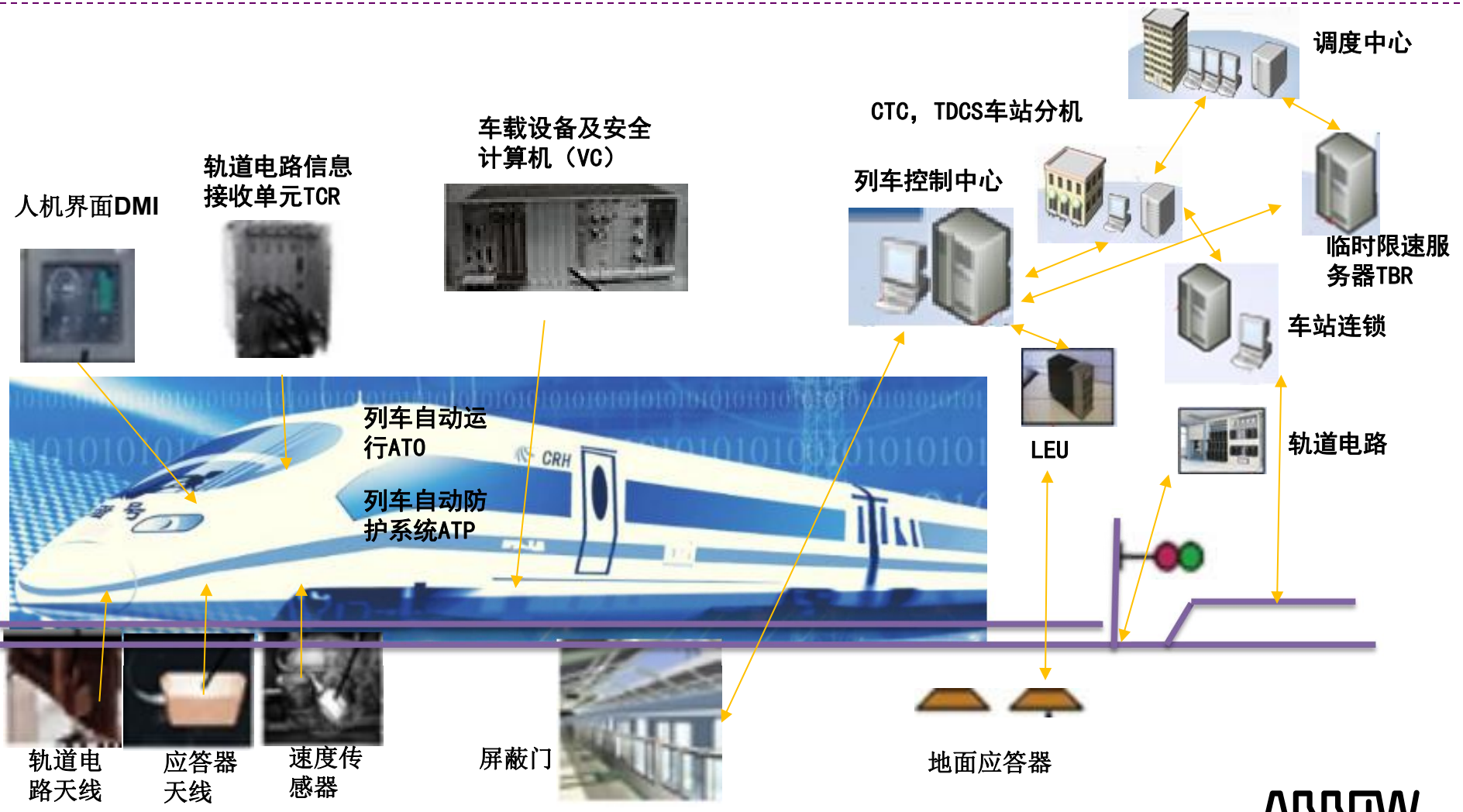
Arrow SEED - TI
Hercules&C2000 on rail applications

Barry Liu
2016/11/24

列车各组成部分间关系


调度中心
CTC，TDCS车站分机
车载设备及安全
计算机（VC）
轨道电路信息
接收单元TCR
人机界面DMI
列车控制中心
临时限速服
务器TBR
车站连锁
列车自动运
行ATO
列车自动防
护系统ATP
LEU
轨道电路
轨道电
路天线
应答器
天线
速度传
感器
屏蔽门
地面应答器

Functional Safety: Important for Many Industries

Automotive and Transportation

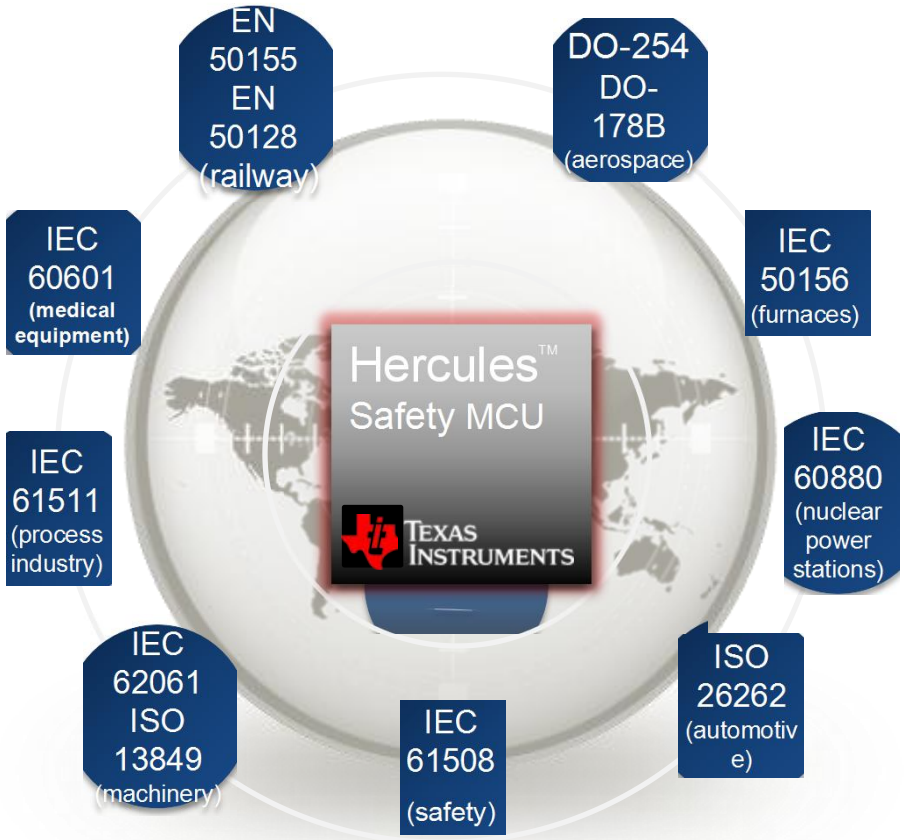
HEV/EV Cars

Radar / Collision Avoidance (ADAS)

Active suspension, ABS, electric power steering, airbag and more!

Railway Systems

Anti-skid control



- Safety critical systems are everywhere
- Systems need to manage hazardous failures
- Many systems need to be safety-certified

Industrial and Medical

Sensor & communications gateway

Manufacturing, robotics, industrial automation, motor control

Wind Power

Anesthesia machines, respirators, ventilators, oxygen concentrators

Hercules™ MCU Platform

ARM® Cortex®-R Based Microcontrollers

Hercules™ MCU Platform

SafeTI™ Design Packages for Functional Safety

RM

Industrial and Medical Safety



- Industrial Grade
- -40 to 105°C Operation
- ENET, USB, CAN & UART
- Developed to Safety Standards
  - IEC 61508 SIL-3
- Cortex-R – up to 550 DMIPs

TMS570

Transportation and Automotive Safety



- Automotive Q100 Qualified
- -40 to 125°C Operation
- FlexRay, ENET, CAN, LIN/UART
- Developed to Safety Standards
  - ISO 26262 ASIL-D
  - IEC 61508 SIL-3
- Cortex-R – up to 500 DMIPs

Hercules™ MCU: Safety End Equipment

SafeTI™ Design Packages for Functional Safety

Aerospace & Railway


Avionics / Autopilot


Flight Control


Anti-Skid Control


Communications Gateway


Motor Control


Braking / Stability Control


Electric Power Steering


Hybrid & Electric Vehicles


Radar / Collision Avoidance (ADAS)


Active Suspension


Airbag


Chassis / Domain Control

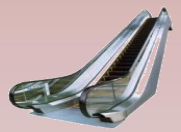
Automotive

Industrial


Industrial Motor Control


Wind Power


Manufacturing / Robotics


Elevator Escalator


Industrial Automation / PLC


Sensor & Communications Gateway


Solar Power


Oxygen Concentrators


Infusion Pumps

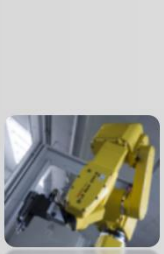

Respirators


Anesthesia

Medical

Hercules™ MCUs

Scalable Platform For Functional Safety Applications



Production

Sampling

RM41L2
80MHz
128kB Flash
32kB RAM
100p QFP

RM42L4
100 MHz
384kB Flash
32kB RAM
100p QFP

RM44L5
180 MHz
768kB Flash
128kB RAM
100p QFP
144p QFP

RM44L9
180 MHz
1MB Flash
128kB RAM
100p QFP
144p QFP

RM46L8
220 MHz
1.2MB Flash
192kB RAM
144p QFP
337p BGA

RM48L7
200 MHz
2MB Flash
256kB RAM
144p QFP
337p BGA

RM48L9
220 MHz
3MB Flash
256kB RAM
144p QFP
337p BGA

RM57L
330 MHz
4MB Flash
512kB RAM
337p BGA

570LS02
80 MHz
128kB Flash
32kB RAM
100p QFP

570LS03
80 MHz
256kB Flash
32kB RAM
100p QFP

570LS04
80 MHz
384kB Flash
32kB RAM
100p QFP

570LS07
160 MHz
768kB Flash
128kB RAM
100p QFP*
144p QFP

570LS09
160 MHz
1MB Flash
128kB RAM
100p QFP*
144p QFP

570LS12
180 MHz
1.2MB Flash
192kB RAM
144p QFP
337p BGA

570LS31
180 MHz
3MB Flash
256kB RAM
144p QFP
337p BGA

570LC43
300 MHz
4MB Flash
512kB RAM
337p BGA

Compatible 100-pin QFP package

Compatible 337-pin BGA, 144-pin QFP package

External certification: ISO 26262, IEC 61508

Documentation: Safety Manual, FMEDA reports

Software: Drivers, libraries, RTOS, Autosar, tools, debug

Development Kits: LaunchPad, HDK, Motor Control Kit, SafeTI™ Kit

* release planned 3Q16

Hercules RM MCUs

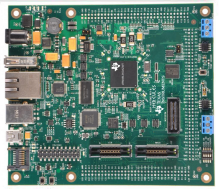
SafeTI™ Design Packages for Functional Safety

Supporting Industrial & Medical safety

Benefits

- **Lockstep ARM Cortex-R based MCU –** *with up to 550 peak DMIPS and 128KB to 4MB Flash Memory*
- **Safety Integrated in HW –** *provides a high level of diagnostic coverage to reduce safety software overhead*
- **SafeTI™ system design packages –** *makes it easier to achieve safety certification and get to market quickly*
- **Developed to safety standards –** developed for use in *IEC 61508 SIL-3 safety applications*
- **Flexible Communication and Control –** *Ethernet, USB, CAN. Up to 84 timer and 41 12-bit ADC channels.*

Tools



Development Kit

Launchpad

Trace

SafeTI Kit

Motor Control

RMx

Temperatures: -40C to 105C

ARM Cortex-R 80 to 330 MHz

Cache (w/ECC) | FPU | MPU

Lockstep Fault Detection

Control Peripherals
- ePWM
- eCAP
- eQEP
- N2HET Timer

Analog
- 12-bit 1 MSPS ADC
- Temperature Sensor

Memory
- Up to 4MB Flash (w/ ECC)
- Up to 512KB SRAM (w/ ECC)
- Up to 128KB Data Flash (w/ECC)

External Memory
- 16-bit Parallel Interface

Communication
- 10/100 Ethernet
- USB
- CAN
- UART
- Multi-Buffer SPI
- I2C

Power & Clocking
- OSC PLL
- CLKMON
- VMON

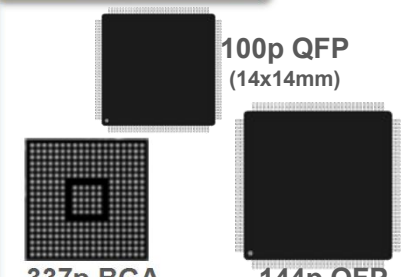
Debug
- Real-time JTAG
- 32-bit Trace (ETM)
- Calibration

Safety & System
- CPU BIST
- SRAM BIST
- DMA
- CRC
- OS Timers
- Windowed Watchdog
- External INT / GPIO

Software

- **Drivers & Libraries** – HALCoGen peripheral driver generation tool, SafeTI™ Diagnostic Library, CMSIS DSP Library
- **RTOS:** SAFERTOS, Codesys
- **IDEs:** Code Composer Studio, IAR
- **SafeTI Compiler Qualification Kit**
- **SafeTI & ARM 3rd Party Ecosystem**

Packages



Hercules TMS570 MCUs

SafeTI™ Design Packages for Functional Safety

Supporting Automotive & Transportation safety

Benefits

- **Lockstep ARM Cortex-R based MCU –** *with up to 500 peak DMIPS and 128KB to 4MB Flash Memory*
- **Safety Integrated in HW –** *provides a high level of diagnostic coverage to reduce safety software overhead*
- **SafeTI™ system design packages –** *makes it easier to achieve safety certification and get to market quickly*
- **Developed to safety standards –** developed for use in *IEC 61508 SIL-3 and ISO 26262 ASIL-D safety applications*
- **Flexible Communication and Control –** *Ethernet, Flexray, CAN. Up to 84 timer and 41 12-bit ADC channels.*

TMS570x

Temperatures: -40C | 125C | Q100

ARM Cortex-R 80 to 300 MHz

Cache (w/ECC) | FPU | MPU

Lockstep Fault Detection

Control Peripherals
- ePWM
- eCAP
- eQEP
- N2HET Timer

Analog
- 12-bit ADC
- Temperature Sensor

Memory
- Up to 4MB Flash (w/ ECC)
- Up to512KB SRAM (w/ ECC)
- 128KB Data Flash (w/ECC)

External Memory
- 16-bit Parallel Interface

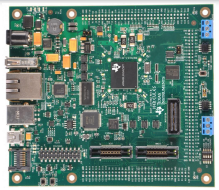
Communication Peripherals
- 10/100 Ethernet
- CAN
- Flexray
- UART (LIN)
- Multi-Buffer SPI
- I2C

Power & Clocking
- OSC PLL
- CLKMON
- VMON

Debug
- Real-time JTAG
- 32-bit Trace (ETM)
- Calibration

Safety & System
- CPU BIST
- SRAM BIST
- DMA
- CRC
- OS Timers
- Windowed Watchdog
- External INT / GPIO

Tools


Development Kit


Launchpad


Trace

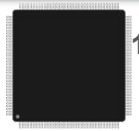

SafeTI Kit

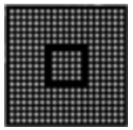

Motor Control

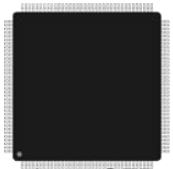
Software

- **Drivers & Libraries –** HALCoGen peripheral driver generation tool, SafeTI™ Diagnostic Library, CMSIS DSP Library,
- **RTOS –** SAFERTOS, AUTOSAR
- **IDEs:** Code Composer Studio, IAR
- **SafeTI Compiler Qualification Kit**
- **Mathworks Simulink**
- **SafeTI 3rd Party Ecosystem**

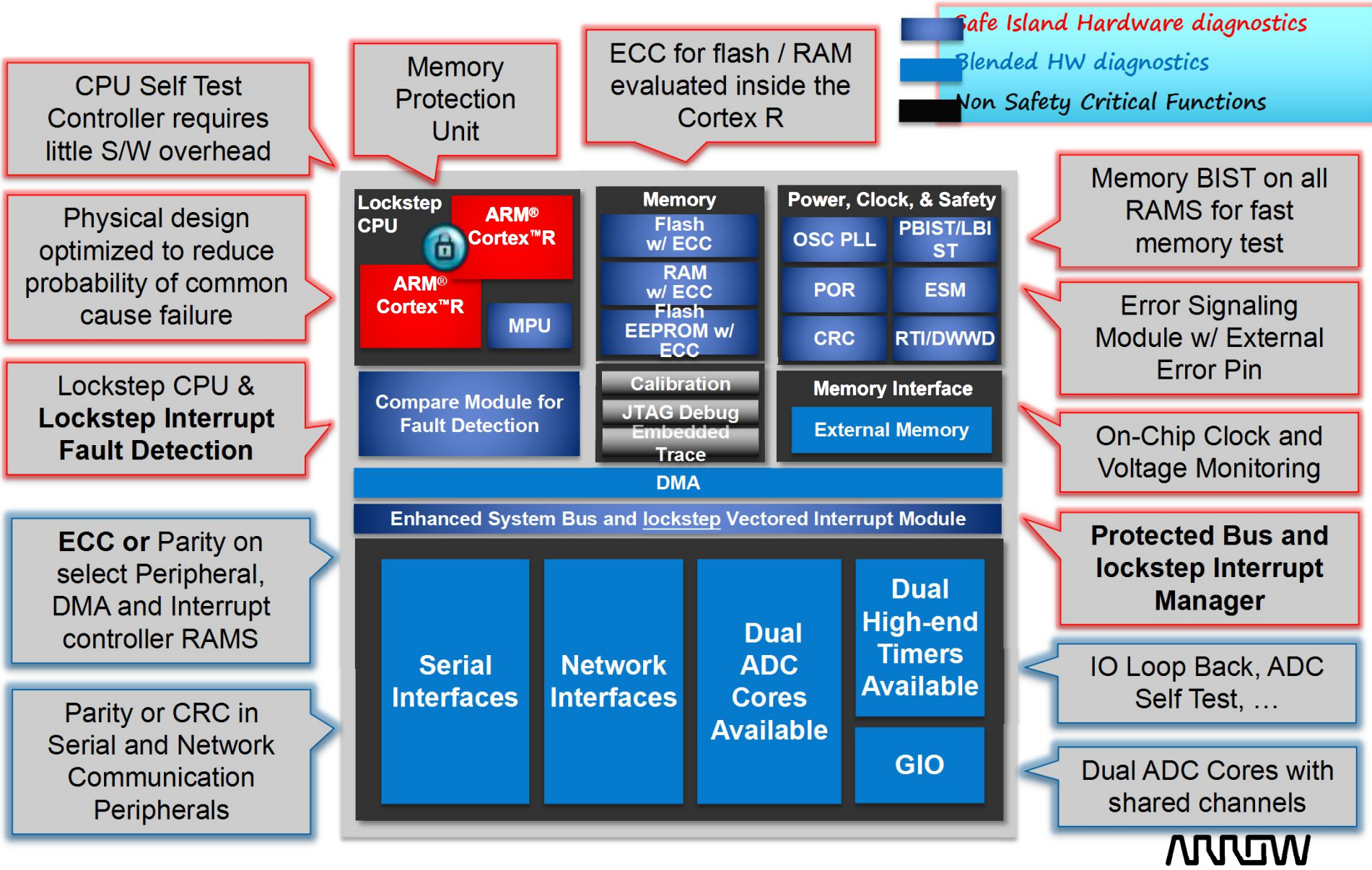
Packages


100p QFP (14x14mm)


337p BGA (16x16mm)


144p QFP (20x20mm)

Hercules MCU safety features



Bold items are available only on Cortex-R5 devices

Cortex-R: Ideal for safety critical applications

Safety features

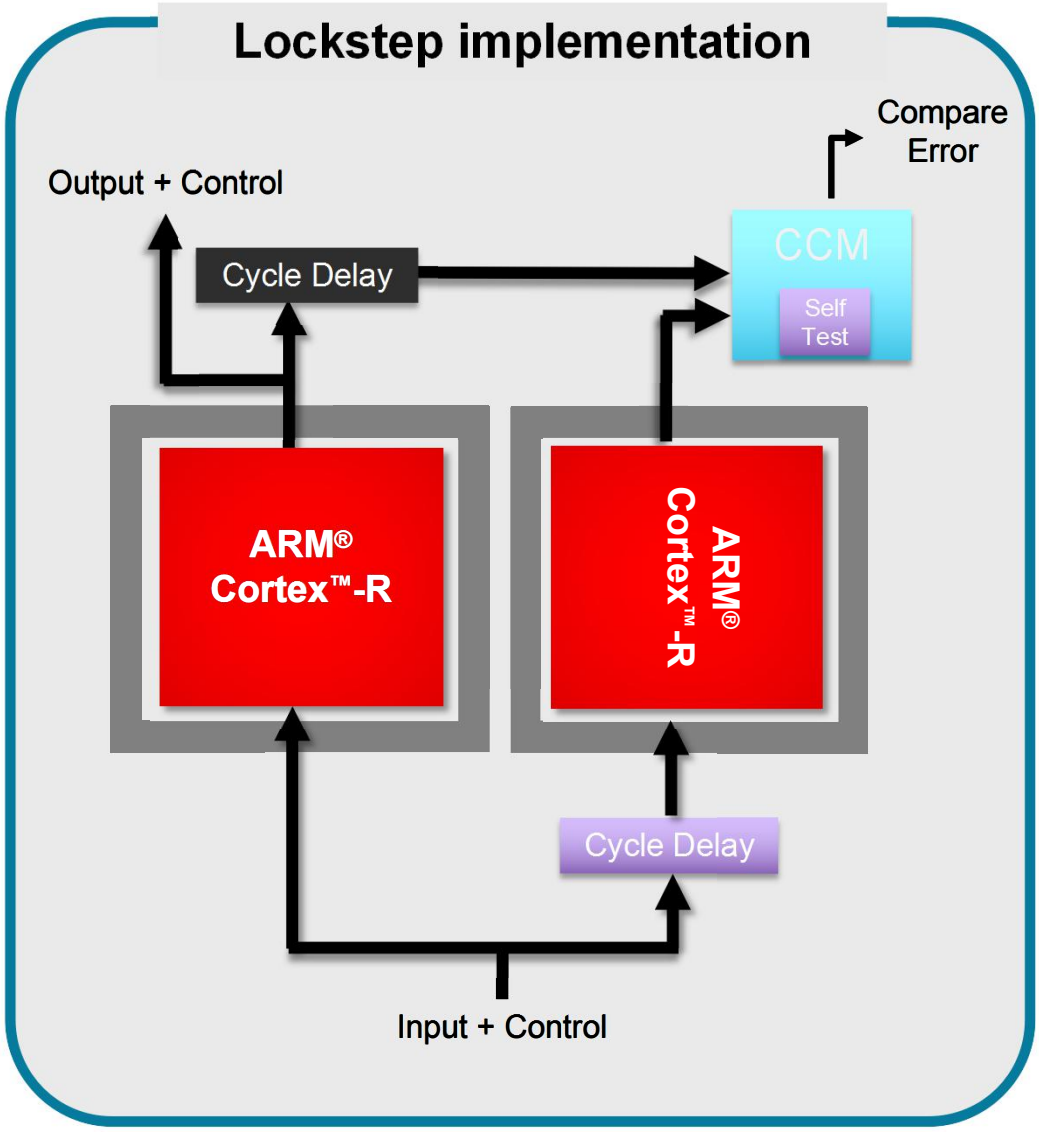
- Supports Lockstep
- Memory Protection Unit (MPU)
- Error-Correcting Code (ECC)

Higher performance

- 8-stage processor pipeline
- Dual issue – two instructions can execute in parallel
- Load store unit reduces stalling
- Pre-fetch and Branch Prediction Units
- Cached*

Real-time / Determinism

- Tightly Coupled Memory (TCM)
- Fast interrupt response
- Deterministic interrupt response



*Cortex R5 based products

SafeTI™ = Design packages for functional safety

Complementary embedded processing and analog components

Work together to help designers meet safety standards

Safety documents, tools and software

Quality manufacturing process

Functional safety-enabled semiconductor components

Texas Instruments
SafeTI™ Design packages

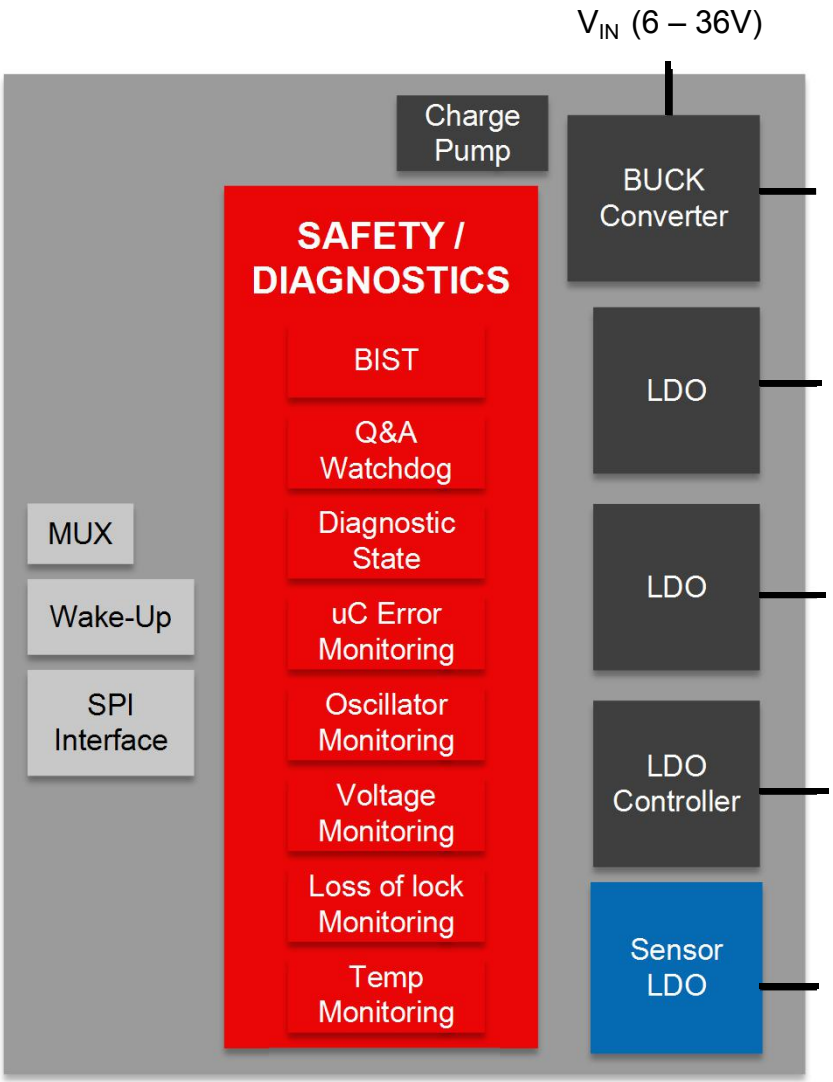
Safety-development process

- SafeTI - 61508 — Industrial, rail, medical, other
- SafeTI - 26262 — Automotive, transportation
- SafeTI - 60730 — Household appliances
- SafeTI – QM — Quality managed

Hercules Product & Process Certification

- First devices certified by Exida for IEC 61508 SIL-3 use in 2011
- TÜV-SÜD certified the SafeTI Hardware functional safety development process in 2013 for:
  - IEC 61508 SIL-3
  - ISO 26262 ASIL-D
- Hercules MCUs certified for IEC 61508 SIL-3, ISO 26262 ASIL-D:
  - Hercules MCU Safety Architecture
  - Device (RM42, RM46x, RM48x)
  - Device (TMS570LS03x/04x/11x/12x/21x/31x)
- TÜV-Nord certified the SafeTI Software functional safety development process in 2015 for
  - IEC 61508 SIL-3
  - ISO 26262 ASIL-D
- TÜV-SÜD concept assessment in 2014 for ISO 13849:
  - Lockstep MCU + Safety Companion Power Supply

TPS65381-Q1 Safety Companion PMIC



Functional safety architecture features

Includes multiple power supply rails in a single device

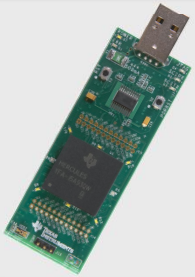
Additional sensor supply built-in

Diagnostic interfaces

AEC 100 qualified and temperature grades to 125 C◦

Hercules Kits

USB Stick



Low cost option to evaluate Hercules MCU platform

$79

TMS570LS31
RM48

LaunchPad

Lowest cost option to evaluate Hercules MCU platform

$19.99

TMS570 LC43/LS12/LS04
RM57L, RM46, RM42

Hercules Development Kit

Get started on development with Hercules MCU platform

$199

TMS570 LC4/LS31/LS12/LS04
RM57L, RM48, RM46, RM42

Hitex Safety Kit

Evaluate Hercules MCU and TPS65381 combination for safety-critical applications

$499

TMS570LS31
RM48

Tools & Software

Click below for a complete listing of [Hercules Tools and Software]

Motor Control Kit

Spin 3 phase Brushless DC and brushless AC motors

Starting at $499

TMS570 LS31/LS12
RM48, RM46

Hercules Training

Recorded Webinars:

- Innovation with Purpose: Optimal MCU Solutions for Safety Critical Applications
- Functional Safety made easy with SafeTI™-HSK
- ARM® Cortex™-R. What is it good for?
- Launching Safety Critical Designs with MCU Hardware Enabled Safety Features
- Safety Challenges for Motor Control Electronics
- TI Safety MCUs in Automotive

Hands-on Training:

- One day Seminar
  - What is Functional Safety?
  - Safety Standards Overview
  - Random Fault Management
  - Safety System Architectures
  - Hercules Safety Concept
- Three day training class
  - One day Seminar material
  - Detailed overview on CPU architecture
  - Detailed overview on device peripherals
  - Detailed overview on development tools
  - Hands-on exercises

Online Hercules Training:

- Hercules LaunchPad Overview
- Hercules How to Tutorial: PWM Generation using the Hercules Launchpad
- Safety Critical Design and Programming with Hercules (TM) Safety MCUs
- Make it Safe! SafeTI(TM) Design Packages
- Hercules How to Tutorial: Using CCS UniFlash
- Hercules How to Tutorial: PCB Design Considerations
- Hercules Tutorial: MibSPI Overview
- Hercules Tutorial: MibSPI and DMA Overview
- Hercules How to Tutorial: Force a Clock Monitor Failure
- Hercules How to Tutorial: CAN Communication
- Hercules How to Tutorial: Using HALCoGen
- Hercules How to Tutorial: 12bit ADC
- Hercules How to Tutorial: Using the SCI for UART Communication
- Hercules How to Tutorial: Using the NHET to generate a PWM
- Hercules How to Tutorial: Ethernet

Hercules Support Structure

SafeTI Web Page: www.ti.com/safeti
Hercules Web Page: www.ti.com/hercules
RM Web Page: www.ti.com/rm4
TMS570 Web Page: www.ti.com/tms570

- Data Sheets
- Technical Reference Manual
- Application Notes
- Software & Tools Downloads and Updates
- Order Evaluation and Development Kits

Engineer 2 Engineer Support Forum:
www.ti.com/hercules-support

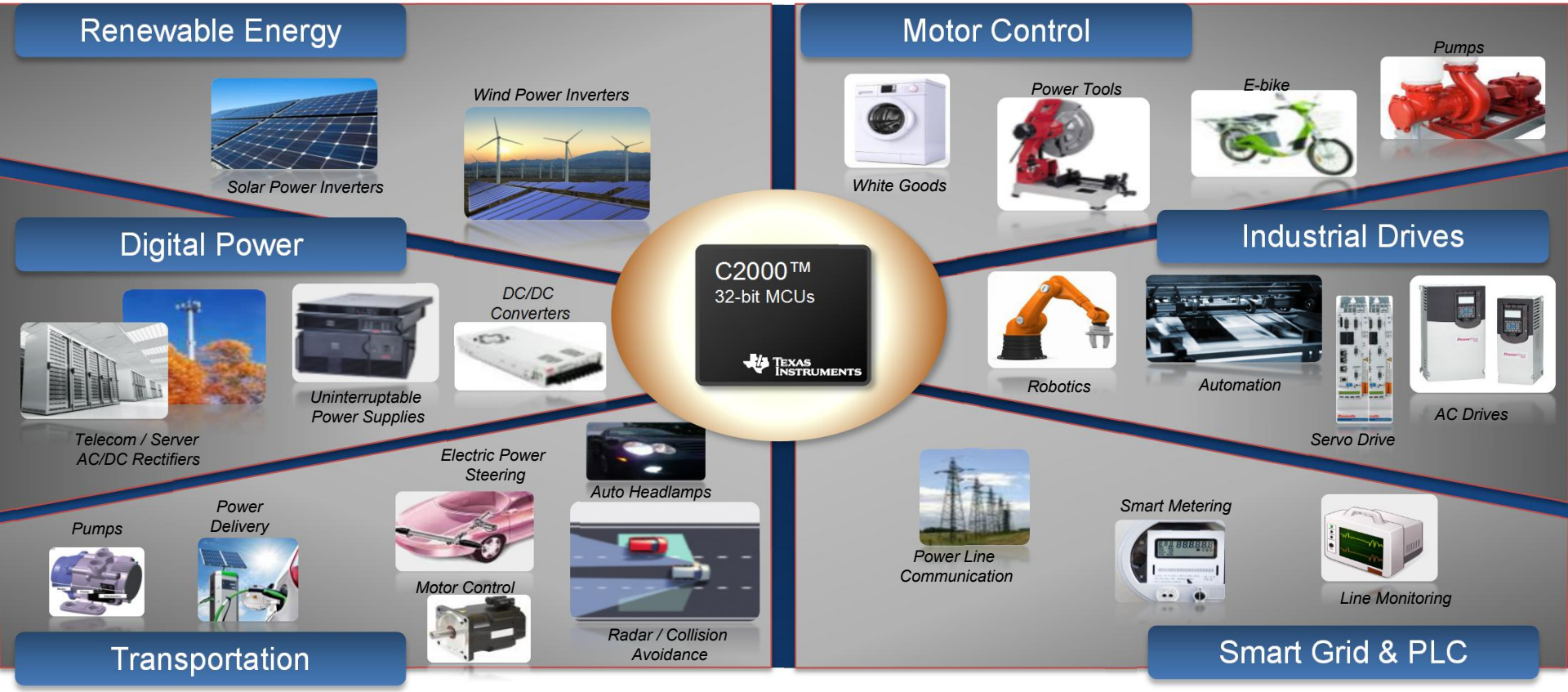
- News and Announcements
- Ask Technical Questions
- Search for Technical Content

TI E2E™ Community

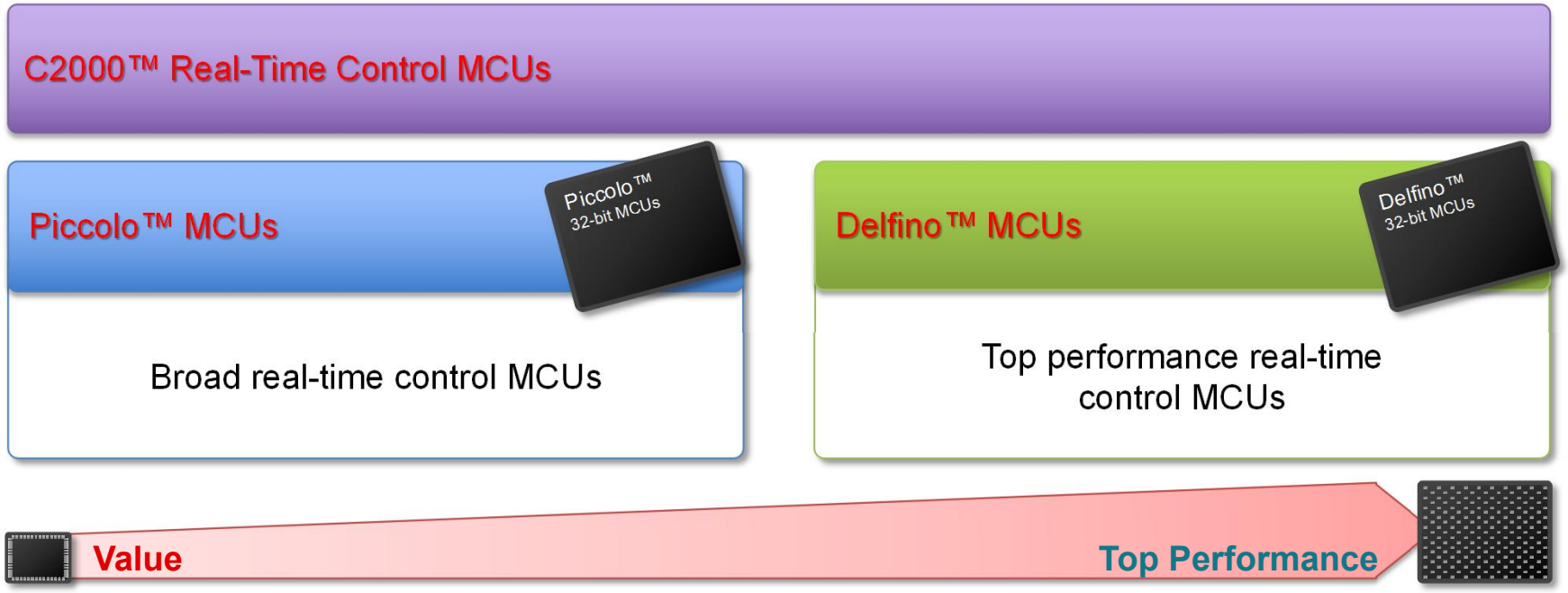
Hercules WIKIs:
RM WIKI: www.ti.com/hercules-rm4-wiki
TMS570 WIKI: www.ti.com/hercules-tms570-wiki

- How to guides
- Intro Videos

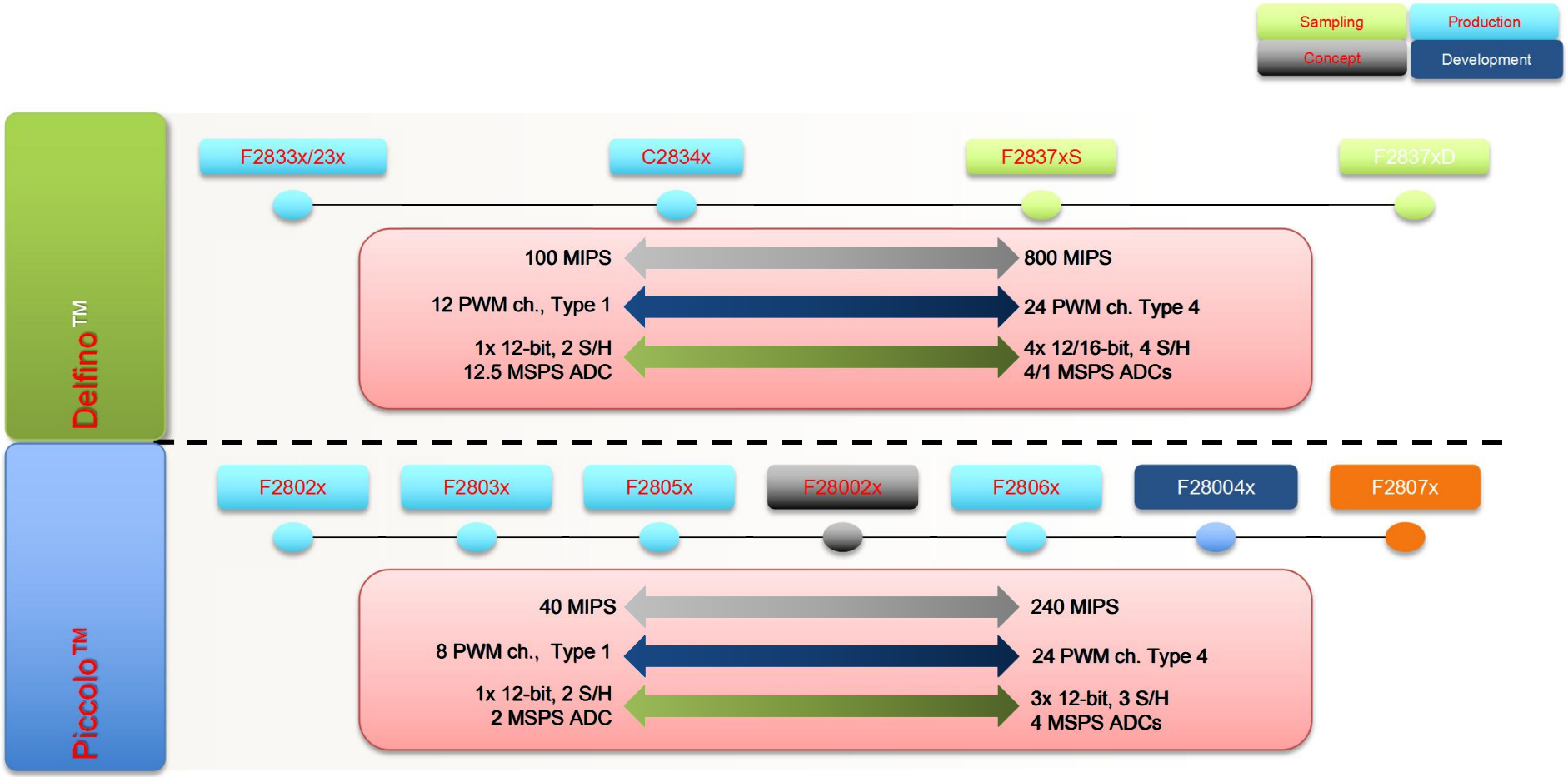
Where is Real-time Control?



C2000™ Offers a Range of Solutions



Real-Time Control Portfolio



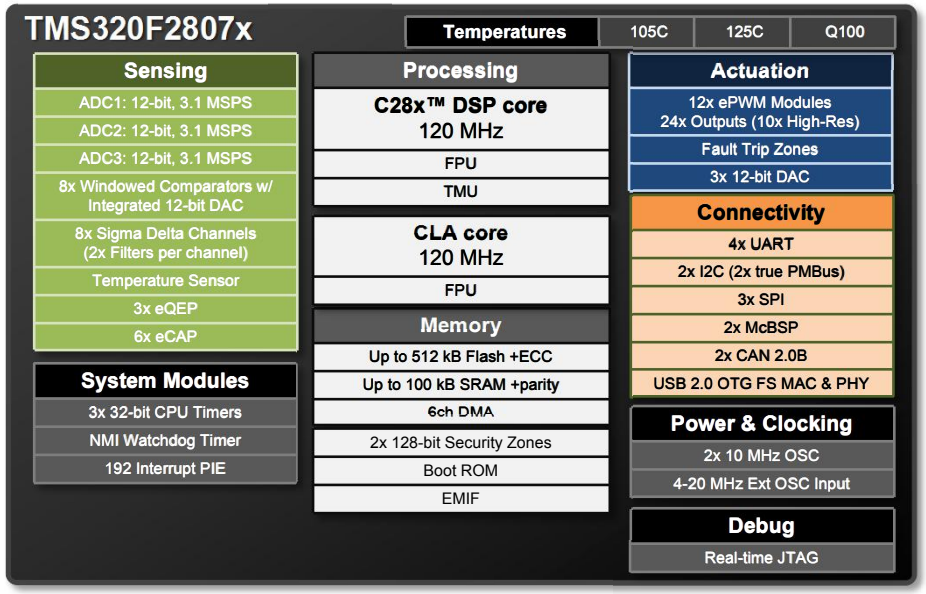
Piccolo™ TMS320F2807x

Production

Starting at $8.41

Differentiation

- Floating point C28x core with real-time control accelerator (CLA) for multi-tasking critical control loops with general applications actions
- Trigonometric Math Unit (TMU) hardware accelerator for reduced cycle times on trig math instructions (common in torque loops)
- Faster flash access speed in new 65nm technology (2-wait states instead of 5) driving faster command execution
- Integration of three independent 12-bit ADCs driving simultaneous conversion of multiple domains
- 8x Windowed Comparators for voltage and current limit protection of power stage
- 8 Sigma Delta Decimation Filters for isolated current sensing



Tools

TMS320F2807x Isolated controlCARD

Part Number: TMDXCNCD28075

TMS320F2807x Experimenter's Kit

Part Number: TMDXDOCK28075

Software

- controlSUITE™ Software
- Code Composer Studio (CCS) IDE

Packages

Package	Dimension
100-pin HTQFP	14x14mm
176-pin HLQFP	24x24mm

Delfino™ TMS320F2837xD

Production

Starting at $14.33

Differentiation

- Real-time performance of dual C28x core with dual CLA co-processors to run parallel control loops
- Configurable decoding of analog and digital sensors with Position Manager
- 4 differential 16-bit ADC, 1MSPS each, 4x S/H
- 3x 12-bit DAC (external)
- Trigonometric Math Unit (TMU) - 1 to 3 cycle SIN, COS, ARCTAN instructions
- Direct memory access through dual EMIFs (16bit/32bit)
- 8x Windowed Comparators w/ 12b DAC which can be used as peak current mode comparators (PCMC)
- 8x Sigma Delta channels, 2x Filters per channel

Tools

Industrial Drives Control Kit

Part Number: TMDXIDDK379D

TMS320F2837xD Isolated controlCARD

Part Number: TMDXCNCD28377D

TMS320F2837xD Experimenter's Kit

Part Number: TMDXDOCK28377D

TMS320F2837xD

Temperatures: 105C | 125C | Q100

Position Manager
- EnDat, BISS, Resolver…

Sensing
- ADC1: 16-bit, 1.1-MSPS 12-bit, 3.5 MSPS
- ADC2: 16-bit, 1.1-MSPS 12-bit, 3.5 MSPS
- ADC3: 16-bit, 1.1-MSPS 12-bit, 3.5 MSPS
- ADC4: 16-bit, 1.1-MSPS 12-bit, 3.5 MSPS
- 8x Windowed Comparators w/ Integrated 12-bit DAC
- 8x Sigma Delta Channels (2x filters per channel)
- Temperature Sensor
- 3x eQEP
- 6x eCAP

System Modules
- 3x 32-bit CPU Timers
- NMI Watchdog Timer
- 2x 192 Interrupt PIE

Processing	Processing
C28x™ DSP core 200 MHz	C28x™ DSP core 200 MHz
FPU	FPU
TMU	TMU
VCU-II	VCU-II
CLA core 200 MHz	CLA core 200 MHz
FPU	FPU
6ch DMA	6ch DMA
Memory	Memory
Up to 512 KB Flash	Up to 512 KB Flash
Up to 102 KB SRAM	Up to 102 KB SRAM

- 2x 128-bit Security Zones
- Boot ROM
- 2x EMIF

Actuation
- 12x ePWM Modules (Type 3) 24x Outputs (16x High-Res)
- Fault Trip Zones
- 3x 12-bit DAC

Connectivity
- 4x UART
- 2x I2C (w/ true PMBus)
- 3x SPI
- 2x McBSP
- 2x CAN 2.0B
- USB 2.0 OTG FS MAC & PHY
- uPP

Power & Clocking
- 2x 10 MHz OSC
- Ext OSC Input

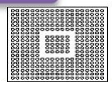
Debug
- Real-time JTAG

Software

controlSUITE™ Software

Code Composer Studio (CCS) IDE

Packages



Package	Dimension
176-pin HLQFP	24x24mm
337-pin NFBGA	16x16mm

View Configurations

Delfino™ TMS320F2837xS

Production

Starting at $11.32

Differentiation

- Real-time performance of C28x core with CLA co-processor to run parallel control loops
- Configurable decoding of analog and digital sensors with Position Manager
- 4 differential 16-bit ADC, 1MSPS each, 4x S/H
- 3x 12-bit DAC (external)
- Trigonometric Math Unit (TMU) - 1 to 3 cycle SIN, COS, ARCTAN instructions
- Direct memory access through dual EMIFs (16bit/32bit)
- 8x Windowed Comparators w/ 12b DAC which can be used as peak current mode comparators (PCMC)
- 8x Sigma Delta channels, 2x Filters per channel

Tools

Industrial Drives Control Kit

Part Number: TMDXIDDK379D

TMS320F2837xD Isolated controlCARD

Part Number: TMDXCNCD28377D

TMS320F2837xD Experimenter's Kit

Part Number: TMDXDOCK28377D

TMS320F2837xS

Temperatures	105C	125C	Q100

Position Manager

EnDat, BISS, Resolver…

Sensing

- ADC1: 16-bit, 1.1-MSPS 12-bit, 3.5 MSPS
- ADC2: 16-bit, 1.1-MSPS 12-bit, 3.5 MSPS
- ADC3: 16-bit, 1.1-MSPS 12-bit, 3.5 MSPS
- ADC4: 16-bit, 1.1-MSPS 12-bit, 3.5 MSPS
- 8x Windowed Comparators w/ Integrated 12-bit DAC
- 8x Sigma Delta Channels (2x filters per channel)
- Temperature Sensor
- 3x eQEP
- 6x eCAP

System Modules

- 3x 32-bit CPU Timers
- NMI Watchdog Timer
- 192 Interrupt PIE

Processing

C28x™ DSP core 200 MHz
- FPU
- TMU
- VCU-II

CLA core 200 MHz
- FPU
- 6ch DMA

Memory

- Up to 1 MB Flash +ECC
- Up to 164 kB SRAM +parity
- 2x 128-bit Security Zones
- Boot ROM
- 2x EMIF

Actuation

- 12x ePWM Modules (Type 3) 24x Outputs (16x High-Res)
- Fault Trip Zones
- 3x 12-bit DAC

Connectivity

- 4x UART
- 2x I2C (w/ true PMBus)
- 3x SPI
- 2x McBSP
- 2x CAN 2.0B
- USB 2.0 OTG FS MAC & PHY
- uPP

Power & Clocking

- 2x 10 MHz OSC
- 4-20 MHz Ext OSC Input

Debug

- Real-time JTAG

Software

controlSUITE™ Software

Code Composer Studio (CCS) IDE

Packages

Package	Dimension
100-pin HTQFP	14x14mm
176-pin HLQFP	24x24mm
337-pin NFBGA	16x16mm

View Configurations

DesignDRIVE solutions for industrial applications

Diverse motor types, multiple encoder standards, evolving sensing technologies and industrial communications networks multiply the challenges for drive designers.

Industrial Robots	Servo Drives	AC Inverter Drives	CNC Computer Numerical Control Machinery	Elevators
				

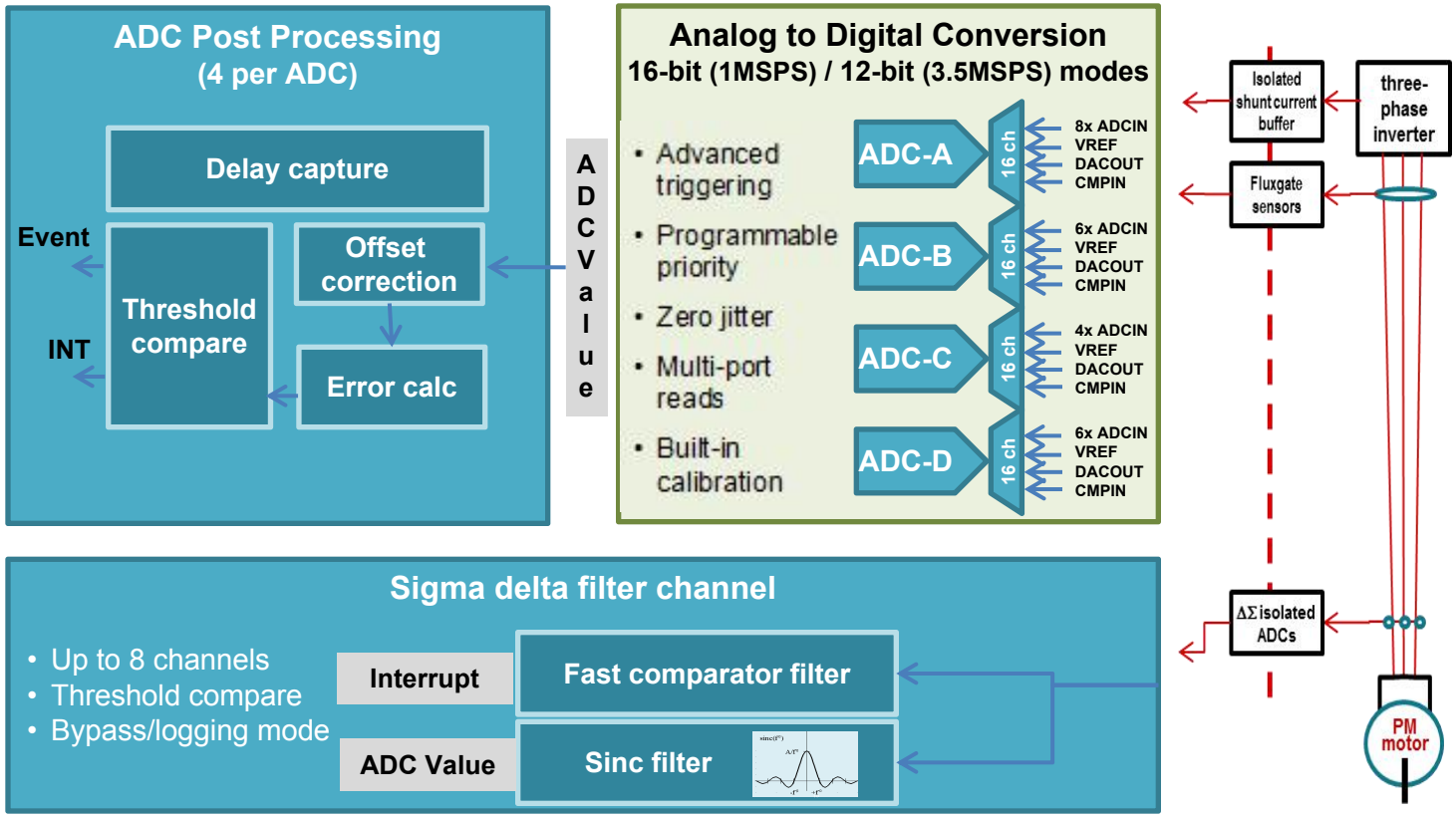
High-performance, high-precision, smart sensing

ADC – precise and concurrent sampling of all three motor phases and DC bus with zero jitter!

ADC post processing – on-chip hardware reduces ADC ISR complexity; shortens current loop cycles

Sigma Delta Filter Modules (SDFM) - enable galvanic isolation with reinforced delta sigma modulators, like TI's AMC1304.

Learn more



ARROWSEED

咨询热线

400-048-1230

微信扫一扫关注我们

Thank you !