

**IN THE UNITED STATES DISTRICT COURT  
FOR THE WESTERN DISTRICT OF TEXAS  
AUSTIN DIVISION**

LUCIO DEVELOPMENT LLC,

Plaintiff,

vs.

NUVOTON TECHNOLOGY  
CORPORATION AMERICA,

Defendant.

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Case No: 1:19-cv-662

PATENT CASE

**COMPLAINT**

Plaintiff Lucio Development LLC (“Plaintiff” or “Lucio”) files this Complaint against Nuvoton Technology Corporation America (“Defendant” or “Nuvoton”) for infringement of United States Patent No. 7,069,546 (hereinafter “the ‘546 Patent”).

**PARTIES AND JURISDICTION**

1. This is an action for patent infringement under Title 35 of the United States Code. Plaintiff is seeking injunctive relief as well as damages.

2. Jurisdiction is proper in this Court pursuant to 28 U.S.C. §§ 1331 (Federal Question) and 1338(a) (Patents) because this is a civil action for patent infringement arising under the United States patent statutes.

3. Plaintiff is a Texas limited liability company with its office address at 555 Republic Dr., Suite 200, Plano, Texas 75074.

4. On information and belief, Defendant is a Delaware corporation with its principal place of business at 2727 N. First St., San Jose, CA 95134. On information and belief, Defendant may be served with process through its registered agent Corporation Service

Company d/b/a CSC, 2710 Gateway Oaks Dr., Suite 150N, Sacramento, CA 95833.

5. This Court has personal jurisdiction over Defendant because Defendant has committed, and continues to commit, acts of infringement in this District, has conducted business in this District, and/or has engaged in continuous and systematic activities in this District.

6. On information and belief, Defendant's instrumentalities that are alleged herein to infringe were and continue to be used, imported, offered for sale, and/or sold in this District.

### **VENUE**

7. Venue is proper in this District pursuant to 28 U.S.C. §1400(b) because acts of infringement are occurring in this District and Defendant has a regular and established place of business in this District at 13625 Pond Springs Rd., # 101, Austin, TX 78729.

### **COUNT I** **(INFRINGEMENT OF UNITED STATES PATENT NO. 7,069,546)**

8. Plaintiff incorporates paragraphs 1 through 7 herein by reference.

9. This cause of action arises under the patent laws of the United States and, in particular, under 35 U.S.C. §§ 271, *et seq.*

10. Plaintiff is the owner by assignment of the '546 Patent with sole rights to enforce the '546 Patent and sue infringers.

11. A copy of the '546 Patent, titled "Generic Framework for Embedded Software Development," is attached hereto as Exhibit A.

12. The '546 Patent is valid, enforceable, and was duly issued in full compliance with Title 35 of the United States Code.

13. On information and belief, Defendant has infringed and continues to infringe one or more claims, including at least Claim 1, of the '546 Patent by making, using, importing,

selling, and/or offering for sale a software platform for embedded software development, which is covered by at least Claim 1 of the '546 Patent. Defendant has infringed and continues to infringe the '546 Patent directly in violation of 35 U.S.C. § 271.

14. Defendant, sells, offers to sell, and/or uses embedded software development packages including, without limitation, the Evaluation/Development kit (such as Nu Micro Family Nu-Tiny-SDK-M0564), and any similar products (“Product”), which infringe at least Claim 1 of the '546 Patent. The Product practices a method for producing embedded software. For example, Defendant provides the Evaluation/Development kit (such as Nu Micro Family Nu-Tiny-SDK-M0564) which integrates with ARM Keil MDK (Microcontroller Development Kit) Nuvoton Edition to generate C, C++ and encapsulated C++ code for embedded processors (such as Arm Cortex-M0/M23/ M4 and/or 8051 MCUs (Microcontroller Units)). Nuvoton and/or its customers specifically use Evaluation/Development kit (such as Nu Micro Family Nu-Tiny-SDK-M0564) based on Arm Cortex-M0/M4 core MCUs (Microcontroller Units) which integrates with ARM Keil MDK (Microcontroller Development Kit) Nuvoton Edition to produce embedded software. Certain elements of this limitation are illustrated in the screenshots below and in the screenshots referenced in connection with other elements herein.

Part No.	Ordering No.	Download	Content	Supported Devices	Evaluation / Development Kit for	Picture
NuTiny-SDK-M0564	Buy Online	Download	NuTiny-SDK-M0564 (Schematic, PCB & Gerber File)	NuLink-ME, NuTiny-EVB-M0564	M0564V	
NuTiny-SDK-M0564V	Buy Online	Download	NuTiny-SDK-M0564V (Schematic, PCB & Gerber File)	NuLink-ME, NuTiny-EVB-M0564	M0564V	
NuTiny-SDK-M0564V	Buy Online	Download	NuTiny-SDK-M0564V (Schematic, PCB & Gerber File)	NuLink-ME, NuTiny-EVB-M0564	M0564V	
NuTiny-SDK-M0564V	Buy Online	Download	NuTiny-SDK-M0564V (Schematic, PCB & Gerber File)	NuLink-ME, NuTiny-EVB-M0564	M0564V	
NuTiny-SDK-M0564V	Buy Online	Download	NuTiny-SDK-M0564V (Schematic, PCB & Gerber File)	NuLink-ME, NuTiny-EVB-M0564	M0564V	

Source: [http://www.nuvoton.com/hq/support/tool-and-software/development-tool-hardware/development-kit/?\\_locale=en](http://www.nuvoton.com/hq/support/tool-and-software/development-tool-hardware/development-kit/?_locale=en)

M0564

## 2 NUTINY-SDK-M0564 INTRODUCTION

NuTiny-SDK-M0564 uses the M0564VG4AE as the target microcontroller. Figure 2-1 NuTiny-SDK-M0564 (PCB Board) Figure 2-1 is NuTiny-SDK-M0564 for M0564 series, the left portion is called NuTiny-EVB-M0564 and the right portion is Debug Adaptor called Nu-Link-Me.

NuTiny-EVB-M0564 is similar to other development boards. Users can use it to develop and verify applications to emulate the real behavior. The on board chip covers M0564 series features. The NuTiny-EVB-M0564 can be a real system controller to design users' target systems.

Nu-Link-Me is a Debug Adaptor. The Nu-Link-Me Debug Adaptor connects your PC's USB port to your target system (via Serial Wired Debug Port) and allows you to program and debug embedded programs on the target hardware. The Nu-Link-Me V3.0 also supports VCOM function, which gives users more flexibility when debug. To use Nu-Link-Me Debug adaptor with IAR or Keil, please refer to "Nuvoton NuMicro" IAR ICE driver user manual "or Nuvoton NuMicro" Keil ICE driver user manual" in detail. These two documents will be stored in the local hard disk when the user installs each driver. To use Nu-Link-Me 3.0 VCOM function, please refer to Chapter 5.

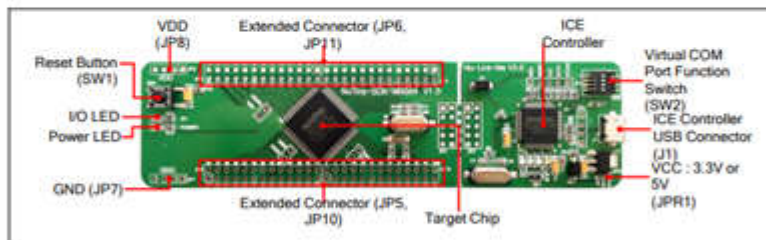


Figure 2-1 NuTiny-SDK-M0564 (PCB Board)

Source: [https://www.nuvoton.com/resource-files/UM\\_NuTiny-SDK-M0564\\_EN\\_V1.00.pdf](https://www.nuvoton.com/resource-files/UM_NuTiny-SDK-M0564_EN_V1.00.pdf), page 5

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**nuvoton** device overview

The Nuvoton's 32-bit microcontroller product line based on the Arm Cortex-M0, M4, and M23 processors with rich peripherals offers versatile features and connectivity capability.

Arm Keil MDK supports the full range of Arm-based Nuvoton devices and the Nu-Link debug adapter.

**Development tools**

Keil development tools provide comprehensive support for Nuvoton device families in a complete development environment for creating, debugging and verifying embedded applications.

- **MDK - Microcontroller Development Kit**  
(Includes Arm C/C++ Compiler, µVision IDE and debugger, Keil RTX, and comprehensive middleware)
- **ULINKpro Debug and Trace Unit**  
(Supports instruction trace for code coverage and profiling)
- **New: ULINKplus Debug Probe**  
(Supports power measurement and test automation)
- **ULINK2 Debug Adapter**  
(Low-cost debug solution)

Download Request a Quote

**µVision**  
Project manager, editor, and debugger

**Arm C/C++ Compiler**  
Certified for functional safety

USB Host Network

USB Device File System

Keil RTX  
CMSIS-RTOS API

Graphics

**Free MDK Nuvoton Edition - Cortex-M0/M23**












In cooperation with Nuvoton, Arm offers the genuine Keil MDK toolchain for Nuvoton's Arm Cortex-M0/M23 based devices free of charge.

**Extended MDK Nuvoton Edition - Cortex-M0/M4/M23**

Users that also require support for Nuvoton's Arm Cortex-M4 based microcontrollers can purchase an extension for the Keil MDK toolchain supporting these devices.

Source: <http://www2.keil.com/nuvoton>

- Based on 8051 core MCU

Ordering No.	Download	Content	Supported Devices	Evaluation / Development Kit for:	Picture
NT-N79E003 Buy Online!	 User Manual  Schematic, PCB & Gerber File	<ul style="list-style-type: none"> <li>No-LINK-ME</li> <li>NuTiny-EVB-N79E003</li> </ul>	N79E003	<ul style="list-style-type: none"> <li>An evaluation/development kit for Nuvoton 8051</li> <li>IAR EW8051 or Keil CS1 (evaluation version) can be download from website</li> <li>Support ICP (In-Circuit Programming)</li> </ul>	
NT-N79E016 Buy Online!	 User Manual  Schematic, PCB & Gerber File	<ul style="list-style-type: none"> <li>No-LINK-ME</li> <li>NuTiny-EVB-N79E016</li> </ul>	N79E016	<ul style="list-style-type: none"> <li>An evaluation/development kit for Nuvoton 8051</li> <li>IAR EW8051 or Keil CS1 (evaluation version) can be download from website</li> <li>Support ICP (In-Circuit Programming)</li> </ul>	
NT-N79E085 Buy Online!	 User Manual  Schematic, PCB & Gerber File	<ul style="list-style-type: none"> <li>No-LINK-ME</li> <li>NuTiny-EVB-N79E085</li> </ul>	N79E085	<ul style="list-style-type: none"> <li>An evaluation/development kit for Nuvoton 8051</li> <li>IAR EW8051 or Keil CS1 (evaluation version) can be download from website</li> <li>Support ICP (In-Circuit Programming)</li> </ul>	
NT-N79E715 Buy Online!	 User Manual	<ul style="list-style-type: none"> <li>No-LINK-S1</li> <li>NuTiny-EVB-N79E715</li> </ul>	N79E715	<ul style="list-style-type: none"> <li>An evaluation/development kit for Nuvoton 8051</li> <li>IAR EW8051 or Keil CS1 (evaluation version) can be download from website</li> <li>Support ICP (In-Circuit Programming)</li> </ul>	

Source: [http://www.nuvoton.com/hq/support/tool-and-software/development-tool-hardware/development-kit/?\\_locale=en](http://www.nuvoton.com/hq/support/tool-and-software/development-tool-hardware/development-kit/?_locale=en)



**MDK-ARM Version 5**  
Microcontroller Development Kit

**KEIL™**  
Tools by ARM

Keil™ MDK-ARM™ (Microcontroller Development Kit) the complete software development environment for ARM processor-based microcontrollers.

- Out-of-the box support for over 1000 ARM® processor-based microcontrollers
- Software Packs with ready-to-use CMSIS and middleware components
- Numerous example projects and templates
- Powerful µVision™ IDE, debugger and simulation environment
- On-the-fly application analysis records full instruction trace with the ULINKpro™ Debug Adapter
- Complete Code Coverage information about your program's execution.
- Execution Profiler and Performance Analyzer for analyzing and optimizing your code.
- CMSIS RTOS RTX real-time operating system with full debugger support.
- Complete and comprehensive middleware including TCP/IP Networking, File Systems and USB.
- Industry-leading ARM C/C++ Compiler with advanced processor-specific optimizations and MicroLib.
- Editor with Code Completion and Dynamic Syntax Checking

Features shown in the diagram:

- CAN Interface
- File System
- USB Host
- USB Device
- TCP/IP Networking
- GUI Library

Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 1

15. The Product practices providing one or more generic application handler programs. Each program has code for performing generic functions common to multiple hardware modules used in a communication system. For example, the ARM Keil MDK (Microcontroller Development Kit) Nuvoton Edition includes generic application handler programs including drivers, libraries, and Abstraction Layers (such as Hardware Abstraction Layer (HAL)) that provide multiple generic Application Programming Interfaces (APIs). The generic code provides common and generic functions to multiple hardware modules (such as Nu Micro Family Nu-Tiny-SDK-M0564) used in a communication system. Further, for ARM Cortex-M processor, ARM Keil MDK generates C code using Cortex Microcontroller Software Interface Standard (CMSIS) Library that provides Hardware Abstraction layer (HAL). Certain elements of this limitation are illustrated in the screenshots below and in the screenshots referenced in connection with other elements herein.

**Create**

**MDK Core & Software Packs**

MDK Version 5 is now split into the MDK Core and Software Packs which makes new device support and middleware updates independent from the toolchain. The MDK Core contains all development tools including IDE, Compiler and Debugger. Software Packs contain device support, CMSIS, and middleware and are installed and updated on demand using the Pack Installer.

Software Packs contain software components that collect libraries, source modules, configuration and header files, and documentation. Software components are generic and support a wide range of devices and applications. The Software Pack structure allows integration of 3rd-party software components.

**Device Database<sup>®</sup>**

When you create a project and select a target device from the integrated Device Database µVision pre-configures the development tools for you and shows only options that are relevant for the selected device.

**Run-Time Environment**

The Run-Time Environment window shows all software components that are compatible with the selected device. Choose from these pre-built software components to accelerate your project development, just select components you need for your application and µVision creates the required run-time environment for you.

The Project Window shows installed source files of selected software components

Create the Run-Time Environment from Software Packs with pre-built software components

Inter-dependencies of software components are clearly identified and additional messages

The Configuration Wizard simplifies the search for selected software components

K

MDK Tools

Software Packs

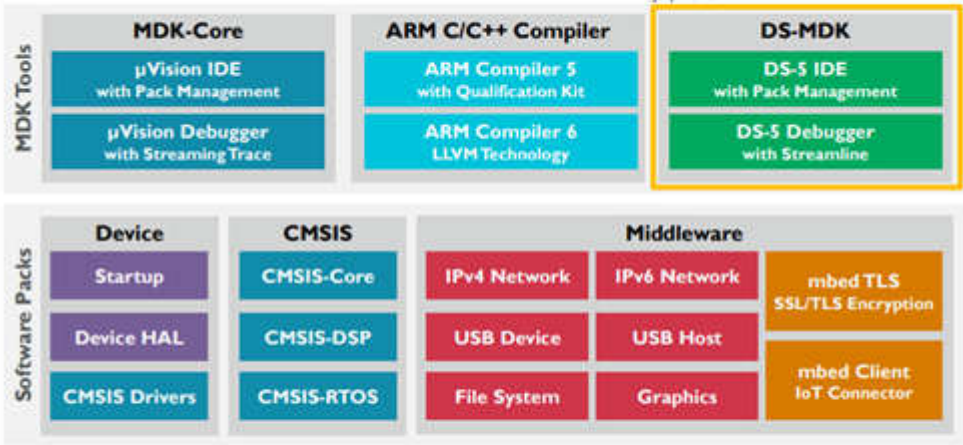
Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 2



# Keil MDK Version 5 Development System



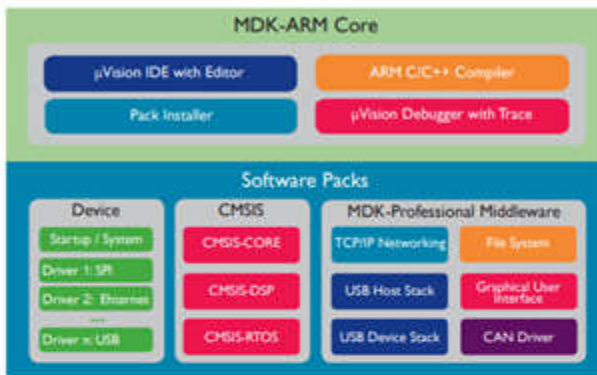
July 2016



Source:

[https://www.arm.com/files/pdf/20160830\\_06\\_ARM\\_Keil\\_MDK\\_FTD.pdf](https://www.arm.com/files/pdf/20160830_06_ARM_Keil_MDK_FTD.pdf),  
page 2

## MDK-ARM Microcontroller Development Kit



### MDK-ARM Core

The MDK-ARM Core contains all the development tools. MDK-ARM is easy to use, yet powerful enough for the most demanding embedded applications.

### Software Packs

Software Packs are added on-demand using the Pack Installer. Software Packs contain device support, CMSIS, and middleware components that are essential for efficient software development.



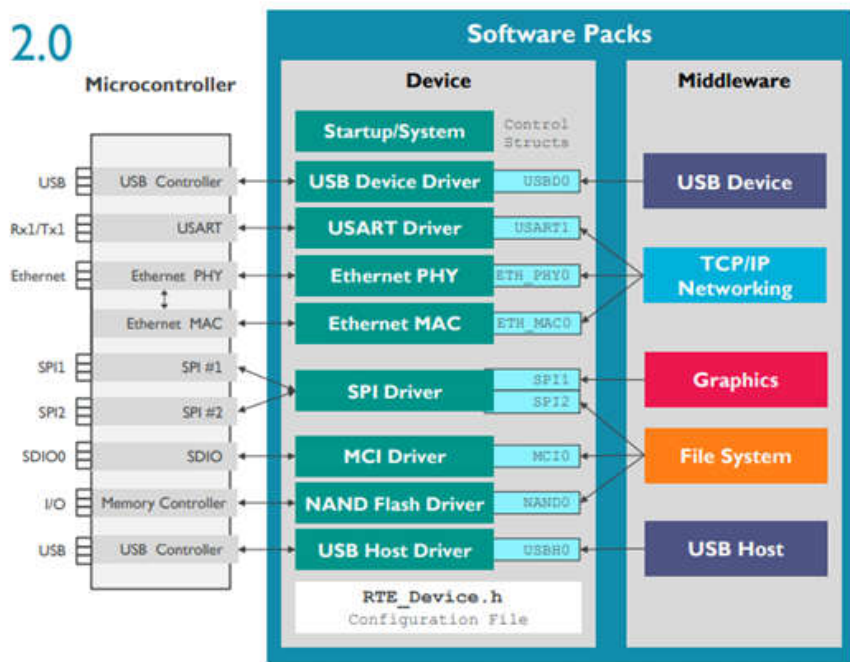
[www.keil.com/arm](http://www.keil.com/arm)

MDK Product Selector:	MDK-Lite	MDK-Cortex-M	MDK-Standard	MDK-Professional
<b>MDK-ARM Core Components</b>				
μVision IDE with editor	✓	✓	✓	✓
μVision Debugger and Trace	32KB	✓	✓	✓
ARM C/C++ Compiler	32KB	✓	✓	✓
Pack Installer	✓	✓	✓	✓
<b>ARM Processor Support:</b>				
Cortex-M series processors	✓	✓	✓	✓
Cortex-R4, ARM7 & ARM9	✓		✓	✓
SecurCore			✓	✓
<b>RTOS &amp; Middleware Libraries:</b>				
MDK-Professional Middleware				✓
CMSIS-RTOS RTX with source code	✓	✓	✓	✓
3rd Party RTOS Support	✓	✓	✓	✓

Source: [https://www.arm.com/files/pdf/20160830\\_06\\_ARM\\_Keil\\_MDK\\_FTD.pdf](https://www.arm.com/files/pdf/20160830_06_ARM_Keil_MDK_FTD.pdf), page 6

## CMSIS-Driver 2.0

- API describing peripheral driver interfaces for middleware stacks and user applications
- Generic and independent of a specific RTOS
- Covers a wide range of use cases for the supported peripheral types



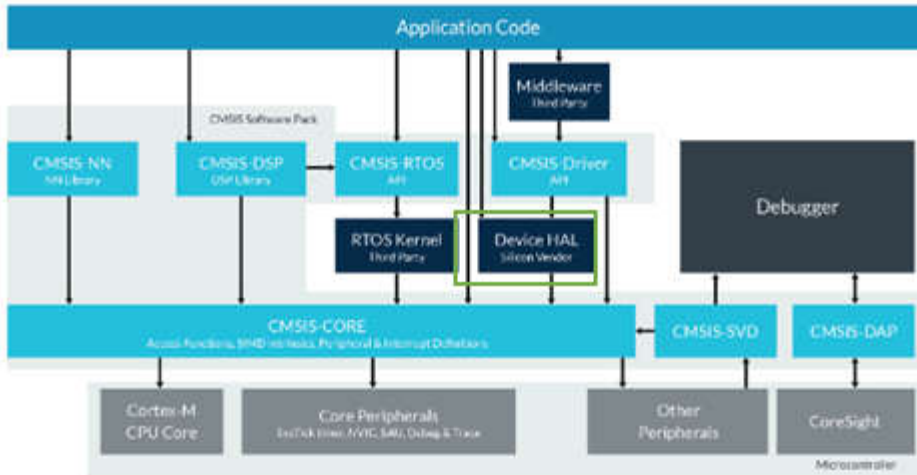
12 ©ARM 2016

Source: [https://www.arm.com/files/pdf/20160830\\_06\\_ARM\\_Keil\\_MDK\\_FTD.pdf](https://www.arm.com/files/pdf/20160830_06_ARM_Keil_MDK_FTD.pdf), page 12

## Overview

Starting from CMSIS-CORE, a vendor-independent hardware abstraction layer for Cortex-M processors, CMSIS has since expanded into areas such as software component management and reference debugger interfaces. Creation of software is a major cost factor in the embedded industry. Standardizing the software interfaces across all Cortex-M silicon vendor products, especially when creating new projects or migrating existing software to a new device, means significant cost reductions.

Source: <https://developer.arm.com/embedded/cmsis>



Source: <https://developer.arm.com/embedded/cmsis>

Develop

**µVision IDE**

µVision integrates a robust editor, project manager and build facility for efficient software development. The flexible window management system supports multiple screens and enables you to drag and drop individual windows anywhere on the visual surface.

**Project Targets**

Projects support multiple targets that contain the same file groups and Software Components. Project targets ease configuration management and may be used to generate debug and release builds or adaptations for different hardware platforms.

**Source Code Editor**

The integrated editor is even available during debugging and includes all standard features you are accustomed to in a source code editor. Color syntax highlighting, text indentation, and search functions are optimized for C/C++.

**Code Completion**

New editor features enhance your productivity while developing C/C++ source code. The Code Completion List and Function Parameter information helps you to keep track of symbols, functions, and parameters. Dynamic Syntax Checking validates the program syntax while you are typing and provides real-time alerts to potential code violations before compilation.

The Function list provides a quick overview of all C/C++ source code symbols.

Dynamic Syntax Checking alerts syntax violations and includes with variable declaration errors.

While coding with a editor, smart Parameter Parameters and the Code Completion list.

The Error List window summarizes all detected error syntax and warnings in the source code.

Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 3

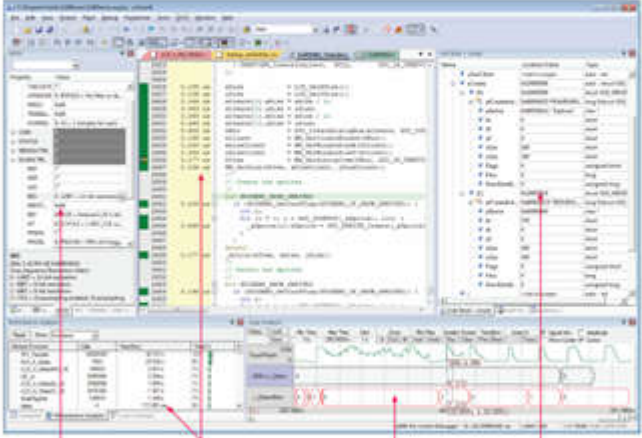
**Verify**

**µVision Debugger**  
The µVision Debugger provides a single environment in which you may test, verify, and optimize your application code. The debugger includes traditional features like single and complex breakpoints, watch windows, and execution control and provides full visibility to device peripherals.

**RTOS Awareness**  
The RTX real-time operating system is fully integrated into the debugger making it easy to monitor thread status and kernel activity in the RTX Task and System window. The RTX Events Viewer displays thread activity and allows identification of thread priority issues in your application.

**Integrated Analysis Tools**  
When using ULINKµ with Streaming Trace, advanced analysis tools show how your program is performing. Code Coverage provides detailed execution statistics for certification testing and validation. The Performance Analyser with execution profiler helps you to identify and optimize hot-spots in your application code.

**Code and Data Trace**  
Code and data trace can be captured on many Cortex-M series processor-based devices using Streaming Trace with ETH or Trace Buffering with ETB or MTB. Trace can help you to find complex timing problems or sporadic software issues.



The System Viewer provides detailed information for each interruptible peripheral.

Execution timing is summarized in the Performance Analyser and detailed view for each statement.


The Log Analyzer shows variable and signal changes in table diagrams or as graphical analysis output.

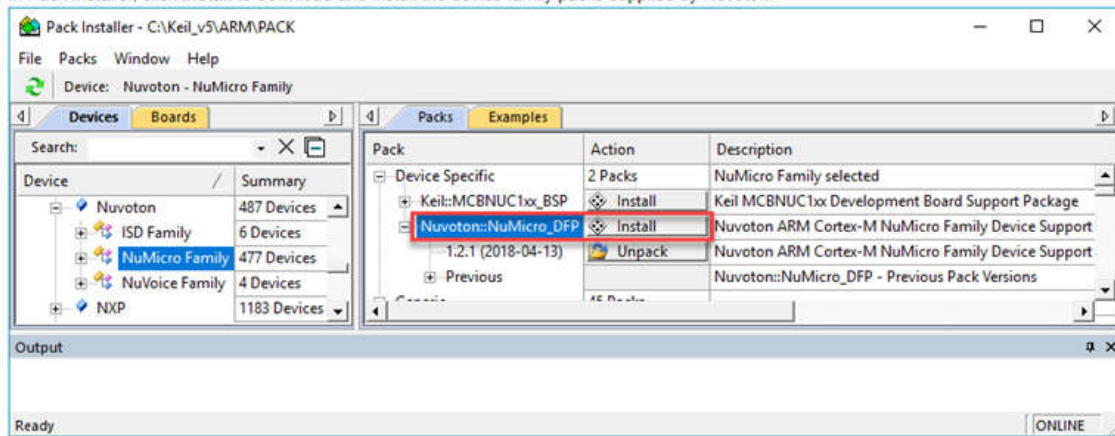
Multiple Watch Windows show selected variables and peripherals with the option to modify values.

Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 4

16. The Product practices generating specific application handler code to associate the generic application functions with specific functions of a device driver for at least one of the types of the hardware modules. For example, in addition to the Hardware Abstraction Layer (HAL), ARM Keil MDK (Microcontroller Development Kit) Nuvoton Edition also include processor-specific application handler code that are specific to particular microcontrollers (such as Arm Cortex-M0/M23/ M4 microcontrollers) and/or evaluation/Development kit (such as Nu Micro Family Nu-Tiny-SDK-M0564) based on Arm Cortex-M0/M4 core and/or 8051 MCUs (Microcontroller Units). Certain elements of this limitation are illustrated in the screenshots below and in the screenshots referenced in connection with other elements herein.

**Installation**

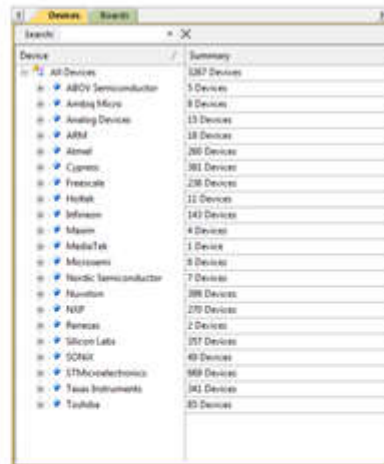
1. Download Arm Keil MDK.
2. Run the downloaded MDK5xx.exe installer. 
3. Select your installation location (default is C:\Keil\_v5). If you have existing MDK installations that you want to keep, select a new folder.
4. In Pack Installer, click **Install** to download and install the device family packs supplied by Nuvoton.



Source: <http://www2.keil.com/nuvoton/M0-M23>

## Device Support

- Support for more than 3200 devices using Device Family Packs
  - System and startup code, device header files
  - SVD files
  - Flash algorithms
- Development board information
- Example projects
- User code templates



Device	Summary
All Devices	1267 Devices
ABOV Semiconductor	5 Devices
Analog Micro	8 Devices
Analog Devices	13 Devices
ARM	18 Devices
Atmel	260 Devices
Cypress	381 Devices
Freescale	236 Devices
Hitachi	12 Devices
Infineon	143 Devices
Maxim	4 Devices
MediaTek	1 Device
Microsemi	3 Devices
Microchip Semiconductor	7 Devices
Monolithic	388 Devices
NXP	270 Devices
Renesas	2 Devices
Silicon Labs	157 Devices
SOCAR	40 Devices
STMicroelectronics	968 Devices
Texas Instruments	141 Devices
Toshiba	85 Devices

Source:  
[https://www.arm.com/files/pdf/20160830\\_06\\_ARM\\_Keil\\_MDK\\_FTD.pdf](https://www.arm.com/files/pdf/20160830_06_ARM_Keil_MDK_FTD.pdf),  
 page 31

**Create**

**MDK Core & Software Packs**

MDK Version 5 is now split into the MDK Core and Software Packs which makes new device support and middleware updates independent from the toolchain. The MDK Core contains all development tools including IDE, Compiler and Debugger. Software Packs contain device support, CMSIS, and middleware and are installed and updated on demand using the Pack Installer.

Software Packs contain software components that collect libraries, source modules, configuration and header files, and documentation. Software components are generic and support a wide range of devices and applications. The Software Pack structure allows integration of 3rd-party software components.

**Device Database<sup>®</sup>**

When you create a project and select a target device from the integrated Device Database uVision pre-configures the development tools for you and shows only options that are relevant for the selected device.

**Run-Time Environment**

The Run-Time Environment window shows all software components that are compatible with the selected device. Choose from these pre-built software components to accelerate your project development. Just select components you need for your application and uVision creates the required run-time environment for you.

The Project Wizard shows software sources that are relevant software components

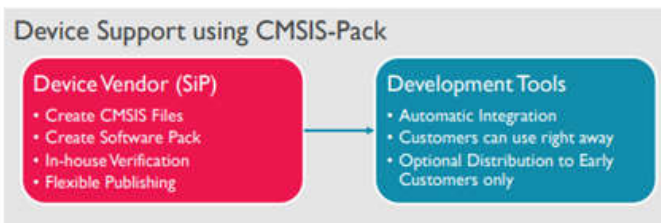
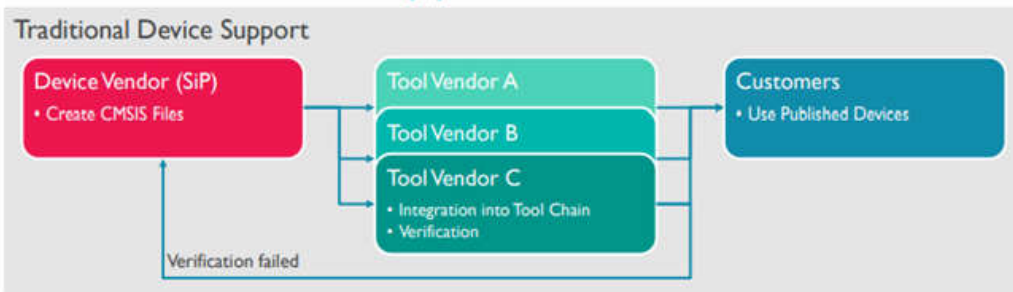
Create the Run-Time Environment from Software Packs will pre-build software components

Interdependencies of software components are clearly identified with additional messages

The Configuration Wizard simplifies the setup for selected software components

Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 2

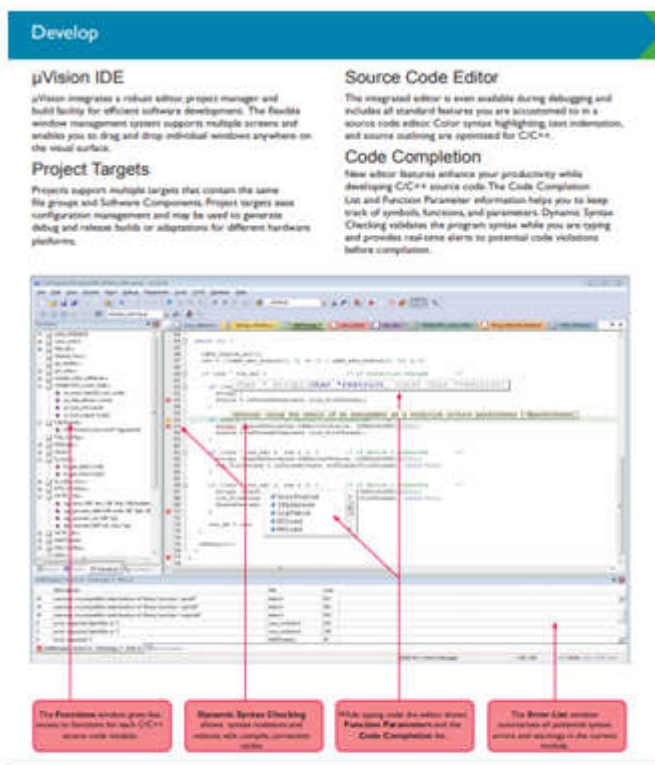
## Faster Device Support with CMSIS-Pack



- Early verification during chip design phase → better overall quality
- One Pack for multiple tool chains
- Flexible distribution to early/general availability customers → faster development start

Source: [https://www.arm.com/files/pdf/20160830\\_06\\_ARM\\_Keil\\_MDK\\_FTD.pdf](https://www.arm.com/files/pdf/20160830_06_ARM_Keil_MDK_FTD.pdf), page 15

17. The Product practices defining a specific element in the specific application handler code to be handled by one of the generic application functions for the at least one of the types of the hardware modules, and registering one of the specific functions of the device driver for use in handling the defined specific element. For example, the ARM Keil MDK generates system-specific application handler code by defining a specific element such as data structures and functions that are handled by one or more generic application functions in the Hardware Abstraction Layer (HAL). Certain elements of this limitation are illustrated in the screenshots below and in the screenshots referenced in connection with other elements herein.



Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 3



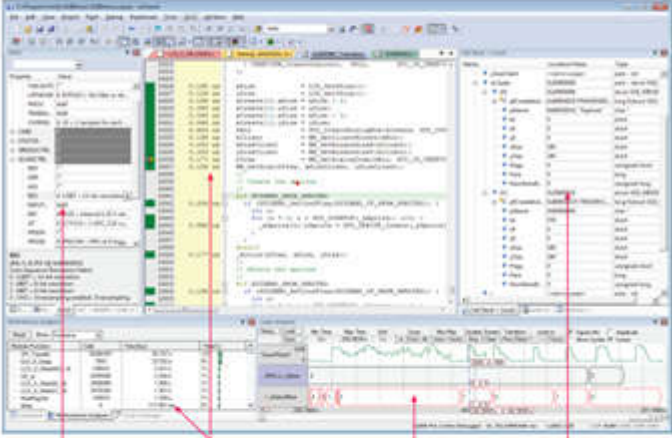
**Verify**

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**Code and Data Trace**  
 Code and data trace can be captured on many Cortex-M series processor-based devices using Streaming Trace with ETH or Trace Buffering with ETB or HTB. Trace can help you to find complex timing problems or sporadic software issues.



The System Viewer provides related information for each microcontroller peripheral.

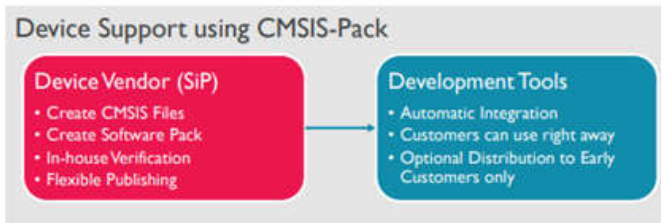
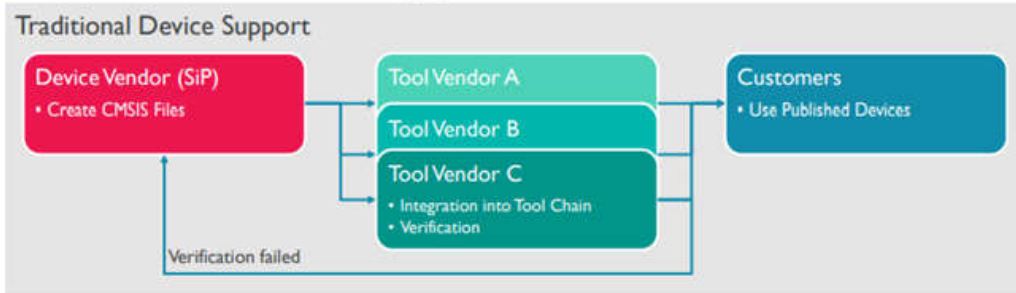
Execution timing is summarized in the Performance Analyzer and detailed view for code statements.

The Logic Analyzer shows results and logic changes as wave diagrams or as graphical storage output.

Multiple Watch Windows show selected variables and structures with the option to modify values.

Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 4

## Faster Device Support with CMSIS-Pack



- Early verification during chip design phase → better overall quality
- One Pack for multiple tool chains
- Flexible distribution to early/general availability customers → faster development start

Source: [https://www.arm.com/files/pdf/20160830\\_06\\_ARM\\_Keil\\_MDK\\_FTD.pdf](https://www.arm.com/files/pdf/20160830_06_ARM_Keil_MDK_FTD.pdf), page 15

## MDK-Professional Middleware Components

### Middleware Pack

Today's microcontroller devices offer a wide range of communication interfaces to meet any embedded design requirement. However, implementing these interfaces presents software developers with real challenges. Middleware components are essential for developers to make efficient use of the device capabilities.

MDK-Professional includes a number of royalty-free, tightly coupled middleware components which enable developers to more easily implement complex communication interfaces in their applications. Middleware components include:

- Graphical User Interface
- USB Host and Device
- TCP Networking Suite
- Flash File System
- CAN Driver



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All middleware components are specifically designed and optimized for ARM processor-based MCU devices. The libraries are seamlessly integrated with the  $\mu$ Vision environment and offer a modular design with well documented APIs.

### Graphical User Interface (GUI)

The GUI Library is a fully featured graphics suite that makes it possible to add graphical user interfaces to embedded applications. It supports a large number of displays and includes tools for rapid GUI creation.

- Supports monochrome, grayscale and color LCDs
- Drivers for many displays and display controllers included
- Window Manager for handling multiple windows
- Many widget-like buttons, checkboxes and icons available
- Skinning support for a custom look and feel
- Optimized for speed and size
- Wide range of examples for evaluation boards.



### USB Device and Host

MDK-Professional provides USB Device and USB Host support for embedded systems.

The USB Device interface uses standard device driver classes that are available with all Windows PCs. No Windows host driver development is required. The USB Device interface uses a generic software layer using RTX Kernel features.

### TCP/IP Networking Suite

The TCP/IP library is a full networking suite optimized for ARM and Cortex-M processor-based MCUs. It has a small code footprint, and delivers excellent performance.

The suite provides comprehensive support for transmission protocols such as TCP/IP and UDP, as well as application level services and clients including HTTP, Telnet, SMTP, SNMP, and FTP. It provides all the features required for modern networking communication in embedded systems.



MDK Middleware components allow you to develop robust applications using a wide variety of communication protocols.

### Flash File System

The Flash File System allows your embedded applications to create, save, read, and modify files in a wide range of standard storage devices. The Flash File System offers:

- Standard ANSI C File I/O application interface
- NOR and NAND Flash support
- RAM, ROM, and SD/MMC/SDHC Memory Cards
- FAT12, FAT16, and FAT32 formats
- SD/MMC card file-caching
- Reentrant and thread-safe operation
- Simultaneous access to multiple storage devices.

Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 5

## MDK-ARM Microcontroller Development Kit

**MDK-ARM Core**

- µVision IDE with Editor
- ARM C/C++ Compiler
- Pack Installer
- µVision Debugger with Trace

**Software Packs**

- Device:** Startup / System, Driver 1: SPI, Driver 2: Ethernet, ..., Driver n: USB
- CMSIS:** CMSIS-CORE, CMSIS-DSP, CMSIS-RTOS
- MDK-Professional Middleware:** TCP/IP Networking, File System, USB Host Stack, Graphical User Interface, USB Device Stack, CAN Driver

**MDK-ARM Core**

The MDK-ARM Core contains all the development tools. MDK-ARM is easy to use, yet powerful enough for the most demanding embedded applications.

**Software Packs**

Software Packs are added on-demand using the Pack Installer. Software Packs contain device support, CMSIS, and middleware components that are essential for efficient software development.

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MDK Product Selector:	MDK-Lite	MDK-Cortex-M	MDK-Standard	MDK-Professional
<b>MDK-ARM Core Components</b>				
µVision IDE with editor	✓	✓	✓	✓
µVision Debugger and Trace	32KB	✓	✓	✓
ARM C/C++ Compiler	32KB	✓	✓	✓
Pack Installer	✓	✓	✓	✓
<b>ARM Processor Support:</b>				
Cortex-M series processors	✓	✓	✓	✓
Cortex-R4, ARM7 & ARM9	✓		✓	✓
SecurCore			✓	✓
<b>RTOS &amp; Middleware Libraries:</b>				
MDK-Professional Middleware				✓
CMSIS-RTOS RTX with source code	✓	✓	✓	✓
3rd Party RTOS Support	✓	✓	✓	✓

Source: [https://www.arm.com/files/pdf/20160830\\_06\\_ARM\\_Keil\\_MDK\\_FTD.pdf](https://www.arm.com/files/pdf/20160830_06_ARM_Keil_MDK_FTD.pdf), page 6

18. The Product practices compiling the generic application handler programs together with the specific application handler code to produce machine-readable code to be executed by an embedded processor in the at least one of the types of the hardware modules. For example, when a specific application is needed for a particular hardware, the generic functions and the specific functions are compiled together to yield a machine readable code. Nuvoton Technology and/or its customers compile the generic functions and the specific functions using ARM Keil MDK or any other IDE (such as Keil C51, NU Eclipse (GCC), IAR EWARM, IAR EW8051) supported by Nuvoton Technology. Certain elements of this limitation are illustrated in the screenshots below and in the screenshots referenced in

connection with other elements herein.

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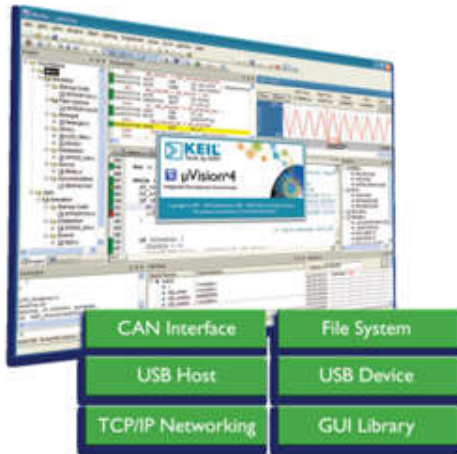
### IDE and Compiler

Nuvoton has been committed to building the customer-oriented MCU eco-System from rich platform products, evaluation boards, device drivers, BSP, own-developed debugging tools, software developing tools, integrated development tools, and mass production supporting tools, and the operating system software to fulfill customers' needs from product selection, development and mass production stages.

IDE	Validated MCUs	License	Debugger	Windows	Linux
NuEclipse (GCC)	NuMicro M0/M4/M23	Free	Nu-Link	V (V1.01.014)	V (V1.01.014)
KEIL MDK Nuvoton edition M0/M23	NuMicro M0/M23	Free	Nu-Link / J-Link / U-Link	V	
KEIL MDK Nuvoton edition M4	NuMicro M4	Special offer	Nu-Link / J-Link / U-Link	V	
IAR EWARM	NuMicro M0/M4/M23	IAR	Nu-Link	V	
KEIL C51	NuMicro 8-bit	Keil	4T: Nu-Tiny-51 1T: Nu-Link	V	
IAR EW8051	NuMicro 8-bit 1T MCUs	IAR	Nu-Link	V	

\*Note: Nuvoton and NuMicro are trademarks or registered trademarks of Nuvoton Technology Corporation. All other trademarks and copyrights mentioned herein are the property of their respective owners.

Source: [https://www.nuvoton.com/hq/support/tool-and-software/software/IDE-Compiler/?\\_locale=en](https://www.nuvoton.com/hq/support/tool-and-software/software/IDE-Compiler/?_locale=en)



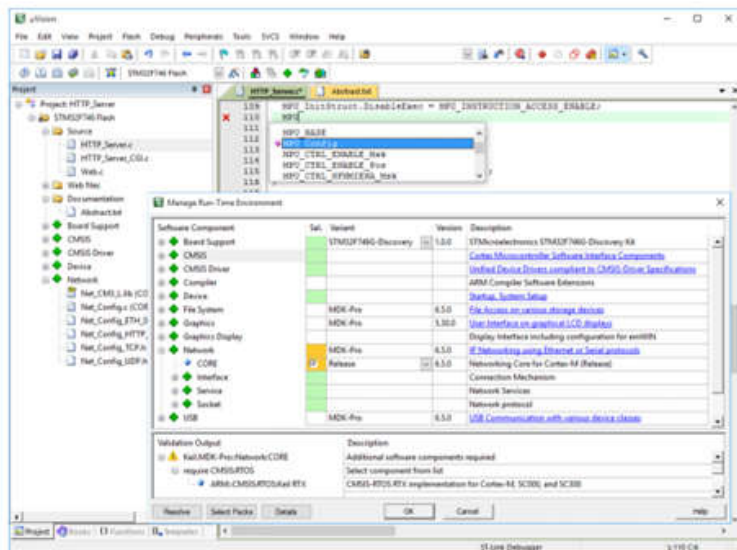
Keil™ MDK-ARM™ (Microcontroller Development Kit) the complete software development environment for ARM processor-based microcontrollers.

- Out-of-the box support for over 1000 ARM® processor-based microcontrollers
- Software Packs with ready-to-use CMSIS and middleware components
- Numerous example projects and templates
- Powerful μVision™ IDE, debugger and simulation environment
- On-the-fly application analysis records full instruction trace with the ULINKpro™ Debug Adapter
- Complete Code Coverage information about your program's execution.
- Execution Profiler and Performance Analyzer for analyzing and optimizing your code.
- CMSIS RTOS RTX real-time operating system with full debugger support.
- Complete and comprehensive middleware including TCP/IP Networking, File Systems and USB.
- **Industry-leading ARM C/C++ Compiler with advanced processor-specific optimizations and MicroLib.**
- Editor with Code Completion and Dynamic Syntax Checking.

Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 1

## μVision IDE

- Project Management
- Source Code Editing
- Program Debugging
- Trace Viewing
- Well-known environment
- Optimized for MCU development



Source: [https://www.arm.com/files/pdf/20160830\\_06\\_ARM\\_Keil\\_MDK\\_FTD.pdf](https://www.arm.com/files/pdf/20160830_06_ARM_Keil_MDK_FTD.pdf), page 30

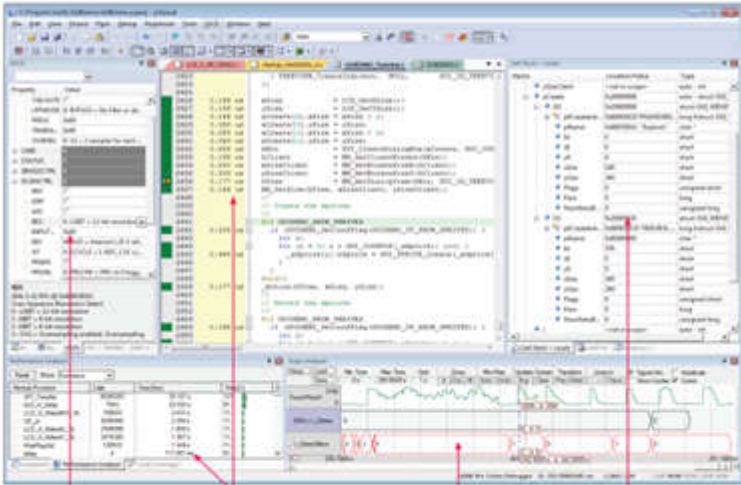
**Verify**

**µVision Debugger**  
 The µVision Debugger provides a single environment in which you may test, verify, and optimize your application code. The debugger includes traditional features like simple and complex breakpoints, watch windows, and execution control and provides full visibility to device peripherals.

**RTOS Awareness**  
 The RTX real-time operating system is fully integrated into the debugger making it easy to monitor thread status and kernel activity in the RTX Task and System view. The RTOS Event Viewer displays thread activity and allows identification of thread priority issues in your application.

**Integrated Analysis Tools**  
 When using ULINKµvis with Streaming Trace, advanced analysis tools show how your program is performing. Code Coverage provides detailed execution statistics for certification testing and validation. The Performance Analyzer with execution profiler helps you to identify and optimize hot-spots in your application code.

**Code and Data Trace**  
 Code and data trace can be captured on many Cortex-M series processor-based devices using Streaming Trace with ETM or Trace Buffering with ETB or HTB. Trace can help you to find complex timing problems or sporadic software issues.



The System Viewer provides detailed information for each microcontroller peripheral.

Execution timing is highlighted in the Performance Analyzer and detailed view for code statements.

The Logic Analyzer shows variable and signal changes in state diagram or as graphic analogic output.

Multiple Watch Windows show selected variables and structures with the option to modify values.

Source: <http://www.keil.com/product/brochures/mdk.pdf>, page 4

19. Defendant’s actions complained of herein will continue unless Defendant is enjoined by this court.

20. Defendant’s actions complained of herein are causing irreparable harm and monetary damage to Plaintiff and will continue to do so unless and until Defendant is enjoined and restrained by this Court.

21. Plaintiff is in compliance with 35 U.S.C. § 287.

**PRAYER FOR RELIEF**

WHEREFORE, Plaintiff asks the Court to:

(a) Enter judgment for Plaintiff on this Complaint on all causes of action asserted

herein;

(b) Enter an Order enjoining Defendant, its agents, officers, servants, employees, attorneys, and all persons in active concert or participation with Defendant who receive notice of the order from further infringement of United States Patent No. 7,069,546 (or, in the alternative, awarding Plaintiff a running royalty from the time of judgment going forward);

(c) Award Plaintiff damages resulting from Defendant's infringement in accordance with 35 U.S.C. § 284;

(d) Award Plaintiff pre-judgment and post-judgment interest and costs; and

(e) Award Plaintiff such further relief to which the Court finds Plaintiff entitled under law or equity.

Dated: June 27, 2019

Respectfully submitted,

*/s/ Jay Johnson*

**JAY JOHNSON**

State Bar No. 24067322

**D. BRADLEY KIZZIA**

State Bar No. 11547550

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**ATTORNEYS FOR PLAINTIFF**



**EXHIBIT A**