



# THE DATASHEET OF TMDSSOLARCEXPKIT



# C2000™ Solar Inverter Development Kits



## Jump start your solar design with development kits for micro, central and string inverters

C2000™ Solar Development Kits provide instructive development platforms for design of highly efficient and reliable solar inverters, including central, string and micro inverter topologies. These kits enable designers to jump-start solar inverter designs using leading technologies found in the solar industry today.

Solar development kits offered today include:

- **Solar Micro Inverter Development Kit**
- **Solar DC/DC MPPT Development Kit**
- **Solar AC/DC Single Phase Inverter Development Kit**
- **Solar Explorer Development Kit with F28M35H52C MCU**
- **Solar Explorer Development Kit with Piccolo TMS320F28035 MCU**

The **Solar Micro Inverter Development Kit** is based on the Piccolo™ **TMS320F28035** microcontroller and serves as a complete grid-tied solar micro inverter. The topology of the micro inverter consists of an active clamp fly-back DC/DC converter with secondary voltage multiplier, maximum power point tracking (MPPT), and a grid-tied DC/AC inverter. The single Piccolo MCU functions as the controller for the complete inverter, including control of both power stages, and MPPT execution.

The **Solar DC/DC MPPT Development Kit** is based on the Piccolo **TMS320F28035** MCU and serves as a DC/DC converter with maximum power point tracking (MPPT) for central or string inverters. Its companion kit, the **Solar AC/DC Single Phase Inverter Development Kit**, is based on the **F28M35H52C**

MCU (alternatively supports the Piccolo **TMS320F28035** MCU as well), and serves as a full-bridge, single-phase, grid-tied DC/AC inverter for central or string inverters. Together, the Solar DC/DC MPPT Development Kit and the Solar AC/DC Single Phase Inverter Development Kit operate as a complete central or string solar inverter.

The Solar Explorer Development Kit is designed as a low-voltage learning

### *Solar DC/DC MPPT Development Kit and Solar AC/DC Single Phase Inverter Development Kit*

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#### Power stages:

- 2-phase interleaved boost DC/DC converter (for MPPT)
- Resonant LLC DC/DC converter with isolation
- Full-bridge single-phase, grid-tied, DC/AC inverter

**Controller(s):** Piccolo TMS320F28035 MCU and F28M35H52C MCU

**MPPT support:** Yes

**Grid-tie support:** Yes with anti-islanding protection

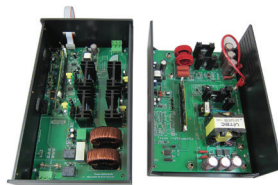
**Input:** 200–300 VDC

**Output:** 120–220 VAC universal, 500W

**Other features:** Ethernet communication

#### Test results:

- Greater than 94 percent peak efficiency through DC/DC converters
- Greater than 96 percent peak efficiency through DC/AC inverter



### *Solar Micro Inverter Development Kit*

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#### Power stages:

- Active clamp fly-back DC/DC converter with isolation
- Grid-tied DC/AC inverter

**Controller(s):** Piccolo TMS320F28035 MCU

**MPPT support:** Yes

**Grid-tie support:** Yes

**Input:** 28–45 VDC

**Output:** 110–220 VAC universal (280W at 220 VAC, 140W at 110VAC)

**Test results:** 93 percent peak efficiency, 4 percent total harmonic distortion (THD)



### *Solar Explorer Development Kit*

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#### Power stages:

- Boost DC/DC converter (for MPPT)
- SEPIC DC/DC converter (for battery charging)
- Full-bridge, single phase, grid-tie-capable DC/AC inverter

**Controller(s):** Piccolo TMS320F28035 MCU or F28M35H52C MCU

**MPPT support:** Yes

**Grid-tie support:** Capable

**Input:** 12 VDC

**Output:** 24 VAC, 50W

**Other features:** Ethernet communication, built-in PV emulator and ambient light sensor



platform for solar development. The kit features a built-in PV emulator, photo diode for light sensing, DC/DC boost converter for MPPT, DC/DC SEPIC converter for battery charging, and a full-bridge, grid-tie-capable, DC/AC inverter stage. Two versions of the kit are offered, allowing users to experiment with various controllers, a Piccolo **TMS320F28035** MCU or an **F28M35H52C** MCU. Ethernet connectivity for remote control and monitoring is available when using the F28M35H52C MCU version of the kit. Additionally, an online training workshop based around this kit is offered for free. Visit the C2000 Applications tab at [www.ti.com/C2000](http://www.ti.com/C2000) and see the Solar Power Training and Videos section.

## Solar and Digital Power Application Library Contents

Solar and digital power software libraries provide code-optimized building blocks to implement a variety of power topologies and algorithms such as MPPT and Software Phase Locked Loops (PLL), perfect for designing customized solar inverter solutions.

### Digital Power Math Algorithms

- Control 2P/2Z
- Control 3P/3Z
- Inverse square
- Exponential moving avg.
- Current command
- Soft /sequential start
- Ramp generators
- And more ...

### Solar Library Functions

- MPPT (various methods)
- Anti-islanding
- Single-phase inverter
- Sine analyzer for RMS, frequency and ZCD
- ADC driver for sense signals
- PI controller for inverter control

- Software PLL for mains phase lock
- And more ...

### Digital Power Hardware Drivers

- Single-channel buck
- High-resolution buck
- Multi-phase interleaved
- MP balanced interleaved
- Half-H bridge
- 2-phase interleaved PFC
- ZVS full bridge
- And more ...

For more information on solar and digital power libraries for C2000 MCUs and a complete listing of all supported functions, please download control-SUITE for *free* at [www.ti.com/controlsuite](http://www.ti.com/controlsuite).

To learn more about these kits before purchase, users are encouraged to download and explore **control-SUITE™** software. controlSUITE is a completely free, centralized portal of design resources for C2000 Real-Time Control Microcontrollers and development kits. Within control-SUITE, designers can quickly find all of the necessary tools and resources for the C2000 Solar Development Kits, including software source code, quick start GUIs, BOMs, gerber files, schematics, step-by-step documentation, and solar and digital power application libraries.

**Solar Application Software Library**

Texas Instruments Inc.'s solar application library is designed to enable flexible and efficient coding of systems designed to use process solar power using the C28x™ processor and CLA accelerator.

Solar applications need different software algorithms like maximum power tracking, phase lock loop for grid synchronization, power monitoring etc. Several different algorithms have been proposed in literature for these tasks. The solar library provides a framework structure, with known algorithms, for the user to implement algorithms needed for Solar Power Conversion Systems quickly. The source code for all the blocks is provided and hence the user can modify / enhance the modules for use in their applications with C2000™ family of devices microcontrollers.

Supports solar library implementation on C28x fixed point (IQ Math), C28x floating point, and Control Law Accelerator (CLA) processors.

**What's Included:**

- Header files containing the software algorithm modules
- Documentation including description, technical background, object definition, interface definition, and usage of each module.

**Solar Library Function Summary:**

#	Module	Module Type	Description
1	ABC_DQ0_POS	Transform	ABC to DQ0 Transform for positive sequence
2	ABC_DQ0_NEG	Transform	ABC to DQ0 Transform for negative sequence
3	DQ0_ABC	Transform	DQ0 to ABC Transform
4	SPLL_1ph	PLL	SPLL 1ph based on notch filter
5	SPLL_1ph_SOGI	PLL	SPLL 1ph based on second order generalized integrator
6	SPLL_3ph_SRF	PLL	SPLL 3ph stationary reference frame based
7	SPLL_3ph_DDSRF	PLL	SPLL 3ph decoupled double synchronous reference frame based
8	CLARKE	Transform	Clarke Transform
9	PARK	Transform	Park Transform
10	iPARK	Transform	Inverse Park Transform
11	iCLARKE	Transform	Inverse Clarke Transform
12	MPPT_PNO	MPPT	Perturb and Observe MPPT Algorithm Module
13	MPPT_INCC	MPPT	Incremental Conductance MPPT Algorithm Module
14	MPPT_INCC_I	MPPT	Incremental Conductance MPPT Algorithm Module
15	CNTL_2P2Z	CNTL	Control Law Two Pole Two Zero
16	CNTL_3P3Z	CNTL	Control Law Three Pole Three Zero
17	CNTL_PI	CNTL	Control Law PI
18	MATH_EMAVG	MATH	Moving Average/ Low Pass Filter Block

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