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](http://www.keil.com/arm/MDK.asp) for more information.
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.

µVision allows you to have multiple Watch and Memory 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 **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.

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.

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

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

**MDK-ARM Microcontroller Development Kit**
**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 ULINKpro 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 ULINKpro 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 ULINKpro provides unique streaming trace directly to your PC, enabling advanced analysis and optimization of your applications.

Further information at: [www.keil.com/ULINK](http://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.

Instruction Trace

All Cortex-M devices with ETM provide instruction trace. The Keil ULINKpro 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.

ULINKpro 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.
RTX RTOS Kernel

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.


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.

![RTX Kernel Function Overview](image)

- **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

<table>
<thead>
<tr>
<th>General Specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Defined Tasks (max)</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Active Tasks (max)</td>
<td>254</td>
</tr>
<tr>
<td>Task Priority Levels</td>
<td>1 - 254</td>
</tr>
<tr>
<td>Signals / Events</td>
<td>16 per task</td>
</tr>
<tr>
<td>User Timers</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Semaphores / Mailboxes / Mutexes</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Context Switch</td>
<td>&lt;4μS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Memory Requirements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CODE Space</td>
<td>&lt;4KB</td>
</tr>
<tr>
<td>RAM Space (Kernel)</td>
<td>~500 Bytes</td>
</tr>
<tr>
<td>RAM Space (Task)</td>
<td>TaskStackSize + 52 Bytes</td>
</tr>
</tbody>
</table>

### 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](http://www.keil.com/support/man/docs/rlarm).
**Microcontroller Development Kit (MDK)**
- Best-in-class ARM C/C++ Compilation Tools.
- Royalty-free RTX Real-Time Operating System.
- Easy device configuration with Device Database support for more than 500 ARM-Powered devices.

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

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

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