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

Format: **TASK.MsgBuFfer** [<*msgbuffer*>]

Displays the message buffer table of µC3/Std or detailed information about one specific message buffer.

Without any arguments, a table with all created message buffers will be shown. Specify a message buffer ID or name to display detailed information on that message buffer.



The “waiting” column shows the task IDs waiting.

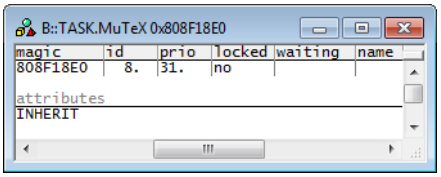
The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

TASK.MuTeX Display mutexes

Format: **TASK.MuTeX** [<*mutex*>]

Displays the mutex table of µC3/Std or detailed information about one specific mutex.

Without any arguments, a table with all created mutexes will be shown.
Specify a mutex ID or name to display detailed information on that mutex.



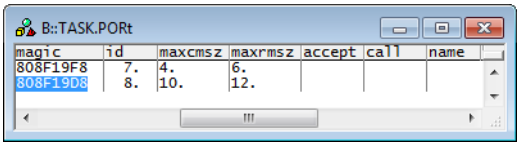
“locked” shows the task ID that locked this mutex.

The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

Format: **TASK.PORt** [<*port*>]

Displays the rendezvous port table of µC3/Std or detailed information about one specific port.

Without any arguments, a table with all created port will be shown. Specify a port ID or name to display detailed information on that port.



“accept” shows the task ID that is waiting for accepting this rendezvous.

The “call” column shows the task IDs waiting for calling the rendezvous.

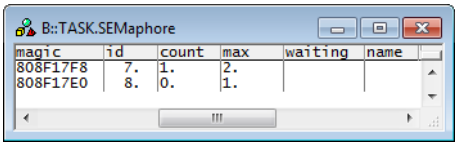
The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

TASK.SEMaphore Display semaphores

Format: **TASK.SEMaphore** [<*semaphore*>]

Displays the semaphore table of µC3/Std or detailed information about one specific semaphore.

Without any arguments, a table with all created semaphores will be shown. Specify a semaphore ID or name to display detailed information on that semaphore.



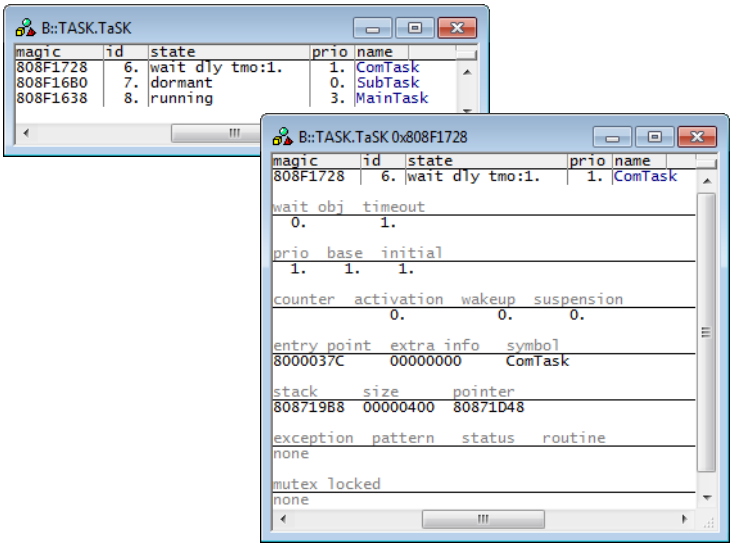
The “waiting” column shows the task IDs waiting.

The field “id” is mouse sensitive. Double-clicking on it opens an appropriate window. Right clicking on it will show a local menu.

Format:	**TASK.TaSK** [<*task*>]

Displays the task table of µC3/Std or detailed information about one specific task.

Without any arguments, a table with all created tasks will be shown.
Specify a task magic, ID or name to display detailed information on that task.



The fields “id” and “entry” are mouse sensitive, double clicking on them opens appropriate windows. Right clicking on them will show a local menu.

MicroC3/Std PRACTICE Functions

There are special definitions for µC3/Std specific PRACTICE functions.

TASK.CONFIG() OS Awareness configuration information

Syntax: **TASK.CONFIG(magic | magicsize)**

Parameter and Description:

magic	**Parameter Type**: String (***without*** quotation marks). Returns the magic address, which is the location that contains the currently running task (i.e. its task magic number).
magicsize	**Parameter Type**: String (***without*** quotation marks). Returns the size of the task magic number (1, 2 or 4).

Return Value Type: Hex value.