Piccolo TMS320F28075 controlCARD R1.1 Information Guide
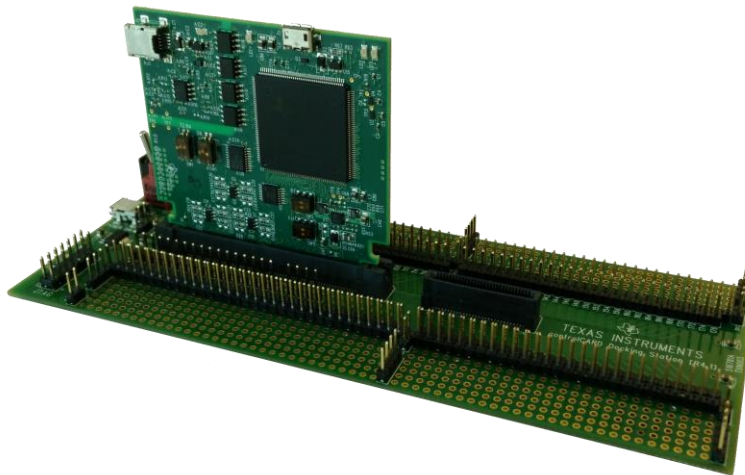
Fig 1: TMDSDOCK28075 Experimenter's Kit

1 Introduction

The Piccolo F2807x controlCARD kit (TMDSCNCD28075) and the F2807x Experimenter's Kit (TMDSDOCK28075) from Texas Instruments (TI) provide a great way to learn and experiment with the F2807x device family within TI's C2000 family of microcontrollers (MCUs). This 120-pin controlCARD is intended to provide a well-filtered robust design which is capable of working in most environments. This document goes over the hardware details of the F28075 controlCARD and explains the functions, locations of jumpers, and connectors present on the board.

Each controlCARD comes with a "Hardware Developer's Kit", a full set of files necessary to evaluate/develop with a C2000 device. These files include:
- Schematics – Designed in Mentor PADS Logic
- Bill of Materials (BOM)
- Layout PCB files – Designed in Mentor Layout
- Gerber files

NOTE: this kit is designed to explore the functionality of the F2807x microcontroller. Even though the controlCARD can be treated as a good reference design, it is not intended to be a complete customer design. Full compliance to safety, EMI/EMC and other regulations are left to the designer of the final customer's system.

2 Errata

Current revision of controlCARD as of 15-August-2014:   PCB R1.1

2.1 Warnings/Notes/Errata –

Notes on all controlCARDs:

1. The F28075 controlCARD supports USB host/device connectivity. However, the micro-USB port, J2, is not isolated from the board ground. Care should be taken when this controlCARD is being used in a high power application and this USB port is also being used. Note that external USB isolation buffers may be required for these types of applications.

2. The F28075 Experimenter's Kit ships with a USB cable and is designed to be powered via USB. However, in extreme cases the board/controlCARD may require more power than the 5V @ 500mA a computer's USB port can provide (<0.01% of use cases). This is especially true when additional circuitry has been added to the Docking Station.

    In such cases, it is recommended to use an external 5V power supply (2.5mm inner diameter x 5.5mm outer diameter) and plug it into J1. A compatible supply could be the: Phihong *PSAC05R-050(P)-R-C2*   +   Phihong *RPBAG*

3. The F28075 MCU's GPIO69 and GPIO70 lines are not connected to the controlCARD. Since GPIO69 and GPIO70 are the control pins in the parallel boot mode's handshaking protocol, the parallel boot mode is not directly supported with the F28075 controlCARD. Please note that if the F28075 is put into Parallel Boot Mode on the controlCARD, the device will boot from FLASH.

4. In Boot-from-SCI mode, the MCU will by default expect GPIO84 and GPIO85 to be the IO pins responsible for sending the program to the device. These GPIOs are different from the GPIOs which connect to the isolated USB-to-serial interface via the FTDI chip (which use GPIO28 & GPIO29). To use GPIO28 & 29 instead:

    a. Change the boot mode to Get Mode and then, in your main flashed code, you can decide to call the bootloader for SCIBoot IOOption2 (in the bootROM) always or based on whatever is desired.
    b. Change the boot mode to Get Mode and configure the OTP such that SCIBoot IOOption2 is called. This is really only an option if you always want to boot from SCI or Parallel GPIO because you'll be overwriting your ability to boot from Flash.
    c. With an emulator connected (TRSTn = 1), registers can be set such that SCIBoot's IOOption2 boot mode is called.

    See the TRM of your specific device for more information.

2.2 Warnings about Specific controlCARD revisions –

Warnings about R1.1 and earlier controlCARDs:

1. The circuitry used to drive the C2000 MCU's voltage references on the controlCARD is not ideal. Instead, we recommend that users use the voltage reference driving circuitry found in F2837xD_VREFHI_12bitDrivingCkt.pdf which can be found in the same directory as this document. The circuit shown there is for the F2837x device, but a similar approach can be done for the F2807x.

3 Getting Familiar with the controlCARD

3.1 F28075 controlCARD Features

- **Piccolo F28075 Microcontroller** – High performance C2000 microcontroller is located on the controlCARD.

- **120pin HSEC8 Edge Card Interface** – Allows for compatibility with all of C2000's 180pin controlCARD based application kits and controlCARDs. Any 120pin C2000 controlCard can be used with 180pin docking stations. Compatibility with 100pin controlCARDs can be accomplished using the TMDSADAP180TO100 adapter card (sold separately).

- **Built-in Isolated JTAG Emulation –** An xds100v2 emulator provides a convenient interface to Code Composer Studio without additional hardware.   Flipping a switch allows an external JTAG emulator to be used.

- **Connectivity –** The controlCARD contains connectors that allow the user to experiment with USB, and isolated UART/SCI with the F2807x MCU.

- **Key Signal Breakout –** Most GPIO, ADC and other key signals routed to hard gold connector fingers.

- **Robust Power Supply Filtering** – Single 5V input supply powers an on-CARD 3.3V LDO. All MCU inputs are then decoupled using LC filters near the device.

- **ADC Clamping** – ADC inputs are clamped by protection diodes.

- **Anti-Aliasing Filters** – Noise filters (small RC filters) can be easily added on several ADC input pins.

3.2 Assumed Operating Conditions

This kit is assumed to run at standard room conditions. The EVM should run at approximately Standard Ambient Temperature and Pressure (SATP) with moderate-to-low humidity.

3.3 Using the controlCARD

In order for the controlCARD to work, the controlCARD's MCU must be powered. This is most often done by inputting 5V through the HSEC connector via an accompanying baseboard. For example, if using a Docking Station baseboard, 5VDC should be input into the Docking Station's J1 or J17 and then SW1 will need to be toggled to the appropriate position.

Optionally, the MCU could also be powered via the micro-USB connector on the controlCARD.

Based on the way that the controlCARD will be used, additional hardware settings will be necessary. See the table below:

	Debug using CCS and the on-card xds100v2 emulator	Debug using CCS and an external emulator via the baseboard	Standalone (Boot from FLASH or other boot mode)
A:SW1 (controlCARD)	Position 1: ON (up)	Position 1: OFF (down)	Position 1: OFF (down)
A:J1 (controlCARD)	Connect a mini USB cable between A:J1 and your computer. In CCS, use this target configuration: TMS320F28075 device with an xds100v2 emulator.	---	---
SW1 (controlCARD)	Position 1: OFF (up) Position 2: ON (down) Putting the C2000 device into Wait Mode can reduce the risk of connectivity issues.	Position 1: OFF (up) Position 2: ON (down) Putting the C2000 device into Wait Mode can reduce the risk of connectivity issues.	Set SW1 as desired
Baseboard's JTAG connector (J2 on the Docking Station baseboard)	---	Connect an external emulator.	---

Table 1: Getting Started Reference

Code Composer Studio (CCS) is an Integrated Development Environment (IDE) used to debug and develop software for the C2000 series of MCUs. It can be downloaded from the following link: http://processors.wiki.ti.com/index.php/Download_CCS

For users new to C2000's F2807x series of devices and CCS, TI's Technical Training Organization provides several workshops (online and in-person) that may be helpful: http://processors.wiki.ti.com/index.php/C2000_32-bit_Real-Time_MCU_Training http://processors.wiki.ti.com/index.php/Hands-On_Training_for_TI_Embedded_Processors

The following PDF documents are provided to describe where each of the F2807x MCU's pins will appear on the controlCARD connector/Docking Station:

TMDSCNCD28075_180cCARD_pinout_R1_1 – tells where each MCU pin will go on the HSEC controlCARD connector or the 120/180-pin controlCARD Docking Station.

TMDSCNCD28075_100DIMmap_R1_1 – tells where each MCU pin will go to on the DIM100 controlCARD connector or the DIM100 Docking Station. This assumes that the TMDSADAP180TO100 adapter card is used.

More information on the controlCARD/Docking Station can be found at the following locations:
\C2000Ware_X_XX_XX_XX\boards\controlCARDS\TMDSCNCD287075
\C2000Ware_X_XX_XX_XX\boards\ExperimenterKits\
    DockingStation_HSEC_120or180pin\

3.4 Experimentation Software

All key examples for the F28075 MCU can be found within C2000Ware at:

\C2000Ware_X_XX_XX_XX\device_support\f2807x\

This example software package includes many projects which allow the user to experiment with the ADC, PWM, and other C2000 peripherals.

4 Special Notes on Connectivity

4.1 xds100v2 Emulator and SCI/UART Connectivity

The F28075 controlCARD provides emulation and USB-to-UART adapter functionality on the controlCARD. This allows for a convenient method to debug and demo the F2807x MCU.

Note that the FTDI chip, its support circuitry, and associated isolation components are placed in Macro A, the left section of the controlCARD. Each of these components contains an additional A within the component reference designator (ie A:R2 for resistor 2 in Macro A).

Each F28075 controlCARD's xds100v2 is programmed with a fixed serial number. If a debug session needs to involve 2 or more F28075 controlCARDs, each controlCARD will need have a unique serial number and some will need to be reprogrammed.   See: http://processors.wiki.ti.com/index.php/XDS100#Q:_Can_I_change_the_serial_number_on_my_XDS100v2.3F
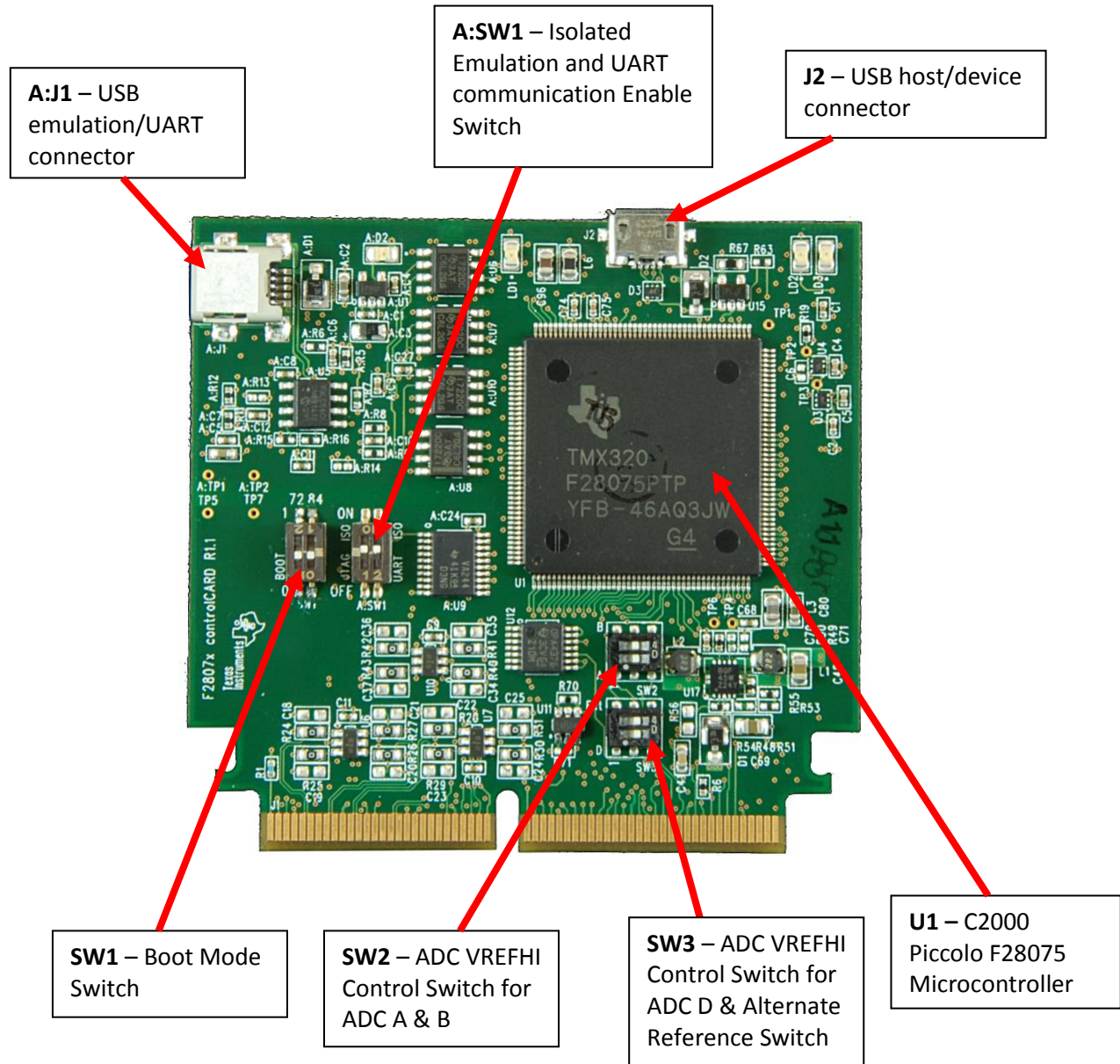
The configuration of the switches on A:SW1 determine whether the on-board emulator is active, whether an external emulator can be used, or whether the device will boot from FLASH/peripherals. See Table 2.
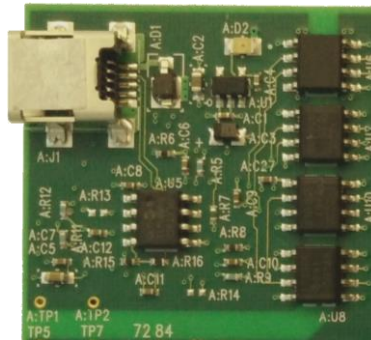
Fig2: xds100v2 Emulation circuitry and isolation circuitry is denoted by A:

5 Hardware References

On the following pages, Table 2 shows the various connections available on the board. Fig 3, below, illustrates the location of many of these components on the board:

A:J1 – USB emulation/UART connector

A:SW1 – Isolated Emulation and UART communication Enable Switch

J2 – USB host/device connector

SW1 – Boot Mode Switch

SW2 – ADC VREFHI Control Switch for ADC A & B

SW3 – ADC VREFHI Control Switch for ADC D & Alternate Reference Switch

U1 – C2000 Piccolo F28075 Microcontroller

Fig3: Key components on the controlCARD

Connectors

A:J1	Emulation/UART connector - USB mini A connector used to provide xds100v2 emulation and USB-to-UART(SCI) communication through FTDI logic. A:SW1 determines which connections are enabled to the MCU.
J2	USB connector – USB micro AB connector supports USB 2.0 host/device

LEDs

LD1	Turns on when the controlCARD is powered ON (green)
LD2	Controlled by GPIO-31 with negative logic (red)
LD3	Controlled by GPIO-34 with negative logic (red)
A:D2	Turns on when ISO JTAG logic is powered on (green)
A:D3	JTAG/UART RX toggle indicator (blue)
A:D4	JTAG/UART TX toggle indicator (blue)

Resistors and Capacitors

R24-R43 and C18-C37	Optional RC input filter for all ADC inputs

Switches (default position in BOLD)

SW1	Boot Mode Switch:

Controls the Boot Options of the F2807x device. See the device datasheet for more information. Note that the switch is placed upside-down, and directions are with respect to the controlCard and not the switch itself. UP is 1 (open) and DOWN is 0 (closed)

Mode #	Switch Position 1 (GPIO-72)	Switch Position 2 (GPIO-84)	Boot from
00	DOWN	DOWN	Parallel I/O
01	DOWN	UP	Boot from SCI
02	UP	DOWN	Wait Boot Mode
03	**UP**	**UP**	**Get Mode (Flash by default)**

SW2	ADC VREFHI Control Switch for ADC modules A & B:
	Switch 1 (lower switch) – VREFHI Control Switch for ADC module A:
	• In the left position – If SW3 Switch 2 is in the left position ADC-A will be referenced to a precise 3.0V reference located on the controlCard. If SW3 Switch 2 is in the right position ADC-A will be referenced to pin 45 of the HSEC controlCARD connector.
	• **In the right position** – ADC-A will be referenced to a precise 3.3V reference located on the controlCARD.
	Switch 2 (upper switch) – VREFHI Control Switch for ADC module B:
	• In the left position – If SW3 Switch 2 is in the left position ADC-B will be referenced to a precise 3.0V reference located on the controlCard. If SW3 Switch 2 is in the right position ADC-B will be referenced to pin 45 of the HSEC controlCARD connector.
	• **In the right position** – ADC-B will be referenced to a precise 3.3V reference located on the controlCARD.
SW3	ADC VREFHI Control Switch for ADC modules D & Alternate Reference Configuration:
	Switch 1 (lower switch) – VREFHI Control Switch for ADC module D:
	• In the left position – If SW3 Switch 2 is in the left position ADC-D will be referenced to a precise 3.0V reference located on the controlCard. If SW3 Switch 2 is in the right position ADC-D will be referenced to pin 45 of the HSEC controlCARD connector.
	• **In the right position** – ADC-D will be referenced to a precise 3.3V reference located on the controlCARD.
	Switch 2 (upper switch) – External VREFHI Enable Switches for ADC:
	• In the left position – A precision 3.0V reference will be provided to ADC-A, ADC-B, or ADC-D if SW2 Switch 1, SW2 Switch 2, or SW3 Switch 1 is in the left position respectively.
	• **In the right position** – The reference will be given by pin 45 of the HSEC controlCARD connector to ADC-A, ADC-B, or ADC-D if SW2 Switch 1, SW2 Switch 2, or SW3 Switch 1 is in the left position respectively. This will presumably allow the baseboard to provide the desired voltage reference.

A:SW1	Isolated emulation & UART communication enables:
	Switch Position 1 – JTAG Enable:
	ON – All signals between the xds100v2 emulation logic and the MCU will be connected. This setting is valid when the MCU is being debugged or programmed via the on-card xds100v2 emulator. - OFF – The xds100v2 emulation logic will **NOT** be connected to the MCU. This setting is valid when the device will boot from FLASH, boot from a peripheral directly, or when an external JTAG emulator will be used.
	Switch Position 2 – ISO UART communication enable:
	ON – The C2000 MCU's GPIO-28 (and pin76 of the 180pin controlCARD connector) will be coupled to the FTDI's USB-to-Serial adapter. This allows UART communication to a computer via the FTDI chip. However, in this position, GPIO-28 will be forced high by the FTDI chip. Functionality of pin76 of the connector will be limited. - OFF – The C2000 MCU will **NOT** be connected to the FTDI USB-to-Serial adapter. Pin76 of the 180pin controlCARD connector will be directly connected to GPIO-28.

Table 2: Hardware References

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off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

Industry Canada Compliance (English)

For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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2. Use EVMs only after user obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or

3. Use of EVMs only after user obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless user gives the same notice above to the transferee. Please note that if user does not follow the instructions above, user will be subject to penalties of Radio Law of Japan.

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日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

http://www.tij.co.jp

Texas Instruments Japan Limited

(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan