Welcome!
Texas Instruments New Product Update

- This webinar will be recorded and available at www.ti.com/npu
- Phone lines are muted
- Please post questions in the chat or contact your TI sales contact or field applications engineer

LOW COST REAL-TIME CONTROL FOR AUTOMOTIVE

New Product Update

Osamah Ahmad
- TI C2000 Product Marketing

Agenda

- The real-time control challenge
- C2000 scalable portfolio & F280015x overview
- Rapid development and faster time to market
- Automotive HVAC eCompressor reference design
- Resources

Solving real-time control challenges

Watch the video

Key real-time control applications

HEV/EV, Body & Lighting

- On-board charger/DC-DC
- Thermal management
- Pumps, fans, blowers
- Auxiliary inverter
- Lighting

Motor Drives

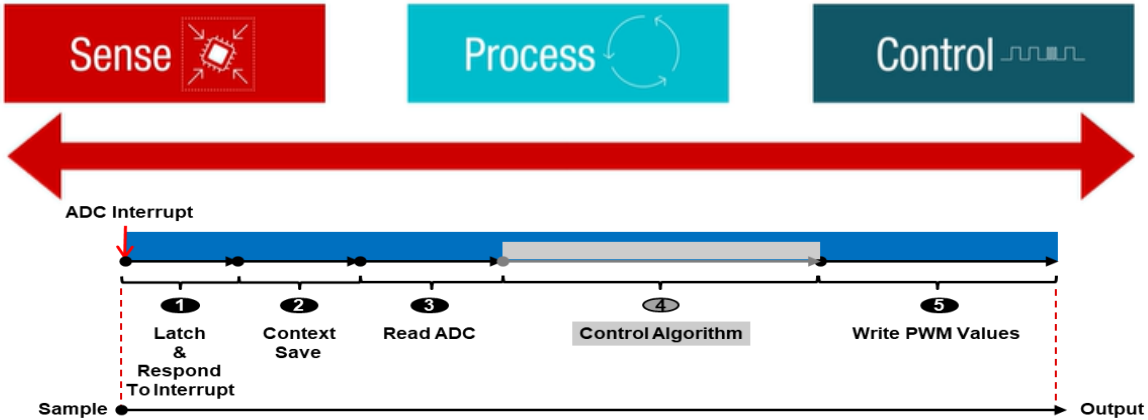
- AC, Servo, Stepper Drives
- CNC, Robotics
- HVAC & AirCon
- Major Appliance

Grid and Power Delivery

- Solar
- EV Charging
- Telecom Rectifier
- Network & Server PSU
- UPS

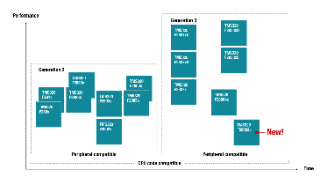
When it comes to real-time control
it is all about the latency

latency is the time it takes from
sensing feedback to forward *control*



Lower latency results in smaller sample to output delay
Do more in less time - or more often - to increase the control performance of your system

C2000 real-time MCU family for power electronics control



Broadest Real-Time Control Platform

SW compatible low/mid/high at various price points
Future-proof performance
Delivering high quality products

Innovation for the future of power conversion

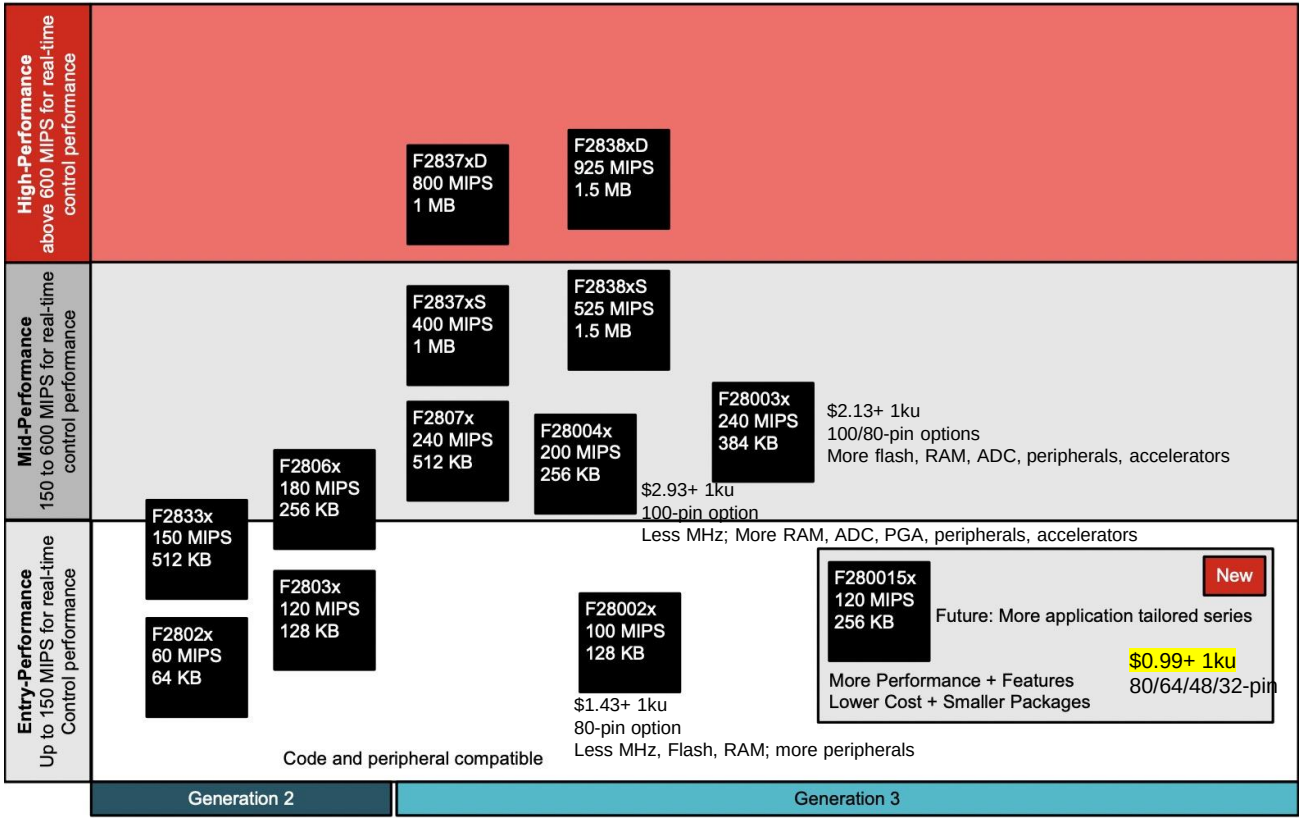
Industry's fastest real-time signal chain Sense-Compute-Control
Enables GaN/ SiC today

Expertise for faster and easier development

25 years of digital control
Numerous Reference Designs
HW/ SW to accelerate development

- ✓ **Billion+** units shipped in Automotive & Industrial
- ✓ **Thousands** of customers worldwide
- ✓ **High quality** and field reliability with high-volume delivery
- ✓ **Multi-source** FAB strategy for safe supply and future expansion

C2000 family: new F280015x series



F280015x target applications

Automotive HVAC and other Body

- HVAC eCompressor
- PTC/Heater
- Pumps, fans, blowers
- DC/AC Auxiliary Inverter
- Door, seat, window control

HEV/EV Powertrain

- Low-cost on-board charger
- HV-LV DC/DC converter
- Companion MCU for safety and other functions

Other automotive

- Low-cost LiDAR
- Low-cost battery management
- 2-wheeler motor control
- Low-cost digital power

Industrial Power and Motor control

- Appliance
- Residential / commercial HVAC
- AD Drives
- UPS
- Solar DC optimizer

C2000™ F280015x features

Real-time Processing Performance:
Lockstep 120 MHz DSP C28x core
+FPU32+TMU equivalent to
240 MHz Arm Cortex-M7

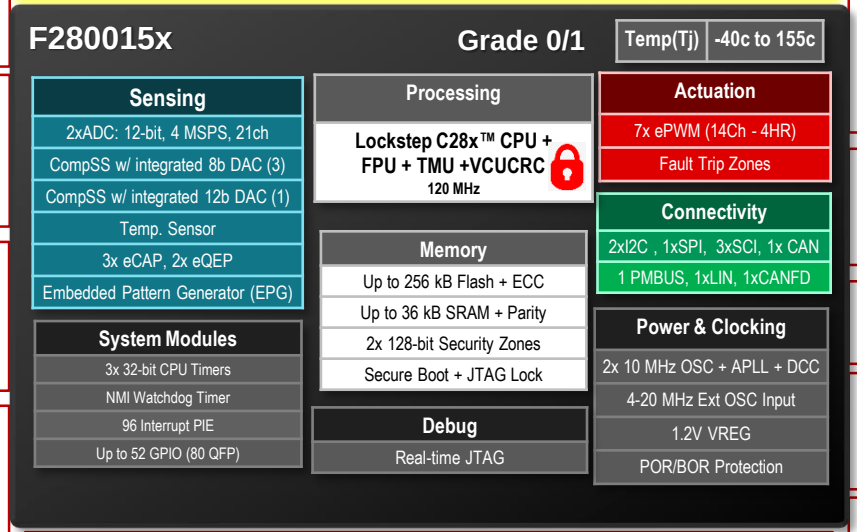
Analog:
2x 12-bit ADC up to 4 MSPS, 21-channels;
4 post processing blocks per ADC;
4x windowed comparators

Signal capture & generation:
2x Quadrature encoder interface;
3x capture modules;
Embedded pattern generator (EPG)

Safety:
Lockstep C28x CPU core; ECC/Parity memory, dual-clock comparator, missing clock detection, windowed watchdog, diagnostic software library

Security:
Dual-zone code security, unique ID, secure boot, JTAG lock, CMAC keys for AES

Price & Availability:
1ku / web price starting @ $0.99
Dual source strategy with TI owned capacity



Package & Pin Information:
New small cost optimized 5x5 32QFN enabling deeply embedded applications;
64/48/80-QFP common to rest of entry / performance portfolio;
Grade 0 option enables up to 150°C ambient operating temp

Portfolio:
Hardware & Software compatible designs across Entry and Performance portfolio

Actuation:
14 PWM channels with 4 150ps high-resolution

Connectivity:
CAN-FD, CAN, I2C, SPI, UART, I2C

Memory:
256 KB / 128 KB / 64 KB Flash
36 KB RAM

Power & Clocking:
3.3V supply with internal Vreg;
2x 10-MHz int oscillators;
+/- 1% with ext precision resistor;
External crystal or clock input

C2000™ F280015x variants and C2000 portfolio

C2000 Family	32 QFN	48 LQFP	64 LQFP	80 LQFP	100 LQFP
F280015x-Q1	✓	✓	✓	✓	
F28002x-Q1		✓	✓	✓	
F28003x-Q1		✓	✓		✓
F28004x-Q1			✓		✓

Orderable Part Numbers: XF2800157SPN, XF2800157QPNQ1, PMQ1, PHPQ1, RHBQ1 variants available during pre-production

Samples: 10u max paid on ti.com

Full production starts 2023 July

Feature	F280015x	F28002x	F28003x
MIPS	120	100	240
CPU (MHz)	120	100	120
Lockstep	Yes	No	No
FPU32	Yes (Type 0)	Yes + FastDIV	Yes + FastDIV
TMU32	Type 0	Type 1	Type 1
CLA (Control Law Accelerator)	No	No	Yes
CLB (Configurable Logic Block)	No	Yes	Yes
DMA	No	Yes	Yes
Flash (kB)	256	128	384
RAM (kB)	36	24	69
ADC	2 x 12-bit	2 x 12-bit	3 x 12-bit
ADC channels (Max)	21	16	23
CMPSS	1	4	4
CAN (DCAN) - Type 0	1	1	1
CANFD (MCAN) - Type 2	1	0	1
I2C	2	2	2
LIN	1	2	2
PMBus	1	1	1
SCI	3	1	2
eCAP/HRCAP module	3 - Type 2	3 (1 with HRCAP capability) - Type 2	3 (1 with HRCAP capability) - Type 3
ePWM/HRPWM Type 4	14 (4 with HRPWM)	14 (8 with HRPWM)	16 (8 with HRPWM)
Functional Safety	ASIL B	Quality Managed	ASIL B
Cybersecurity	JTAG Lock, Secure Boot	Dual-zone Security	JTAG Lock, Secure Boot, AES Engine
Starting Price (1ku)	<$1	<$2	<$3

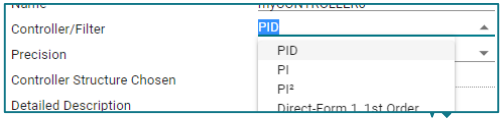
Development: rapid start

Pick a Device

- Search using TI.com
- Preview in SysConfig

Try Tools + Examples in the Cloud

Run examples quickly and easily on real hardware, no SW installations needed



Add Libraries with a Click

One click to add FREERTOS, optimized PID Control Algorithms, CPU accelerators and more!

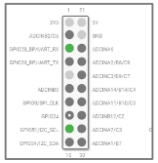
Learn with Academy

Follow along with labs and videos to learn quickly!

1 2 3 4 5 6 7

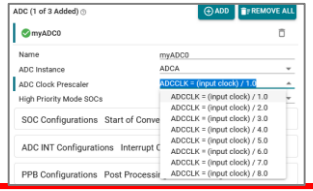
Pick a Board

- Preview EVMs in SysConfig
- Use later in reference designs



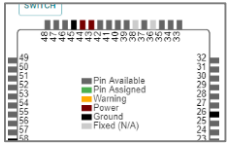
Configuring Examples

Begin configuring peripherals and code for your system needs



Download for Free

CCStudio IDE, SysConfig, Software Development Kits to begin development



Real-time made easy

C2000 Academy

All your training needs in one place including: getting started resources; interactive classes; and advanced workshops

- Content and labs for all peripherals:
  - ADC, EPWM, CMPSS, ECAP, and more

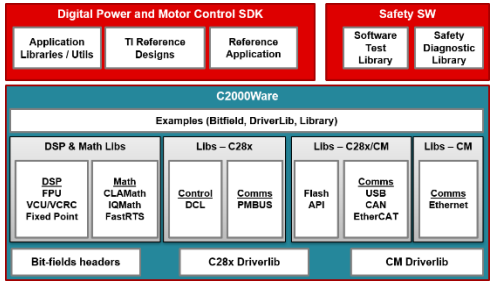
C2000 Videos

Videos to accelerate learning and system development

Examples:

- Series for EPWM, ADC, EQEP and other real-time peripherals
- Software library training (InstaSPIN Motor Control, Digital Control, etc.)
- Reference design demos/showcases (HVAC, Solar Inverters, EV Charging, etc.)
- End application and system design (EV, Motor Control, sensing, etc.)
- Software tools training (CCS, C2000Ware, SysConfig, and more)
- Recorded seminars and sessions for digital power
- And much, much more!

Software Dev Kits

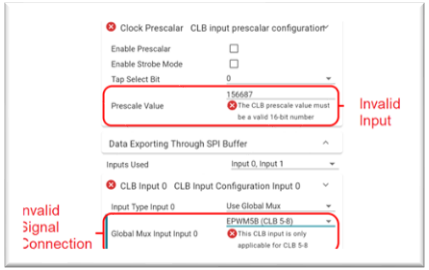


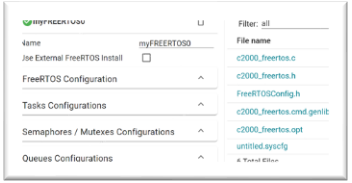
3-ph motor control and digital power applications

- Drivers
- Libraries
- Diagnostics
- Utilities
- Documentation, reference designs and EVM

SysConfig

Fast and Intuitive GUI based tool to speed up development



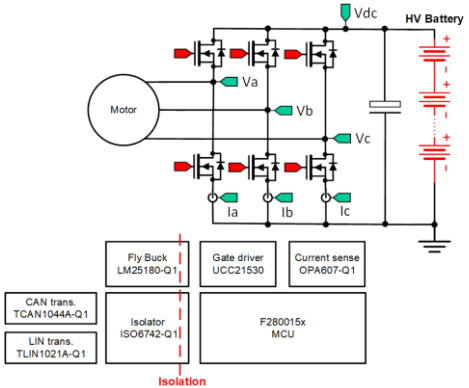


- Configure peripherals using an intuitive GUI
- Application-specific calculators built-in
- Integrated tool support: GPIO Pin Muxing, Security (DCSM), CLB, etc.
- Automatic dependency and error detection across modules
- One-Click set up + initialization of C2000 libraries (no more manual imports!)
- Memory configuration
- Configure EVM board components (LEDs, pin headers, etc.) for easier migration to custom boards + faster development
- Import device memory from non-Sysconfig EPWM code into Sysconfig
  - Error check settings
  - Easily port bitfield/driverlib to SysConfig
- FreeRTOS added with one click

TIDM-02012 HEV/EV Compressor Reference Design

Features

- Cost-optimized C2000 real time MCUs (F28003x, F280015x)
- Observer for sensorless-FOC: InstaSPIN FAST observer
- Motor over current protection with on-chip comparator
- Field weakening control, MTPA, Overmodulation
- Stall detection and recovery
- Lost phase detection/protection
- Startup failure detection and restart
- Torque ripple / vibration compensation
- Efficiency improvement algorithm for IPM type compressor
- CAN-FD and LIN interface support
- Multi-shunt and single-shunt support



Benefits

- Proven, highly integrated single MCU motor control design based on real HVAC systems
- Innovative algorithms for high efficiency, lowest/highest speed, low vibration and acoustics, robust start-up, wide adaptability
- Scalability across low-end and mid-end MCUs to cover wide range of application requirements
- Hardware-based ASIL B functional safety enablers
- Migration path to ASIL D / EVITA Full / high-end roadmap devices

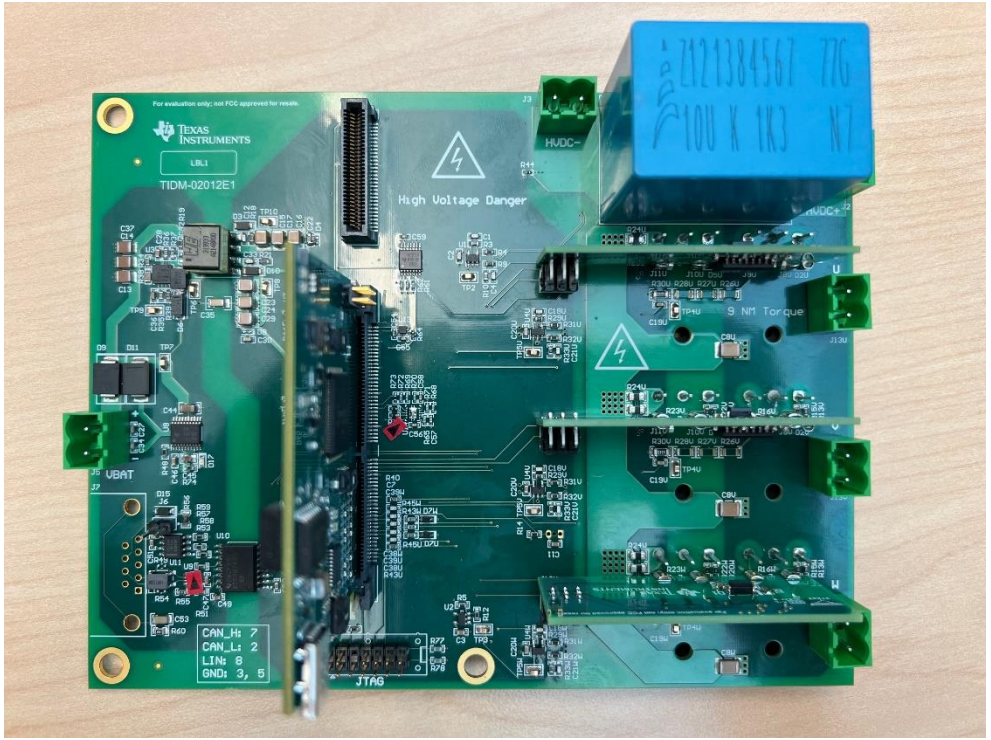
Target Applications

- HEV/EV HVAC eCompressor

TI.com

- Reference design tool page: https://www.ti.com/tool/TIDM-02012
- Reference design video: https://youtu.be/DIVtSa8hMUQ

TIDM-02012 HEV/EV Compressor Reference Design



Video: See it in action!

Based on F280015x controlCARD EVM:

https://www.ti.com/tool/TMDSCNCD2800157

Development resources

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
Product & Samples	120 MHz 32-bit MCU, FPU, TMU, 256-KB flash, Lockstep ASIL B Product overview	www.ti.com/product/TMS320F2800157-Q1 www.ti.com/lit/sprt757
Reference design	High-Voltage Automotive HVAC eCompressor reference design	www.ti.com/tool/TIDM-02012
Training	New to C2000? On-demand training, examples, and videos	C2000 Five Minute Overview C2000 Academy
Technical white papers	Technical blog for F280015x Real-time performance benchmarks C2000-Automotive functional safety overview	How to optimize your automotive HVAC design www.ti.com/lit/spracw5 www.ti.com/lit/swab014
Development tools	Full featured controlCARD EVM C2000Ware Motor Control SDK Digital Power SDK Universal Motor Control Project Guide One-click set-up, pin-mux, device configuration	www.ti.com/tool/TMDSCNCD2800157 www.ti.com/tool/c2000ware www.ti.com/tool/c2000ware-motorcontrol-sdk www.ti.com/tool/c2000ware-digitalpower-sdk www.ti.com/lit/spruj26 C2000 SysConfig

Visit www.ti.com/npu

For more information on the New Product Update series, calendar and archived recordings

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