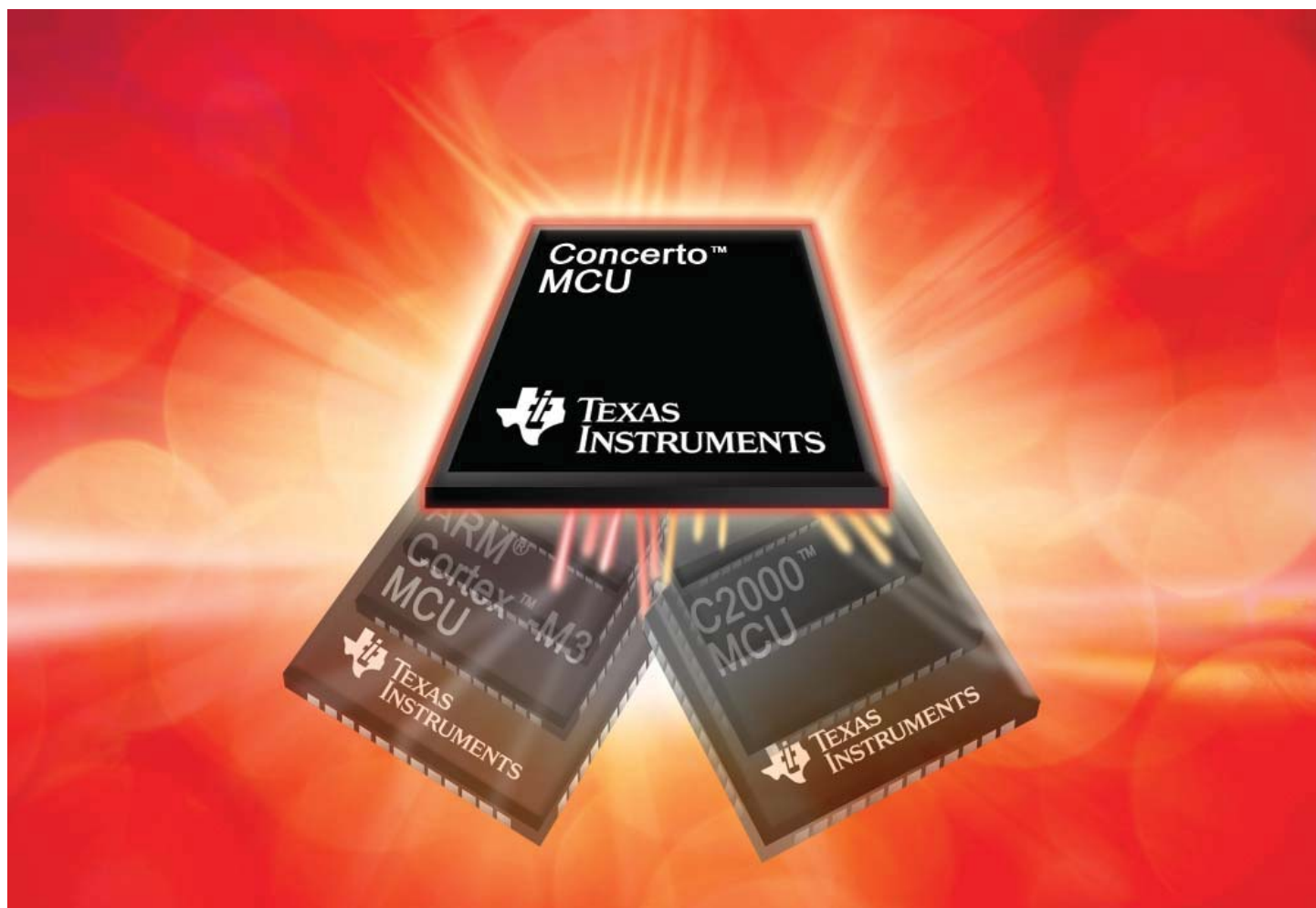


C2000™ Concerto™ Microcontrollers



Control or communications? Why compromise?

Engineering is full of compromises. It's a balance between numerous aspects – cost, power consumption, reliability, feature set, flexibility, and the list goes on. With every generation, engineers push the envelope of efficiency and functionality in their designs. Digital control is bringing new possibilities in driving smarter and more efficient systems. Connectivity is becoming pervasive in applications that

previously didn't require communication. Today, in many real-time control applications, such as automation or energy conversion, one of the biggest compromises is finding a balance between robust loop control and adding communications or host functionality. But what if you could eliminate some of those compromises?

Standard MCU Challenge

- Compromise between ideal host and control capability



Controller

- Real-time interrupt priority
- Fast closed loops
- Small sampling windows
- Background task for host functions
- Sub-prioritization of host functions



In the past, there were two solutions to this problem. The first, in cost-sensitive applications, was to select one MCU that would perform both control and communications functions. From a hardware

standpoint, it's a simple solution, but often requires a compromise on features and performance. In addition, software becomes more difficult as tasks and interrupts must be prioritized properly.

Classic Control Challenge

- Additional complexity
- Dual developments plus interface challenges/latency



Loop Controller

- Real-time control
- Faster/more loops
- Small sampling windows



Host Controller

- Communications
- Logic/profile
- Sequencing/monitoring



A second solution is to use two microcontrollers – a host microcontroller taking care of communications, monitoring, and other system functions while a second loop microcontroller focuses on the

real-time control aspect. This solution provides clean partitioning, but adds cost, complexity, and latency from communication between the two controllers.

Concerto™ MCU Solution

- Optimized subsystems
- Single-chip solution reduces complexity
- Faster interprocessor communication reduces latency



Control Subsystem

- Real-time control
- Faster/more loops
- Small sampling windows



Host Subsystem

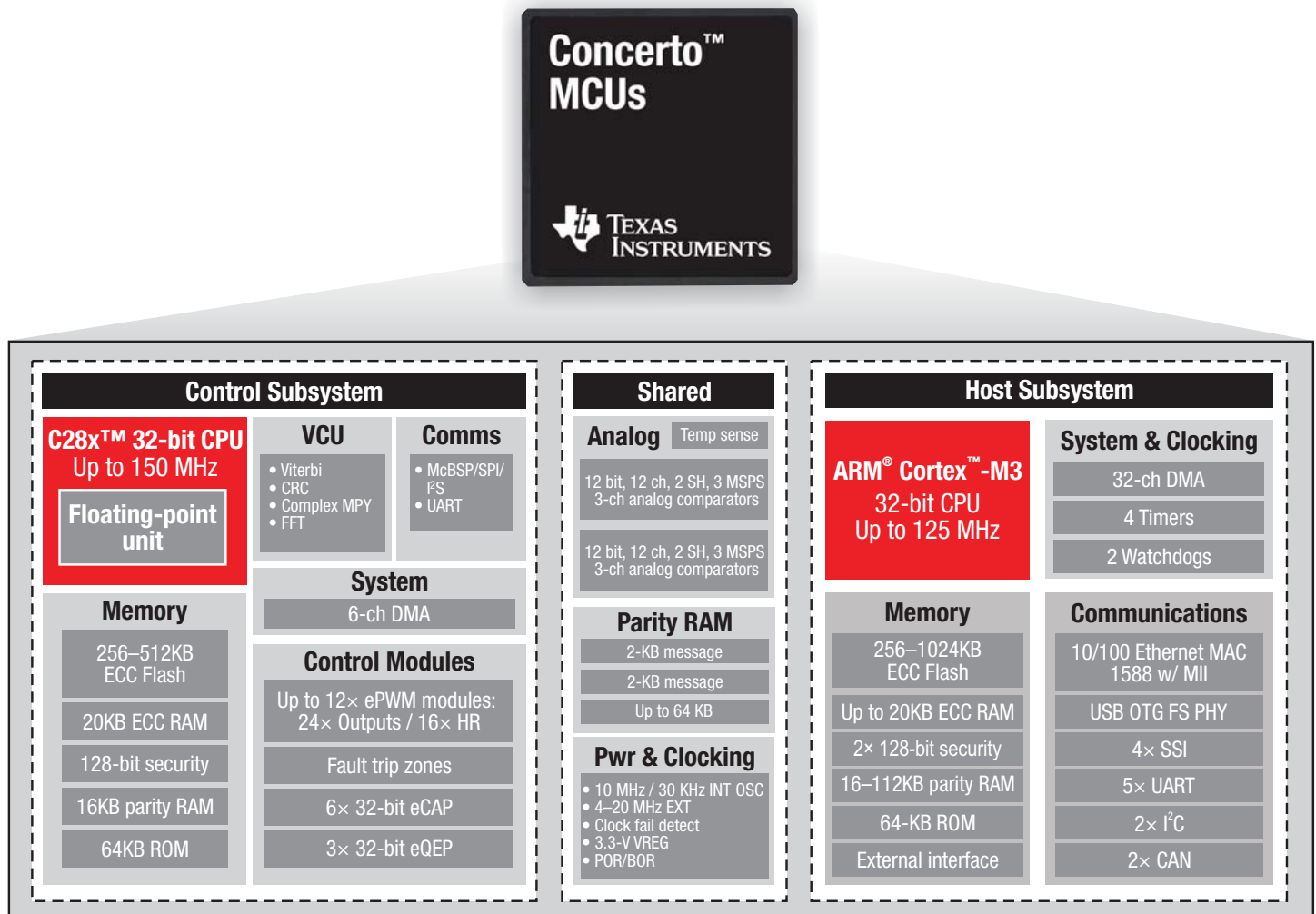
- Communications
- Logic/profile
- Sequencing/monitoring



With the C2000 Concerto™ family of microcontrollers, the need to compromise is eliminated. By combining an industry-leading Host core along with an industry-leading control core, Concerto

MCUs provide the best of both worlds in one device, simplifying both hardware and software aspects, all while reducing cost.

Introducing Concerto™ MCUs: Connectivity without compromise



Real-Time Control **TI 32-bit F28x with FPU**

Processing and control

- Industry leading computational performance
- Lowest control loop latency
- Robust control software support
- Fine-tuned control architecture

Precision peripherals

- Flexible, highest resolution, best synchronization PWMs
- High-speed precision-synchronized analog
- Flexible power line modem solution

+

Host MCU **ARM® 32-bit Cortex™-M3**

Ecosystem

- Operating systems
- Middleware
- Software infrastructure

Rich Communications

- Ethernet
- USB
- CAN, serials
- Wireless
- Various field busses

Application Layer

- Sequencing, profiles
- Diagnostics, monitoring

**Industry's #1 MCU for
power electronics and
power-line modem**

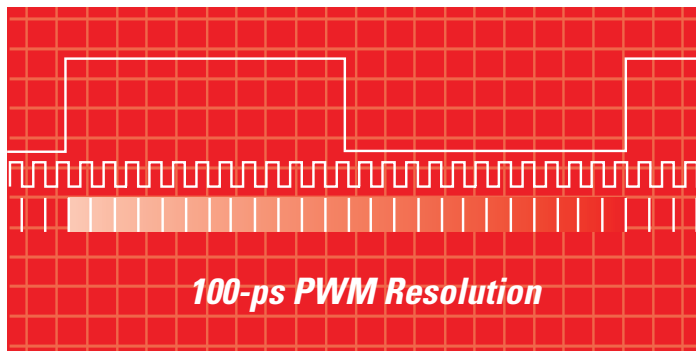
**Industry's #1 MCU for general
purpose and communication**

Concerto™ MCUs: Best of both worlds

With both host and control subsystems on one device, Concerto MCUs bring you the best of both worlds:

C28x Core (control):

- Up to 150 MHz with floating point
- Sensing and DSP filtering and processing
- Firmware programmable power line modem solutions
- PWMs with unmatched flexibility, programmability, and resolution (down to 100 picoseconds)
- Enhanced Quadrature Encoder interface (eQEP) is compatible with almost any linear or rotary encoder for motor control applications
- Enhanced capture for precision in applications like radar and ultrasonic sensing



Focus on differentiation

Concerto MCUs allow engineers to leverage easy-to-use software and application libraries from the C2000™ controlSUITE™ software platform as well as ARM Cortex-M3's ecosystem, resulting in an unparalleled environment of software and support. Previous developments on C2000 can be ported to Concerto MCUs

- Scalability between the entire C2000 portfolio – from 40 MHz to 300 MHz
- Single IDE built in functionality with dual core debugging and programming

ARM® Cortex™-M3 (host):

- Up to 125 MHz
- Take advantage of Cortex-M3's rich ecosystem
- Optimized for host communications

Shared / System:

- Up to 1.5MB of 65-nm Flash and 232K RAM
- Dual 12-bit ADC, 3 MSPS and 2 sample-and-holds each, up to 24 channels. Unique start-of-conversion triggering for intelligent sampling.
- Error detection and correction on Flash and RAM sectors
- Redundancy for safety
 - Two independent cores with monitoring
 - Dual ADCs for speed and reliability
 - Built-in clock monitoring with multiple system watch dogs
- Security features for memory protection
- Inter-processing communications library for simple, no-lag information transfer between subsystems
- On-chip analog comparators for instantaneous over-current/over-voltage protection
- Even more integration to simplify hardware design
 - Integrated high-speed oscillator and real-time clock
 - On-chip POR/BOR
 - Single-rail supply, on-chip voltage regulator
- Automotive Q100

- Multi-OS support
- controlSUITE software
 - 40+ man years of application software libraries and device drivers
 - Plethora of libraries - communication stacks (USB, Ethernet) motor control, digital power, power line communication
 - Application kit software and hardware completely open source, including schematics, bill of materials, even layouts

controlSUITE: C2000 C28x

- Header file library
 - Allows for bit-field register access or driver-based functions
- Math, DSP libraries for both fixed and floating point
- Application libraries (motor control, digital power, and more!)
- Code examples and utilities
- SYSBIOS from TI
- Complete source code available, free license and royalty-free use

controlSUITE: ARM Cortex-M3

- Peripheral driver library
 - Allows for direct register access or driver-based functions
- Display, graphics library
- Code examples
- In-system programming support
- CMSIS hardware abstraction
- Complete source code available, free license and royalty-free use

Concerto™ MCU applications and benefits

With Concerto MCUs, a variety of applications can benefit from separate host and control subsystems.

Industrial automation



Host
OS / RTOS
Communication bridge
Motion profile
System management

Control
Multiple motors
Torque and speed control
Precision sensing

Benefits

- Host subsystem takes care of communication and system management without being sidetracked by strict control loop interrupts
- Control subsystem is not burdened by communication, more bandwidth for custom control algorithms and multi-axis control
- Industry-leading PWMs for precision motor control
- On-chip comparators for over-current and over-voltage detection to protect equipment

Solar farms



Host
OS / RTOS
Communication bridge
Diagnostics
System management

Control
Max power point tracking
DC/DC boost
DC/AC conversion

Benefits

- Host subsystem takes care of diagnostics and management
- Control subsystem optimized for maximum power point tracking algorithms
- Integrate power tracking along with power conversion
- Enable smart switching between grid connection and battery systems
- Programmable for any power line communications protocol

Server farms



Host
Load balancing
Diagnostics
System management

Control
Power conversion
Multiple rails and loads
Driving efficient topologies
UPS

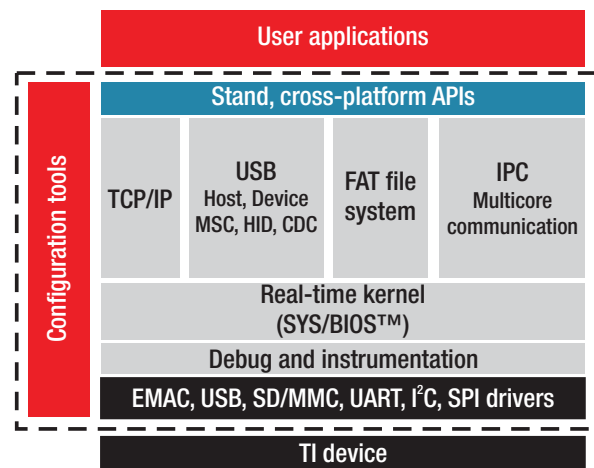
Benefits

- Host subsystem takes care of communication, load balancing, and more
- Control subsystem can focus on digital power techniques for higher efficiency, increased reliability
- Programmable control subsystem allows for increased scalability between power rating levels and topologies
- Instantaneously detect power irregularities and switch to UPS backup systems

TI-RTOS™ for Concerto™ microcontrollers

TI-RTOS is a deterministic, scalable real-time operating system (RTOS) for the ARM® Cortex™-M3 that builds on the SYS/BIOS™ real-time kernel and C2000™ controlSUITE™ software middleware and peripheral libraries. TI-RTOS provides TCP/IP, USB host and device, a FAT file system and drivers all completely integrated and tested in a multithreaded environment to enable engineers to begin development right out of the box. TI-RTOS provides low-overhead communication mechanisms between the ARM Cortex-M3 and C28x cores, enabling developers to easily exchange command-and-control or data buffers. TI-RTOS uses the same real-time kernel (SYS/BIOS) on both cores, to provide a uniform programming environment in which developers can quickly switch tasks from one core to another to optimize system performance.

TI-RTOS is fully integrated with the Code Composer Studio™ integrated development environment (IDE) and is supported by TI. It is available at no charge and is royalty-free.



TI-RTOS components

Development tools

Concerto tools will continue the C2000™ controlCARD tools methodology. By detaching the C2000 processor and all necessary support circuitry and putting them on controlCARDs, a designer can test multiple processors on one application board. These controlCARDs require only one 5-V supply and plug into a simple motherboard connector

that gives access to every pin on the device. All C2000 application kits are also based on controlCARDs

Start exploring what Concerto MCUs have to offer, right out of the box! Now you can add Internet connectivity to your Concerto tool with the addition of SimpleLink™ Wi-Fi® Evaluation Modules.

Part number	Description	
TMDXCNCDS2C1	F28M35H52 controlCARD	
TMDXDOCKH52C1	F28M35H52 Experimenter Kit	
TMDXCNCDS2M36	F28M36P63 controlCARD	
TMDXDOCK2M36	F28M36P63 Experimenter Kit	
CC3000TIWISLEM	LSR TIWi SL SimpleLink™ Wi-Fi® Evaluation Module	
CC3000TYPEVKEM	Murata Type VK SimpleLink WiFi Evaluation Module	



F28M35H52 Experimenter Kit



F28M35H52 controlCARD

Visual Solutions is the developer of VisSim, an award-winning, graphical software for model-based development and control design. VisSim v8 integrates OMG UML compliant “bubble and wire” state charts with data-flow block diagrams. The downloadable VisSim Viewer allows anyone to open and run a VisSim diagram royalty-free. In addition to industry leading ease of use and execution speed, VisSim provides tight integration to Texas Instruments C2000™, MSP430™ and ARM® MCUs. With its benchmark

winning C-code generation, fast multi-threading RTOS and fixed-point support, VisSim gives complete tool chain support for motor control, digital power and industrial control applications from initial concept to final flash burn. VisSim-based products can be found in places like the cockpit of the Joint Strike Fighter, medical respirators, electric vehicles, industrial UPS, multi-megawatt wind turbines, HVAC systems, nuclear power trainers and automotive electric oil pumps. Visit www.vissim.com to learn more.



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