TMS470M

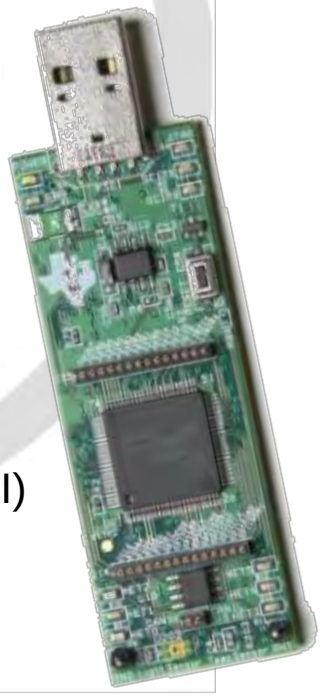
ARM® Cortex™-M3 based Hercules™ Microcontrollers

Texas Instruments

1 Day Workshop

TMS470M 1 Day Workshop Agenda

- Introduction and Roadmap
- Development Tools: Hardware kits, Software tools
- Safety Overview and Modules
  - ***Lab 1:TMS470M Safety MCU Demos***
- TMS470M Architecture: Memory Map, Clocking, Exceptions
- Embedded Flash Memory tools: nowECC, nowFlash, Application Programmer Interface (API)
- Real Time Interrupt (RTI)
- Vectored Interrupt Manager (M3VIM)
- General-purpose I/O (GIO)
- Programmable Timer Unit (HET)
  - ***Lab 2: Using HET as GIO***
- Multi-Buffered Serial Peripheral Interface (MibSPI)
- Controller Area Network (DCAN)
- Local Interconnect Network (LIN) / Serial Communication Interface (SCI)
  - ***Lab 3: PC to SCI Communication***
- Multi-buffered Analog-to-Digital Converter (MibADC)
- Support Structure: Web, Forum, WIKI

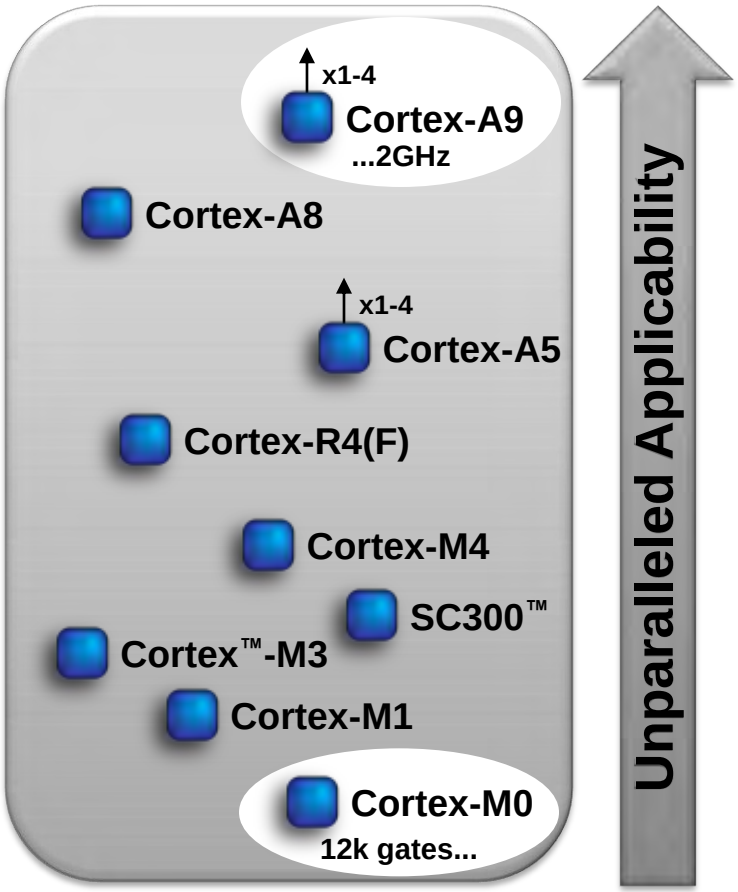


ARM Cortex Advanced Processors

Architectural innovation, compatibility across diverse application spectrum

Cortex™
Low-Power Leadership from ARM®

- ARM Cortex-**A** family:
  - Applications processors for feature-rich OS and 3rd party applications
- ARM Cortex-**R** family:
  - Embedded processors for real-time signal processing, control applications
- ARM Cortex-**M** family:
  - Microcontroller-oriented processors for MCU, ASSP, and SoC applications



•ARM® Cortex™

•Embedded Processing Cores at Texas Instruments

•ARM Cortex-A family:

- High-performance, low power core
- Multimedia, DSP acceleration
- Mobile computing capabilities
- Internet-enabled

•Sitara
• AMxx

- Interactive media and graphics experience
- Neon optimization
- Full-featured OS support (Linux, WinCE, etc…)

•ARM Processor Family

•ARM Cortex-R family

•Hercules
• TMS570
• RM4

- Real-time control
- High reliability
- Built-in redundancies
- Safety focused
- Commitment to enhancing performance and increasing memory footprint
- System coherency

•ARM Cortex-M family

- Active/sleep power
- Efficient gate count
- Optimized price/performance

•Stellaris®
• LMxx

•TMS470M for Transportation

- Proven processors cores with ongoing architectural innovation that simplifies the ease of use

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What is TMS470M?

Value Line of Safety MCUs

What's new

- Efficient 16/32-bit ARM® Cortex™-M3
- Developed specifically for safety critical systems
- Configurations from 256KB to 640KB embedded flash with ECC
- Support for fast engineering ramp and time to market.

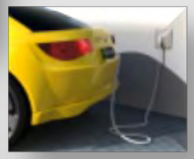
Ideal for applications requiring

- Performance in harsh environments
- Cost sensitive safety applications
- Safety oriented and high reliability
- And…
  - Scalability
  - System cost constraints
  - Software re-use and portability

TMS470M – A good fit for Transportation & Safety

Automotive Safety Systems

Hybrid & Electric Vehicles



Offroad Vehicles

Industrial

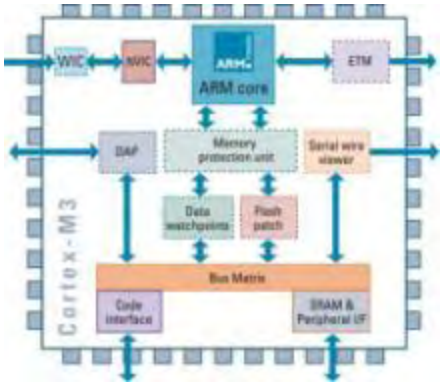
Medical

Railway

Avionics

Cortex-M3 – The New MCU Standard

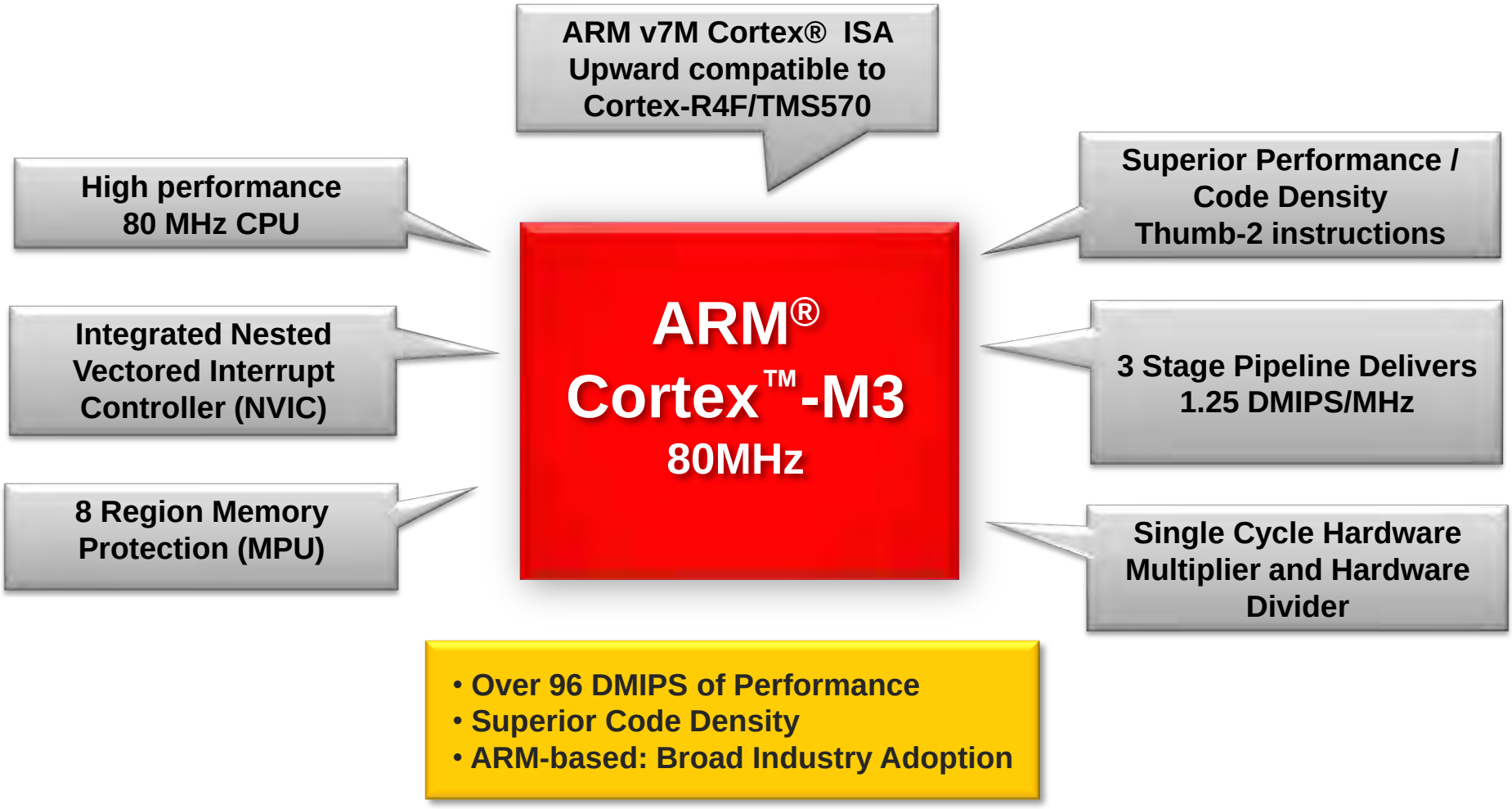
- An ARM7TDMI-S for the 21st century
  - For extreme cost and power-sensitive complex applications
  - Comparable or better F_{MAX} and gate count with r2p0 min config
  - 30% more DMIPS, 28% more geomean EEMBC
  - 85% more DMIPS per mW



- State-of-the-art functionality
  - Code ***everything*** in C
  - Thumb-2 ISA → 6X code density, 10X perf. v 8051
  - Integrated Nested Vectored Interrupt Controller (NVIC) with lowest interrupt latency of any ARM
  - Configurable/optional memory protection, debug, trace
  - uA device stand-by enabled with integrated sleep modes, ULL libraries, state retention

- Broad adoption within microcontroller and embedded SoC markets

High Performance ARM® Cortex™-M3 CPU



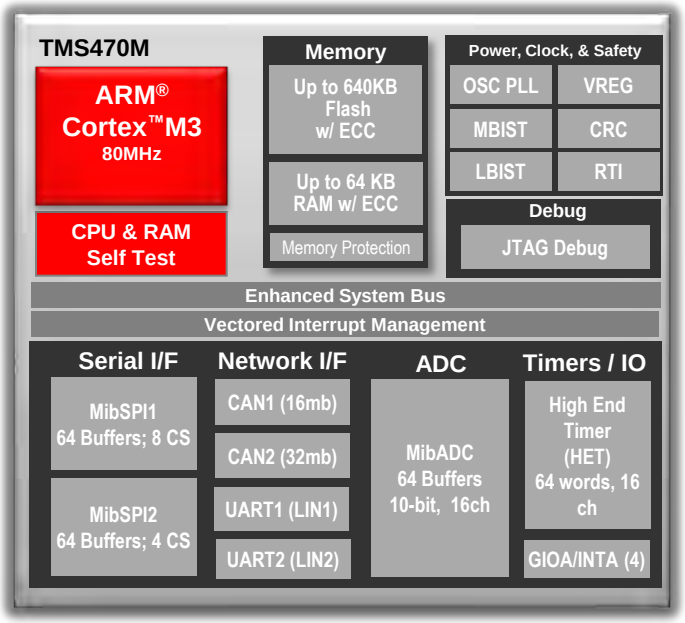
TMS470M Safety Features

ECC for Flash / RAM (SECDED)

CPU Self Test Controller requires little S/W overhead

Error Signaling Module

Parity on all Peripheral RAMS, ECC protected Interrupt Vector Table in Flash/RAM



Memory BIST on all RAMS allows fast memory test at startup

On-Chip Clock Monitoring

CRC, Calibration, ADC Self Test, …

- Developed for safety applications
- Built in self test for CPU and RAMs
- ECC for Flash and RAM

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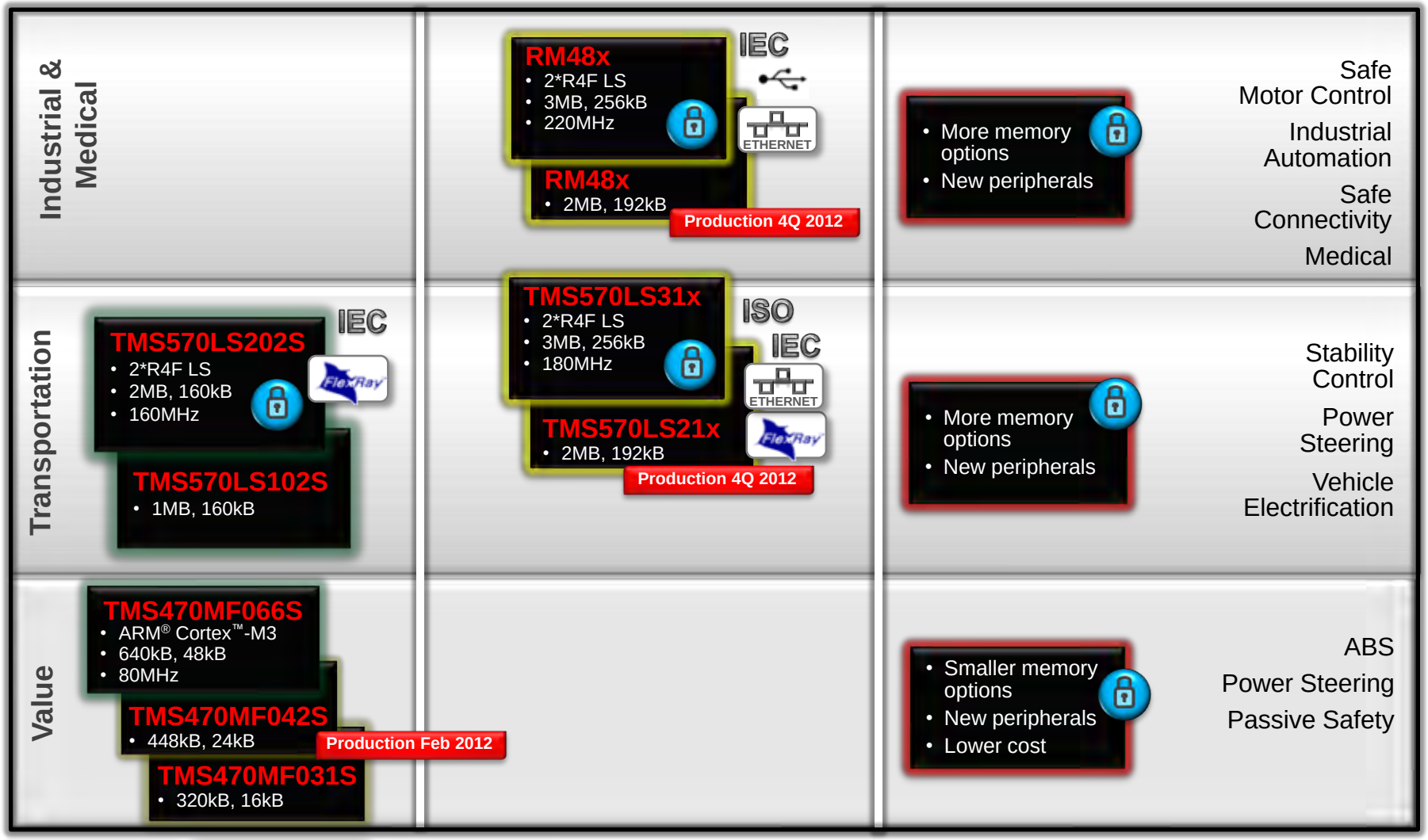
Hercules™ Safety MCU Roadmap



Production | Sampling | Development

Lockstep CPUs

IEC 61508 SIL3

ISO 26262 support planned

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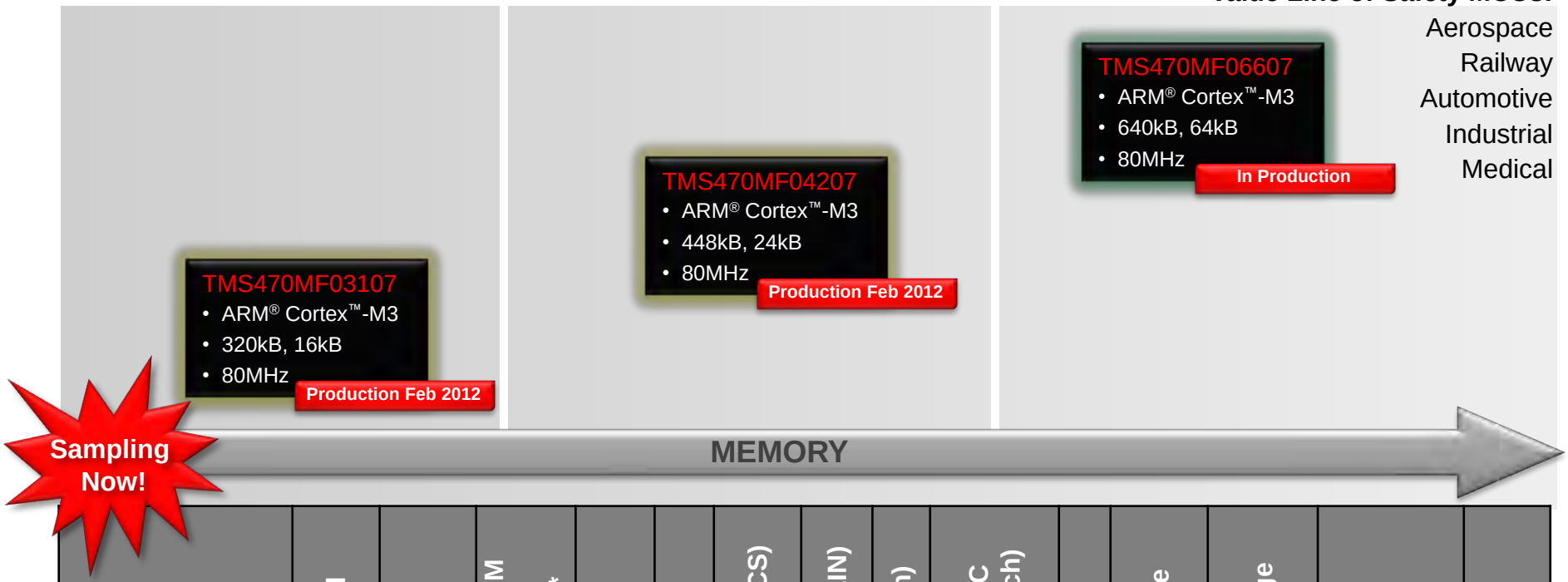
TMS470M Series Configurations

Value Line of Safety MCUs:
Aerospace
Railway
Automotive
Industrial
Medical



Device **NOTE:** For orderable part #: replace 'TMS470' with 'S4'	Speed	Flash	EEPROM Or Flash*	RAM	CAN	MibSPI(CS)	UART (LIN)	HET(ch)	MibADC 10-bit (ch)	GIO	Voltage	Package	Temp	Q100
TMS470MF03107	80MHz	256kB	64kB	16kB	2	2 (12)	2(2)	16	16	4	3.3V	100QFP	-40..+125C	Yes
TMS470MF04207	80MHz	384kB	64kB	24kB	2	2 (12)	2(2)	16	16	4	3.3V	100QFP	-40..+125C	Yes
TMS470MF06607	80MHz	512KB	128kB	64kB	2	2 (12)	2(2)	16	16	4	3.3V	100QFP	-40..+125C	Yes

* Can be used as program flash or as emulated EEPROM

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TMS470M Block Diagram

TI Automotive Qualified ARM Cortex-M3 MCU

Performance / Memory

- 80 MHz ARM Cortex-M3
- Up to 640KB Flash (128KB can be used as emulated EEPROM)
- Up to 64KB Data SRAM
- EEPROM Emulation Capability

Features

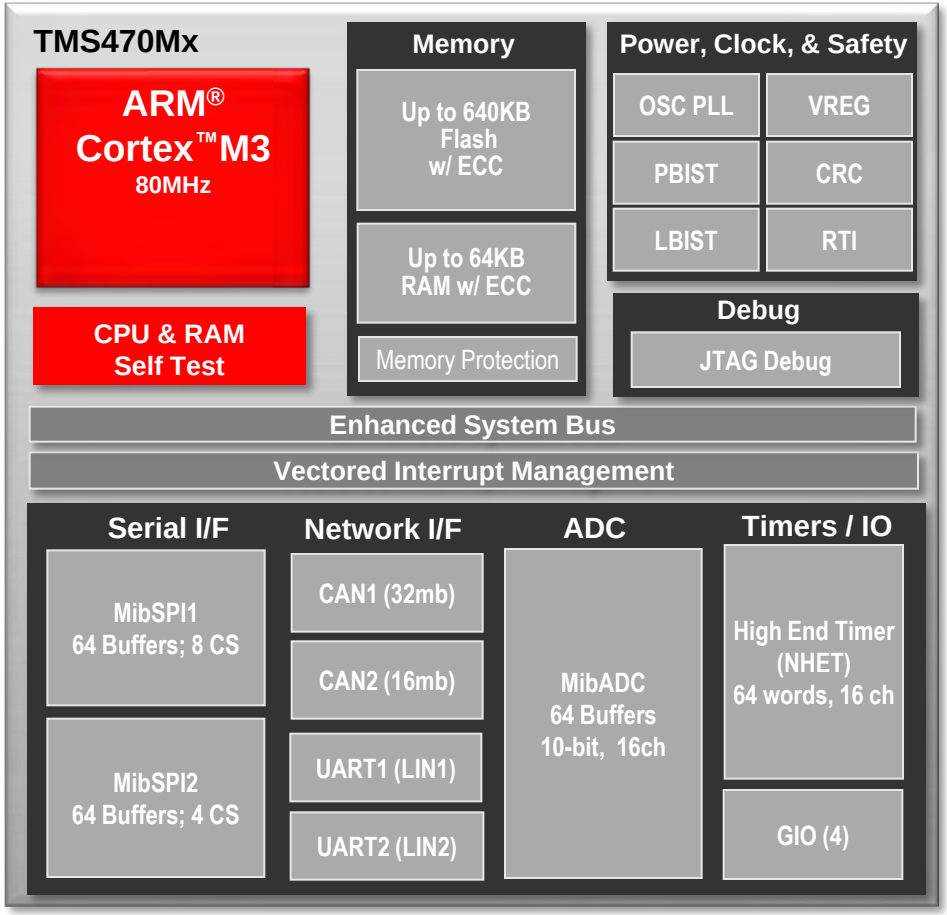
- **Safety**
  - CPU Self Test Controller
  - Flash & RAM w/ ECC
  - Memory Built-in Self Test
  - Cyclic redundancy checker module (CRC)
- **Reliability**
  - Low PPM Production Flow Support
  - Extended Temp and AEC-Q100 Qualification
- **On-chip VREG (only 3.3v required)**
- **Enhanced I/O Control**

  High End Timer Coprocessor (HET)
  - 16 I/O Channels
  - All pins can be used as PWM or Input Capture
  - Hardware Encoders & Time Stamping

  10-bit MibADC (16 channels)
  - Continuous Conversion Channels
  - Buffered FIFO
  - Self Test on ADC
- **Strong Communication Networks**
  - 2 x CAN Interfaces
  - 2 Multi-Buffered SPI
  - 2 x LIN / UART (SCI)

Targeted Applications

- General Safety Applications
- Automotive/Aerospace
- Industrial/Medical



100pin QFP - 14x14mm
-40 to 125°C Temperature Range

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TMS470M Development Tools

TMS470M Software Tools

Code Composer Studio IDE

Program & debug code using Code Composer Studio:

- Full Featured Debugger
- Compiler
- Linker
- Integrated Flash Programming

GUI Demos & Code Examples

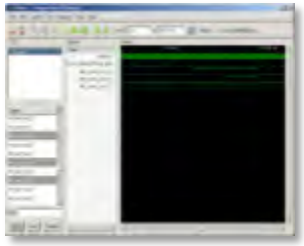
Safety MCU Demos:

- Safety Feature Highlight
- Ambient Light Demo
- Temperature Sensor Demo
- LED Light Show
- Source Code Viewable via CCS

GUI-based Code Generation Tools and Other SW Tools

HALCoGen

- User Input on High Abstraction Level
- Graphical-based code generation
- Easy configuration
- Quick start for new projects



HET IDE

- Graphical Programming Environment
- Output Simulation Tool
- Generates CCS-ready software modules
- Includes functional examples from TI

FMzPLL Calculators
Easily configure the FMzPLL in the TMS470M Phase Lock Loop modules.

now ECC™ ECC Generation Tool
Command line program for generating Error Correction Code for TMS470M devices. Can be used in conjunction with CCSv4

now Flash™ Flash Programming Tool
GUI and command line programmer for loading code into TMS470M devices without an IDE.

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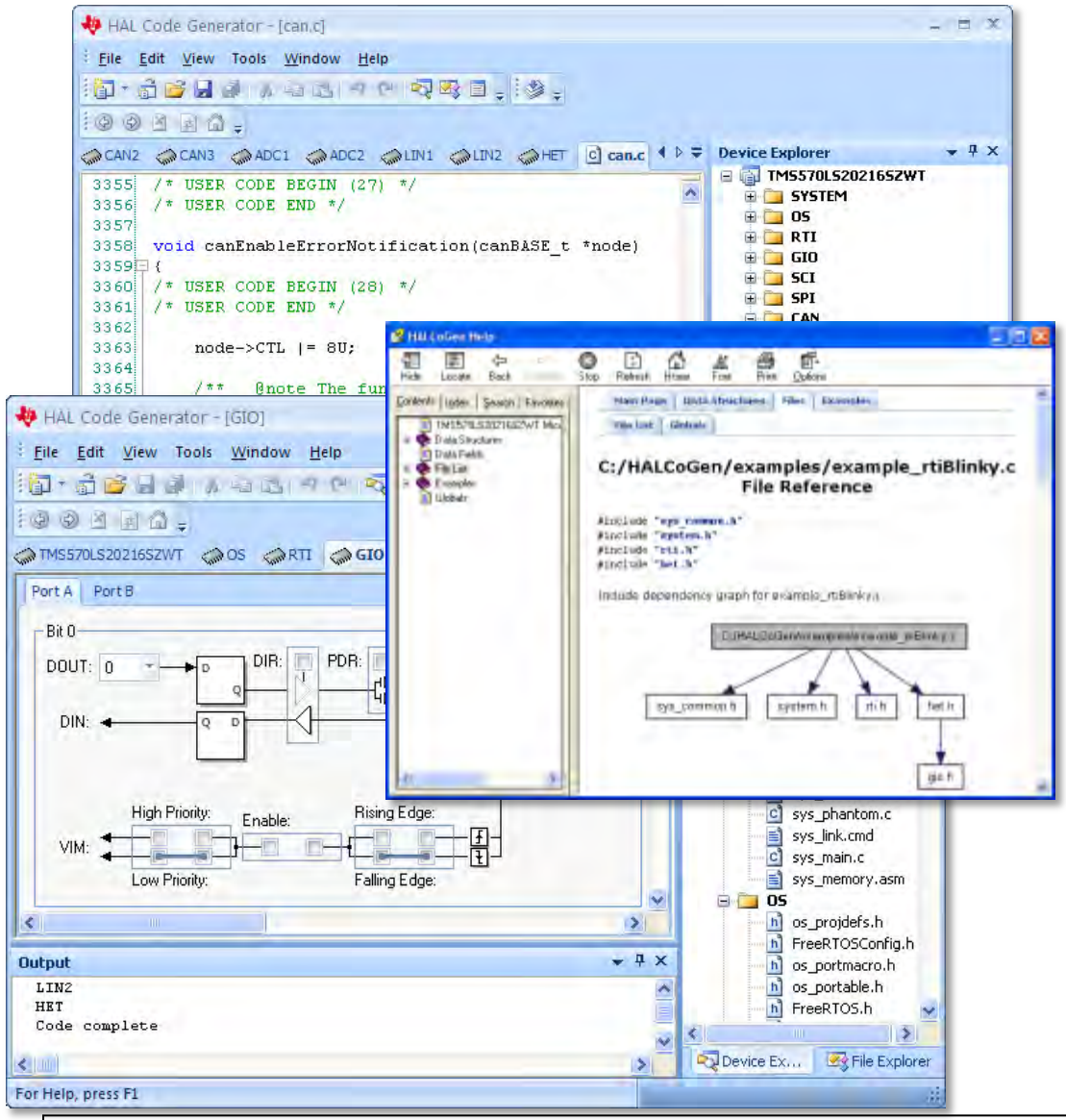
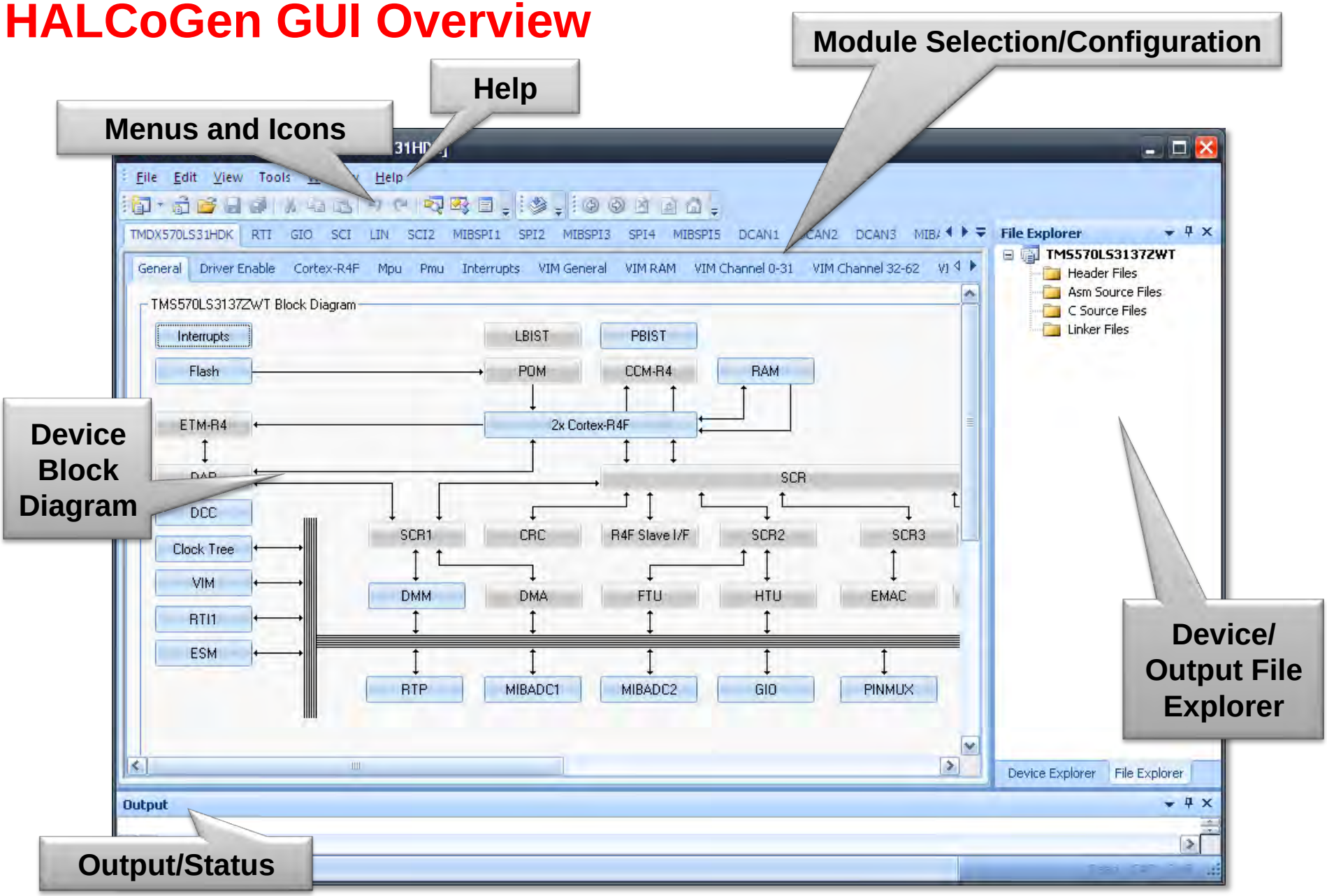
HALCoGen: Hardware Abstraction Layer Code Generator



Features

- **User Input on High Abstraction Level**
  - Graphical-based code generation
  - Easy configuration
  - Quick start for new projects
- **Generates C Source Code**
  - ANSI Conforming
  - Clear, structured, coding style
  - Customizable code for user maintenance
- **Supported Peripherals**
  - System Module
  - RTI
  - GIO
  - SCI/LIN
  - CAN
  - SPI
  - ADC
  - Timer Co-processor (HET)
- **Interactive Help System**
  - Describes tool features and functions
  - Provides detailed dependency graphs
  - Provides useful example code
  - Tool tip help available

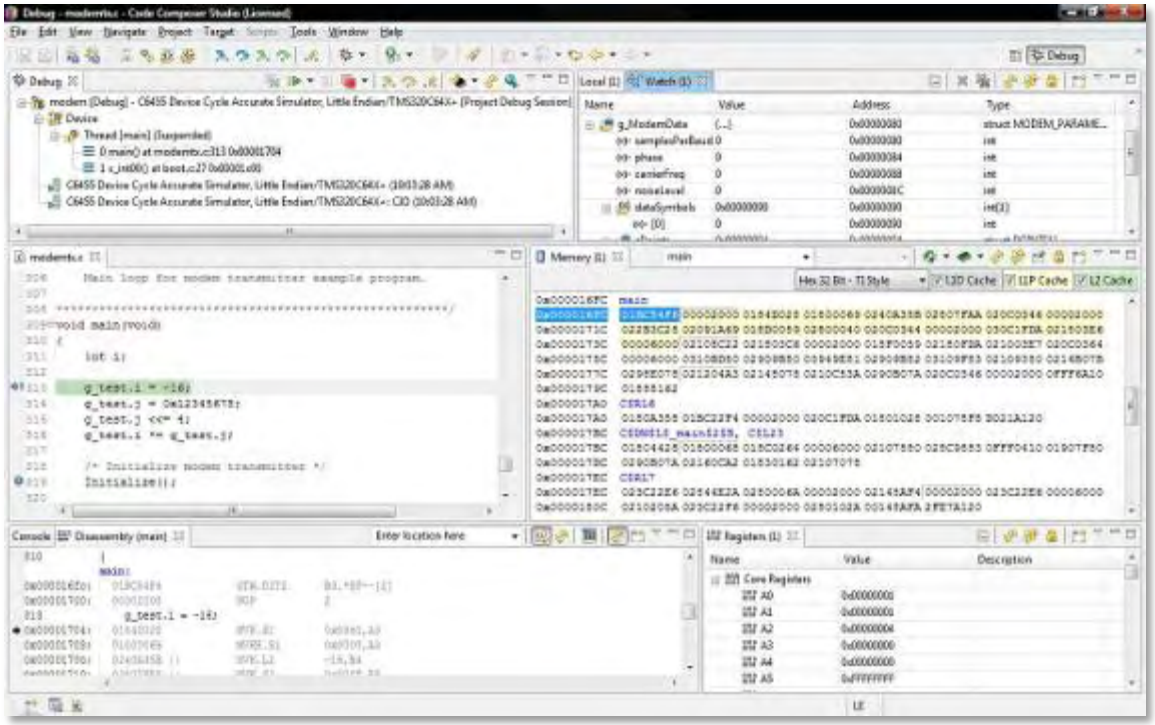
HALCoGen GUI Overview



Code Composer Studio v4.x

- **Based on Eclipse industry standard for embedded debug tools**
  - Modern window environment
  - Advanced source code editor
  - Scalable multi-core/processor environment
  - Program and Debug Application via JTAG
  - Test Automation via Scripting

- **TMS470M Debug Features**
  - 6 Hardware Breakpoints
  - Unlimited Software Breakpoints
  - Integrated Flash Programming



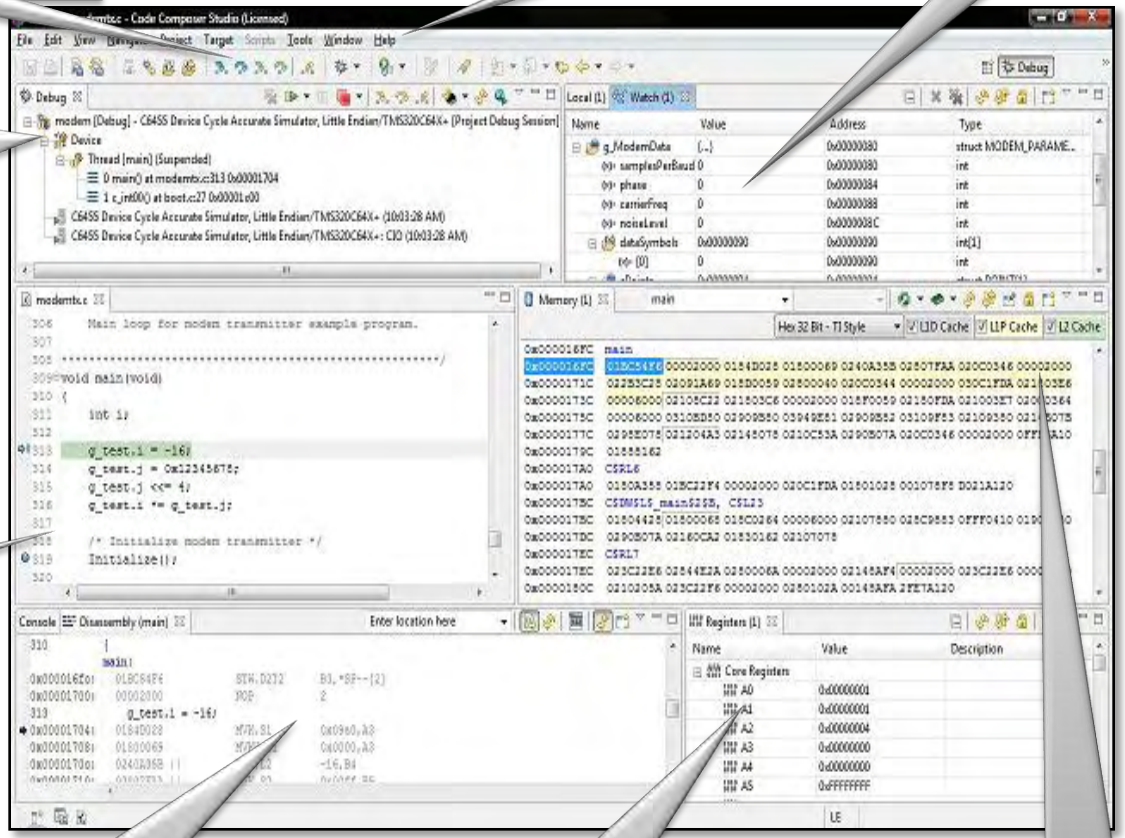
Code Composer Studio Components:

Menus and Icons

Help

Watch Window

Target Connection
- Source & object files
- File dependencies
- Compiler, assembler & linker build options



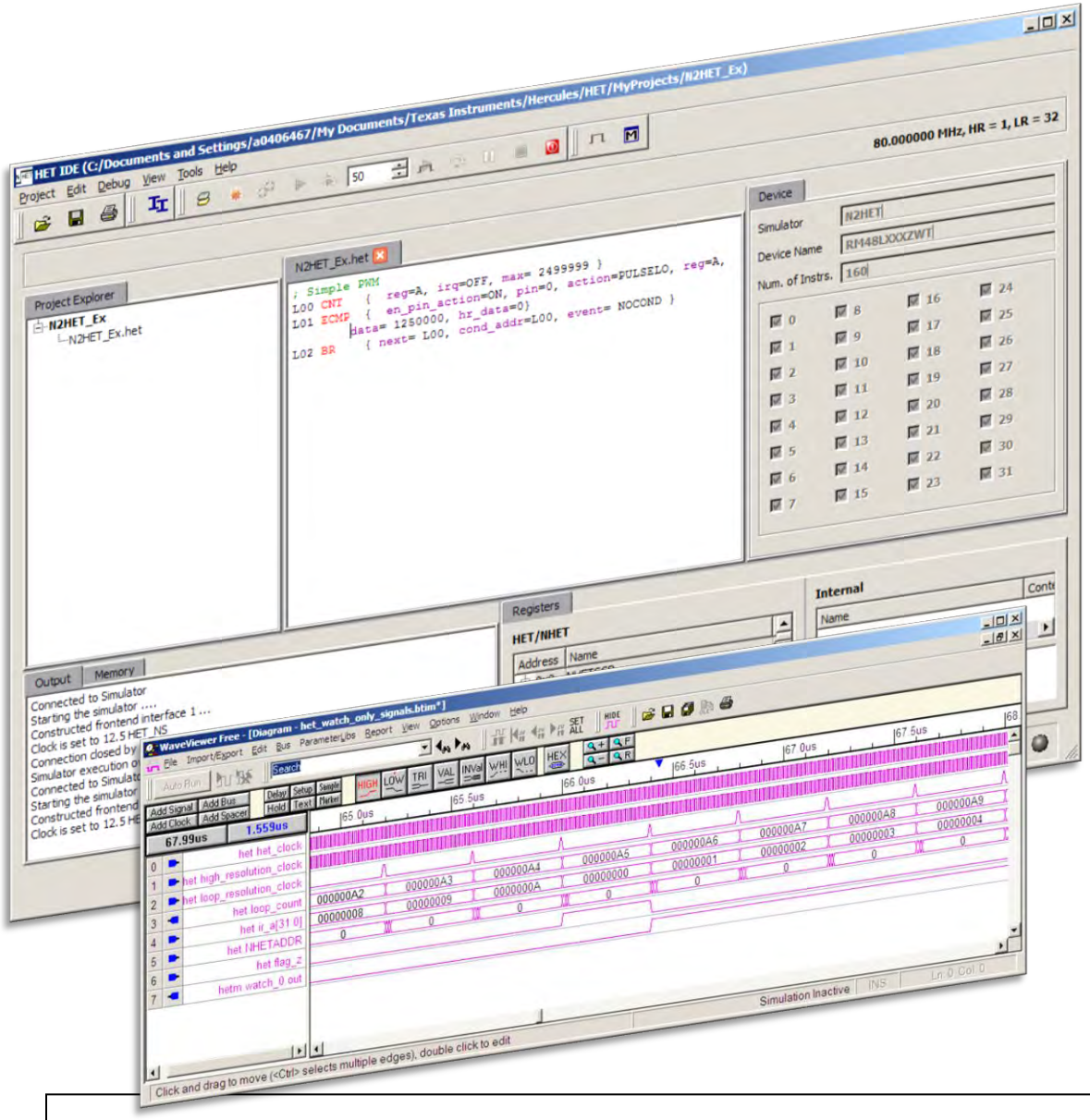
Source Code View

Disassembly Window

CPU Window

Memory Window

HET IDE (Timer Co-Processor Development Tool)



HET Device Configuration

- HET/NHET/N2HET
- Clock configuration
- Number and direction of pins
- XOR, AND and SHARE configuration on pins

HET Program Development

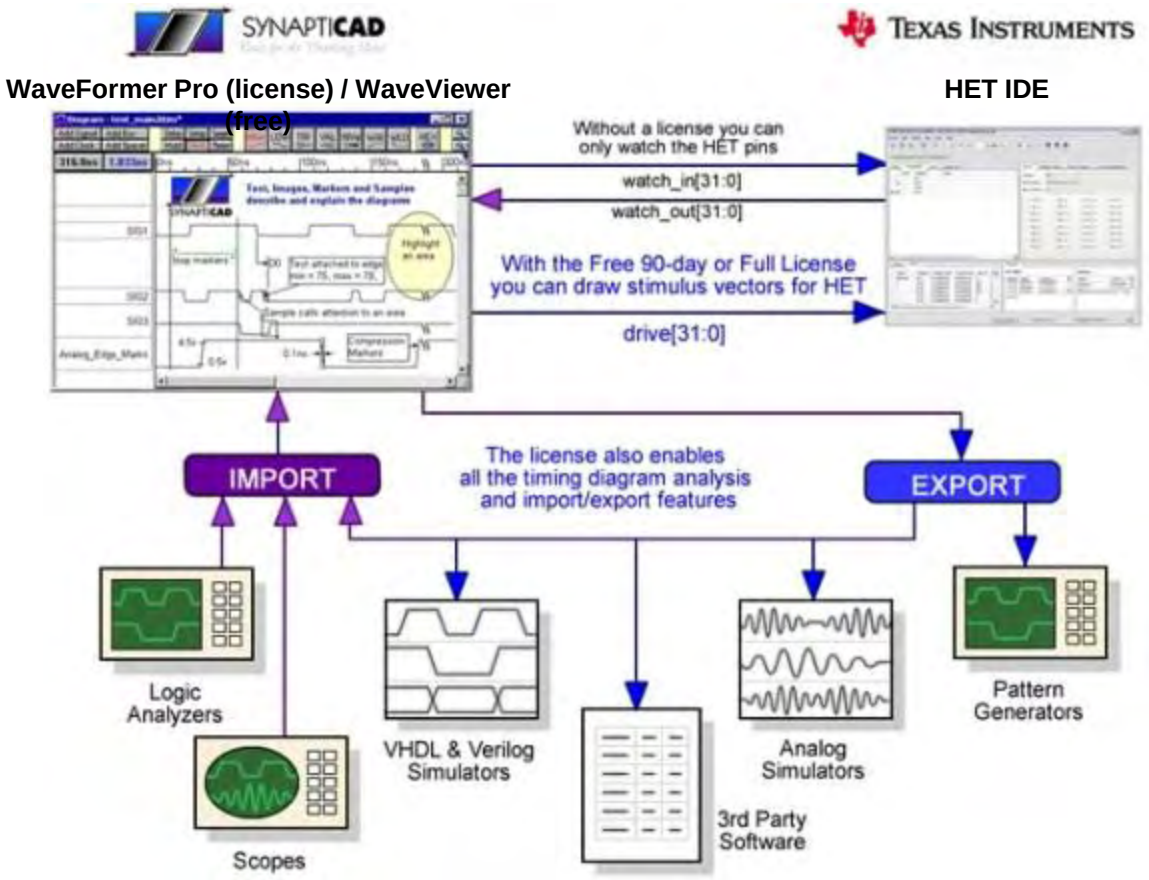
- Library with common predefined algorithms
- Insert functionality for algorithms and instructions
- *.c and *.h file creation for given *.het file

HET Program Simulation

- View resulting signal waveforms (WaveViewer, WaveFormer Pro)
- Various debugging options
- Memory and register windows
- Input stimuli (stimulus creator or VCD files)

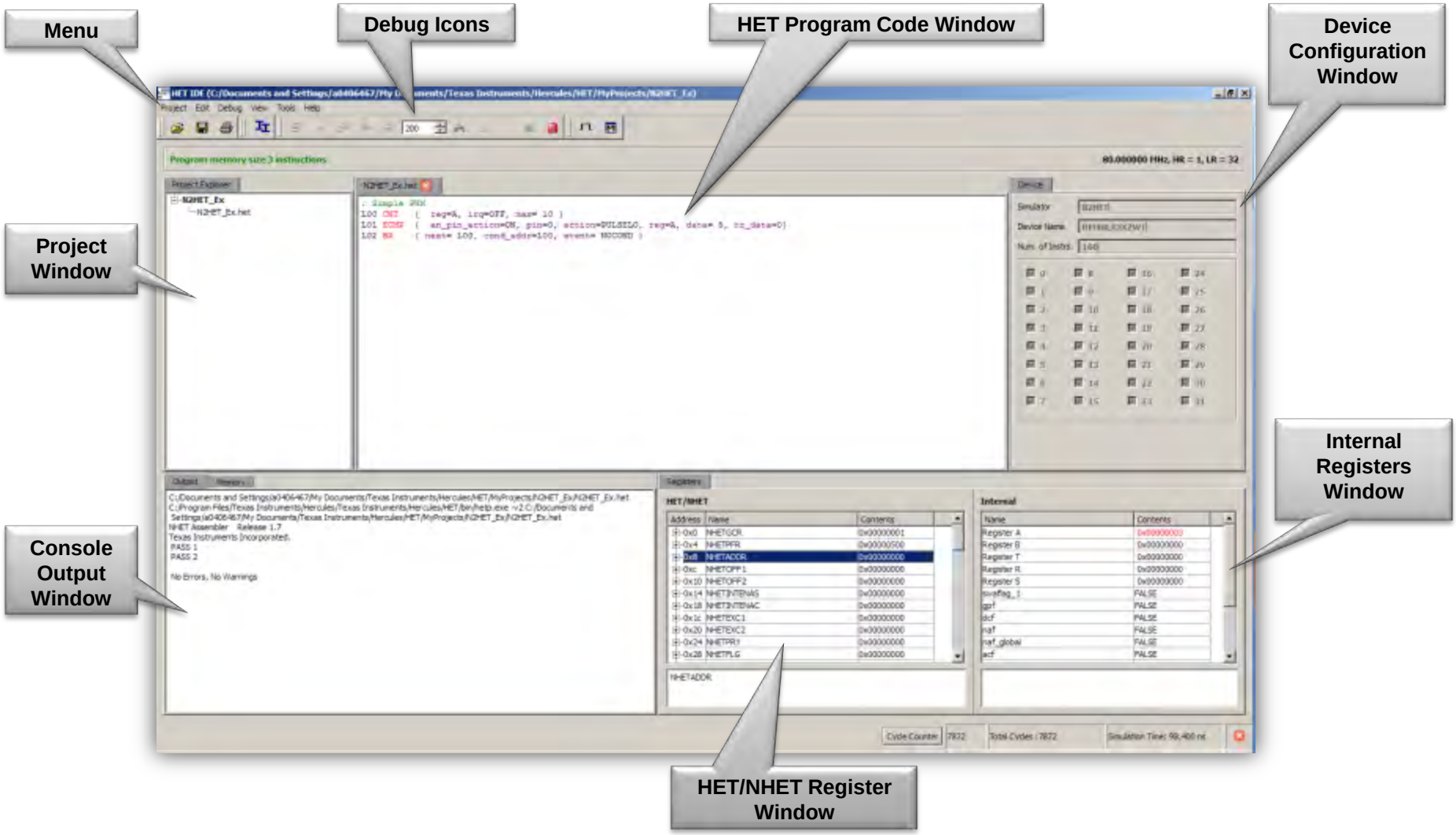
HET IDE

The HET IDE works in conjunction with SynaptiCAD's WaveFormer Pro (license necessary or 90-day trial) or WaveViewer (free). Both are installed with HET IDE and can be used to watch and check HET signals.



HET IDE – User Interface

HET IDE Program Development View



TMS470M Tools

External Tools:

- **IDE's**
  - Lauterbach, iSystems, CCS
- **Compiler**
  - ARM, CCS
- **Emulator**
  - Spectrum Digital, Lauterbach, iSystems, Blackhawk, Signum Systems, XDS100, XDS560 …
- **Operating System**
  - ETAS
- **CAN**
  - Vector
- **Trace / Calibration**
  - Lauterbach, iSystems
- **Production Flash Programming**
  - BP Microsystems, Data-IO

TMS470M Evaluation and Development Kit Overview

Evaluation

TMDX470MF066USB ($79) – Low Cost TMS470M Evaluation Kit

- USB Powered
- On Board USB XDS100v2 JTAG Debug
- On Board SCI to PC Serial Communication
- Access to Select Signal Pin Test Points
- CAN transceiver
- LEDs, Temp Sensor, Light Sensor
- QFP Packaged MCU

Development

TMDX470MF066HDK ($179) - Full Featured TMS470M Development Kit

- USB Powered
- On Board USB XDS100v2 JTAG Debug
- On Board SCI to PC Serial Communication
- External high speed emulation via JTAG
- CAN Transceivers
- LEDs, Temp Sensor, Light Sensor
- Access to all peripheral pins
- Communications Expansion Board Compatible
- QFP Packaged MCU

Software Included in Each Kit:

- CCStudio v4.x IDE: C/C++ Compiler/Linker/Debugger
- HALCoGen Peripheral Driver Generation Tool
- CCS and nowFlash™ Flash Programming Tools
- HET GUI/Simulator/Assembler
- Demo Project/Code Examples

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TI Suggested ABS System

•Battery

•Power Management Module

•Supervisor

•Buck/LDO

•Wake up

•ABS IC
•TPIC7218

•Pump Motor Driver

•Charge Pump

•Main Relay Driver

•Watchdog
•Monitor

•LS Switch Driver

•LS Switch Driver
•x4

•Solenoid

•Solenoid

•CAN
•Transceiver

•Chassis
•CAN Bus

•ABS
•MCU
•TMS470M/570

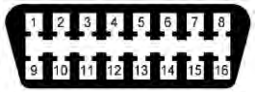
•SPI

•LS Switch Driver
•PWM

•LS Switch Driver
•PWM x4

•Wheel
•Speed
•Sensor x4

•Wheel Speed
•Sensor
•Interface



•Diagnostic Systems
•ISO K-Line

•K-Line

•Lamp Driver

•Lamp Driver
•x2

•Warning
•Lamp

LEGEND
Logic
Processor
Power
Interface
ADC/DAC
RF/IF
Clocks
Amplifier
Other