Hercules™ Safety Microcontrollers

TEXAS INSTRUMENTS

Make the world safer with the new Hercules safety MCU platform

# Hercules™ MCUs help developers make the world safer

Hercules safety microcontrollers are based on TI's 20+ years of safety-critical system expertise, industry collaboration and proven hardware for the automotive market. The platform consists of three ARM® Cortex™-based microcontroller families (RM48x, TMS570 and TMS470M) that deliver scalable performance, connectivity, memory and safety features. Unlike many microcontrollers that rely heavily on software for safety capabilities, Hercules microcontrollers implement safety in hardware to maximize performance and reduce software overhead.

The Hercules RM4x family provides the highest level of performance for broad safety applications, including medical and industrial, and are developed to the IEC 61508 SIL-3 safety standard. The Hercules TMS570 family provides high performance for transportation applications and is very well suited for applications that need to meet IEC 61508 SIL-3 or ISO 26262 requirements. The Hercules TMS470M family cost efficiently meets the needs of applications that require less performance and lower safety levels.

The RM48x and TMS570 dual-CPU lockstep architectures simplify development while eliminating redundant system requirements to reduce cost. CPU hardware built-in self test (BIST) detects latent defects without complex safety software and code-size overhead. Hardware comparison of CPU outputs provides nearly instant safety response time without any additional performance impact. ECC logic is integrated in the CPU to protect both memories and busses. All RAM memories can be tested using HW BIST for high diagnostic coverage and an integrated Memory Protection Unit (MPU) helps protect against deterministic errors in application software.

| RM48x	TMS570	TMS470M
High-Performance Industrial and Medical Safety MCUs	**High-Performance Transportation and Safety MCUs**	**Value Line Transportation and Safety MCUs**

• Industrial applications
• Medical applications
• TMS qualification
• –40 to 105°C operation
• Ethernet, USB connectivity
• Developed to safety standards:
  ○ IEC 61508 SIL-3
• Cortex-R – over 350 DMIPS
	• Transportation applications
	• Automotive Q100 qual
	• –40 to 125°C operation
	• FlexRay, CAN connectivity
	• Developed to safety standards:
	  ○ IEC 61508 SIL-3
	  ○ ISO 26262 ASIL-D
	• Cortex-R – over 280 DMIPS
		• Transportation applications
		• Automotive Q100 qual
		• –40 to 125°C operation
		• LIN, CAN connectivity
		• Supports safety for:
		  ○ IEC 61508 systems
		• Cortex-M – up to 100 DMIPS
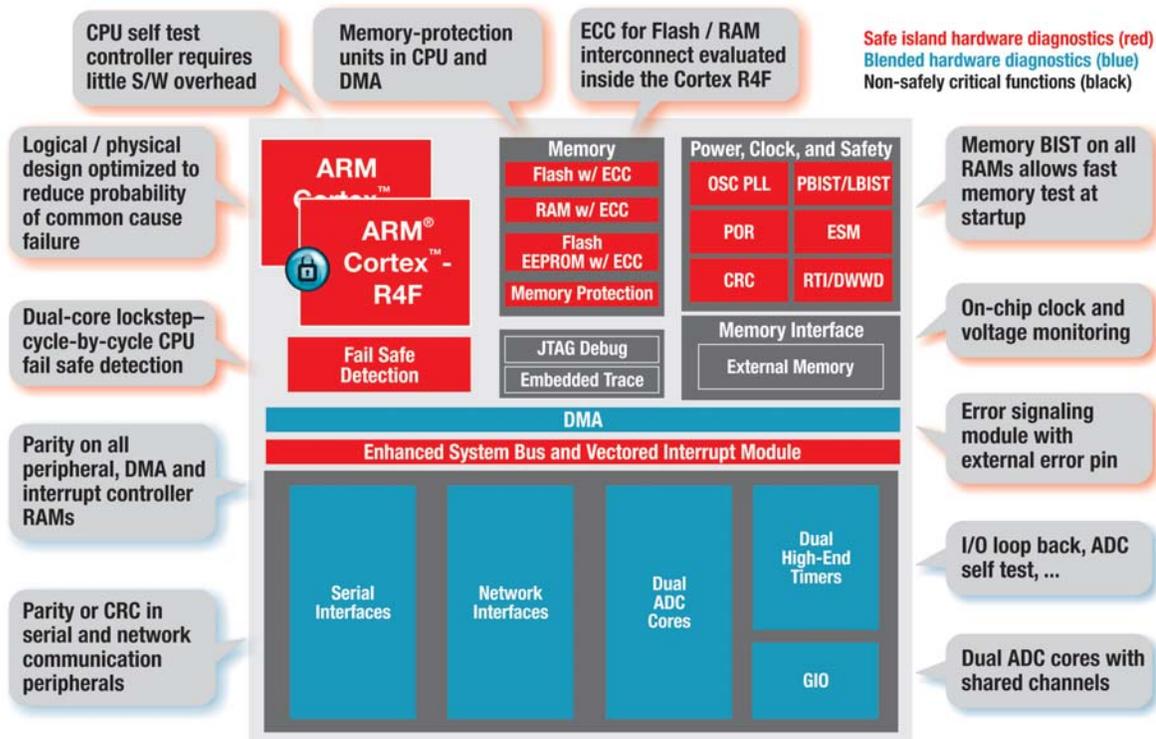
The RM48x is the highest performance Hercules Safety microcontroller family. Based on the ARM® Cortex™-R4F floating point core running at up to 220 MHz it includes several flash memory and connectivity options. Developed with the capability to meet the requirements of the IEC 61508 SIL-3 safety standard and supporting many functional safety features including a dual-CPU lockstep architecture, hardware built-in self test (BIST), memory protection unit (MPU), error correction code (ECC) and parity checking, the RM4x safety microcontrollers provide a high level of diagnostic coverage without costly safety software overhead. A wide choice of communication interfaces makes this family an ideal solution for safety critical industrial and medical applications.

Key features

- ARM Cortex-R4F core with floating-point support
- Up to 220 MHz
- Lockstep safety features built-in simplify SIL-3 applications
- Up to 3-MB Flash/256-KB RAM with ECC
- Memory protection units in CPU and DMA
- Multiple network peripherals:
  - Ethernet, USB, CAN
- Flexible timer module with up to 44 channels
- 12-bit analog/digital converter
- External memory interface

Targeted industrial/medical applications

- Industrial automation and control
- Safety Programmable Logic Controllers (PLCs)
- Power generation and distribution
- Turbines and windmills
- Ventilators and defibrillators
- Infusion and insulin pumps
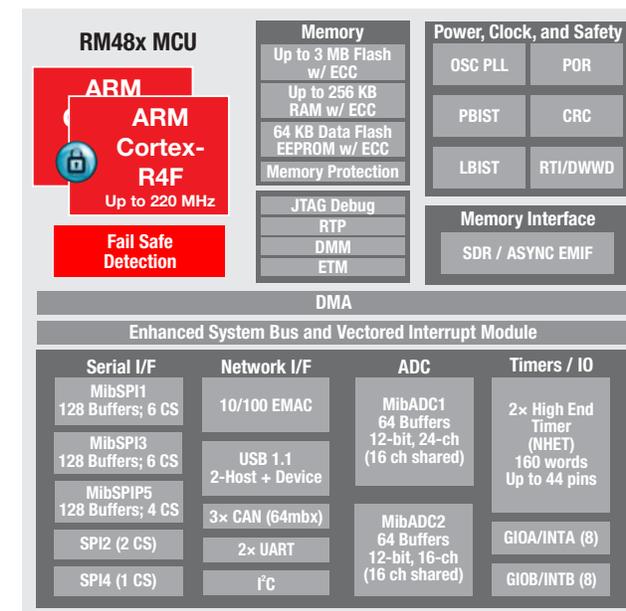
Packages: LQFP: 144 pin - 20 × 20; nfBGA: 337 pin - 16 × 16, 0.8 mm; –40 to 105°C temperature range

RM48x family overview

Device	Speed (MHz)	Flash (MB)	RAM (kB)	Data Flash/EEPROM (kB)	EMAC	USB OHCI+ Device	CAN	MibSPI	SPI	I²C	UART	HET (ch)	MibADC 12-b (ch)	EMIF	GIO (Int)	ETM/RTP/DMM	Package	Temperature Range
RM48L530	200	2	192	64	–	Yes	3	3	1	1	2	2 (40)	2 (24)	–	4 (4)	–	144 QFP	–40–105°C
	200	2	192	64		Yes	3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L540	200	2	192	64	10/100	–	3	3	1	1	2	2 (40)	2 (24)	–	10 (10)	–	144 QFP	–40–105°C
	200	2	192	64	10/100		3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L550	200	2	192	64	10/100	Yes	3	3	1	1	2	2 (40)	2 (24)	–	4 (4)	–	144 QFP	–40–105°C
	200	2	192	64	10/100	Yes	3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L730	200	2	256	64	–	Yes	3	3	1	1	2	2 (40)	2 (24)	–	4 (4)	–	144 QFP	–40–105°C
	200	2	256	64		Yes	3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L740	200	2	256	64	10/100	–	3	3	1	1	2	2 (40)	2 (24)	–	10 (10)	–	144 QFP	–40–105°C
	200	2	256	64	10/100		3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L750	200	2	256	64	10/100	Yes	3	3	1	1	2	2 (40)	2 (24)	–	4 (4)	–	144 QFP	–40–105°C
	200	2	256	64	10/100	Yes	3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L930	200	3	256	64	–	Yes	3	3	1	1	2	2 (40)	2 (24)	–	4 (4)	–	144 QFP	–40–105°C
	200	3	256	64		Yes	3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L940	200	3	256	64	10/100	–	3	3	1	1	2	2 (40)	2 (24)	–	10 (10)	–	144 QFP	–40–105°C
	200	3	256	64	10/100		3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L950	200	3	256	64	10/100	Yes	3	3	1	1	2	2 (40)	2 (24)	–	4 (4)	–	144 QFP	–40–105°C
	200	3	256	64	10/100	Yes	3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	
RM48L952	220	3	256	64	10/100	Yes	3	3	1	1	2	2 (40)	2 (24)	–	4 (4)	–	144 QFP	–40–105°C
	220	3	256	64	10/100	Yes	3	3	2	1	2	2 (44)	2 (24)	Yes	16 (16)	Yes	337 BGA	

Note: Above reflects max configuration of each module – some functions are multiplexed.

Hercules™ TMS570LS Safety MCU

The Hercules TMS570LS safety microcontroller family enables customers to easily develop safety-critical products for transportation applications. Developed to the requirements of the ISO 26262 ASIL-D and IEC 61508 SIL-3 safety standards and qualified to the AEC-Q100 automotive specification this ARM® Cortex™-R4F-based family offers several options of performance, memory and connectivity. Dual-core lockstep CPU architecture, hardware BIST, MPU, ECC and on-chip clock and voltage monitoring are some of the key functional safety features available to meet the needs of automotive, railway and aerospace applications.

Key features

- ARM Cortex-R4F core floating-point support
- Up to 180 MHz
- Lockstep safety features built-in simplify SIL-3/ASIL D applications
- Up to 3-MB Flash/256-KB RAM with ECC
- Memory protection units in CPU and DMA
- Multiple communication peripherals:
  - Ethernet, FlexRay, CAN, LIN, SPI
- Flexible timer module with up to 44 channels
- 12-bit analog/digital converter
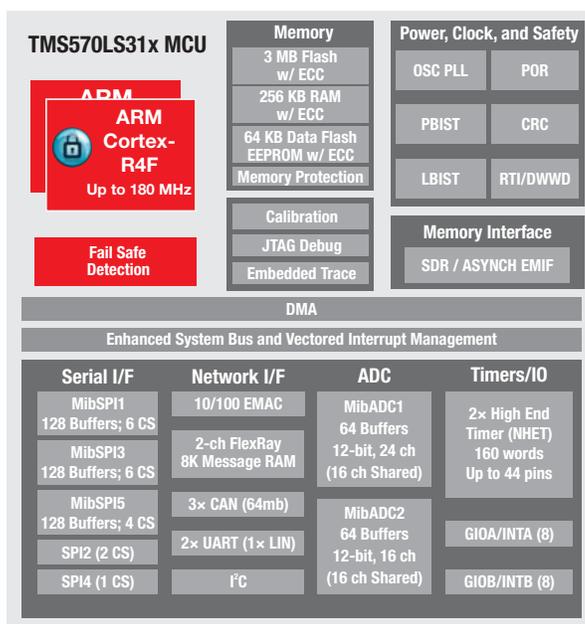- External memory interface

Targeted transportation applications

- Braking systems (ABS and ESC)
- Electric power steering (EPS)
- HEV/EV inverter systems
- Aerospace
- Railway control, communications and signaling
- Off-road vehicles

TMS570LS31x MCU

ARM Cortex-R4F — Up to 180 MHz
Fail Safe Detection

Memory: 3 MB Flash w/ ECC; 256 KB RAM w/ ECC; 64 KB Data Flash EEPROM w/ ECC; Memory Protection

Power, Clock, and Safety: OSC PLL; POR; PBIST; CRC; LBIST; RTI/DWWD

Calibration; JTAG Debug; Embedded Trace

Memory Interface: SDR / ASYNCH EMIF

DMA

Enhanced System Bus and Vectored Interrupt Management

Serial I/F: MibSPI1 128 Buffers; 6 CS; MibSPI3 128 Buffers; 6 CS; MibSPI5 128 Buffers; 4 CS; SPI2 (2 CS); SPI4 (1 CS)

Network I/F: 10/100 EMAC; 2-ch FlexRay 8K Message RAM; 3× CAN (64mb); 2× UART (1× LIN); I²C

ADC: MibADC1 64 Buffers 12-bit, 24 ch (16 ch Shared); MibADC2 64 Buffers 12-bit, 16 ch (16 ch Shared)

Timers/IO: 2× High End Timer (NHET) 160 words Up to 44 pins; GIOA/INTA (8); GIOB/INTB (8)

Packages: LQFP: 144 pin - 20 × 20; nfBGA: 337 pin - 16 × 16, 0.8 mm; −40 to 125°C temperature range

TMS570 family overview

Device	Speed (MHz)	Flash (MB)	RAM (kB)	FlexRay (ch)	CAN	MibSPI/SPI	UART (LIN)	HET(ch)	MibADC 12-b (ch)	EMIF	GIO (Int)	ETM (Data)	RTP (Data)	DMM (Data)	Package	Temperature Range
TMS570LS10106	140	1	128	–	2	3	2 (2)	(25)	2 (20)	–	8 (8)				144 QFP	−40 − +125°C
	160	1	128		3	3	2 (2)	(32)	2 (24)	Yes	16 (8)	(32)	(16)	(16)	337 BGA	
TMS570LS10116	140	1	128	2	2	3	2 (2)	(25)	2 (20)	–	8 (8)				144 QFP	−40 − +125°C
	160	1	128	2	3	3	2 (2)	(32)	2 (24)	Yes	16 (8)	(32)	(16)	(16)	337 BGA	
TMS570LS10206	140	1	160	–	2	3	2 (2)	(25)	2 (20)	–	8 (8)				144 QFP	−40 − +125°C
	160	1	160		3	3	2 (2)	(32)	2 (24)	Yes	16 (8)	(32)	(16)	(16)	337 BGA	
TMS570LS10216	140	1	160	2	2	3	2 (2)	(25)	2 (20)	–	8 (8)				144 QFP	−40 − +125°C
	160	1	160	2	3	3	2 (2)	(32)	2 (24)	Yes	16 (8)	(32)	(16)	(16)	337 BGA	
TMS570LS20206	140	2	160	–	2	3	2 (2)	(25)	2 (20)	–	8 (8)				144 QFP	−40 − +125°C
	160	2	160		3	3	2 (2)	(32)	2 (24)	Yes	16 (8)	(32)	(16)	(16)	337 BGA	
TMS570LS20216	140	2	160	2	2	3	2 (2)	(25)	2 (20)	–	8 (8)				144 QFP	−40 − +125°C
	160	2	160	2	3	3	2 (2)	(32)	2 (24)	Yes	16 (8)	(32)	(16)	(16)	337 BGA	
TMS570LS2124	160	2	192	–	3	3/1	2 (1)	2 (40)	2 (24)	–	10 (10)				144 QFP	−40 − +125°C
	180	2	192		3	3/2	2 (1)	2 (44)	2 (24)	Yes	16 (16)	(32)	(16)	(16)	337 BGA	
TMS570LS2125	160	2	192	2	3	3/1	2 (1)	2 (40)	2 (24)	–	4 (4)				144 QFP	−40 − +125°C
	180	2	192	2	3	3/2	2 (1)	2 (44)	2 (24)	Yes	16 (16)	(32)	(16)	(16)	337 BGA	
TMS570LS2134	160	2	256	–	3	3/1	2 (1)	2 (40)	2 (24)	–	10 (10)				144 QFP	−40 − +125°C
	180	2	256		3	3/2	2 (1)	2 (44)	2 (24)	Yes	16 (16)	(32)	(16)	(16)	337 BGA	
TMS570LS2135	160	2	256	2	3	3/1	2 (1)	2 (40)	2 (24)	–	4 (4)				144 QFP	−40 − +125°C
	180	2	256	2	3	3/2	2 (1)	2 (44)	2 (24)	Yes	16 (16)	(32)	(16)	(16)	337 BGA	
TMS570LS3134	160	3	256	–	3	3/1	2 (1)	2 (40)	2 (24)	–	10 (10)				144 QFP	−40 − +125°C
	180	3	256		3	3/2	2 (1)	2 (44)	2 (24)	Yes	16 (16)	(32)	(16)	(16)	337 BGA	
TMS570LS3135	160	3	256	2	3	3/1	2 (1)	2 (40)	2 (24)	–	4 (4)				144 QFP	−40 − +125°C
	180	3	256	2	3	3/2	2 (1)	2 (44)	2 (24)	Yes	16 (16)	(32)	(16)	(16)	337 BGA	
TMS570LS3137 (10/100 EMAC)	160	3	256	2	3	3/1	2 (1)	2 (40)	2 (24)	–	4 (4)				144 QFP	−40 − +125°C
	180	3	256	2	3	3/2	2 (1)	2 (44)	2 (24)	Yes	16 (16)	(32)	(16)	(16)	337 BGA	

*Note: Above reflects max configuration of each module – some functions are multiplexed.*

The TMS470M safety microcontroller family is based on the widely adopted ARM® Cortex™-M3 CPU running at 80 MHz. The family offers several flash memory and RAM options and a wide range of connectivity and control peripherals. Built-in safety features like CPU and RAM self-test (BIST) engines, ECC and parity-checking enable the TMS470M to support applications that meet the IEC 61508 safety standard. The TMS470M safety microcontrollers are AEC-Q100 qualified and are the right fit for safety and transportation applications with lower performance needs.

Key features

- 80-MHz Cortex-M3 CPU
- Up to 640-KB Flash / 64-KB RAM with ECC protection and EEPROM emulation
- Single 3.3-V supply (Vreg on-chip)
- Multiple communication interfaces
  - 2 CAN, 2 MibSPIs, 2 LIN/UART
- Flexible timer module (16 ch)
- 10-bit analog/digital converter (16 ch)
- Safety features (ECC, BISTs, CRC)
- Pin and software compatible family
- Embedded debug module

Targeted transportation applications

- Electric Power Steering (EPS)
- Braking systems (ABS, ESC)
- Safety-related automotive
- Automotive infrastructure
- Commercial vehicles
- Off-road vehicles
- Airbags, electric park brake, safe communication, parking assist
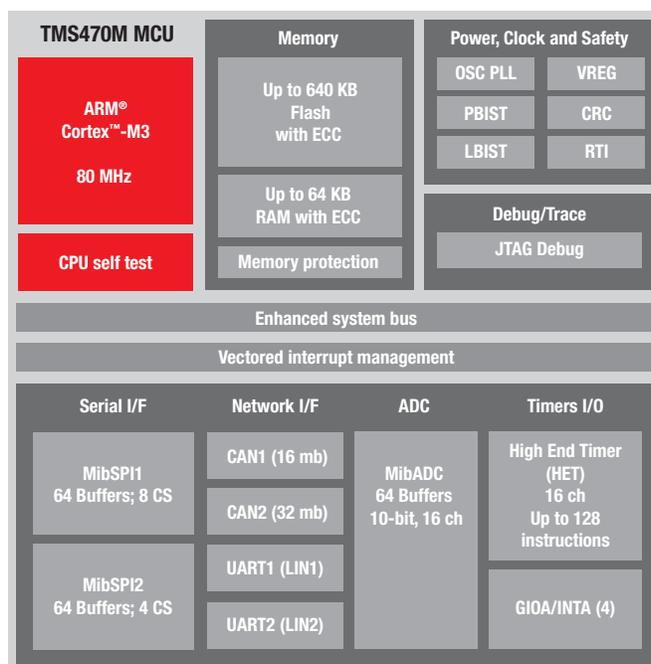
Package: LQFP: 100-pin - 14 × 14 mm;
−40 to 125°C temperature range

TMS470M family overview

Device	Speed (MHz)	Flash (KB)	EEPROM or Flash* (KB)	RAM (KB)	CAN	MibSPI (CS)	UART (LIN)	HET (ch)	MbADC 10-b (ch)	GIO	Voltage (V)	Package	Temperature Range	Q100
TMS470MF03107	80	256	64	16	2	2 (12)	2 (2)	16	16	4	3.3	100QFP	−40 − +125°C	Yes
TMS470MF04207	80	384	64	24	2	2 (12)	2 (2)	16	16	4	3.3	100QFP	−40 − +125°C	Yes
TMS470MF06607	80	512	128	64	2	2 (12)	2 (2)	16	16	4	3.3	100QFP	−40 − +125°C	Yes

*Note: * Memory area can be used for code Flash or EEPROM emulation.*
*Please see the datasheet online at **www.ti.com/tms470m** for orderable part numbers.*

Hercules™ evaluation and development tools

Evaluation

Low-cost USB stick evaluation/development kits

TMDXRM48USB – RM48 USB Stick Kit
TMDX570LS31USB – TMS570 USB Stick Kit
TMDX470MF066USB – TMS470M USB Stick Kit

USB Stick Kit features:
• USB powered
• On-board USB XDS100v2 JTAG debug
• On-board SCI-to-PC serial communication
• Access to select signal pin test points
• LEDs, temp sensor and light sensor
• CAN transceiver

$79

Development

Full-featured development kits

TMDXRM48HDK – RM48 Development Kit
TMDX570LS31HDK – TMS570 Development Kit
TMDX470MF066HDK – TMS470M Development Kit

$199

Hercules Development Kit features:
• On-board USB XDS100v2 JTAG debug
• On-board SCI-to-PC serial communication
• External high-speed emulation via JTAG
• Access to signal pin test points
• LEDs, temp sensor and light sensor
• 2 CAN transceivers
• MIPI connector for 32-bit ETM trace (RM48 and TMS570)
• RJ-45 10/100 Ethernet interface (RM48 and TMS570)
• USB-A host interface (RM48)
• USB-B device interface (RM48)

Software

Software included in each kit

• CCStudio v4.x IDE: C/C++ compiler/linker/debugger
• HALCoGen peripheral driver generation tool
• CCStudio and nowFlash flash programming tools
• HET IDE/simulator/assembler
• GUI demo with project/code examples

Integrated development environment (IDE)

Program/compile/debug code using these IDEs:
- Code Composer Studio™ (CCStudio) IDE
- IAR Workbench
- KEIL µVision

IAR SYSTEMS

KEIL An ARM® Company

Hercules™
MCU Development Kit
www.ti.com/hercules

DVD

Documentation+Software

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Real-Time Operating Systems

- SAFERTOS: High-integrity systems
- µC/OS: Micrium
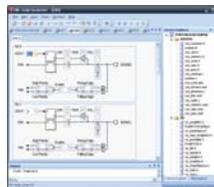- ThreadX: Express Logic
- AUTOSAR: Vector Microsar and EB tresos

WITTENSTEIN

Micrium   **expresslogic**   **AUTOSAR**

GUI-based code-generation tools and other software tools

Safety MCU demos
- Safety feature highlight
- Ambient light demo
- Temperature demo
- LED light show
- Maze game (RM48 and TMS570)
- Source Code viewable via CCStudio

PLL calculators
- Easily configure the FMzPLL and FPLLs in the Hercules platform Phase Lock Loop modules.

HET IDE
- Graphical programming environment
- Includes WaveFormer Pro SynaptiCAD
- Generates CCStudio-ready software
- Includes functional examples

HALCoGen
- User input on high-abstraction level
- Graphical-based code generation
- Easy configuration
- Quick start for new projects
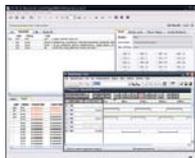- Supports CCStudio, IAR and KEIL IDEs

nowECC Generation Tool
- Command line program for generating error correction code for Hercules devices. Can be used in conjunction with CCStudio.

nowFlash Programming Tool
- GUI and command line programmer for loading code into Hercules devices without an IDE.

Third-party Hercules software/tools partners

Blackhawk Powering DSP Development™ **i SYSTEM** **EB** **ETAS** **KEIL** An ARM® Company

LAUTERBACH DEVELOPMENT TOOLS **SCIOPTA** **Simma Software** **SYNAPTICAD** **vector** **WITTENSTEIN**

Hercules™ MCU training and support

Whether you have a support question you need answered right away, you're looking for in-person training, or you just want to learn more about the Hercules microcontroller platform – we have the support you need! Talk to Hercules MCU experts in the E2E™ forum, check out the tools, videos, examples and other resources available on the Hercules MCU web and WIKI pages, or check out the in-person training opportunities including hands-on multi-day workshops and single-day seminars to help get started with Hercules MCU development.

Hercules MCU web resources

Hercules MCU web pages provide access to device data sheets, technical reference manuals, application notes, videos, software downloads/updates, and online ordering of evaluation and development kits.
• Hercules MCU web page: **www.ti.com/hercules**
• RM48 web page: **www.ti.com/rm4**
• TMS570 web page: **www.ti.com/tms570**
• TMS470M web page: **www.ti.com/tms470m**

Hercules MCU E2E forum

Search for topics or ask technical questions about Hercules MCUs.
www.ti.com/hercules-support

Hercules MCU WIKI

Download development kit schematics, software examples, training videos and information and much more on the Hercules MCU WIKI pages.
• Hercules MCU WIKI: **www.ti.com/hercules-wiki**
• RM48 WIKI: **www.ti.com/hercules-rm4-wiki**
• TMS570 WIKI: **www.ti.com/hercules-tms570-wiki**
• TMS470M WIKI: **www.ti.com/hercules-tms470m-wiki**

Hercules MCU training

Texas Instruments provides one-day seminars and multi-day hands-on workshops to help with Hercules MCU development. The three-day "Safety Critical Design and Programming with ARM® Cortex™-based Hercules MCUs" course provides an overview of many applicable functional safety standards and directives. In addition, attendees learn how Hercules microcontrollers can easily be used to implement a safety-critical system. An in-depth look at all the MCU peripherals and development tools is provided in addition to several hands-on labs based on the USB Stick Development Kit.

For more information about Hercules MCU training classes visit: **www.ti.com/herculestraining**

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