TI Developer Conference
March 7-9, 2007 • Dallas, TX

Minds in Motion

What's New with C2000™ Controllers?

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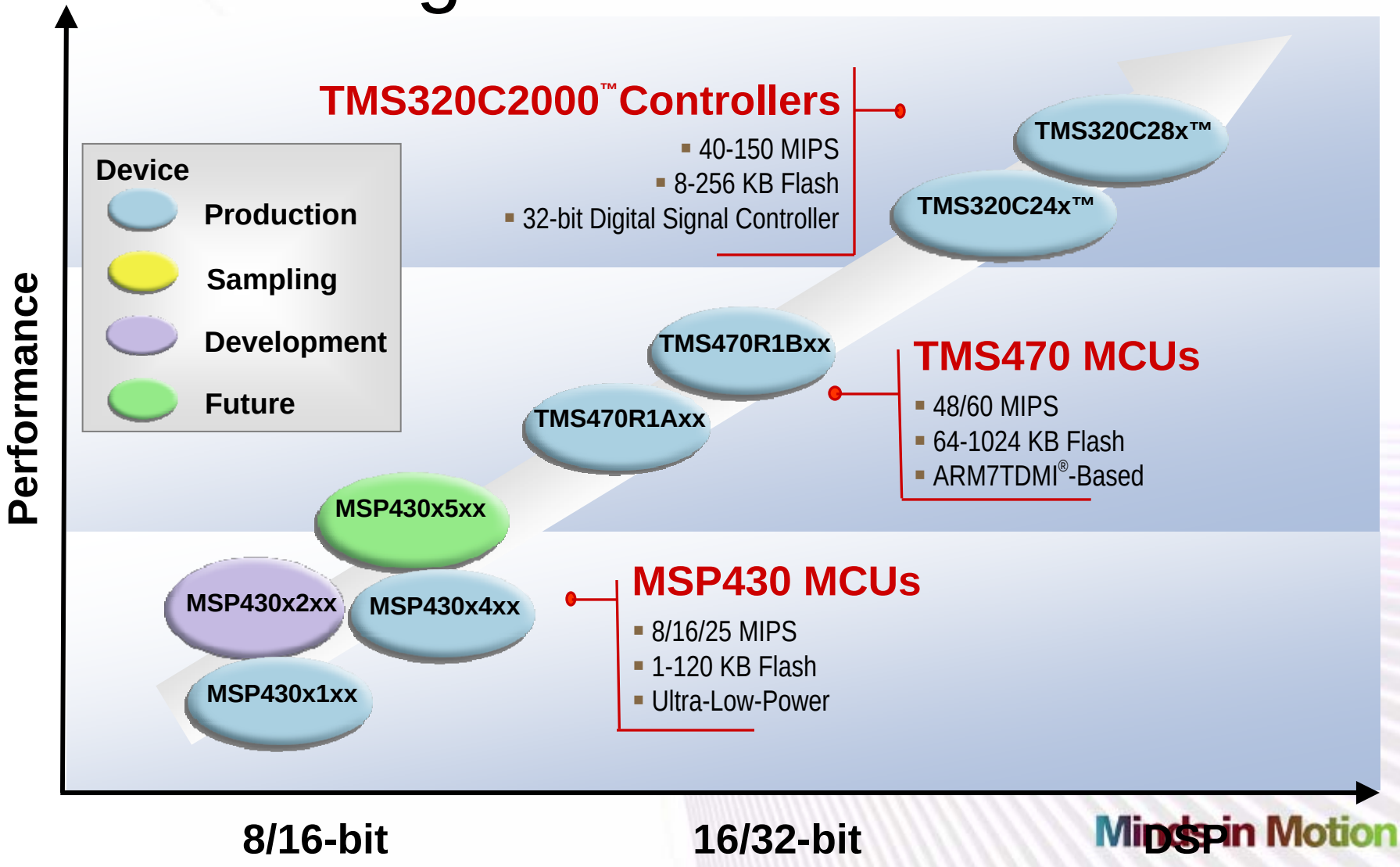
C2000 WW Marketing Manager
Texas Instruments, Inc.

Agenda

- TI Industrial Controllers
- Key Applications Using C2000 Controllers
- Latest C2000 products and Applications
- Roadmap Directions
- Key TIDC Sessions

TI Leading Embedded Controllers



C2000 DSC Target Markets

Digital Motor Control



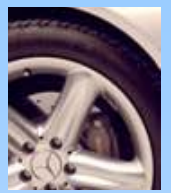

- Industrial Drives
- Servo Control
- Home appliances
- Electric Power Steering
- Medical Equipment

Digital Power Supplies




- Rectifiers, UPS
- Multi-channel DC/DC converters
- Solar & Wind inverters
- Hybrid Vehicles
- HDTV

Advanced Sensing

- PLC for metering, lighting
- Torque, pressure, liquid flow, or gas sensors
- Automotive Radar
- RFID
- Point of Sales Terminals

Fast, high resolution signal processing

Peripheral suite optimized for control applications

Energy Efficiency – Driven By C2000 Controllers

2/3 of industrial electricity is used to run electric motors...

..only 5% of the motors are equipped with variable speed drives…

…enabling them to be run using 1/8 of the energy used by their constant speed counterparts…

The 5% of efficient motors save the energy produced by 10 power plants and annually prevent the emission of 68 million tons of greenhouse gases

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Source: Dinesh Paliwal, ABB's chief executive for North America

Making Motors More Efficient

Improved system performance and lower system cost

- Home Appliances
- Industrial Drives
- Hybrid/Electric Vehicles

Indesit Company

30% increase in washing efficiency

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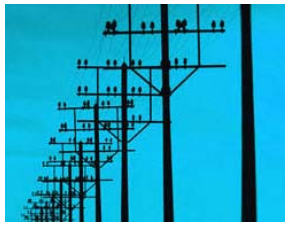
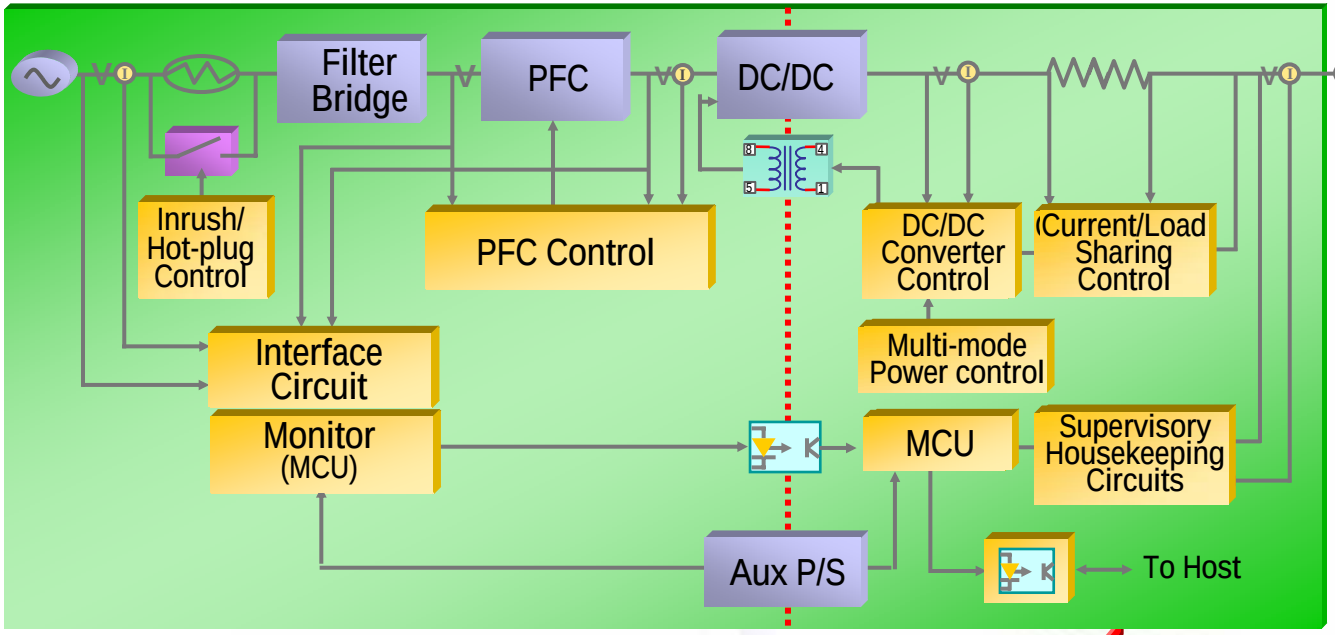
Making Alternative Energy More Efficient

Going digital with C2000 Controllers:

- Maximize energy conversion from renewable sources
- Lower system cost to widen deployment

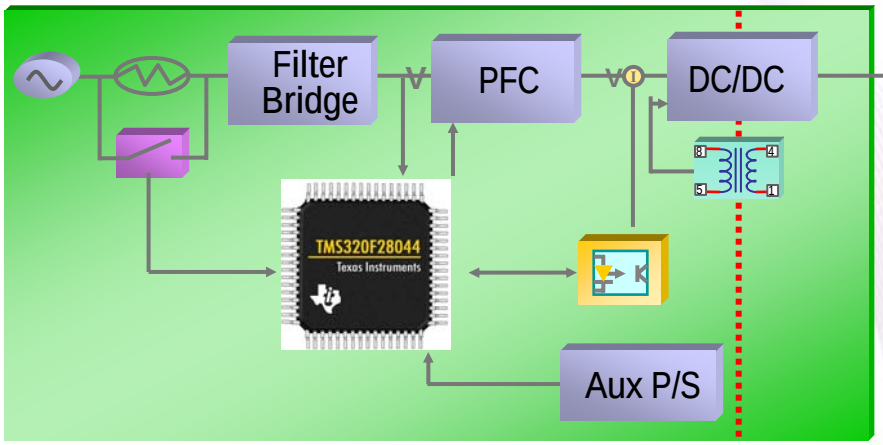


DSP-Based Digital Power Systems



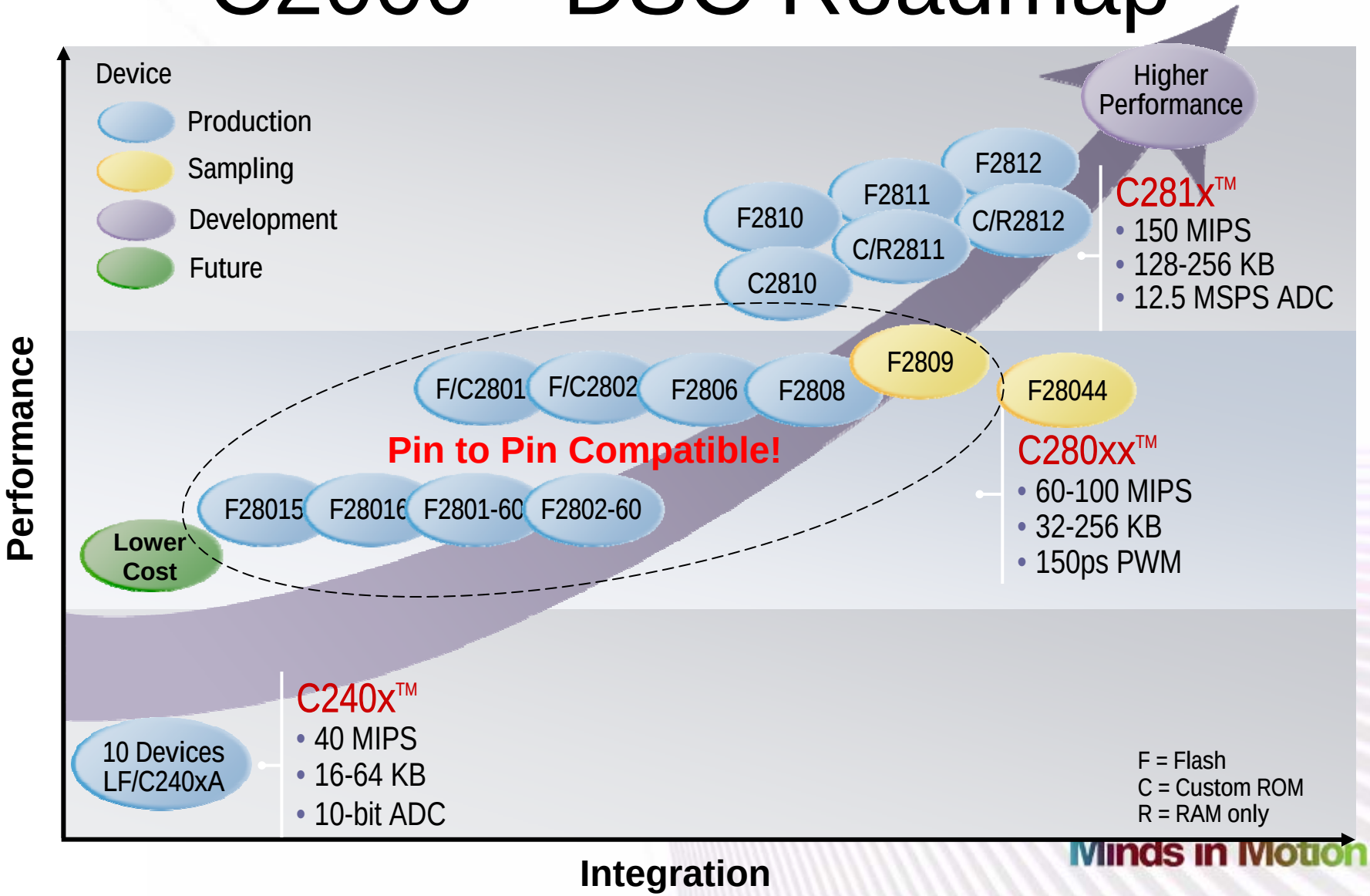
Traditional Analog Power Supply

- Multiple chips for control
- Micro-controller for supervisory
- Dedicated design

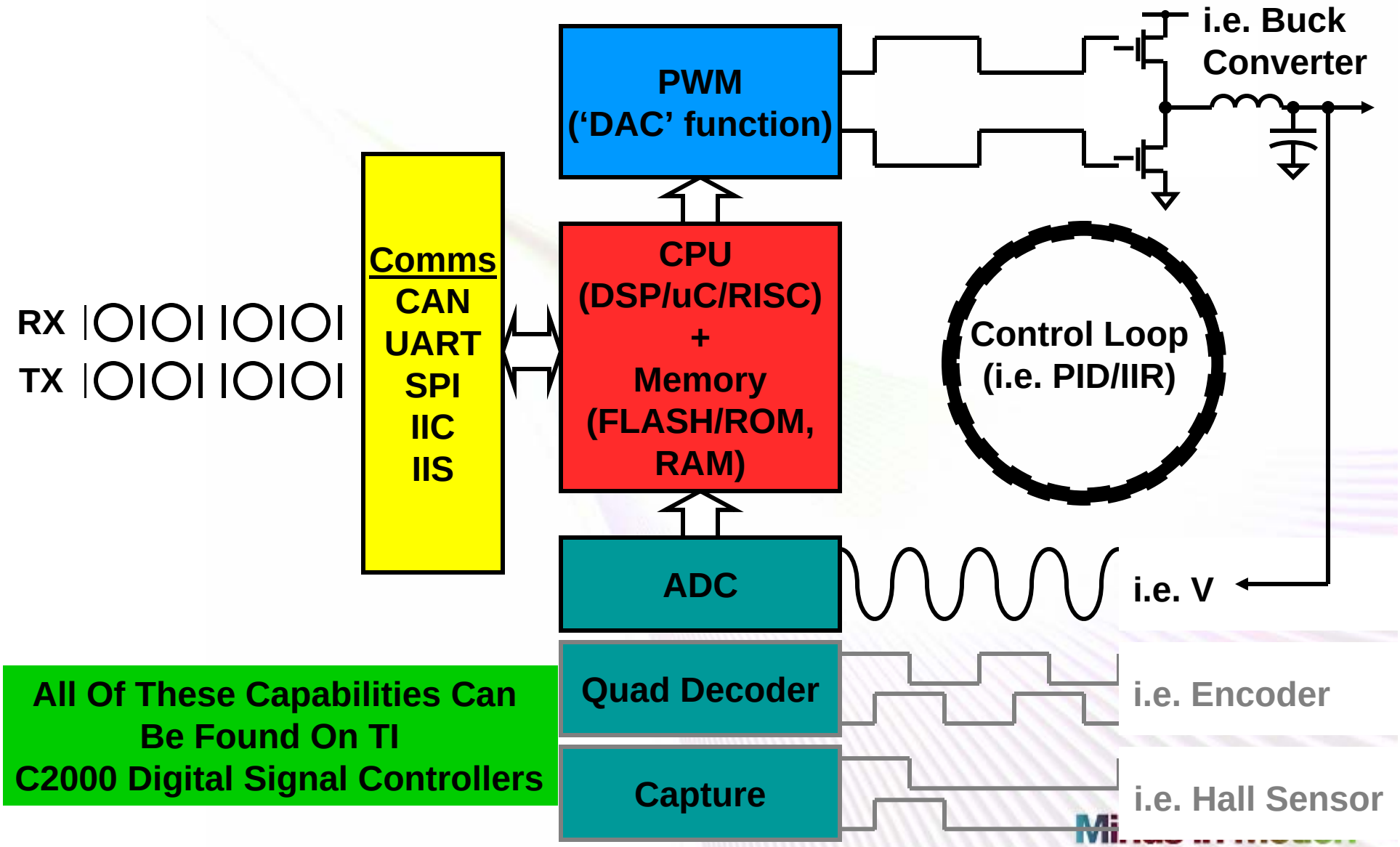


- ✓ **Eliminate Components**
- ✓ **Reduce Manufacturing Cost**
- ✓ **Better Performance Across Corners**
- ✓ **One Design, Multiple Supplies**
- ✓ **Failure Prediction**
- ✓ **One Device, Multiple DC Outputs**
- ✓ **Variable DC Output**

C2000™ DSC Roadmap



Control System On A Chip



All Of These Capabilities Can Be Found On TI C2000 Digital Signal Controllers

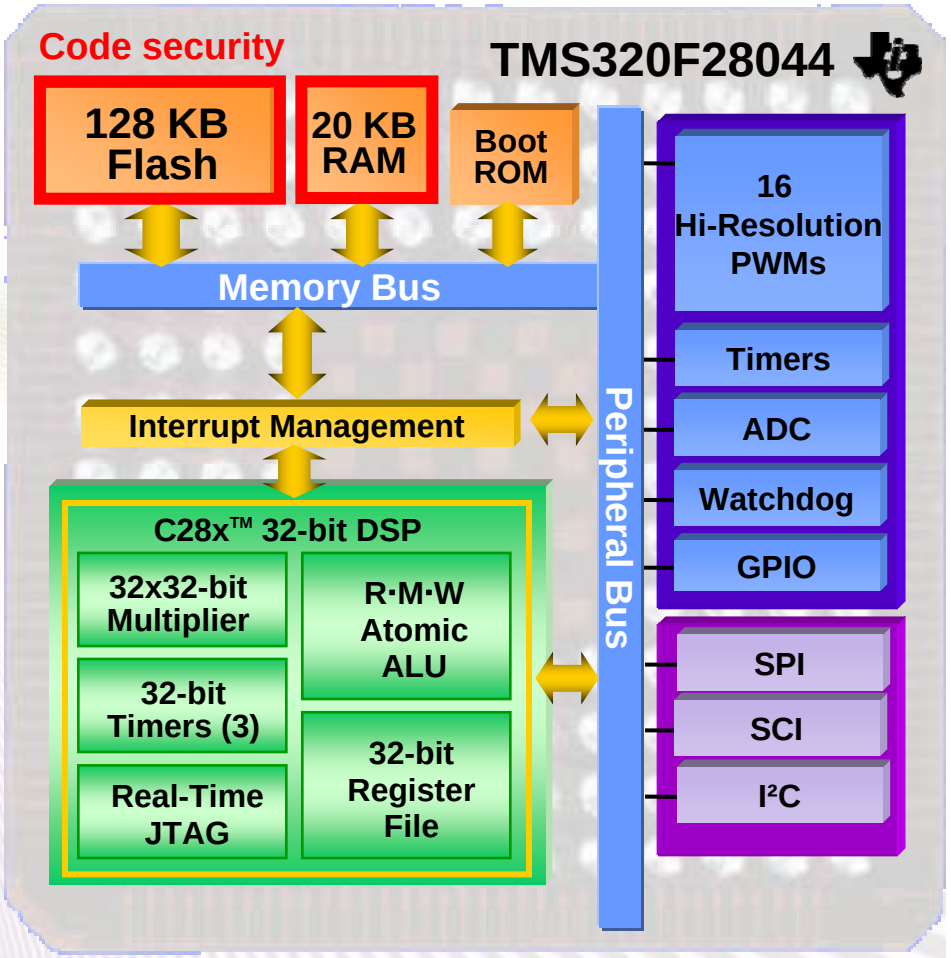
Expanding F280xx Controller Portfolio

All Devices are 100% Hardware, Software & Pin Compatible

TMS320™	Flash KB	RAM KB	ADC	PWM/ Hi-Res.	CAP/ QEP	Communication Ports
F28015	32	12	267ns	10/4	2/0	SPI, SCI, I^2C
F28016	32	12	267ns	10/4	2/0	SPI, SCI, CAN, I^2C
F2801-60	32	12	267ns	8/3	2/1	2x SPI, SCI, CAN, I^2C
F2802-60	64	12	267ns	8/3	2/1	2x SPI, SCI, CAN, I^2C
F2801	32	12	160ns	8/3	2/1	2x SPI, SCI, CAN, I^2C
F2802	64	12	160ns	8/3	2/1	2x SPI, SCI, CAN, I^2C
F2806	64	20	160ns	16/4	4/2	4x SPI, 2x SCI, CAN, I^2C
F2808	128	36	160ns	16/4	4/2	4x SPI, 2x SCI, 2x CAN, I^2C
F2809	256	36	80ns	16/6	4/2	4x SPI, 2x SCI, 2x CAN, I^2C
F28044	128	20	80ns	16/16	0	SPI, SCI, I^2C

New TMS320F28044 Controller

- Complex PoL Applications
  - Servers, Base stations, etc.
- Less than $5.00 for volume production
- 100 MHz Performance
- Integration
  - Complete controller for up to 16 outputs/phases
  - Supports PMBus™



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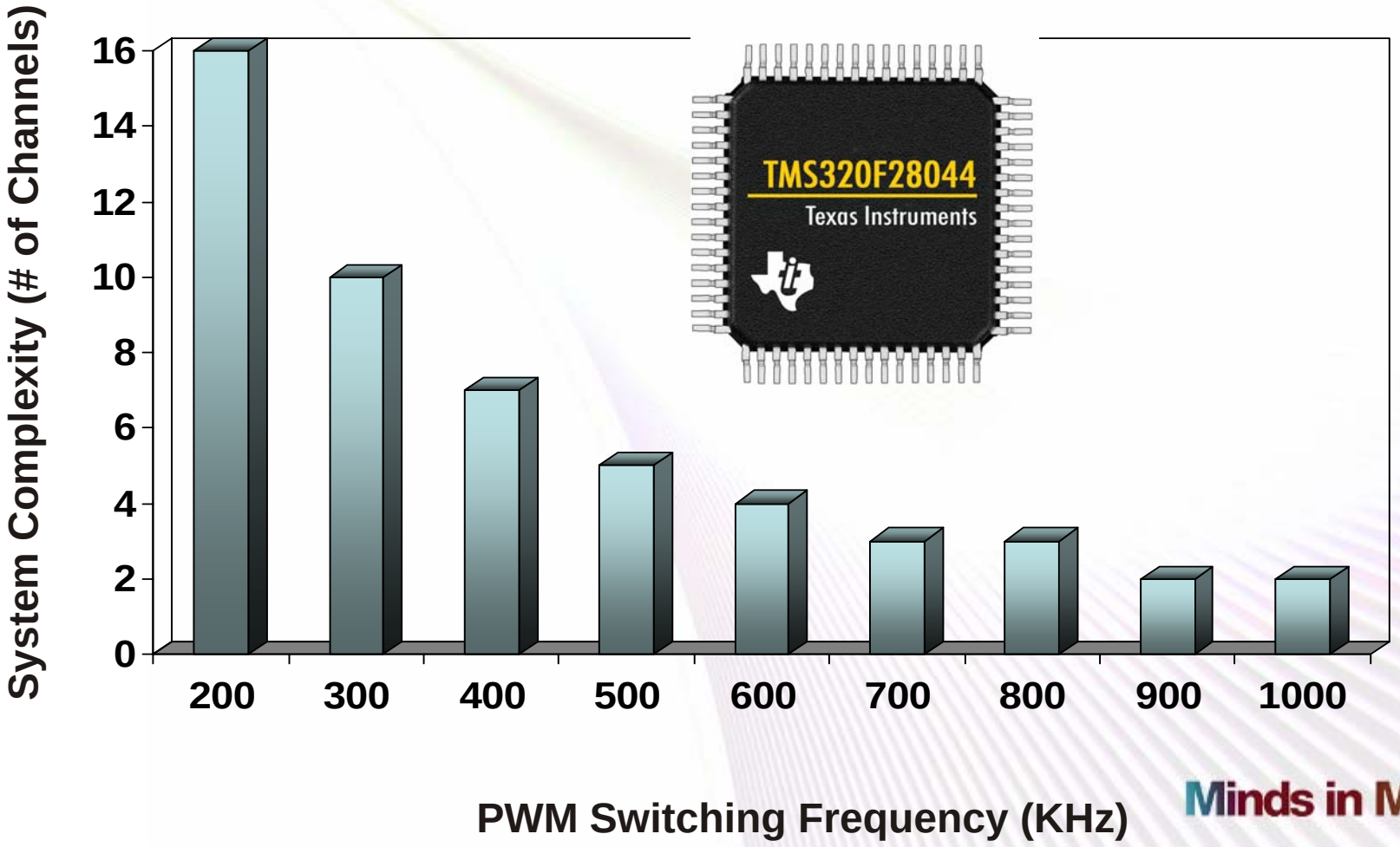
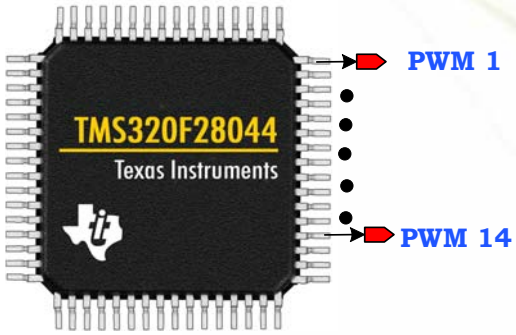
F28044 Controller For System Flexibility

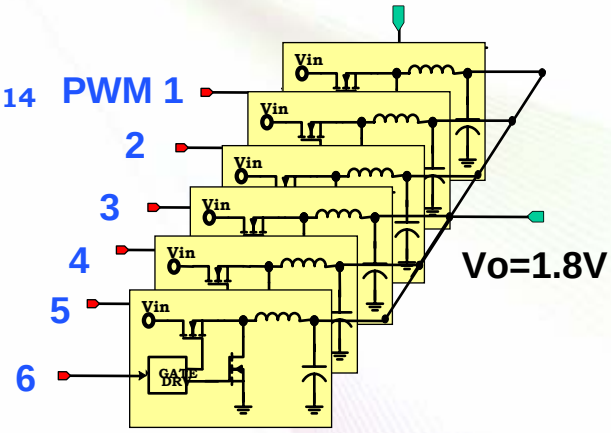


Multi-Phase Control With One F28044



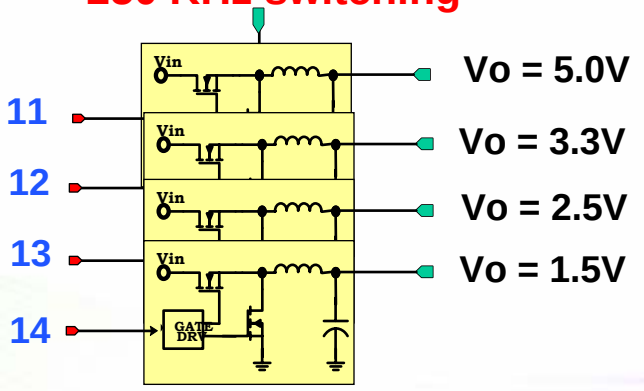
One Controller

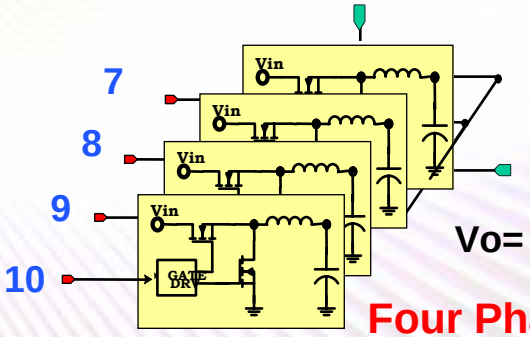
- Six Outputs
- Fourteen Phases
- Soft-start Capability
- Sequencing
- Margining
- Phase Compensation



Six Phases
500 KHz switching

Four Single-Phase
250 KHz switching





Four Phases
250 KHz switching

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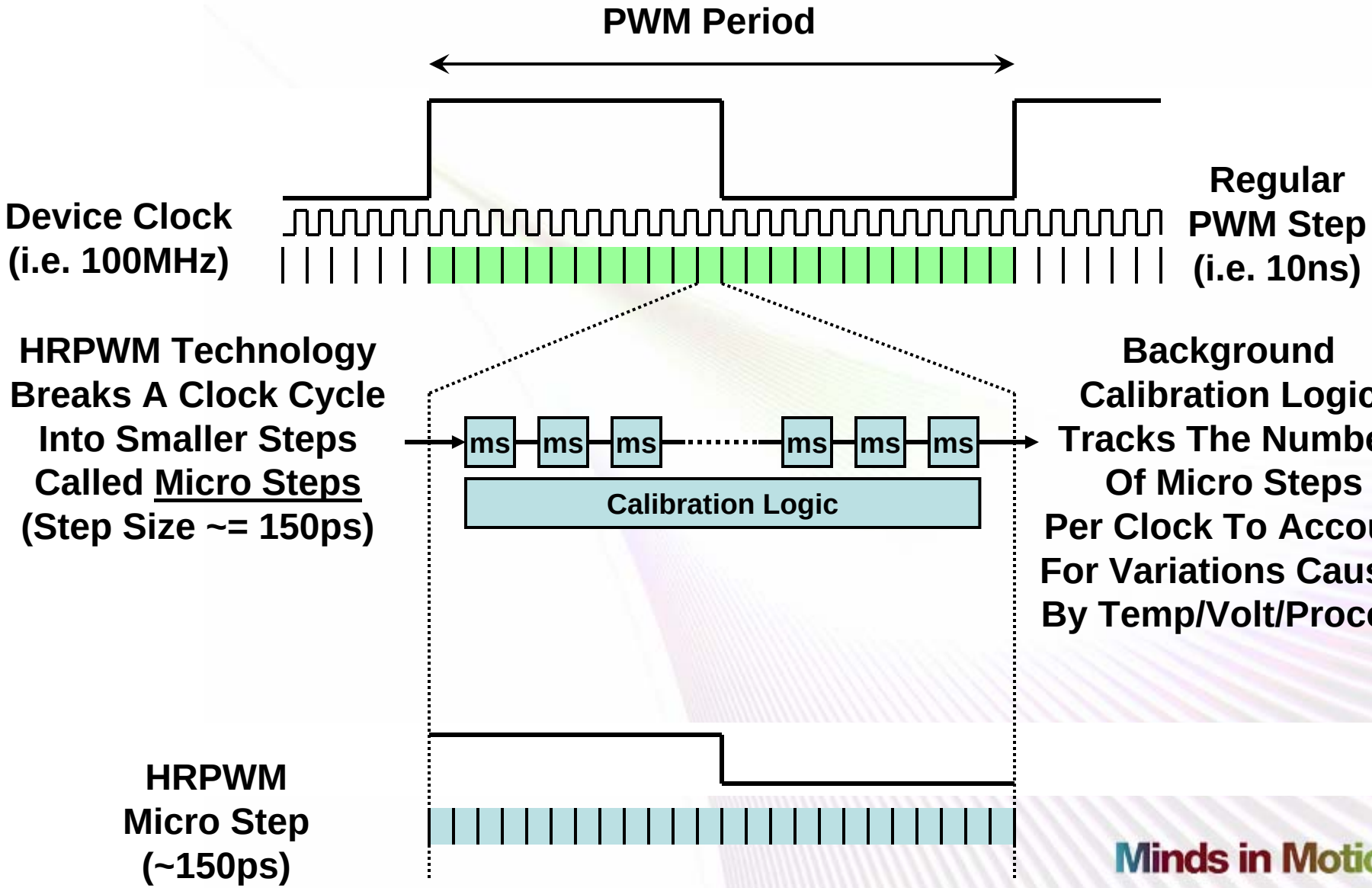
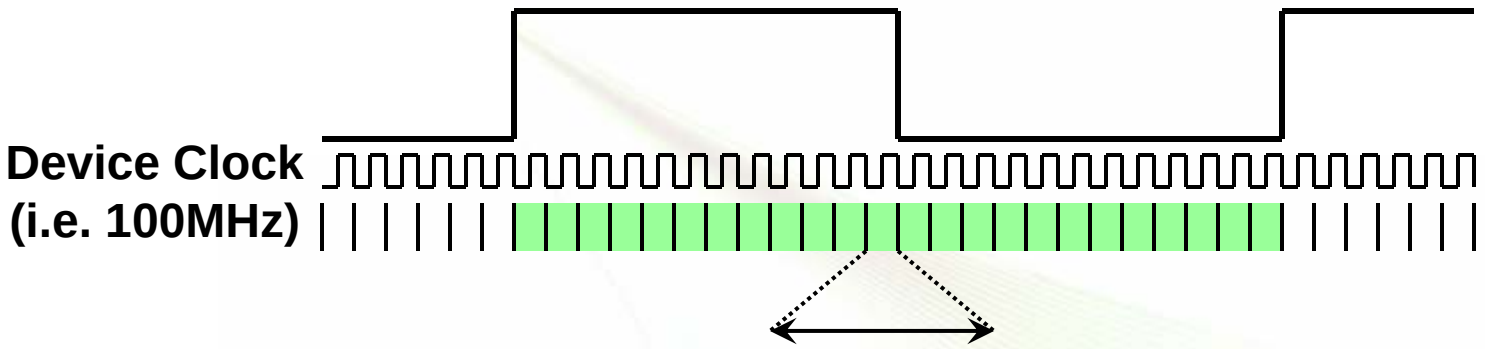
High Resolution PWM



PWM 'DAC' Bits

PWM Period (or Frequency)
(determined by control loop B/W requirements)



PWM Step (i.e. 10ns)
(minimum step typically tied to device clock period)

Equivalent 'DAC' Bits = $\frac{\log_2(\text{Number Of Steps In PWM Period})}{\log_2(2)}$

i.e. Number Of Steps In PWM Period	Equivalent 'DAC' Bits
10000	13.29
1000	9.97
100	6.64

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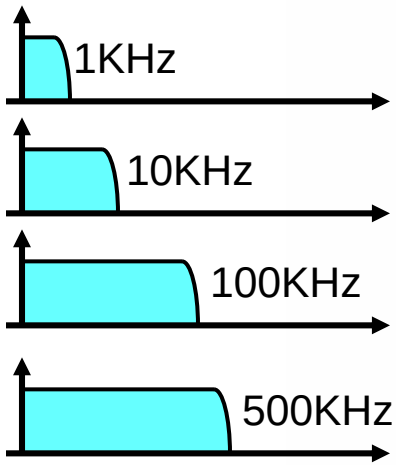
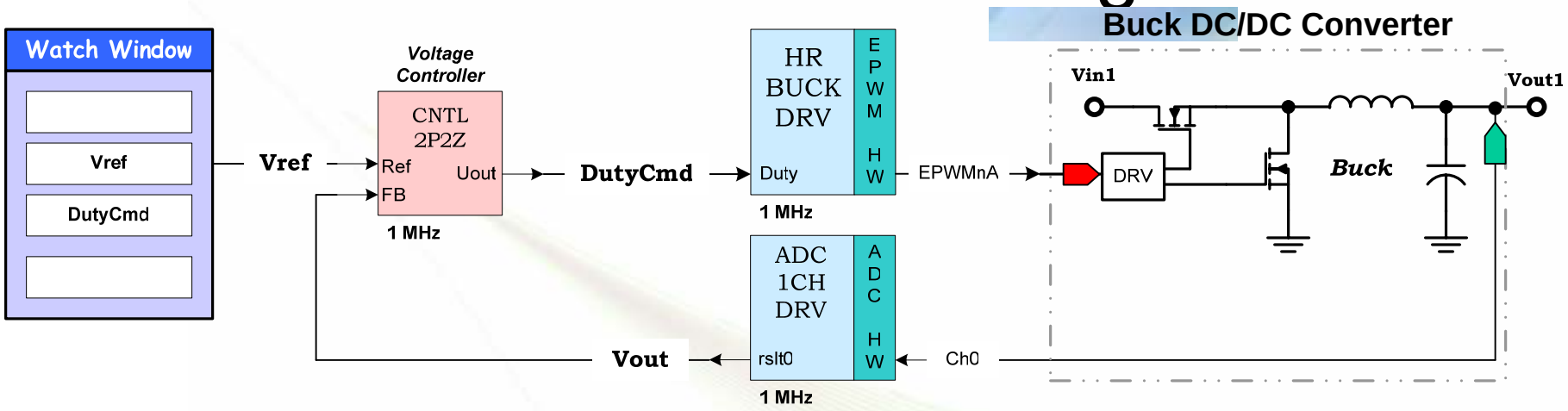
Regular PWM vs. HRPWM



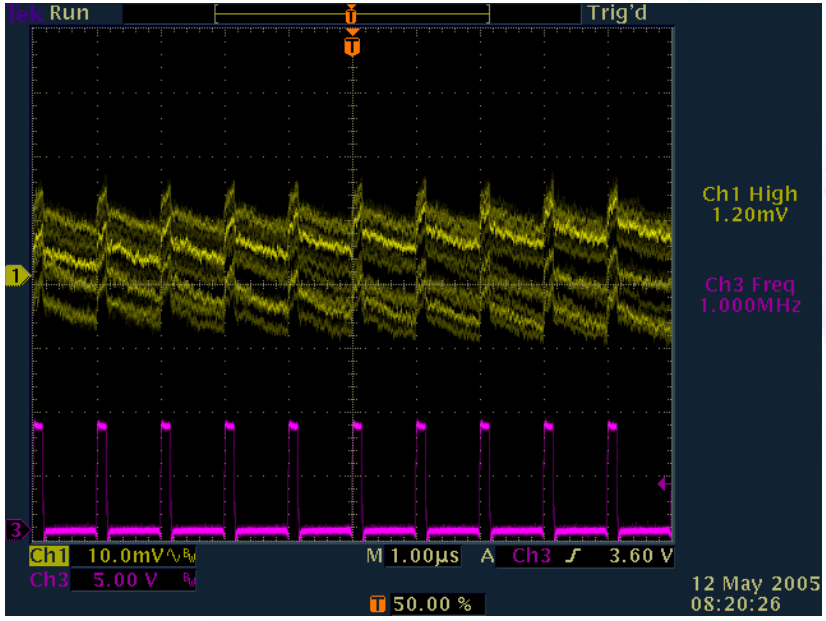
~Required PWM Frequency (x10 B/W)	Regular Steps In PWM Period	**Regular PWM 'DAC' Bits**	Micro Steps In PWM Period	**High Res PWM 'DAC' Bits**
10KHz	10000	**13.29**	~66*10000	**~19.33**
100KHz	1000	**9.97**	~66*1000	**~16.01**
1MHz	100	**6.64**	~66*100	**~12.69**
5MHz	20	**4.32**	~66*20	**~10.37**

With HRPWM Technology,
We Can Now Adequately Control Systems With Control Loop Bandwidths Up to 500KHz

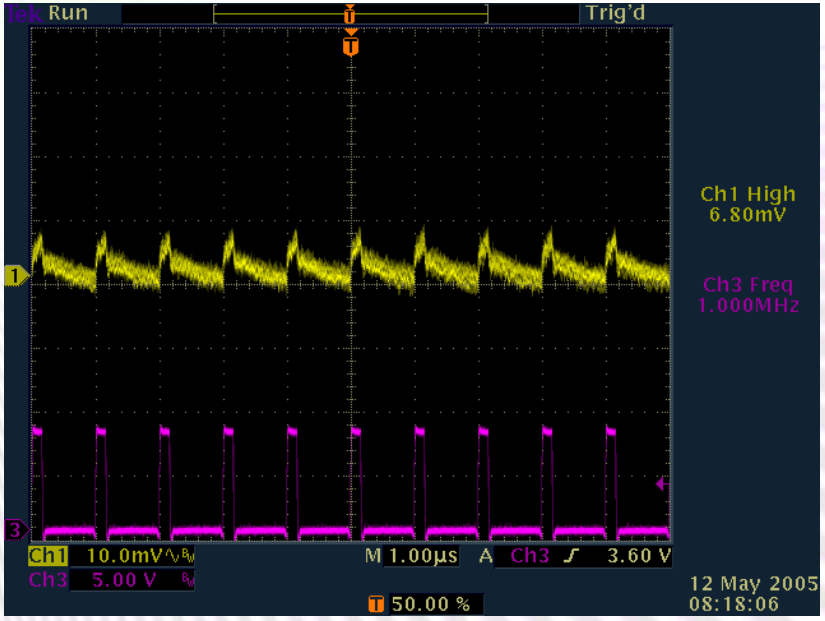
HRPWM for Digital Power



Regular (10nS) PWM – Not Stable 'Hunting'



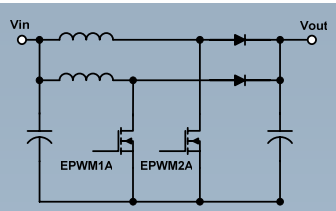
High Res PWM Enabled – Stable Output



Accelerate Design with Digital Power Tools

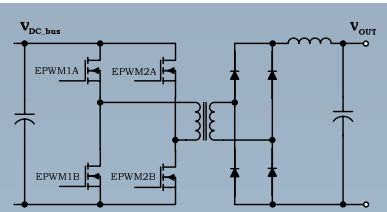
F28044 eZdsp Starter Kit

F28044 Starter Board
Embedded On-Board Emulation
Compiler/Assembler/Linker
C2000 Code Composer Studio™
(eZdsp board specific)
Power Supply
Price: $495



Power Factor Correction Adapter Board PFC2808

Topology	2 ph boost
Input voltage	12-33V AC
Input current	~3A-8A
Output voltage	48VDC
Output current	1.67A
Output power	80W
Efficiency	>90%
Switching frequency	100kHz
Price	*$295*



DC/DC Adapter Board PSFB2808

Topology	Ph Shifted Full Bridge
Input voltage	48 VDC
Input current	1.67 A
Output voltage	5-24 VDC
Output current	10 A
Output power	75 W
Efficiency	>90%
Switching frequency	100kHz
Price	*$295*

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And Free Digital Power Software

- Digital Power Software Library
  - **Scalable, documented, optimized C-code**
    - **DC/DC Buck Converter**
    - **DC/AC Single Phase Inverter**
    - **Two-phase PFC**
    - **DC/DC Phase-shifted Full-Bridge**
  - **Royalty free**
  - **Downloadable from www.ti.com/dpslib**

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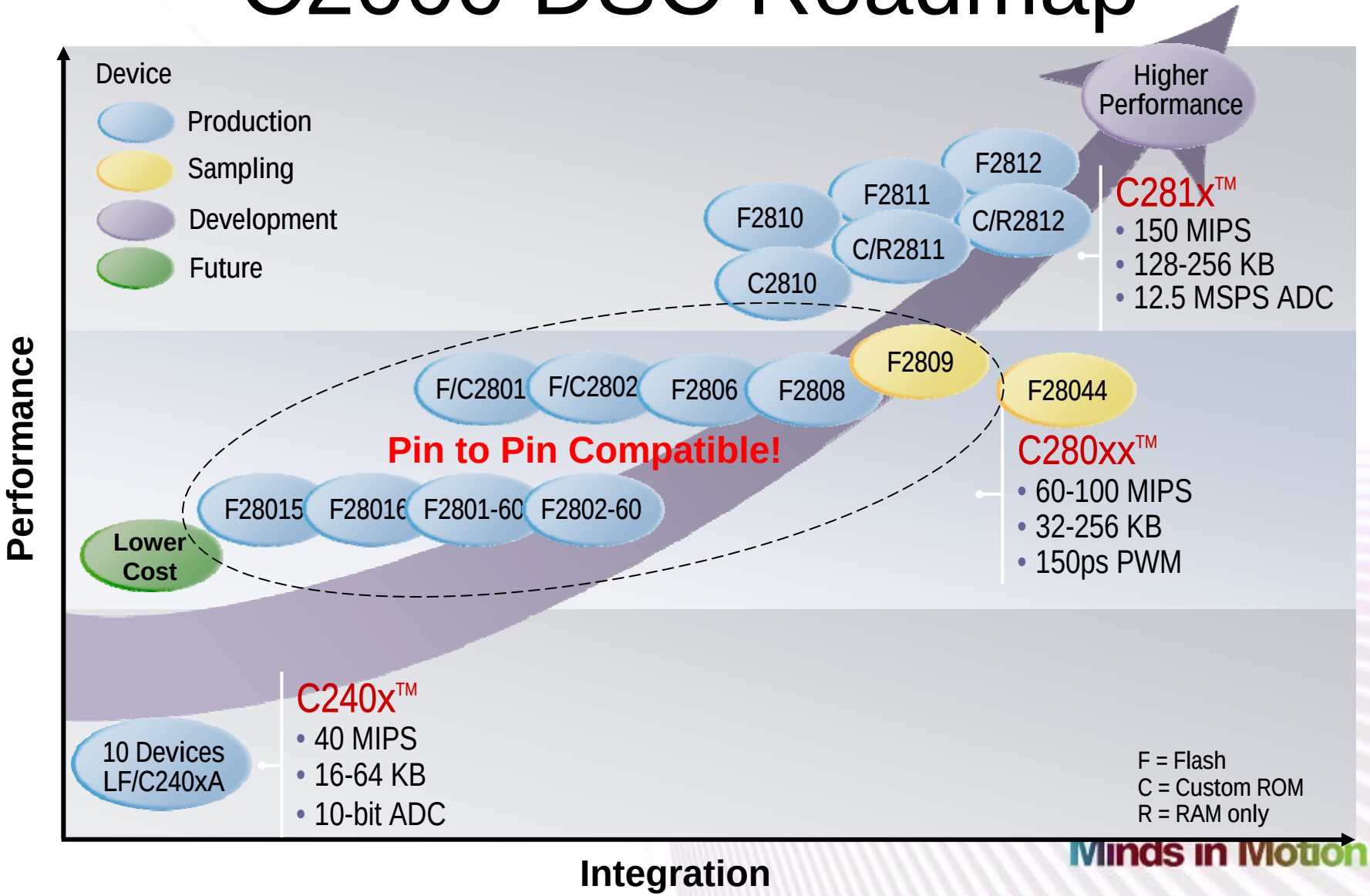
C2000 DSC Roadmap



C2000 Roadmap Directions

- Over the next year;
- More than 2X the performance
- Dramatically LOWER system cost
- Higher PRECISION control

Key TIDC Sessions

- TMS320F2808 Peripheral Programming
  - Three hour hands-on workshop
  - Wednesday from 2:00-5:00 (Ming)
- MATLAB® and Simulink® for Design and Implementation of Motor Control Systems
  - Ninety-minute presentation
  - Thursday from 9:15-10:45 (Miro)

Thank You!