User's Guide
SPRUIC4A–January 2017–Revised December 2017

Piccolo F280049C controlCARD Information Guide

The Piccolo F280049C controlCARD from Texas Instruments (TI) is intended to provide a well-filtered robust design capable of working in most environments. This document describes the hardware details of the F280049C controlCARD and explains the functions, locations of jumpers, and connectors present on the board.

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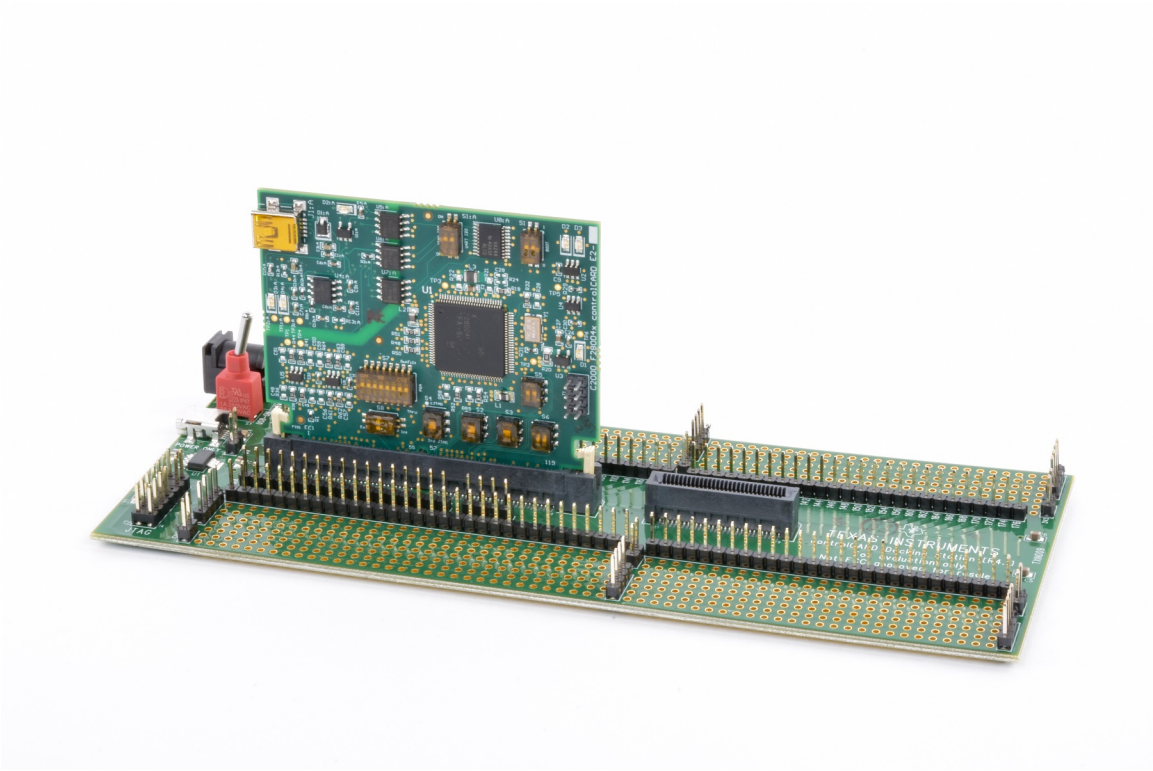


The Piccolo F280049C controlCARD from Texas Instruments (TI) provides a great way to learn and experiment with the F28004x device family within TI's C2000 family of microcontrollers (MCUs). This controlCARD, which uses the 120HSEC controlCARD connector, is intended to provide a well-filtered robust design capable of working in most environments. This document describes the hardware details of the F280049C 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 and develop with a C2000 device. These files can be found in C2000Ware and include:

- Schematics – Designed in Altium
- Bill of Materials (BOM)
- Layout PCB files – Designed in Altium
- Gerber files

This controlCARD can be obtained by ordering:

- TMDXDOCK280049M – controlCARD, docking station, and cables necessary for evaluation

NOTE: This kit is designed to explore the functionality of the F28004x microcontroller. The controlCARD can be treated as a good reference design, but 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 system.

2 Errata

Current revision of controlCARD as of Jan2017: PCB rev - A, ASSY rev - none.

2.1 Warnings, Notes, and Errata

Notes for all controlCARDs:

- The F280049C Experimenter's Kit ships with a USB cable and is designed to be powered through USB. However, when external components are added to the docking station for experimentation, the board or controlCARD may require more power than the 5 V @ 500 mA that a computer's USB port can provide. This is especially true when additional circuitry has been added to the docking station. In such cases, TI recommends using an external 5-V power supply (2.5-mm inner diameter × 5.5-mm outer diameter), and plug it into J1. A compatible supply could be the: Phihong PSAC05R-050(P)-R-C2 + Phihong RPBAG
- The MCU by default expects GPIO24 and GPIO32 to be the IO pins responsible for determining the boot mode of the device at power up. These GPIOs may be edited by programming the OTP in the device, if desired. Refer to the Boot ROM section of the specific device's Technical Reference Manual (TRM) for more information.
- Early versions of the control card contain prototype silicon XF280049M. XF280049M is a prototype variant only, and is not offered in production. It has the same functionality and configuration as the F280049C.

3 Getting Familiar With the controlCARD

3.1 F280049C controlCARD Features

- **Piccolo F280049C Microcontroller** – High performance C2000 microcontroller is located on the controlCARD.
- **120pin HSEC8 Edge Card Interface** – Allows for compatibility with all of C2000's 120- or 180-pin controlCARD-based application kits and controlCARDs. Compatibility with 100-pin DIMM 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. This external emulator may use standard 4-pin JTAG or 2-pin cJTAG.
- **Key Signal Breakout** – Most GPIO, ADC, and other key signals routed to hard gold connector fingers.
- **Robust Power Supply Filtering** – Single 5-V input supply powers an on-CARD 3.3-V 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 F28004x Device Description

For a complete description of the F28004x device, see Section 1.3 of the *TMS320F28004x Piccolo™ Microcontrollers* data sheet (SPRS945).

3.3 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.

3.4 Using the controlCARD

For the controlCARD to work, the controlCARD MCU must be powered. This is usually done by inputting 5 V through the HSEC connector through an accompanying baseboard. For example, if using a docking station baseboard, 5 VDC should be input into the docking station's J1 or J17, then SW1 must be toggled to the appropriate position.

Based on the way that the controlCARD is used, additional hardware settings may be necessary, as shown in Table 1.

Table 1. Getting Started Reference

	Debug Using CCS and the on-card xds100v2 Emulator	Debug Using CCS and an External Emulator Through the Baseboard	Standalone (Boot From FLASH or Other Boot Mode)
S1:A (controlCARD)	Position 1: Up (ON)	Position 1: Down (OFF)	Position 1: Down (OFF)
J1:A (controlCARD)	Connect a mini USB cable between J1:A and the computer. In CCS, use this target configuration: F280049C device with an xds100v2 emulator.	—	—
S1 (controlCARD)	Position 1: Down (ON) Position 2: Up (OFF) Putting the C2000 device into Wait Mode can reduce the risk of connectivity issues.	Position 1: Down (ON) Position 2: Up (OFF) Putting the C2000 device into Wait Mode can reduce the risk of connectivity issues.	Set S1 as desired
Baseboard's JTAG connector (J2 on the Docking Station baseboard)	—	Connect an external emulator and appropriately configure the CCS target configuration.	—

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.

The following PDF documents are provided to describe where each of the F28004x MCU's pins appears on the controlCARD connector/Docking Station:

- **TMDSCNCD28004x_120cCARD_pinout_RevA** – Indicates where each MCU pin is located on the HSEC controlCARD connector or the 120/180-pin controlCARD docking station.
- **TMDSCNCD28004x_DIM100Adapter_pinout_RevA** – Indicates where each MCU pin is located 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:

- \ti\c2000\C2000Ware_X_XX_XX_XX\boards\controlCARDs\TMDSCNCD280049M\
- \ti\c2000\C2000Ware_X_XX_XX_XX\boards\ExperimentersKits\DockingStation_HSEC_120or180pin\

3.5 Experimentation Software

C2000Ware contains a full suite of example software designed to work with the F280049C controlCARD. This software can be found at http://www.ti.com/tool/C2000Ware.

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

4 Special Notes

4.1 xds100v2 Emulator and SCI/UART Connectivity

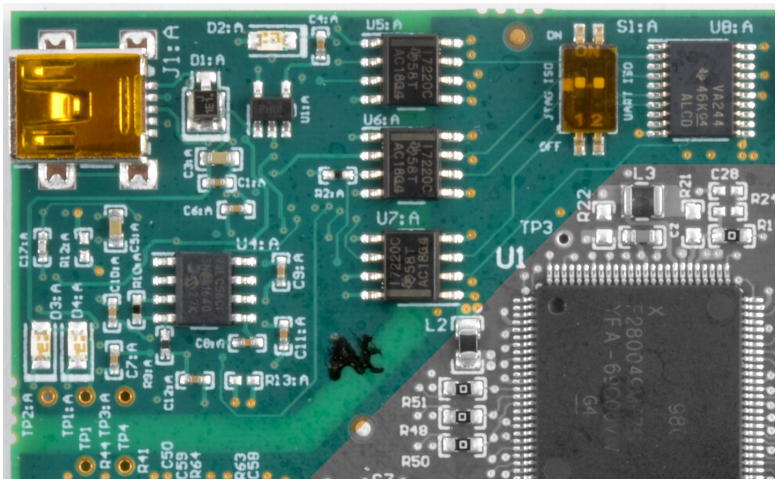
The F280049C controlCARD provides emulation and USB-to-UART adapter functionality on the controlCARD. This allows for a convenient method to debug and demo the F28004x MCU.

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 (that is R2:A for resistor 2 in Macro A).

Each F280049C controlCARD's xds100v2 is programmed with a fixed serial number. If a debug session must involve two or more F280049C controlCARDs, each controlCARDs must have a unique serial number, and some must 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 S1:A 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 Figure 2.

Figure 2. xds100v2 Emulation Circuitry and Isolation Circuitry is Denoted by :A



4.2 cJTAG Usage

The F280049C MCU supports the cJTAG 2-pin debugging interface. The controlCARD's onboard xds100v2 emulator does not support cJTAG; however, the controlCARD enables a customer to experiment with cJTAG using an external emulator connected to the baseboard. To enable cJTAG:

1. Connect an external emulator to the controlCARD's baseboard.
2. Change S4 to the cJTAG position (switch flipped up).
3. If cJTAG is used, the F280049C MCU will have two additional GPIO which can be used by the application. Configure S2 and S3, as desired, to control which controlCARD fingers or pins the newly available GPIO is connected to.

4.3 Supporting Evaluation of the Internal DC/DC Converter

The controlCARD, by default, assumes the F280049 internal VREG will be used to generate the 1.2-V power supply required by the MCU. The controlCARD enables the user to utilize the internal DC/DC converter capabilities, with some soldering.

To enable the internal DC/DC converter:

- R18 and R19 must be unpopulated.
- R21 and R22 must be populated with a 0-Ω resistor.
- C19 must be populated with a 2.2-µF X5R/X7R capacitor.
- C20 and C21 must each be populated with a 10-µF X5R/X7R capacitor.

Functionally, the F280049C powers up the 1.2-V power rail using the internal VREG, then requires software to change from the VREG to the DC/DC. See the F28004x Technical Reference Manual for more details.

5 Hardware References

Table 2 shows the various connections available on the board. Figure 3 illustrates the location of many of these components on the board.

Figure 3. Key Components on the controlCARD

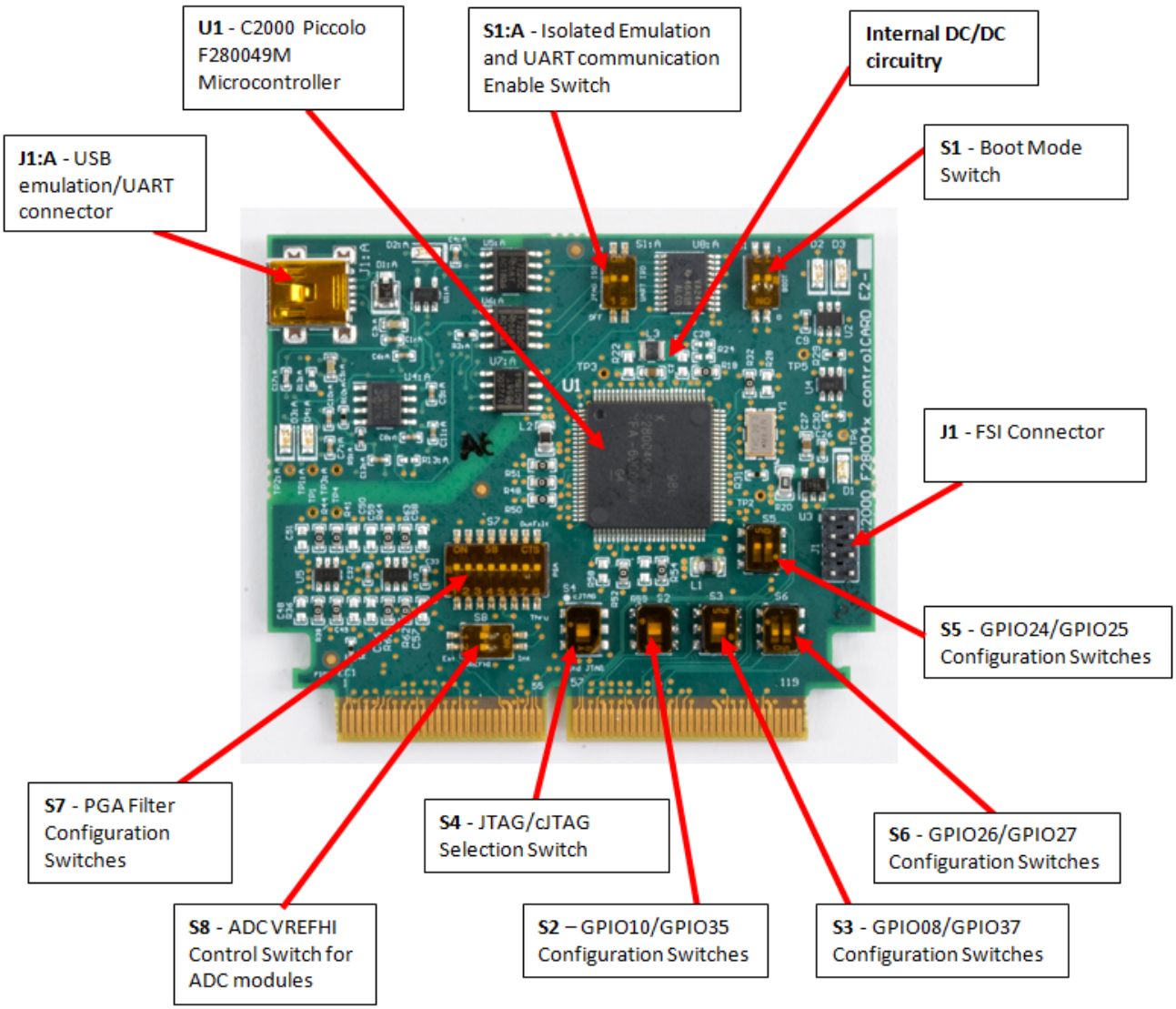


Table 2. Hardware References

Connectors	
J1:A	Emulation/UART connector - USB mini A connector used to provide xds100v2 emulation and USB-to-UART(SCI) communication through FTDI logic. S1:A determines which connections are enabled to the MCU.
Jumpers	
J1	FSI Connector - Gives an ability to connect FSI signals from the F28004x to another board.
LEDs	
D1	Controlled by GPIO-31 with negative logic (red)
D2	Controlled by GPIO-34 with negative logic (red)
D3	Turns on when the controlCARD is powered ON (green)
D2:A	Turns on when ISO JTAG logic is powered on (green)
D3:A	JTAG/UART RX toggle indicator (blue)
D4:A	JTAG/UART TX toggle indicator (blue)
Resistors and Capacitors (default setting in BOLD)	
R18, R19, R21, R22	GPIO22/23 configuration resistors These resistors allow the user to choose whether GPIO22/23 is used as GPIO (and go to the baseboard) or whether they will be used in conjunction with the F28004x MCU's internal DC/DC capability: • **R18,R19 populated with 0-Ω resistors and R21,R22 unpopulated** – GPIO22 and GPIO23 are used as GPIO and go to the baseboard through EC1. The internal DC/DC cannot be used. • R18,R19 unpopulated and R21,R22 populated with 0-Ω resistors – Internal DC/DC can be used to generate the 1.2-V VDD power rail. GPIO22 and GPIO23 are used as VFBSW and VSW, respectively. The internal DC/DC can be used.
C19, C20, C21	These capacitors should be populated when the F28004x's internal DC/DC capability is used. C19 should be populated with a 2.2-µF capacitor. C20 and C21 should each be populated with a 10-µF capacitor.
R24, C28	R24 and C28 create an optional snubber circuit, which can be used if the DC/DC is used.
R36-R47,R49,R53, R60-R64, C41-C47, and C48-C59	Optional RC input filter for all ADC/PGA inputs
C34-C40	PGA filter capacitor when PGA filtering is used
R55-R59	PGA-GND configuration resistors
R48,R50-R52,R54	These resistors control whether the negative input (PGAGND) for each PGA are grounded locally or whether they should be grounded through pins on the HSEC connector (for use in Kelvin grounding). By default, **resistors R55-R59 are not populated and R48, R50-R52, R54 are populated**. Because of this, all the PGAs are, by default, expected to be referenced to ground by the baseboard. If, for example, R55 was populated and R48 was unpopulated, then PGA1's PGAGND would be grounded on the controlCARD.
Switches (default position in BOLD)	
S1	Boot Mode Switch Controls the boot options of the F28004x device. See the device data sheet for more information. This switch is intentionally upside-down, so that logic 0 is down (the switch is closed) whereas logic 1 is up (the switch is open). See Table 3.
S2	GPIO10/GPIO35 Configuration Switches In the up position – GPIO10 goes to pin 60 of the HSEC connector. If S4's switch 1 is in the up position, GPIO35 goes to pin 85 of the HSEC connector. **In the down position** – GPIO10 goes to pin 85 of the HSEC connector. If S4's switch 1 is in the up position, GPIO35 goes to pin 60 of the HSEC connector.
S3	GPIO08/GPIO37 Configuration Switches **In the up position** – GPIO08 goes to pin 87 of the HSEC connector. If S4's switch 2 is in the up position, GPIO37 goes to pin 58 of the HSEC connector. In the down position – GPIO08 goes to pin 58 of the HSEC connector. If S4's switch 2 is in the up position, GPIO37 goes to pin 87 of the HSEC connector.
S4	JTAG/cJTAG Selection Switch In the up position – 2-pin cJTAG mode is expected to be used. GPIO35 and GPIO37 go to the baseboard based on the settings of S2 and S3, respectively. **In the down position** – 4-pin standard JTAG is expected to be used. GPIO35 and GPIO37 are used to support JTAG functionality. The on-card xds100v2 emulator requires 4-pin JTAG to be used.

Table 2. Hardware References (continued)

S5	GPIO24/GPIO25 Configuration Switches Switch 1 (left switch) – GPIO24 Configuration Switch: • **In the up position** – GPIO24 goes to pin 75 of the HSEC connector. • In the down position – GPIO24 goes to pin 100 of the HSEC connector. Switch 2 (right switch) – GPIO25 Configuration Switch: • **In the up position** – GPIO25 goes to pin 77 of the HSEC connector. • In the down position – GPIO25 goes to pin 102 of the HSEC connector.
S6	GPIO26/GPIO27 Configuration Switches Switch 1 (left switch) – GPIO26 Configuration Switch: • In the up position – GPIO26 goes to pin 107 of the HSEC connector. • **In the down position** – GPIO26 goes to pin 79 of the HSEC connector. Switch 2 (right switch) – GPIO27 Configuration Switch: • In the up position – GPIO27 goes to pin 109 of the HSEC connector. • **In the down position** – GPIO27 goes to pin 81 of the HSEC connector.
S7	PGA Filter Configuration Switches From the left, the switches control whether PGA1-PGA7's outputs, respectively, are filtered. Switch 8 is unused. Each switch: • **In the up position** – an HSEC pin is connected to the respective PGA+ input pin, and is now also tied to an additional ADC input pin. In software, PGA output filtering, for the respective PGA, functionality should NOT be used. • In the down position – an HSEC pin only goes to the PGA+ input pin. PGA output filtering, for the respective PGA, may be used. The description above is similar, but not quite true of S7's switch 6 (PGA6). Its implementation is slightly different; see the schematic for details. The switch does still give whether PGA output filtering may or may not be used.
S8	ADC VREFHI Control Switch for ADC modules Switch 1 (left switch) – VREFHI Control Switch for ADC module A: • In the up position – ADC-A is configured to use an external voltage reference, which should be connected to pin 45 of the HSEC connector. • **In the down position** – ADC-A should be configured to use the internal voltage reference. Switch 2 (right switch) – VREFHI Control Switch for ADC module B and module C: • In the up position – ADC-B and ADC-C are configured to use an external voltage reference, which should be connected to pin 45 of the HSEC connector. • **In the down position** – ADC-B and ADC-C should be configured to use the internal voltage reference.
S1:A	Isolated emulation and UART communication enable switches Switch Position 1 – JTAG Enable: • **ON** – All signals between the xds100v2 emulation logic and the MCU are connected. This setting is valid when the MCU is being debugged or programmed through the on-card xds100v2 emulator. • OFF – The xds100v2 emulation logic will NOT be connected to the MCU. This setting is valid when the device boots from FLASH, boots from a peripheral directly, or when an external JTAG emulator is used. Switch Position 2 – ISO UART communication enable: • **ON** – The C2000 MCU's GPIO-28 (and pin76 of the 180pin controlCARD connector) are coupled to the FTDI's USB-to-Serial adapter. This allows UART communication to a computer through the FTDI chip. However, in this position, GPIO-28 is forced high by the FTDI chip. Functionality of pin76 on the connector is limited. • OFF – The C2000 MCU will NOT be connected to the FTDI USB-to-Serial adapter. Pin76 of the 180pin controlCARD connector is directly connected to GPIO-28.

Table 3. Boot Mode Switch Positions

Mode #	Switch Position 1 (GPIO-24)	Switch Position 2 (GPIO-32)	Boot from
00	0	0	Parallel I/O
01	0	1	Boot from SCI / Wait Mode
02	1	0	Boot from CAN
03	1	1	Boot from FLASH

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (January 2017) to A Revision	Page
• Updated Title to Piccolo F280049C controlCARD Information Guide.	1
• Updated Warnings, Notes, and Errata section.	3

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3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment 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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

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.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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