MDK-ARM

Microcontroller Development Kit

KEIL™ Tools by ARM

The Keil™ Microcontroller Development Kit (MDK) is the complete software development environment for all ARM® and Cortex™-M processor-based microcontrollers.

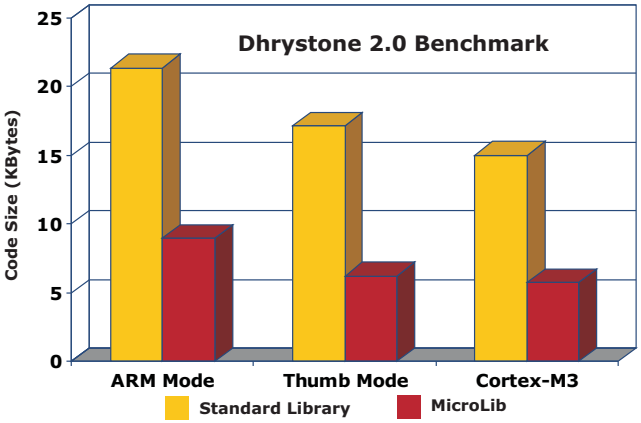
It combines the Keil µVision®4 IDE/Debugger with the industry leading ARM Compilation Tools, to provide developers with an easy to use, feature-rich environment optimized for ARM-Powered devices.

MDK provides many unique features designed to help you quickly develop your project. Save time by using the **Device Database** which automatically configures device and project parameters. Optimize and verify your applications with new **Trace** and **Analysis Tools**, enabling you to measure performance and code coverage. Bring resource management to your applications by using the fully functional **RTX** Real-Time operating system.

ARM Compiler Performance

MDK is based on the ARM compilation tools, which deliver the tightest, highest performing code for all ARM-Powered devices. Further code size savings can be gained by selecting the **MicroLib**, which has been specifically developed and optimized for microcontrollers.

Visit www.keil.com/arm/mdk.asp for more information.



By using MicroLib, the library code sizes can be significantly reduced, enabling product memory and cost savings.

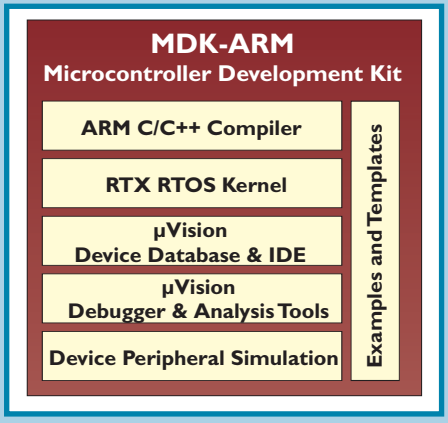
ARM C/C++ Compilation Tools with MicroLib

µVision4 IDE Supports Complete Development Cycle

Powerful Debugger with Real-Time Analysis Tools

JTAG & Serial Wire Debug plus Real-Time Trace

Full Featured Royalty-Free RTX RTOS Kernel



The MDK-ARM Microcontroller Development Kit offers a complete development environment for ARM and Cortex-M devices.

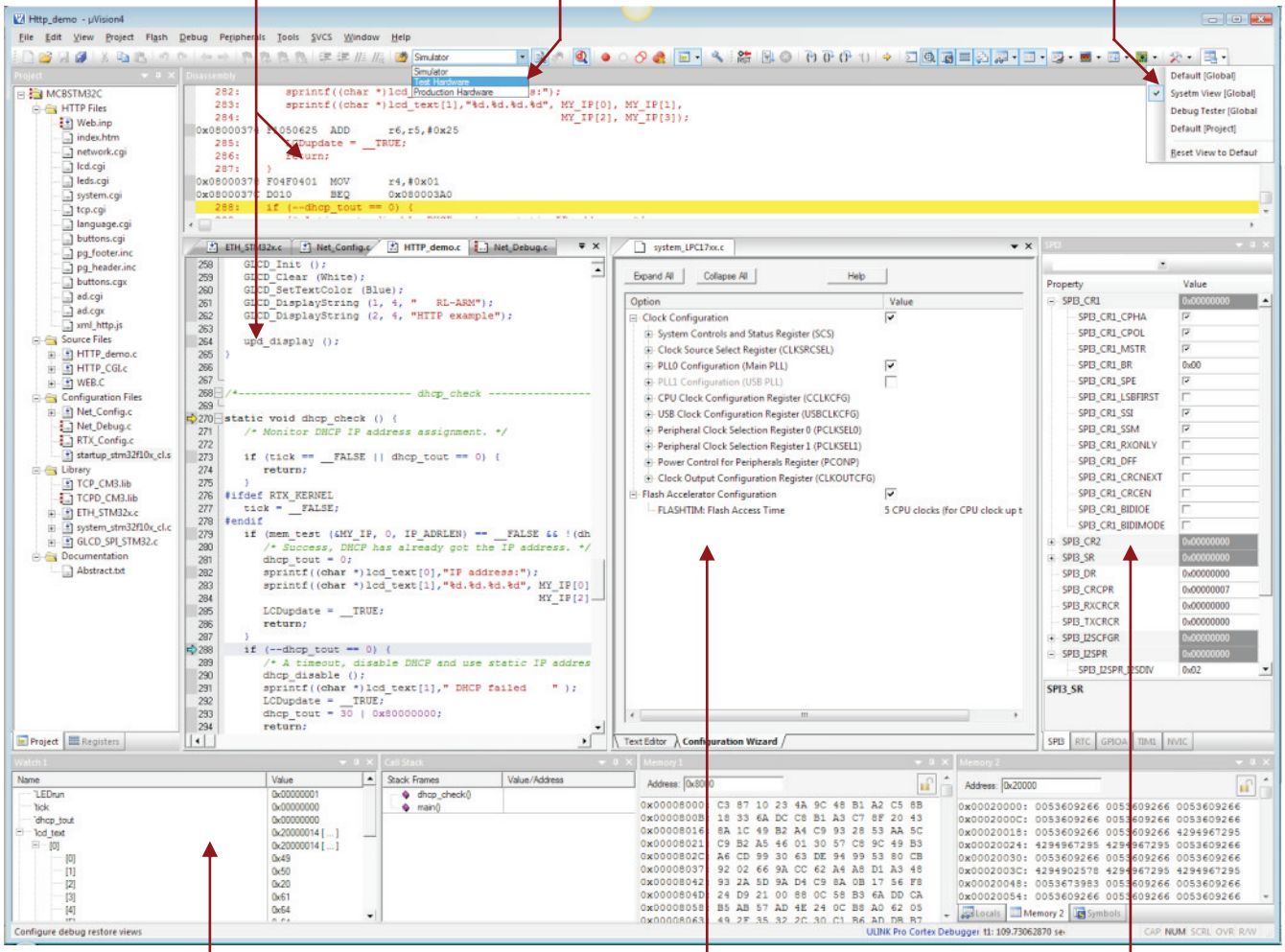
MDK-ARM

µVision Project Management

The **Disassembly** and **Source** windows are fully synchronized

Each project may contain multiple target configurations

Debug Restore Views allow you to save multiple window layouts.



µVision allows you to have multiple Watch and Memory windows

The **Configuration Wizard** simplifies tool and device setup

The **System Viewer** provides information of peripheral registers

The µVision IDE incorporates a **Device Database** of supported ARM-Powered microcontrollers. In µVision projects, required options are set automatically when you select the device from the Device Database. µVision displays only those options that are relevant to the selected device.

The **Flexible Window Management System** enables you to drag and drop individual windows anywhere on the visual surface. This interface allows you to make better use of your screen space and to organise multiple windows.

The **Editor** includes all the standard features you expect in a professional editor. Workflow is optimized with intuitive toolbars providing quick access to editor functions, most of which are also available while debugging for easy source code changes.

The integrated **Source Browser** provides access to all application symbols, together with name, type, and class information. It allows you to instantly navigate to the definition and references of any symbol.

Debugger and Simulator

The **Debugger** can be configured as a Simulator or as a Target Debugger. It provides one environment in which you may test your application.

The µVision Debugger simulates a complete ARM-Powered MCU including the instruction set and on-chip peripherals.

Debug Windows

The Debugger provides windows and dialogs to help you monitor and control your system. These include:

- **Memory Window** - used to review and modify memory contents.
- **Watch Window** - view and modify program variables and lists the current function call nesting.
- **Symbol Window** - view debug symbol information of the application program.
- **Disassembly Window** - synchronized with the Source Windows making program debugging easier.
- **Call Stack Window** - view current call nesting including variable values.
- **Breakpoints** - allows you to define stop conditions for program execution.
- **Browse Window** - search for objects in your code.

System Viewer

The **System Viewer** provides an advanced method of viewing and modifying peripheral registers. Detailed status information is displayed while the processor runs, and can be changed directly from within the System Viewer window.

Analysis Tools

The advanced analysis tools work with the simulator or with target hardware via the ULINK*pro* streaming trace adapter.

The configurable **Logic Analyzer** provides a graphical display of signals and variables. You may click on variable changes to display the instructions that caused that change in the source code editor window.

The Debugger provides **Code Coverage** statistics to verify applications that require certification testing and validation. Color coding highlights the execution status of instructions helping you to refine your testing.

The **Performance Analyzer** displays the execution time recorded for functions in your application. Bar graphs display the time spent in a function, and the number of calls to it.

The **Execution Profiler** records execution statistics for each CPU instruction, including the execution count and execution time for each instruction. These can be reviewed in the editor and disassembler windows.

ULINK2 and ULINK*pro* Adapters

The ULINK family of USB-JTAG Adapters connect your PC's USB port to your target system (via JTAG or SWD), allowing you to debug and analyze embedded programs running on target hardware.

The new ULINK*pro* provides unique streaming trace directly to your PC, enabling advanced analysis and optimization of your applications.

Features	ULINK*pro*	ULINK2
Run control debug (ARM & Cortex-M)	Yes	Yes
Memory + Breakpoint (while running)	Yes	Yes
Data Trace (Cortex-M3/M4)	Yes	Yes
Instruction Trace (Cortex-M3/M4)	Yes	-
Performance		
CPU Clock speed	200MHz	200MHz
JTAG Clock speed	50MHz	10MHz
Memory read/write	1MByte/s	25KByte/s
Data Trace streaming (UART mode)	-	1Mbit/s
Data Trace streaming (Manchester mode)	100Mbit/s	-
ETM Trace streaming	800Mbit/s	-
Analysis Tools		
Logic Analyzer	Yes	Yes
Performance Analyzer	Yes	-
Execution Profiler	Yes	-
Code Coverage	Yes	-

Further information at: **www.keil.com/ULINK**

Cortex-M CoreSight

All Cortex-M based devices feature the ARM CoreSight™ technology with advanced debug and trace capabilities.

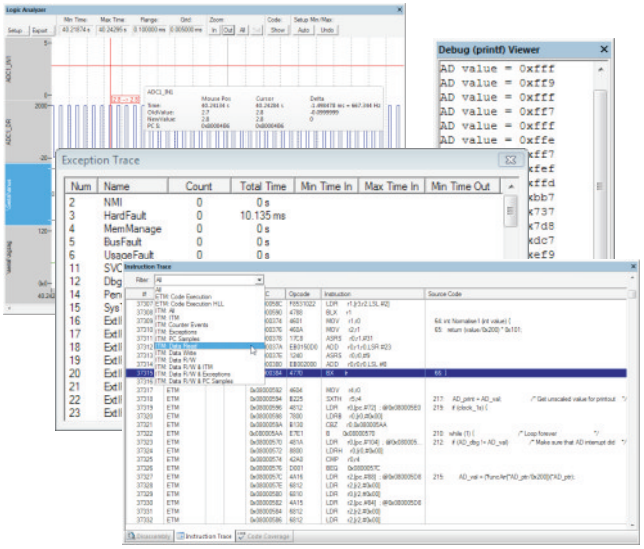
MDK, together with a ULINK adapter, uses these features to enable you to debug your program. You are able to:

- Control the CPU allowing program start/stop.
- Single Step one source or assembler line.
- Set breakpoints while the processor is running.
- Read/write memory and peripheral registers on-the-fly, while it is running at full-speed.

Data and Event Trace

All Cortex-M3 and Cortex-M4 devices provide data and event trace. MDK provides a number of ways to analyze this information while your system is running:

- **Trace Window** - Display program flow by capturing timestamps, PC samples, and Read/Write accesses.
- **Debug (printf) Viewer** - Displays the printf-style output of the Instrumented Trace (ITM).
- **Exceptions window** - Displays statistical information about program exceptions and interrupts.
- **Event Counters** - Display real-time values of specific event counters providing performance indications.
- **Logic Analyzer** - Graphically displays variable changes in captured data trace.

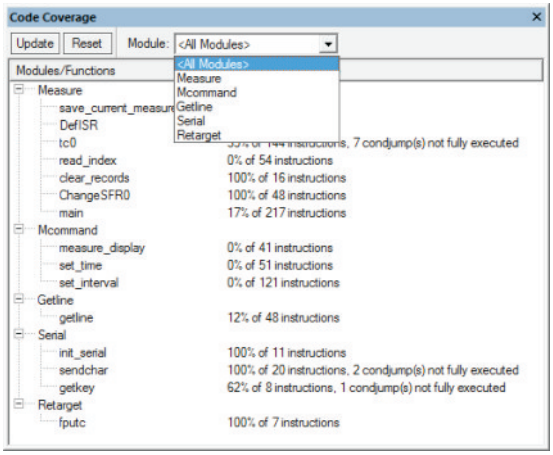


Data Trace Windows provide information from the running target for program data, exceptions, variables, and printf-style outputs

Instruction Trace

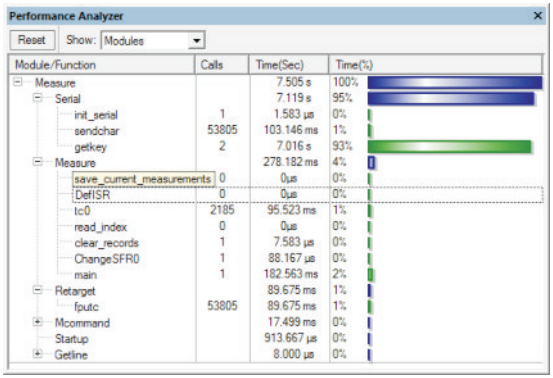
All Cortex-M devices with ETM provide instruction trace. The Keil ULINK*pro* is the only Trace adapter which streams instruction trace directly to your PC. This enables debugging of historical sequences, execution profiling, and code coverage analysis.

The virtually unlimited stream of trace information enables MDK to provide complete **Code Coverage** of your program. Code coverage identifies every instruction that has been executed, ensuring thorough testing of your application. This is an essential requirement for complete software verification and certification.



Code Coverage shows the percentage of instructions that have executed.

ULINK*pro* allows applications to be run for long periods of time while collecting trace information. This can be used by the **Execution Profiler** and **Performance Analyzer** to identify program bottlenecks, optimize your application, and to isolate problems.



The performance analyzer displays time spent in each part of your program.

RTX Kernel

Today, microcontroller applications often require simultaneous execution of multiple tasks in a real-time environment.

While it is possible to implement an embedded program without using a real-time kernel, the proven Keil RTX allows you to focus on application development, enabling you to save time, and produce a more reliable, expandable system.

RTX is a royalty-free, real-time kernel specifically developed for the ARM and Cortex-M feature-sets. RTX provides features to manage system resources:

- Applications separated into independent tasks (threads).
- Extensive time control (scheduling, time delay/intervals).
- Deterministic execution times and task scheduling.
- Inter-task communication, resource sharing, and memory allocation features with message pools.
- Supports development with error checking, debug and test facilities.

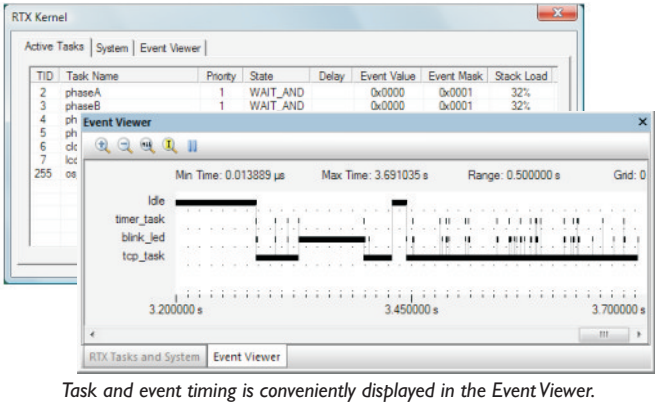
RTX is provided as fully configurable object code within MDK, and as source code in RL-ARM Real-Time Library.

Visit www.keil.com/rl-arm/kernel.asp for more information.

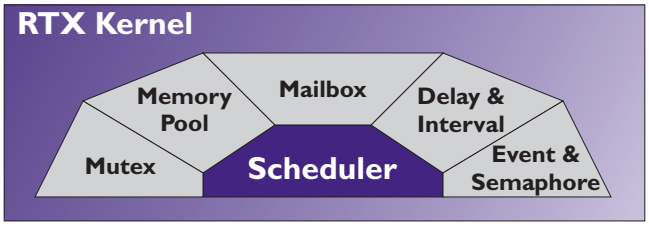
Kernel-Aware Debugging

RTX is fully integrated in the µVision **Debugger** making it easy to monitor task status and kernel activity.

The **kernel-aware** dialog is available in simulation and also when running on target hardware. It displays information about all aspects of the kernel and the running tasks. This enables you to view statistics about the active tasks, stack loading, and system resource usage.



Task and event timing is conveniently displayed in the Event Viewer.



RTX Kernel Function Overview

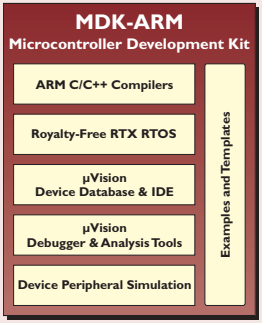
- **Task Management Functions** allows you to create and delete tasks. RTX supports up to 254 active tasks, each with 254 priority levels.
- **Task Stacks** are allocated from a stack memory pool or can be supplied when a task is created.
- Fast **Memory Pool Management** allows you to create an unlimited number of fixed size pools.
- **Event Flag Management** allows synchronization with up to 16 event flags per task.
- **Time Management** and **Timer Callback Functions** provide task time delays/intervals.

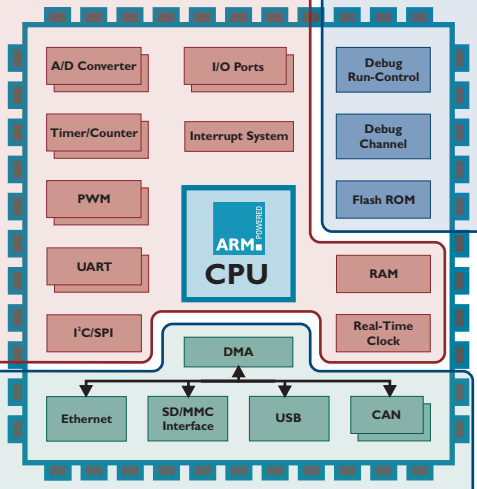
RTX Real-Time Kernel Specifications	
General Specifications	
Defined Tasks (max)	Unlimited
Active Tasks (max)	254
Task Priority Levels	1 - 254
Signals / Events	16 per task
User Timers	Unlimited
Semaphores / Mailboxes / Mutexes	Unlimited
Context Switch	<4µS
Memory Requirements	
CODE Space	<4KB
RAM Space (Kernel)	~500 Bytes
RAM Space (Task)	TaskStackSize + 52 Bytes
Typical Timing Performance (based on a Cortex-M running at 72MHz)	
Initialize system, start task	22.1µs
Create defined task, (no task switch)	8.1µs
Create defined task, (with task switch)	9.3µs
Delete task	4.8µs
Task switch (by os_tsk_pass)	3.9µs
Set event (no task switch)	1.9µs
Send semaphore (no task switch)	1.6µs
Send message (no task switch)	2.5µs

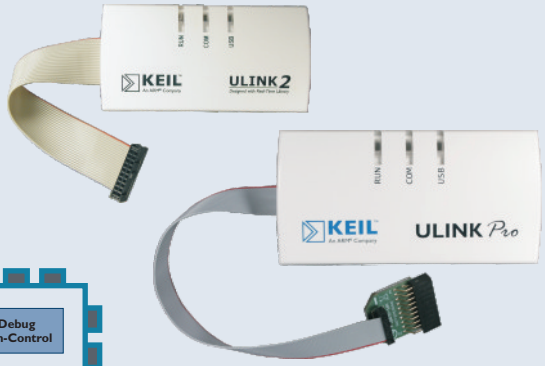
***CODE** and **RAM** space depend on which RTX functions are used. Detailed performance figures are available at www.keil.com/support/man/docs/rlarm.*

Microcontroller Development Kit (MDK)

- Best-in-class ARM C/C++ Compilation Tools.
- Genuine Keil µVision®4 IDE/Debugger/Simulator.
- Royalty-free RTX Real-Time Operating System.
- Easy device configuration with Device Database support for more than 500 ARM-Powered devices.

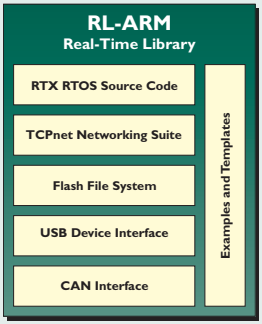






ULINK® USB Adapters

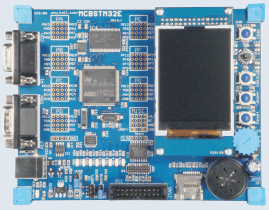
- JTAG & Serial Wire Interface.
- Flash Programming.
- On-the-fly Target Debugging.
- Real-Time Data Trace.
- ETM Instruction Trace (ULINK*pro*).



RTOS and Middleware

- RTX Real-Time OS with Source Code.
- TCP/IP Suite with Server Applications.
- File System for ROM and Memory Cards.
- Direct suport for USB and CAN interfaces.

Evaluation Boards



Keil provides a wide range of evaluation boards for 8, 16 and 32-bit devices

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KEIL™ Tools by ARM

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Program examples and detailed technical information are available from your distributor and our web site (www.keil.com).

Keil 0223-3/01.10