



WT MICROELECTRONICS

文晔科技 股份有限公司

TI Solar Solutions

2019 Q3

Agenda

- Solar product categories
- Solar Inverter
- TI Key products
- TI Reference designs
- TI web source

Solar Product Categories

- Central inverter
- String inverters
- Micro inverters
- Rapid Shutdown
- Smart combiner box
- Solar arc protection
- Solar charge controller
- Solar power optimizer

Solar Inverter



Central inverter

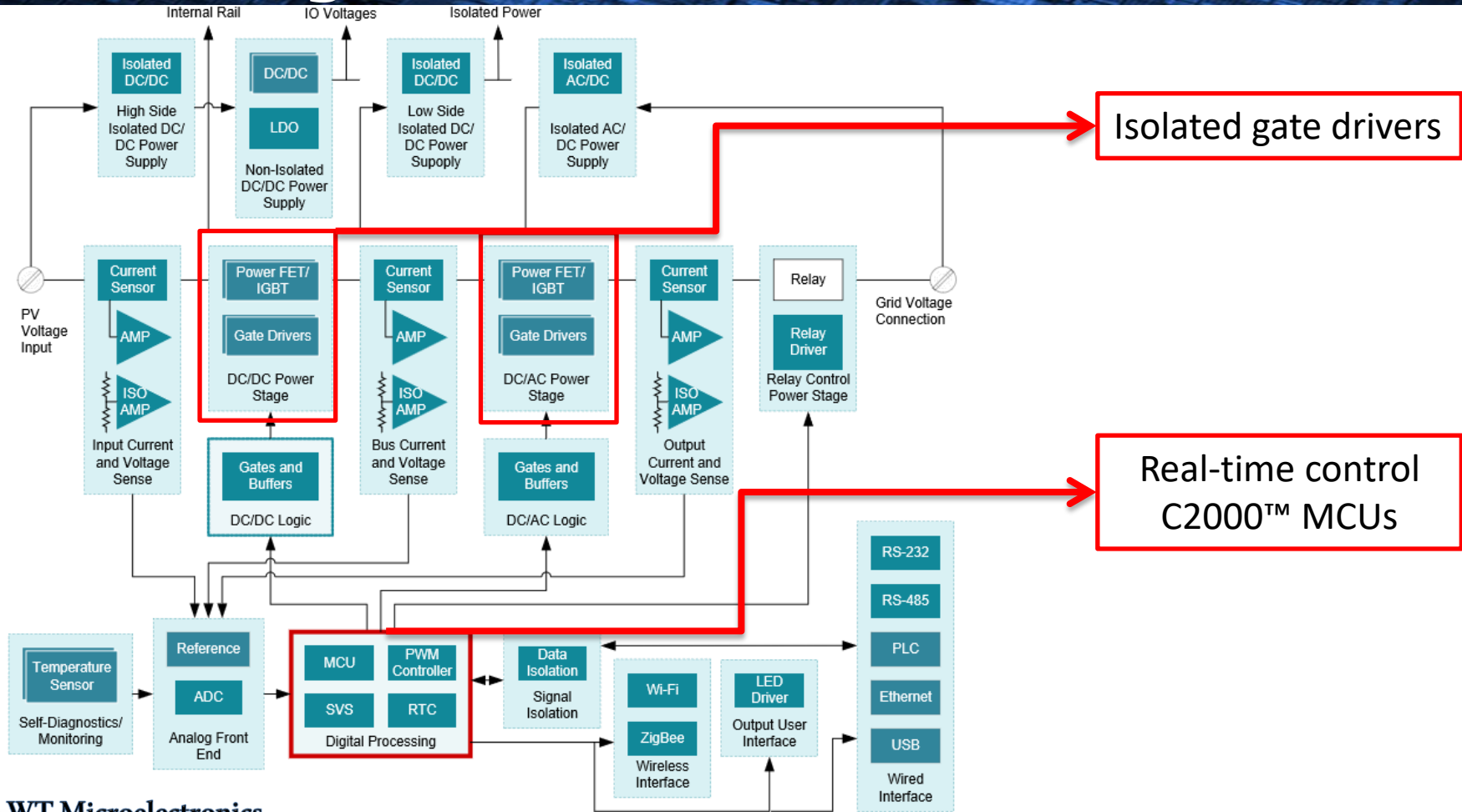


String inverters



Micro inverters

Solar String Inverter



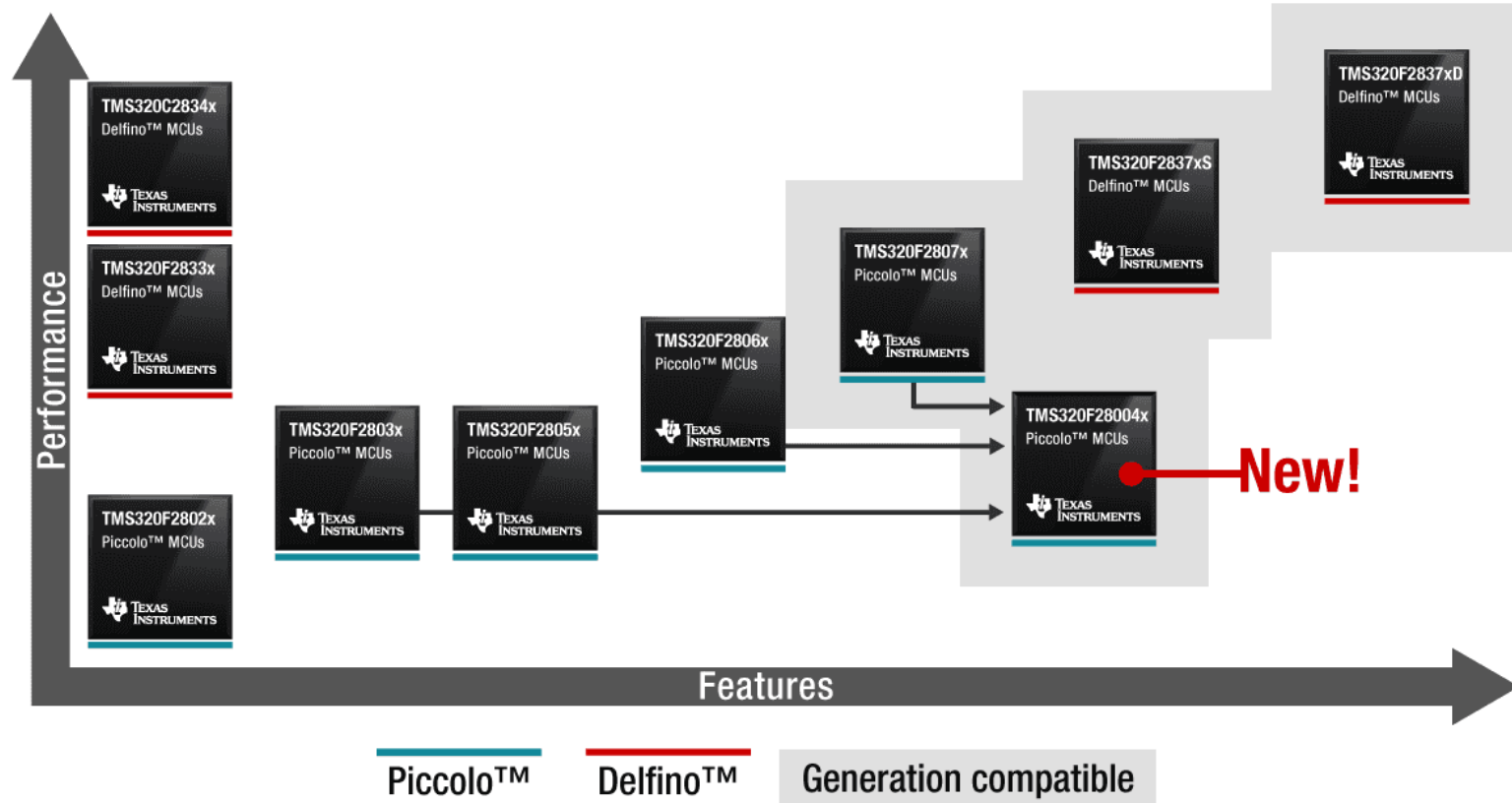


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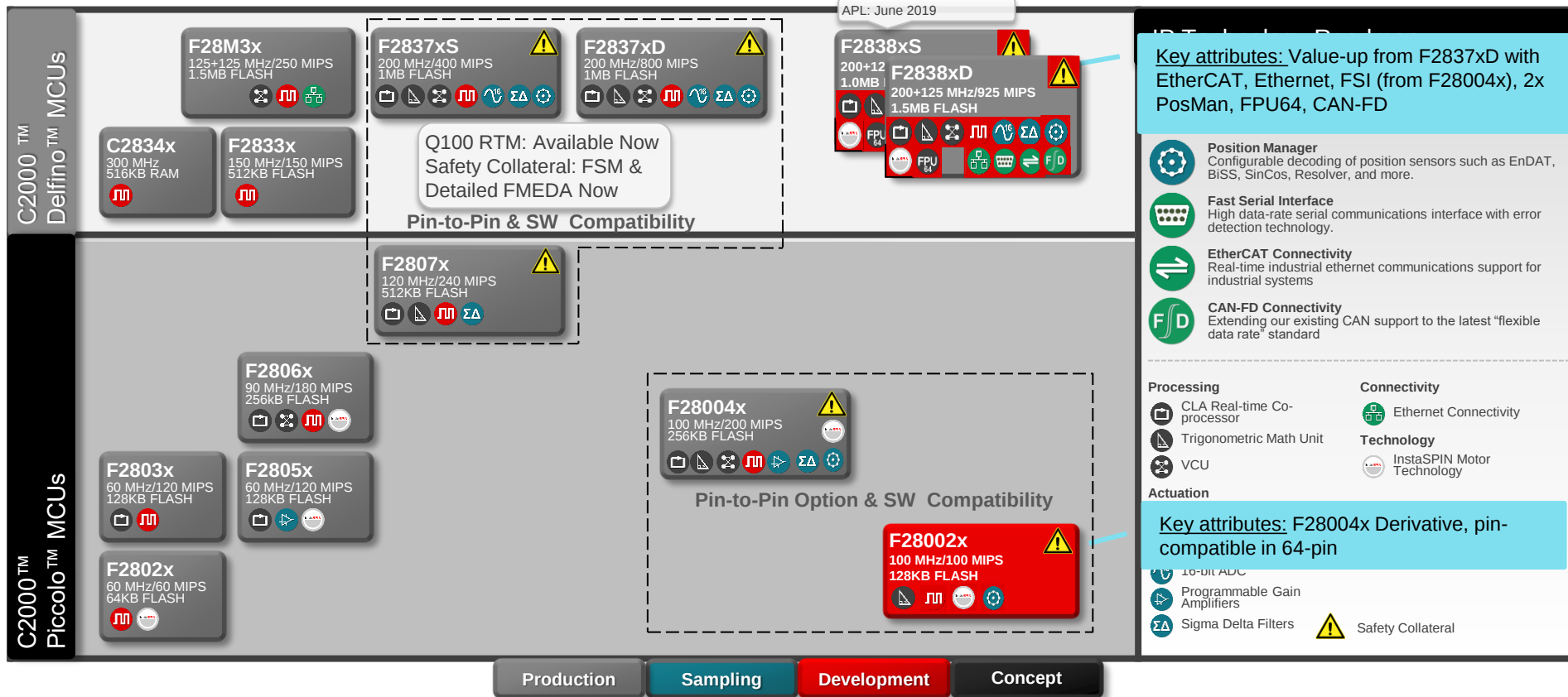
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C2000

C2000 Product roadmap



C2000 Product roadmap



C2000™ Real-Time Microcontroller

Processing

Floating-point C28x™ core with hardware accelerators to simplify digital power operations such as DIV, SQRT, COS, SIN, ARCTAN

Floating-point CLA Real-Time Co-Processor for offloading control loop functions from the main core

Color Key

Sensing

Processing

Actuation

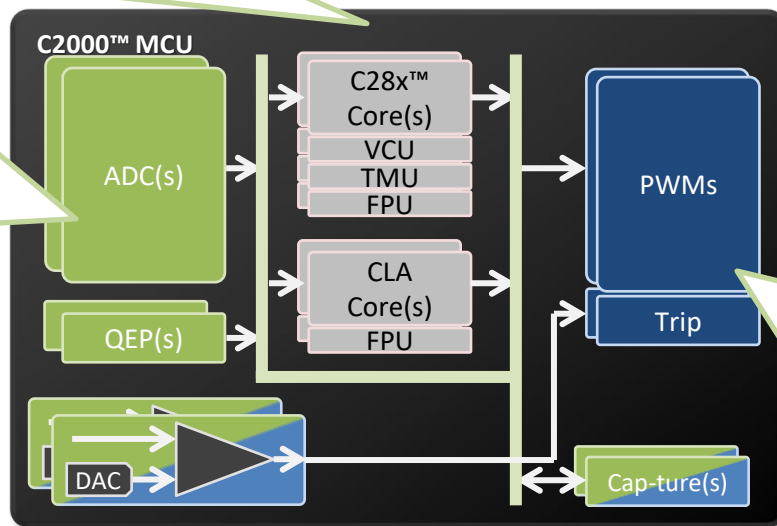
Sensing

12-/16-bit ADCs with up to 3.46MSPS to enable accurate system-level measurements

Tightly coupled ADCs / PWMs

Externally accessible DACs for fault detection

ADC post processing



Actuation

High-resolution PWMs (150 ps) enable faster switching frequencies

Hardware-enabled and fully programmable trip zones for accurate PWM shape definition

Integrated comparators for peak current mode control

Real-Time Control Portfolio

Sampling

Production

Concept

Development

Delfino™

F2833x

C2834x

F2837xS

F2838xS

F2837xD

F2838xD

100 MIPS

800 MIPS

12 PWM ch., Type 1

32 PWM ch. Type 4

1x 12-bit, 2 S/H
12.5 MSPS ADC

4x 12/16-bit, 4 S/H
4/1 MSPS ADCs

Piccolo™

F2802x

F28002x

F2803x

F2805x

F2806x

F28004x

F2807x

40 MIPS

240 MIPS

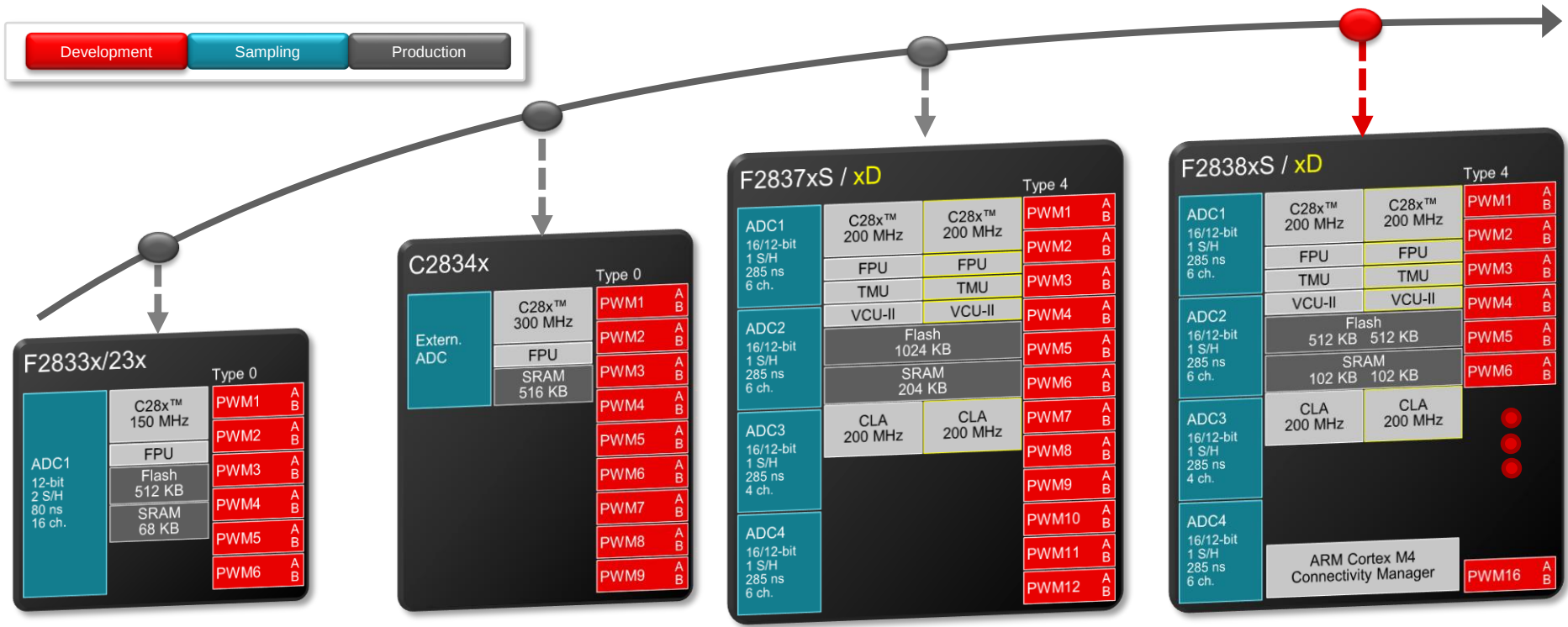
8 PWM ch., Type 1

24 PWM ch. Type 4

1x 12-bit, 2 S/H
2 MSPS ADC

3x 12-bit, 3 S/H
4 MSPS ADCs





Increasing Processing, Memory, and Peripheral Counts

Piccolo™ F28004x

RTM: 64-pin & 100-pin (NOW), 100Q (Sept'18), 64Q (Sept'18), 56-pin (192Q)

<http://www.ti.com/product/TMS320F280049C>

Differentiation

Optimized for Power Control Applications

Streamlined performance and power

- 100MHz / 256KB flash / 100 KB SRAM
- Floating Point and Trigonometric Math Unit
- Next Generation CLA; support for continuous background task
- 60% lower power consumption vs. F2806x + DC-DC option

Advanced actuation and design flexibility

- 4th gen ePWM enables implementation of the most advanced switching techniques for increased efficiency and power density
- Enhanced crossbars provide flexibility in combining inputs, outputs and internal resources for most advanced control and protection mechanisms

Integrated analog and protection

- 3 12-bit 3.45MSPS ADC with post processing and threshold actions
- 7 on-chip PGA(3/6/12/24) with post gain filtering and bypass option
- 7 Windowed Comparators + 2 12-bit output DACs
- 4 Sigma Delta Demodulation Channels

Tools



F28004x Experimenter's Kit

Part Number: TMDSCNCD280049C

<http://www.ti.com/tool/TMDSCNCD280049C>



F28004x LaunchPad

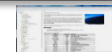
Part Number: LAUNCHXL-F280049C

<http://www.ti.com/tool/launchxl-f280049c>

F28004x

F28004x	Temperatures	
	125C	Q100
Sensing	Processing	Actuation
ADC1: 12-bit, 3.45 MSPS, 8ch	C28x™ DSP core	8x ePWM Modules
ADC2: 12-bit, 3.45 MSPS, 8ch	100 MHz	16x Outputs (16x High-Res)
ADC3: 12-bit, 3.45 MSPS, 8ch	FPU	Fault Trip Zones
7x Windowed Comparators w/ Integrated 12-bit DAC	TMU	2x 12-bit DAC
7x PGAs	VCU-I	Connectivity
4x Sigma Delta Channels (2x Filters per channel)	CLA core	2x UART, 1x LIN/UART
Temperature Sensor	100 MHz	2x I2C (1x true PMBus)
2x eQEP	Floating Point Math	2x SPI
7x eCAP (2x HRCAP)	6ch DMA	2x CAN 2.0B
Configurable Logic Block	Memory	FSI
4 Tiles	Up to 256 KB Flash (dual-bank) +ECC	Power & Clocking
Position Manager: Flexible Absolute Encoder Interfaces	Up to 100 KB SRAM +parity	2x 10 MHz 0-pin OSC
System Modules	2x 128-bit Security Zones	1.2V VREG
3x 32-bit CPU Timers	Boot ROM	POR/BOR Protection
NMI Watchdog Timer	InstaSPIN™ Motor ROM	Debug
192 Interrupt PIE		cJTAG / Real-time JTAG
		Embedded Real-time Analysis And Diagnostic unit (ERAD)

Software



C2000Ware Software Package

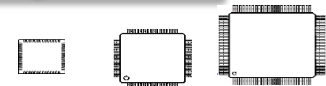


DigitalPower SDK & powerSUITE



Code Composer Studio (CCS) IDE

Packages



Package	Dimension
56-pin QFN	7x7mm
64-pin LQFP	12x12mm
100-pin LQFP	16x16mm

Delfino™ F2838xD

Short Datasheet: NOW on [Intolink Room](#)

FCS: Dec'18 APL: June'19 RTM: June'20

Differentiation

High performance C2000 Delfino enhanced with rich connectivity

Real-time Connectivity

- EtherCAT Industrial Fieldbus or 10/100 Ethernet MAC
- CAN-FD, CAN, USB, multiple serial ports

Connectivity Manager

- Arm® Cortex-M4: 125MHz / 512KB / 96KB
- uDMA / AES / CRC
- Dedicated, fully programmable communications sub-system

Real-time Control

- 800 / 400 MIPS performance with extended 64-bit FPU and HW divide
- Premium A/D Converters and Comparator Sub-system
- Most flexible and advanced timers and PWMs
- Position Manager for multi-protocol rotor position encoder support

Tools



F2838x Experimenter's Kit

Part Number: TBD

Software



Application SDKs



C2000Ware Software Package



Code Composer Studio (CCS) IDE

Packages



Package	Dimension
176-pin HLQFP	24x24mm ²
337-pin NFBGA	16x16mm ²

F2838xD

		Temperatures	
		125C	125C Q100
Connectivity		Processing	Processing
Connectivity Manager (CM) Access	C28x Access	C28x™ DSP core 200 MHz	C28x™ DSP core 200 MHz
10/100 Ethernet	FSI: 2x Tx, 8x Rx	FPU64	FPU64
CAN-FD	2x McBSP	TMU	TMU
UART	4x UART	VCRC	VCRC
SSI	4x SPI	CLA core 200 MHz	CLA core 200 MHz
I2C	2x I2C, 1x PMBus	Floating Point	Floating Point
EtherCAT		Memory	Memory
USB MAC & PHY		512 KB Flash	512 KB Flash
2x CAN 2.0B		44 KB RAM	44 KB RAM
System Modules		128 KB RAM Shared	
3x 32-bit CPU Timers per C28x CPU		26 KB RAM Shared for IPC	
192 Interrupt PIE per C28x CPU		2x Security Zones	
Watchdog Timer		Boot ROM	
Missing Clock Detection		InstaSPIN-FOC Motor ROM	
Power & Clocking		6-ch DMA 6-ch DMA	
2x 10 MHz OSC		2x EMIF	
Ext OSC Input		Debug	
		Real-time JTAG	
		Real-time Analysis And Diagnostic unit (ERAD)	
		Actuation	
		16x ePWM Modules (Type 4)	
		32x Outputs (16x High-Res)	
		Fault Trip Zones	
		3x 12-bit DAC	
		Sensing	
		4x Analog to Digital Converters	
		16-bit Mode	
		1.1-MSPS	
		12 differential or	
		24 single-ended channels	
		12-bit Mode	
		3.5 MSPS	
		24 single-ended channels	
		8x Windowed Comparators w/ Integrated 12-bit DAC	
		8x Sigma Delta Interface	
		Temperature Sensor	
		3x eQEP	
		7x eCAP (2x HRCAP)	
		Configurable Logic Block	
		8 Tiles	
		Position Manager:	
		Flexible Absolute Encoder Interface	



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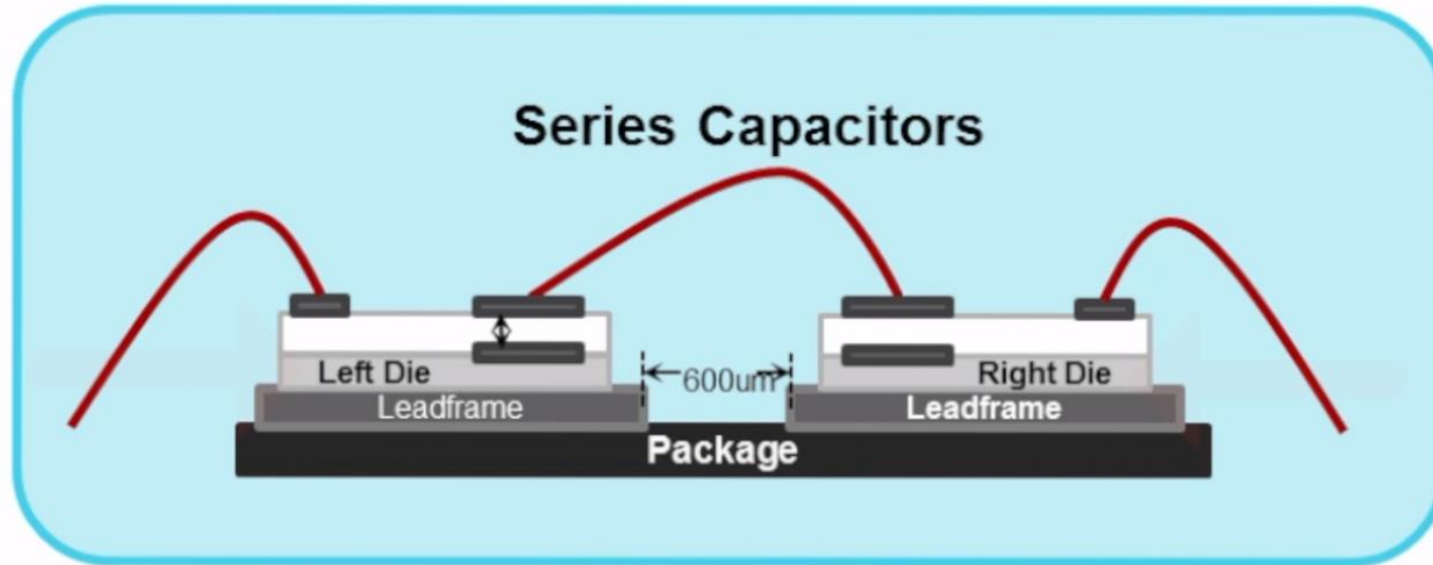
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TI Isolation solutions

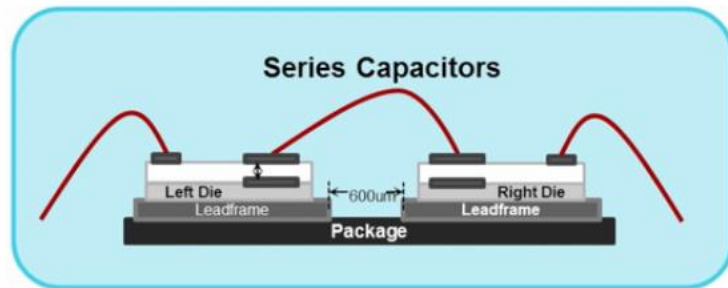
TI Isolation solutions

- Isolated gate drivers
- Digital isolators
- Isolated interface
- Isolated ADCs & amplifiers

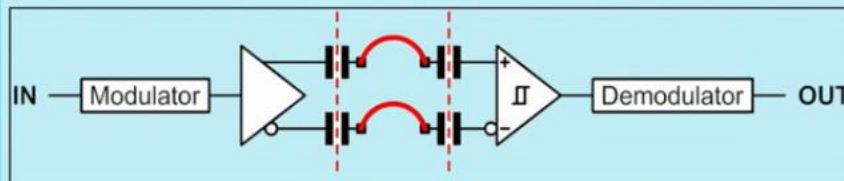
Reinforced Isolation Technology



Reinforced Isolation Technology



ISO78xx/77xx
AMC1303/06/11
UCC2x52x



- Reinforced Isolation is realized by thick SiO₂ capacitors combined in series
 - Each channel uses high voltage isolation capacitors on both die
- Combined Isolation capacitor thickness is >21μm
- 12.8kV surge voltage, 8kV peak transient over-voltage, 1.5kVrms working voltage

UCC23513: 3A, 5KVrms Opto-Compatible Input, Single Channel Isolated Gate Driver in Stretched SO6

Features

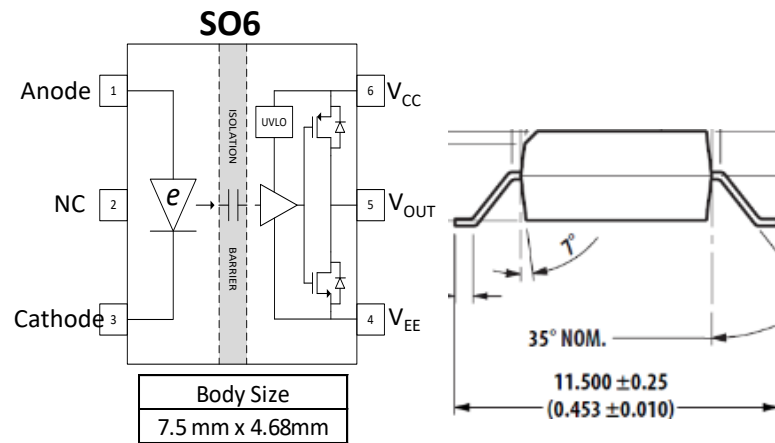
- Opto-compatible Input, Isolated Gate Driver for IGBT/MOSFET/SiC
- SiO₂ Based Capacitive Isolation Technology
- Pin-compatible, Drop-in Upgrade for ACPL-W341, W346
- 3A Peak Output Drive Current
- 33V Max Output Drive ($V_{CC}-V_{EE}$)
- SO6 (6 pin-SOIC Wide Lead)
- >8.5mm Cr & Clr; 5 KV_{rms} Reinforced Isolation
- 115ns Propagation Delay with 25ns Part-to-Part Delay Matching
- >100 KV/us Common Mode Transient Integrity (CMTI)
- 12V Under Voltage Lockout (UVLO)
- Input Stage Can be Reverse Biased for Interlock
- Wide Operating Temperature Range (Tj) : -40°C to 150 °C

Applications

- Industrial Motor Control Drives
- Industrial Power Supplies
- Solar Inverters, UPS

Benefits

- Higher Common Mode Transient Integrity
- Smaller Propagation Delay and Tighter Part-to-part Delay Matching
- Lower Pulse Width Distortion
- Higher Reliability, Resistant to Temperature & Aging



UCC21520: 2-Channel Isolated Gate Driver (5.7kVrms V_{ISO})

Features

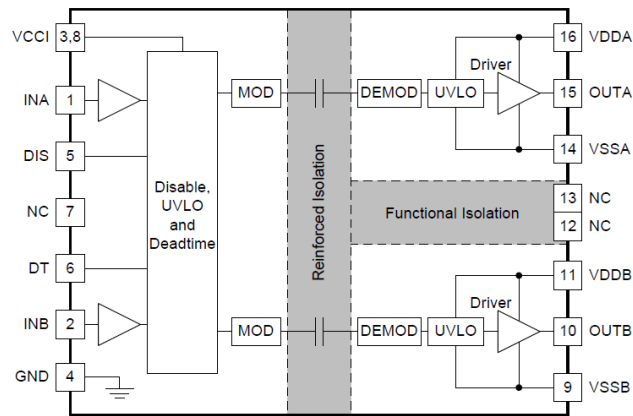
- Pin-for-pin with Competitors
- 6-A Peak Sink and 4-A Source Output
- 30ns Prop Delay, < 5ns Delay Matching, 5ns Max PWM Distortion
- 5.7kVrms Isolation Capability Input-to-Output
- >12.8kV Surge Immunity
- Programmable Overlap and Dead-time Control
- CMTI: 100V/ns (min)
- 1500Vdc Output Channel-to-Channel Isolation
- 3V to 18V Input Supply Voltage
- 4.5 V to 30 V Output Drive Supply Voltage, w/ UVLO
- TTL Compatible, Independent Inputs for Each Channel
- Operating range from -40 to 125°C
- Wide Body SOIC-16 (DW) Package

Applications

- AC/DC & Isolated DC-DC Converters
- High Frequency Inverters, Motor Drives
- UPS, Solar Power
- Si, GaN and SiC MOSFET Gate Drive

Benefits

- Drop-in replacement with better performance in key areas
- High(er) drive can eliminate buffer stages and meet the requirements of a wide range of applications
- UL, CQC, VDE certified
- Flexible settings to prevent shoot-through in ½ bridge applications
- Provides high noise immunity for fast/high current designs



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ISO5452: +2.5A/-5A, Isolated, High CMTI, Miller Clamp

Features

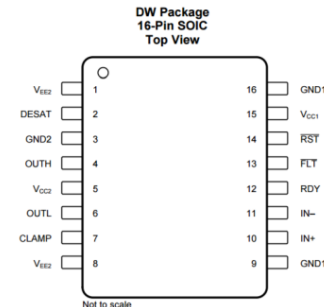
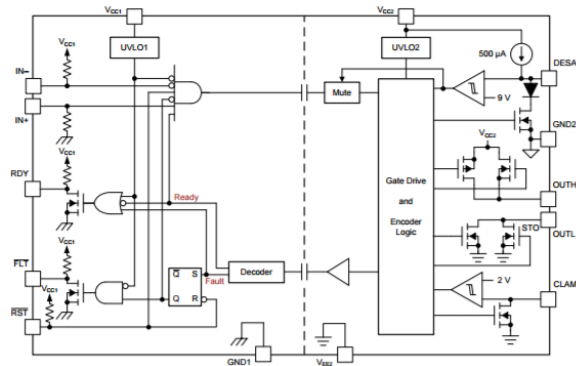
- **Integrated SiO₂ Dielectric Capacitor**
 - CMOS compatible logic input threshold
 - Safety Features: Miller Clamp, Desat Detect, UVLO, Fault feedback, Ready status feedback, auto soft-shutdown on short
 - +2.5/-5A Peak Source/Sink Split Outputs
 - 100 kV/μs CMTI (typ) / 50 kV/μs (min)
 - 30ns Integrated Glitch Filter
 - 110 ns (max) Prop Delay
 - 4kV ESD on all pins
- **Immunity and Certifications**
 - 10 kVpk Surge (6kV V_{IORM}) per VDE Reinforced Isolation
 - 5.7 kVrms Isolation rating per UL1577
 - 8 kVpk V_{IOTM} (transient) and 1420 Vpk V_{IORM} (working voltage) per VDE0884-10
 - Enables IEC61800-5-1, IEC60664-1 & IEC62109-1
- **Power and Package**
 - Wide V_{CC2} Range: 15V-30V
 - 16-pin Wide SOIC Package (>8mm Creepage)
 - Extended Temp: -40 to 125 °C

Benefits

 : AEC-Q100

- Component-level Reinforced rating
- Improved system performance
- Enabling low power & efficient solutions
- High Immunity for Noisy Environments
- High Reliability in Harsh Environments
- Certified by all 3 World Wide agencies

PART #	Split outputs	Soft Turnoff	UVLO+/UVLO- (typ)	PKG
ISO5452	Yes	Yes	11.6/10.3	16DW



UCC5350MCD: 5A/5A, 3-kVRMS Single-Channel Isolated Gate Driver with Miller Clamp

Features

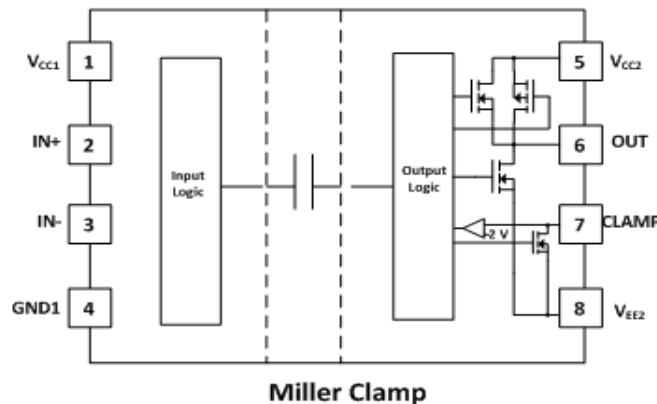
- **Integrated SiO₂ Dielectric Capacitor**
 - 5A/5A Peak Source/Sink Drive
 - Miller Clamp Output
 - >100 kV/us CMTI
 - 100 ns Propagation Delay (max)
 - Negative voltage handling on input pins (-5V)
 - 4kV ESD on all pins
- **Immunity and Certifications**
 - Basic Isolation
 - Safety-related certifications:
 - 4242-VPK Isolation per DIN V VDE V 0884-10 and DIN EN 61010-1 (Planned)
 - 3000-VRMS Isolation for 1 Minute per UL 1577 (Planned)
 - CSA Component Acceptance Notice 5A, IEC 60950-1 and IEC 61010-1 End Equipment Standards (Planned)
 - CQC Certification per GB4943.1-2011 (Planned)
- **Power and Package**
 - Wide V_{CC2} Range: 13.2 to 33V
 - 8-pin Narrow Body SOIC (4 mm Creepage)
 - 3V to 15V input supply range

Applications

- Industrial Motor Control Drives
- Industrial Power Supplies
- Solar Inverters
- HEV & EV power modules

Benefits

- Family (UCC53x0) with different configuration options available
- Miller clamp option connects gate of transistor to internal clamp to prevent false turn on caused by Miller current
- Enabling low power & efficient solutions
- Improved system performance



AMC1301 200 kHz Reinforced Isolated Amplifier for Current Sensing

Features

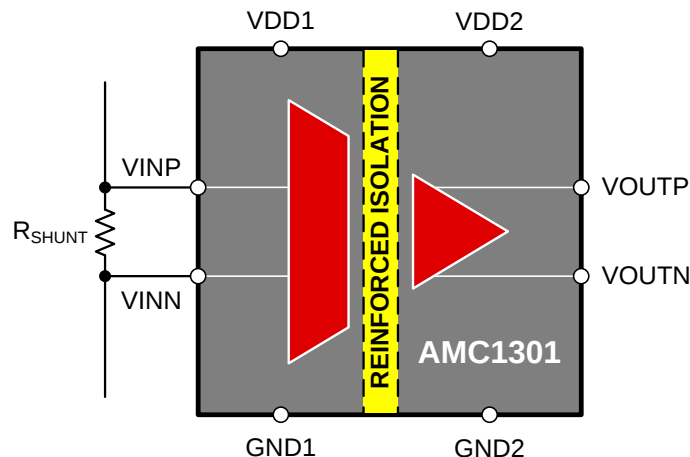
Device	AMC1301	AMC1301S
Isolation	Reinforced	Reinforced
Voltage Input Range	± 250 mV	± 250 mV
Input Offset / Drift (max)	± 0.2 mV / ± 3 μ V/ $^{\circ}$ C	± 0.2 mV / ± 4 μ V/ $^{\circ}$ C
Gain Error / Drift (max)	$\pm 0.3\%$ / ± 50 ppm/ $^{\circ}$ C	$\pm 0.3\%$ / ± 60 ppm/ $^{\circ}$ C
Nonlinearity (max)	0.03%	0.03%
Output BW (typ)	210 kHz	210 kHz
Working Voltage	1 kV _{RMS}	1 kV _{RMS}
Isolation Transient Overvoltage	7 kV _{PEAK}	7 kV _{PEAK}
CMTI (min)	10 kV/ μ s	10 kV/ μ s
Temperature Range	-40 $^{\circ}$ C to 125 $^{\circ}$ C	-55 $^{\circ}$ C to 125 $^{\circ}$ C

Application

- Isolated Current Measurement:
- Motor Drives
- Power Monitoring
- Inverter Applications
- Over-Current Protection Systems

Benefits

- Pin-to-pin performance upgrade to ACPL-C79B
- Highest accuracy measurements with >2x better linearity
- 64% lower power dissipation (73% on VDD1)
- 10% faster step response time due to a wider bandwidth
- VDD1 missing detection to simplify system-level design



DC-PADC Isolated Amplifiers Isolated Current and Voltage Measurement

Parameter	AMC1100	AMC1200	AMC1301	AMC1301S	AMC1311	AMC1311B
Isolation Rating	Basic	Basic	Reinforced	Reinforced	Reinforced	Reinforced
Application	Current Measurement	Current Measurement	Current Measurement	Current Measurement	Voltage Measurement	Voltage Measurement
Input Voltage Range	±250 mV	±250 mV	±250 mV	±250 mV	2 V	2 V
Isolation Working Voltage V _{IOWM} (V _{rms})	800	800	1000	1000	1500	1500
Isolation Transient Overvoltage V _{IOTM} (V _{peak})	4250	4250	7000	7000	8000	8000
Small Signal Bandwidth (Typ) (kHz)	100	100	210	210	220	275
Input Offset Voltage V _{os} (Typ/Max) (mV)	±0.2/±1.5	±0.2/±1.5	±0.05/±0.2	±0.05/±0.2	±9.9 (max)	±1.5 (max)
Input Offset Drift TC _{Vos} (Typ/Max) (μV/°C)	±1.5/±10	±1.5/±10	±1/±3	±1/±4	±20 (typ)	±3/±15
Gain Error (Max) (%)	±1	±1	±0.3	±0.3	±1	±0.3
Gain Error drift (Max) (ppm/°C)	±56 (typ)	±56 (typ)	±50	±60	±30 (typ)	±45
Gain Nonlinearity (Max) (%)	±0.075	±0.075	±0.03	±0.03	±0.04	±0.04
CMTI (Min) (kV/μs)	2.5	10	15	15	15	75
Operating Temperature Range (°C)	-40 to 105	-40 to 105	-40 to 125	-55 to 125	-40 to 125	-55 to 125
Package	SOP-8 SOIC-8	SOP-8	SOP-8 SOIC-8	SOIC-8	SOIC-8	SOIC-8

ISO77xx–Robust 5kVrms Isolators High-Immunity, 100 Mbps, 2.25V Rail support

Features

• Integrated SiO₂ Dielectric Capacitor

- 100 Mbps max data rate
- Typ Prop Delay: **11 ns**
- Max Ch-Ch Skew: **2.5ns**
- MAX Part-Part-Skew: **<5ns**
- Low Power:
 - 1.5mA / channel typical at 1Mbps
 - 1mA/channel in default state
 - 0.5mA/channel in disable state
- Fast recovery from errors.
- High and Low Default states available.

• Immunity and Certifications

- Reinforced Isolation (DIN V VDE V 0884-11)
- CMTI: **100kV/μs** typical (**85kV/us** min)

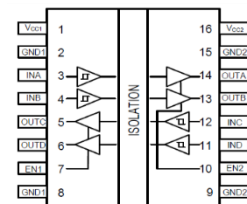
	ISO Rating	Surge	Working Voltage
SOIC-16 DW	5000 Vrms	12800 Vpk	1000 Vrms
SOIC-8 DWV	5000 Vrms	12800 Vpk	1000 Vrms
SOIC-8 D	3000 Vrms	8000 Vpk	450 Vrms
QSOP-16 DBQ	3000 Vrms	6400 Vpk	400 Vrms

• Power and Package

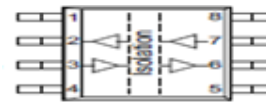
- **2.25V to 5.5V** Wide Supply Range
- Operating temperature range -55C to 125C
- SOIC-16W w/ 8 mm creepage / clearance (6, 4, 3, 2 and 1 channels)
- SOIC-8DWV w/ 8 mm creepage / clearance (2 channels)
- Small QSOP-16 package (6, 4 and 3 channels)
- Small SOIC-8 package (2 and 1 channels)

Benefits

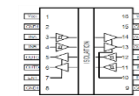
- Reinforced Isolation Rating
- High Immunity and Robustness
 - System Level EMC for IEC61000-4-x ESD, EFT events, Radiated and Conducted RF immunity.
 - Low EM emissions.
- Precision timing:
 - Low propagation delay, low skew and fast recovery from errors
 - beneficial for switching mode synchronous power supplies, and SPI communications
- Pin to Pin compatible with competitor parts



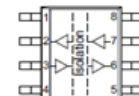
SOIC 16 pin
7.5mmx10.3mm



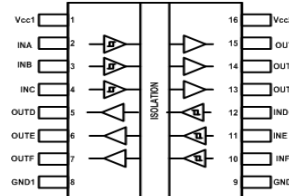
SOIC 8 pin DWV
7.5mmx5.85mm



QSOP 16 pin
3.9mmx4.9mm



SOIC 8 pin
3.9mmx4.9mm



ISO78xx – Robust Reinforced ISOHigh-Immunity

Features

- **Integrated SiO2 Dielectric Capacitor**
 - 100 Mbps data rate supported
 - Typical Prop Delay: 11 ns
 - Max Ch-Ch Skew: 2.5ns, MAX Part-Part-Skew: <5ns
 - Power: 1.7mA / channel typical (3.3V)
- **Immunity and Certifications**
 - CMTI: 100kV/ μ s minimum
 - 5700 VRMS Isolation Rating (UL 1577)
 - 12800 VPEAK Surge
 - 1500 VRMS Working Voltage (DIN V VDE V 0884-10)
- **Power and Package**
 - 2.25V to 5.5V Wide Supply Range
 - SOIC -16W with 8 mm creepage / clearance
 - SOIC – 16DWW with 14mm creepage / clearance (2015)

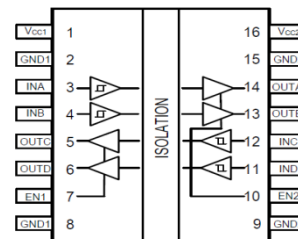
Applications

- **Industrial Automation**
 - PLC, Servo, Motor Control, Sensors
 - Fieldbus – Modbus, Profibus, DeviceNet
 - Data Buses, CAN, RS485
- **Power Supplies**
- **Solar Inverters**
- **Medical Equipment**
- **Automotive – EV & HEV**

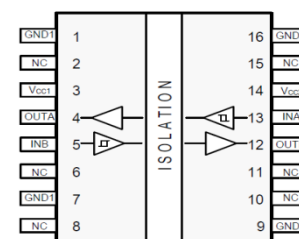
Benefits

- **Reinforced Isolation Rating**
 - Unmatched reliability with 50% higher working voltage for 40 years barrier lifetime
- **Industry Leading Immunity**
 - 2x higher immunity to disruptive CMTI events
 - Robust EMI for IEC61000-4-x ESD, EFT events
 - Class A; High Conducted & Radiated RF immunity
 - Glitch filters are not required.
- **Precision timing for low latency and high speeds**

ISO7842



ISO7821





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TI Amplifiers for any system

Products List - GPAMPS

高性能系列

高压

¹²⁴
TLV910x | 1MHz
16V, Vos=1.4mV

¹²⁴
TLV930x | 1MHz
40V, Vos=2.5mV

¹²⁴
OPAx990 | 1MHz
40V, Vos=1.4mV

¹²⁴
TLVx172 | 10MHz
36V, Vos=1.7mV

低压

¹²⁴
TLV900x | 1MHz
5.5V, Vos=1.5mV,
Iq=60uA

¹²⁴
TLV905x | 5MHz
5.5V, Vos=1.6mV,
Iq=330uA

¹²⁴
TLV906x | 10MHz
5.5V, Vos=1.5mV,
Iq=538uA

通道数 ^x

标准系列

高压

LM358B
36V, Vos=3mV

LM2904B
36V, Vos=3mV

低压

LM321LV
5.5V, Vos=3mV

LM358LV
5.5V, Vos=3mV

LM324LV
5.5V, Vos=3mV

LM2902/04LV
5.5V, Vos=3mV

555
时钟

NE555 | 0.1MHz
15V, Iq=2mA

LMC555 | 3MHz
16V, Iq=50uA



WT MICROELECTRONICS

文晔科技 股份有限公司

TI Reference designs & Support For Solar

TIDM-SOLAR-DCDC

Features

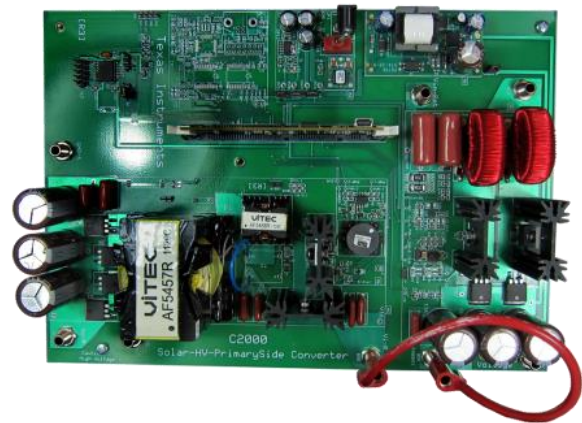
- Implements a solar DC/DC converter with maximum power point tracking (MPPT). The DC/DC converter consists of a two-phase interleaved boost converter for maximum power point tracking and a resonant LLC converter with isolation.
- MCU serves as a high-performance controller for the complete DC/DC converter, executing high-frequency control loops to control the power stages and compute maximum power point algorithms.
- Supports input panel voltages of 200V to 300V and an output of 400VDC, rated up to 500W.
- Greater than 94 percent peak efficiency allows for more overall energy output from a solar installation and reduces detrimental heat generation in the converter.

Benefits

- This design is a digitally-controlled, solar DC/DC converter with maximum power point tracking (MPPT), for use in central or string solar inverters.
- It is a companion to the TI Design TIDM-SOLAR-ONEPHINV, a grid-tied, single phase, DC/AC inverter.
- Together, the TIDM-SOLAR-DCDC and the TIDM-SOLAR-ONEPHINV comprise a complete solar inverter for central or string topologies.

Tools & Resources

- [Design Details](#)
- Key Products
 - [TMS320F28035](#)
 - [UCC27324](#)
 - [ISO7240C](#)
 - [OPA365](#)



C2000 Solar DC/AC Single Phase Inverter

Features

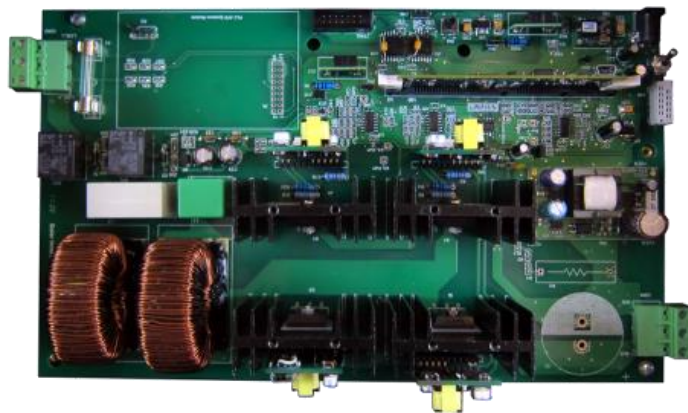
- Implements control of a single phase, full bridge, grid-tied, DC/AC inverter with anti-islanding protection.
- Selectable 120/220 VAC outputs up to 600W, suitable for worldwide solar markets.
- Greater than 96 percent peak efficiency and less than 5 percent total harmonic distortion mean improved energy extraction and longer inverter lifetime.
- MCU serves as a high performance controller for the DC/AC inverter, executing high-frequency control loops to control the power stage and feed the output into the power grid
- Single-MCU system implementation offers design simplicity and reduced system cost

Tools & Resources

- [Design Details](#)
- Key Products
 - [F28M35H52C](#)
 - [TMS320F28027](#)

Benefits

- This design is a digitally controlled, grid-tied, single phase, full-bridge DC/AC inverter stage for use in central or string solar inverters.
- It achieves total harmonic distortion (THD) of less than 5 percent, and full load efficiency greater than 96 percent, providing more energy extraction from a solar installation, reducing detrimental heat dissipation in the inverter, and increasing inverter longevity.



TIDM-SOLARUINV: Grid-tied Solar Micro Inverter with MPPT

Features

- Implements control of an active clamp fly-back DC/DC converter with secondary voltage multiplier, MPPT and a grid-tied DC/AC inverter
- Supports panel voltages of 28 to 45V at input as well as universal power output at up to 280W for 220VAC and up to 140W for 110VAC
- 93 percent peak efficiency and less than four percent total harmonic distortion (THD)
- Single-MCU system implementation offers design simplicity and reduced system cost
- Integrated support for Power Line Communications

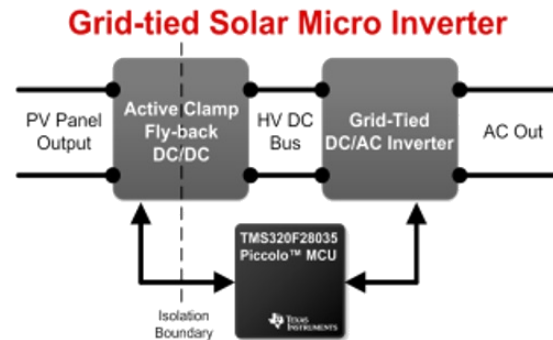
Tools & Resources



- [Design Details](#)
- Key Products
 - [TMS320F28035](#)
 - [UCC27211](#): DCDC – Flyback stage driver
 - [UCC27531](#): DCAC – Inverter high side drive
 - [UCC27324](#): DCAC – Inverter low side drive

Benefits

- A C2000™ Piccolo™ TMS320F28035 microcontroller (MCU) is the digital controller for the complete inverter, including control of the power stages, MPPT, and grid-tie synchronization.
- The power conversion stages include an active clamp fly-back DC/DC converter with secondary voltage multiplier and a grid-tied, DC/AC inverter.
- The design achieves 93 percent peak efficiency and less than 4 percent total harmonic distortion, providing more power output per solar panel, reducing detrimental heat dissipation, and increasing system longevity.



TIDA-01606: 10-kW, Three-Level, Three-Phase Grid Tie Inverter Reference

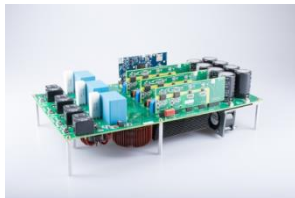
Features

- Rated Nominal and Max Input Voltage at 800-V and 1000-V DC
- Max 10-kW/10-kVA Output Power at 400-V AC 50- or 60-Hz Grid-Tie Connection
- Operating Power Factor Range From 0.7 Lag to 0.7 Lead
- High-Voltage (1200-V) SiC MOSFET-Based Full-Bridge Inverter for Peak Efficiency of 98.5%
- Compact Output Filter by Switching Inverter at 50 kHz
- <2% Output Current THD at Full Load
- Isolated Driver ISO5852S With Reinforced Isolation for Driving High-Voltage SiC MOSFET and UCC5320S for Driving Middle Si IGBT
- Isolated Current Sensing Using AMC1301 for Load Current Monitoring
- TMS320F28379D Control Card for Digital Control

Tools & Resources

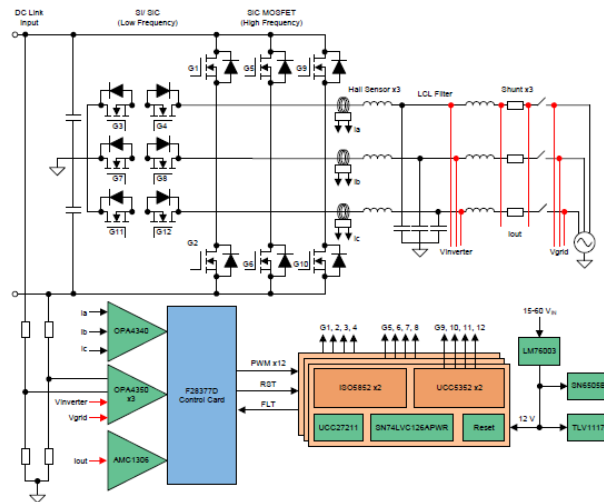
- [Design Guide](#)
- **Device Datasheets:**

- | | |
|---------------------------------|-----------------------------|
| • ISO5852S | • LM76003 |
| • UCC5320 | • PTH08080W |
| • TMDSCNCD28379 | • TLV1117LV |
| • AMC1306M05 | • OPA350 |
| • OPA4340 | • UCC27211 |



Benefits

- High voltage enables reduced current for same power levels
- Less copper and smaller power conducting devices in design
- High voltage handling capability
- DC bus voltage of up to 1000V
- Peak efficiency of 99%



C2000 Solar DC/AC Single Phase Voltage Source Inverter

Features

- 380V DC input, 110Vrms 60Hz or 220Vrms 50Hz output
- **98% peak efficiency**
- Low total harmonic distortion (THD) <1% for linear loads and <3% for typical non linear loads
- Easy adaptation of software and tuning of custom power stage using powerSUITE tools: Solution Adapter, SFRA and Compensation Designer
- Implementation of key algorithms such as adaptive proportional resonant (PR) and resonant controllers, software phase locked loop (SPLL) for grid sync and active damping of LCL resonance using an adaptive fourth-order notch filter

Tools & Resources

Board Image

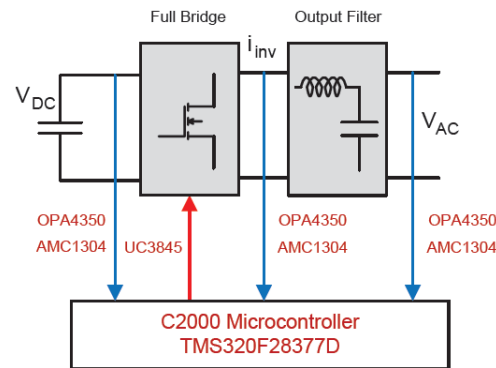


- [TIDM-HV-1PH-DCAC Tool Folder](#)
- [Design Guide](#)
- **Design Files:** Schematics, BOM, Gerbers, Software, and more
- **Device Datasheets:**
 - [TMS320F28377D](#)
 - [AMC1304](#)
 - [OPA4350](#)
 - [UC3865](#)

Benefits

- Full grid connected Voltage Source Inverter
- High efficiency and low THD
- Selectable Operation of the Controller on Cold or Hot, that is, Isolated or Non-Isolated Side
- Software Frequency Response Analyzer (SFRA) and Compensation Designer for Ease of Turning of Control Loops and Robustness of Design

Block Diagram



Solar Power kits

Micro Inverter TMDSSOLARUINVKIT



Power Stages:

- Active clamp fly-back DC/DC converter with secondary voltage multiplier
- Grid-tied DC/AC inverter
- Maximum power point tracking (MPPT)

MCUs Supported:

TMS320F28035 Piccolo™

Power Ratings:

- 280W @ 220VAC, 140W @ 110VAC max power output
- 28 to 45V panel input

Power Metrics:

- 93% efficiency at full load

DC/AC Inverter TMDSHV1PHINVKIT



Power Stages:

- Single phase, full-bridge DC/AC inverter
- Anti-islanding protection
- Ethernet remote control and monitoring
- Companion to MPPT DC/DC converter kit

MCUs Supported:

F28M35H52C

Power Ratings:

- 600W @ 120/220VAC output

Power Metrics:

- 96% efficiency at full load
- <5% THD

MPPT DC/DC Converter TMDSHVMPPTKIT



Power Stages:

- 2-phase interleaved boost converter with maximum power point tracking (MPPT)
- Resonant LLC DC/DC converter with isolation
- Companion to DC/AC Inverter Kit

MCUs Supported:

TMS320F28035 Piccolo™

Power Ratings:

- 500W, 400VDC output
- 200-300V panel input

Power Metrics:

- 94% efficiency at full load

Solar Explorer TMDSSOLARCEXPKIT TMDSSOLARPEXPKIT



Learning platform for solar application development

- Online workshop material

Power Stages:

- Single phase boost DC/DC with MPPT
- SEPIC DC/DC battery charging
- Grid-tied DC/AC inverter
- On-board PV emulator or external PV connection

MCUs Supported:

TMS320F28035 Piccolo™
F28M35H52C

Power Ratings:

- 20VAC, 50W max output

C2000 Software

C2000Ware

C2000Ware is a cohesive set of development tools for C2000 real-time controllers. It includes device-specific drivers, bit-fields, libraries (math, DSP, Control, Signal Generation), peripheral examples, utilities, hardware files, and documentation.

Application specific software and hardware files are delivered through additional Software Development Kits (SDK).

<http://www.ti.com/tool/C2000WARE>

controlSUITE

controlSUITE is the legacy content delivery tool for device and application support. All new content updates will be through C2000Ware and Application SDK only.

<http://www.ti.com/tool/CONTROLSUITE>

enter search keyword

- > English
- > Chinese
 - > 器件
 - > 开发工具
 - > 库
 - > 应用程序库
 - > 电机控制
 - > 数字电源
 - > 太阳能
 - > SFRA
 - > PMBus over I2c
 - > 数学库
 - > DSP 库
 - > Control Libraries
 - > 实用程序
 - > powerSUITE
 - > 解决方案适配器
 - > SFRA
 - > 补偿设计器
 - > 开发套件
 - > 数字电源 BoosterPack
 - > Two-Phase Interleaved PFC
 - > Single Phase Inverter: Voltage Sc

Solar lib

Address:



powerSUITE Single Phase Inverter: Voltage Source — TIDM-HV-1PH-DCAC

To get started follow the instructions in the User's Guide linked below.

Note: For the best experience, it is recommended to use the controlSUITE integrated inside of the Code Composer Studio Integrated Development Environment. With CCS, you will be able to directly load and experiment with projects from this screen.

User's Guide

CCS

Browse F2837x Project

HW Dev Package

Website

Launch CCS



Single Phase Inverter: Voltage Source

TIDM-HV-1PH-DCAC

Description:

Voltage source inverters (VSI) are commonly used in uninterruptible power supplies (UPS) to regulate an AC voltage at the output. Control design of UPS can be challenging because of the unknown nature of load that can be connected to the output of the inverter.

This design uses a **Delfino™ TM320F28377D MCU** from the **C2000 microcontroller family** to implement control of a voltage source inverter with an LC output filter. The design software is supported in the powerSUITE framework which enables easy adaptation of the software and control design for a custom voltage source inverter.

High efficiency, low THD and intuitive software makes it fast and easy to design voltage source inverters. VSIs are increasingly being used in many new alternative energy applications such as photovoltaic inverters, micro grids, grid storage etc.

Features

- 380 DC Vin, 110Vrms 60Hz or 220Vrms 50Hz output selectable, 600VA max Output
- 98% peak efficiency

Featured Applications

- Uninterrupted Power Supply (UPS)
- Micro Grids
- Photovoltaic Inverters

View TI Design



<http://www.ti.com/applications/industrial/grid-infrastructure/overview.html>

← ⓘ www.ti.com/applications/industrial/grid-infrastructure/overview.html 70% x 🔍

- Transducer
- Grid Communications
 - Data Concentrators
 - Ethernet Repeaters
 - Wireless Communications
- Other Alternative Energy
 - Other Energy Harvesting
- Power Quality
 - Power Quality Analyzer
 - Power Quality Meter
- Protection Relay
 - AC Analog Input Module
 - Applications Processor Module
 - Binary Input Module
 - Compact Relay
 - DC Analog Input Output Module
 - Multi Function Relay
 - Power Supply Module
 - RTD, Thermistor Module
 - Wired Communication

Circuit breakers

- Air circuit breaker (ACB)
- Miniature circuit breaker (MCB)
- Molded case circuit breaker (MCCB)
- Residential breakers
- Surge protection device

Grid communications

- Data concentrator
- Ethernet & repeaters
- Wireless communications

Solar energy

- Solar arc protection
- Central inverters
- Solar charge controller
- Micro inverters
- Solar power optimizer
- Smart combiner box
- String inverters

Grid automation

- Fault indicator (FI)
- Process BUS (IEC61850)
- Terminal unit (RTU, DTU, FTU, TTU)
- Transducer

Power quality

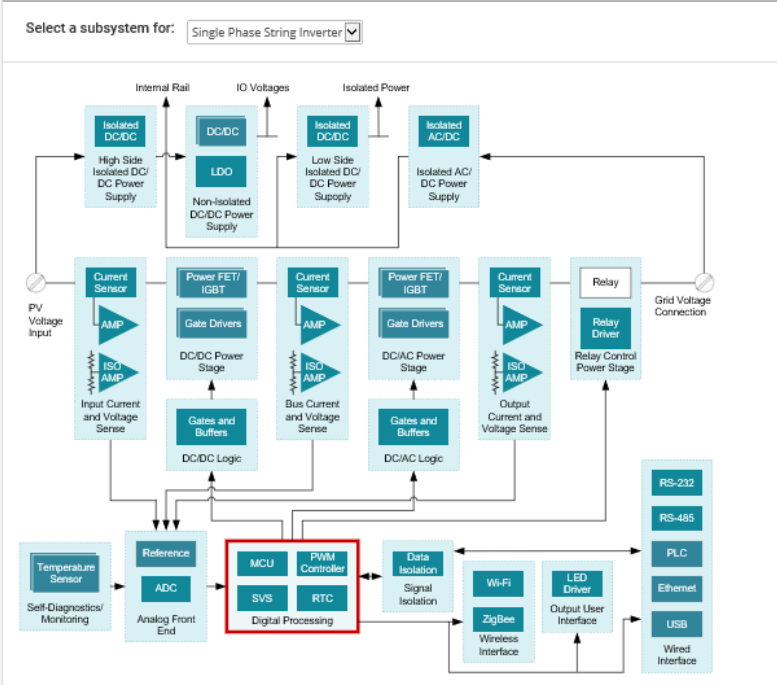
- Power quality analyzer
- Power quality meter

Renewable energy storage

- Energy harvesting
- Lead acid battery manager
- Lipo battery manager
- Stationary energy storage

Products

Reference designs



Digital Processing Description ▾	
Products (9)	Reference designs (6)
Processors (2)	10kW 3-Phase 9-Level Grid Tie Inverter Reference Design for Solar String Inverter ▾
AM335x Arm Cortex-A8 (2) Compare	 Schematic/Block diagram
AM3352 – Sitara Processor: Arm Cortex-A8, 1Gb Ethernet, display, CAN	 Reference guide
AM3359 – Sitara processor: Arm Cortex-A8, EtherCAT, 3D, PRU-ICSS, CAN	 View reference design
Logic (3)	Single-Phase Inverter Reference Design With Voltage Source and Grid Connected Modes ▾
Microcontrollers (MCU) (4)	Grid-tied Solar Micro Inverter with MPPT ▾
	C2000™ Solar DC/AC Single Phase Inverter ▾
	C2000™ Solar DC/DC Converter with Maximum Power Point Tracking (MPPT) ▾
	Phase-Shifted Full Bridge DC/DC Power Converter ▾



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Thanks!

WT Microelectronics

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PM: Edward.LT.Li@wtmec.com