Delfino™ TMS320F28379D controlCARD R1.3

The Delfino F28379D controlCARD (TMDSCNCD28379D) from Texas Instruments (TI) provides a great way to learn and experiment with the F2837x device family within TI's C2000™ family of microcontrollers (MCUs). This 180-pin controlCARD is intended to provide a well-filtered robust design that is capable of working in most environments. This document provides the hardware details of the F28379D controlCARD and explains the functions, locations of jumpers, and connectors present on the board.
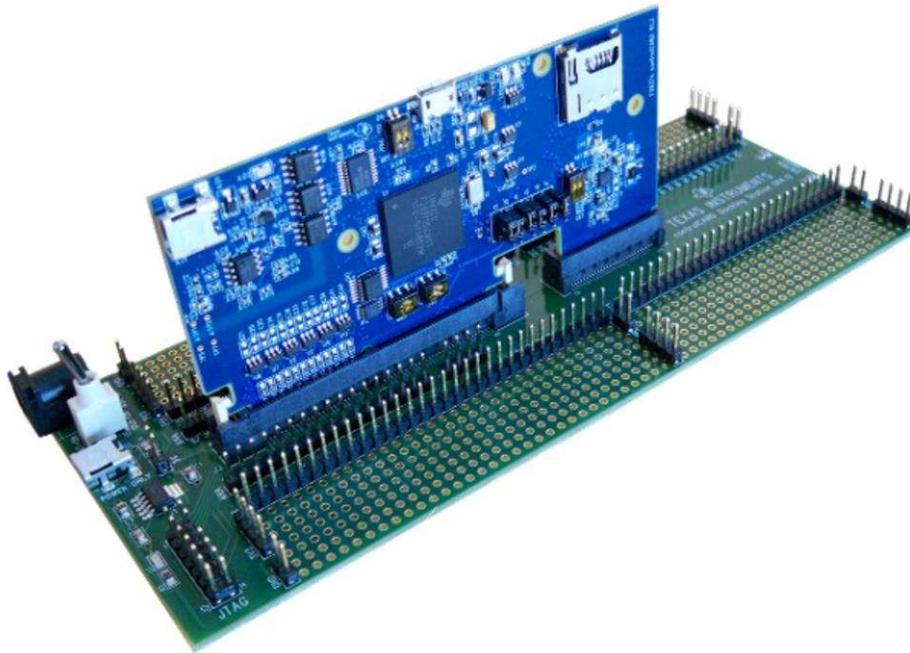

Figure 1. TMDSDOCK28379D Experimenter's Kit

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1   Introduction

As of January 2016, all kits based on the F28377D MCU will now be replaced with the new F28379D superset device. These two MCUs are identical except for the addition of the CLB on the F28379D MCU to enable Position Manager. If the CLB is not a requirement in your application, that feature can be left untouched and the MCU will perform like the F28377D.

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 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 F2837x 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.

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2   Errata

Current revision of controlCARD as of 2-Oct-2015: PCB rev - R1.3, ASSY rev - B.

NOTE: The Letter B on the controlCARD's Serial Number sticker denotes ASSY rev – B.

2.1   Warnings/Notes/Errata

Notes for all controlCARDs:

*   The F28379D controlCARD supports USB host/device connectivity. However, the micro-USB port, J8, 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.
*   The F28379D 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 (2.5 mm inner diameter x 5.5 mm outer diameter) and plug it into J1. A compatible supply could be the: Phihong PSAC05R-050(P)-R-C2 + Phihong RPBAG.
*   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 that connect to the isolated USB-to-serial interface via the FTDI chip, which uses GPIO28 and GPIO29. To use GPIO28 and 29 instead:
    *   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.

– 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 will be overwriting your ability to boot from Flash.

– With an emulator connected (TRSTn = 1), registers can be set such that SCIBoot's IOOption2 boot mode is called.

For more information, see the device-specific TRM.

• R83 on the controlCARD is populated to allow a customer to evaluate the controlCARD without a baseboard if desired. Because R83 is populated, the controlCARD putd more capacitance on the USB 5V supply than the USB specification allows. R83 should be removed in order to meet the specification.

2.2 *Warnings About Specific controlCARD Revisions*

Warnings about R1.0a revision F28377D controlCARDs:

• Among many other changes made, the pinout of the R1.1 F28377D controlCARD is different from the pinout of the pre-release R1.0a controlCARDs. When porting code, see the kit documentation and schematics in the C2000Ware install on your computer in the */boards/controlCARDs* subdirectory.

Warnings about R1.1 and earlier F28377D controlCARDs:

• The F28377D MCU is not 5 V tolerant. Because of this, some additional protection is needed between the USB port J8 and the MCU. In particular, resistor R72 should change from 0R0 to 100K and resistor R74 should change from 0R0 to 10K. This effectively limits the voltage/current received by the MCU pin. This issue was fixed in R1.1a and later revision controlCARDs.

• If used, the crystal X1 should be acceptable in most applications. However, it can fail under some worst case conditions. To assure proper operation, see the *TMS320F2837xD Dual-Core Delfino™ MCUs Silicon Errata*. This issue was fixed in R1.1a and later revision controlCARDs.

• Several name changes were made to pins on the device and are now reflected in R1.1a controlCARD documentation. No functionality was affected.

Warnings about R1.1a and earlier F28377D controlCARDs:

• The circuitry used to drive the C2000 MCU's voltage references is not ideal. Instead, it is recommended that users use the voltage reference driving circuitry found in the R1.3 controlCARD.

Warnings about R1.3 of F28379D controlCARD:

• R51-R54 were mistakenly populated with 100 MΩ resistors instead of 100 mΩ resistors. With 100 MΩ resistors used, the voltage references for the analog-to-digital converters (ADCs) may not be held adequately constant and the accuracy/precision of ADC results may be affected during sampling/conversion. It is recommended that customers replace R51-R54 with 100 mΩ, 0603, 5% tolerance (or better) resistors. For evaluation of the controlCARD in a lab environment, it is also acceptable to short R51-R54 using 0 Ω resistors or solder bridges, however, populating with 100 mΩ is preferred. For more information, see the following E2E post: https://e2e.ti.com/support/microcontrollers/c2000/f/171/t/576301.

3 Getting Familiar With the controlCARD

3.1 *F28379D controlCARD Features*

• Delfino F28379D Microcontroller – High performance C2000 microcontroller is located on the controlCARD.

• 180-pin HSEC8 Edge Card Interface – Allows for compatibility with all of C2000's 180-pin controlCARD-based application kits and controlCARDs. Compatibility with 100-pin 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, a microSD card, and isolated UART/SCI with the F2837x MCU. A hi-density connector is also provided to experiment with external memory.
- 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 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 5 V 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. Then, SW1 needs 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 the controlCARD will be used, additional hardware settings are necessary, see Table 1.

Table 1. Getting Started Reference

	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: TMS320F28379D 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.	---

Code Composer Studio is an Integrated Development Environment (IDE) used to debug and develop software for the C2000 series of MCUs.

CCS can be downloaded from the following URL: http://processors.wiki.ti.com/index.php/Download_CCS.

For users new to C2000's F28x7x 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 F2837x MCU's pins will appear on the controlCARD connector/docking station:
- TTMDSCNCD28379D_180cCARD_pinout_R1_3 – tells where each MCU pin will go on the HSEC controlCARD connector or the 120/180-pin controlCARD docking station.

- TMDSCNCD28379D_100DIMmap_R1_3 – 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:

- \controlSUITE\development_kits\~controlCARDs\TMDSCNCD28379D_vX_X\
- \controlSUITE\development_kits\~ExperimentersKits\120or180pin_HSEC_DockingStn-HWdevPkg_vX_X\

3.4 _Experimentation Software_

All key examples for the F28379D MCU can be found within controlSUITE at:

\controlSUITE\device_support\f2837xD\

This example software package includes many projects that 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 F28379D controlCARD provides emulation and USB-to-UART adapter functionality on the controlCARD. This allows for a convenient method to debug and demo the F2837x 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 (that is, A:R2 for resistor 2 in Macro A), see Figure 2.

Each F28379D controlCARD's xds100v2 is programmed with a fixed serial number. If a debug session needs to involve two or more F28379D controlCARDs, each controlCARD needs to have a unique serial number and some 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.
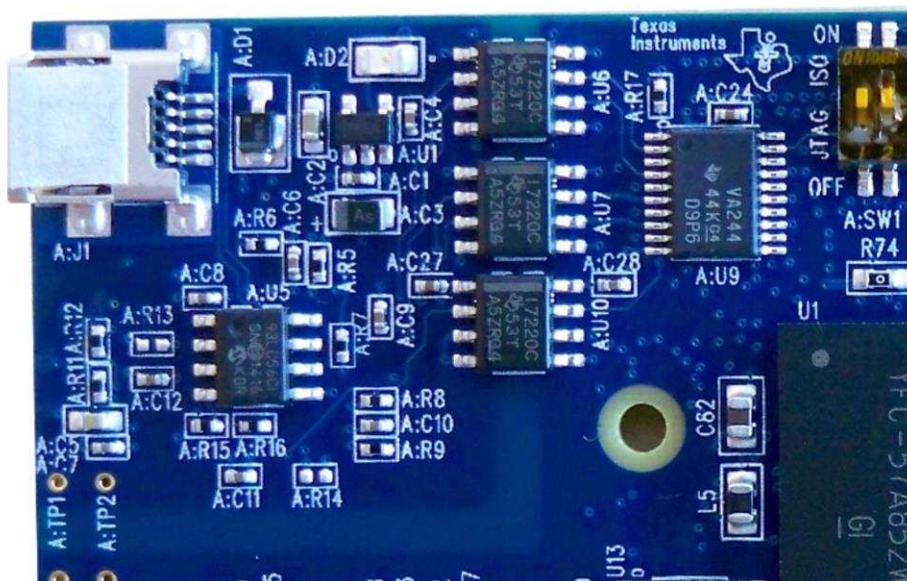

Figure 2. xds100v2 Emulation Circuitry and Isolation Circuitry is Denoted by A

4.2   *External Connector – J9*

External connector, J9, can be used to connect the controlCARD to another board. The ability to connect up to EMIF2, SPI-C, I2C-A, and 2 GPIO are provided – although any peripheral mux option provided on these GPIOs is technically possible.

Note that the GPIOs (122-125) that attach to the SPI portions of this connector, also go to the microSD connector. At any specific time, only one should be used to avoid contention.

Note that the GPIOs (53-68) that attach to the EMIF data lines of this connector and GPIOs (91 and 92) that attach to the I2C portions of this connector also go to the baseboard via the HSEC connector. These GPIOs should either be used to connect to the baseboard OR utilized on this header to avoid contention.

Figure 3 shows the connector that mates with J9 is the Hirose DF40HC(4.0)-60DS-0.4V(51).
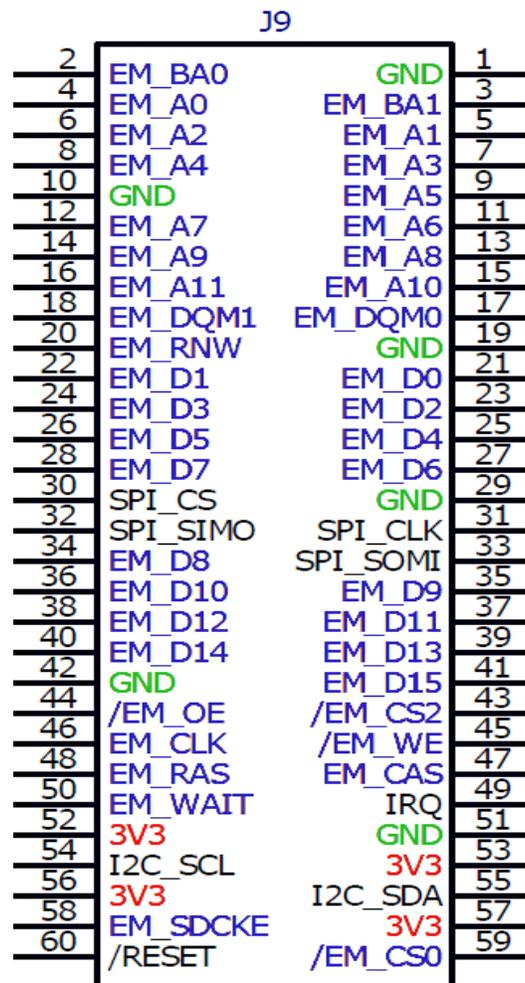
Figure 3. Hirose DF40HC(4.0)-60DS-0.4V(51)

4.3 Evaluation of the Analog-to-Digital Converters (ADCs)

When using the F28379D on-chip ADCs, there are some useful guidelines to help realize the performance numbers listed in the *TMS320F2837xD Dual-Core Delfino™ Microcontrollers* data sheet. This is especially true for the AC parameters such as: SNR, THD, and SINAD. Furthermore, it can also be shown that there is a direct correlation between the SNR of the ADC results and the spread of ADC codes seen for a DC input. These tips will improve the range and standard deviation of a DC input as well. Finally, while topics addressed will be with respect to the controlCARD, they are also applicable to other implementations using the F28379D MCU.

On-board resistors and capacitors: By default (Figure 4), all inline resistors to the ADC pins are a simple 0-Ω shunt and all capacitors to the ground plane are not populated. While this circuit can be used to supply the ADC inputs with a voltage, likely both the resistor (R) and capacitor (C) will need to be populated based on the voltage source's characteristics. Referring to the ADC Input Model, the ADC input has its own RC network made up of the internal sample and hold capacitor, switch resistance, and parasitic capacitance. By changing the inline resistance and parallel capacitor, the input circuit can be optimized to assist with settling time and/or filtering the input signal. Finally, it is recommended in general to use either Negative-Positive 0 PPM/°C (NPO) or Ceramic On Glass (COG) as these have better stability over temperature and across input frequencies than other types of capacitors.
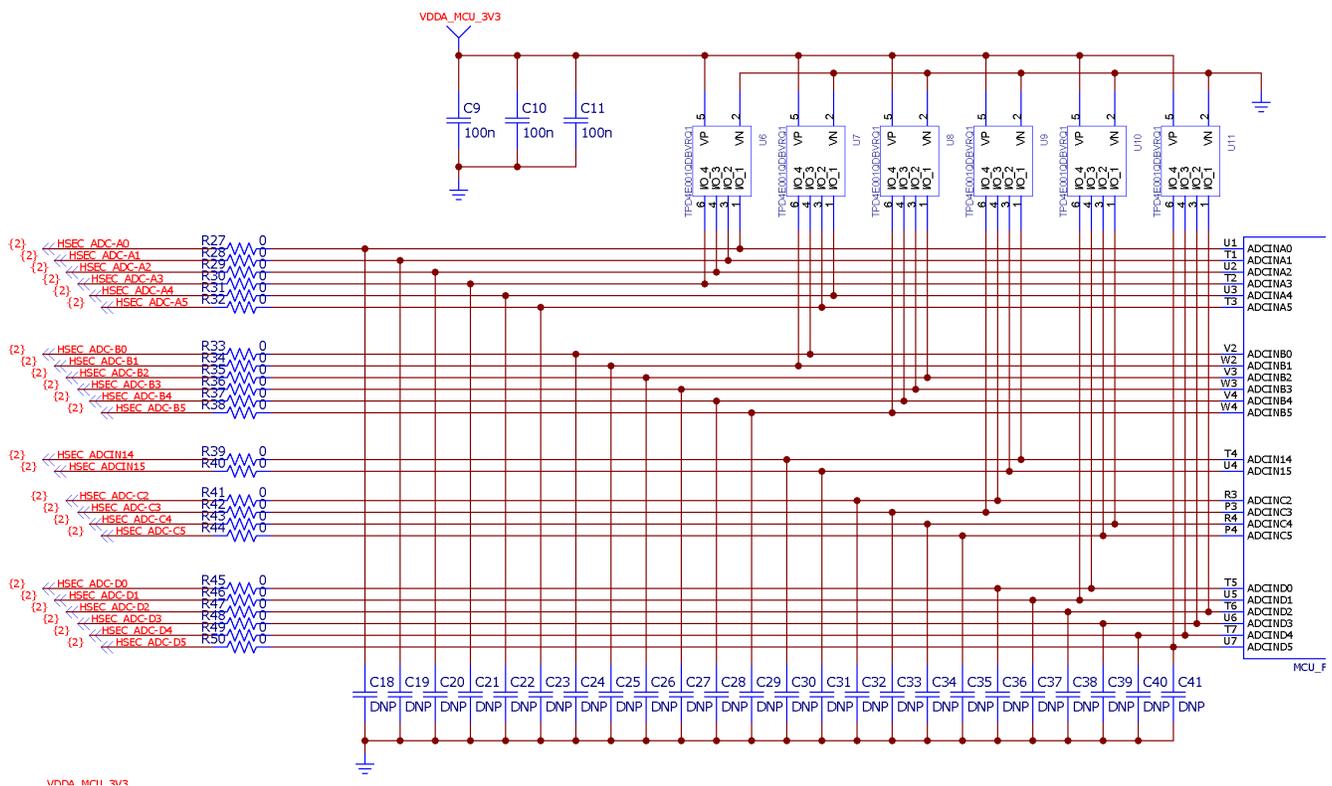

Figure 4. Partial Schematic Showing Default R and C values

Voltage source and drive circuitry: While the on-chip ADCs are configurable 12-bit/16-bit architectures (4096/65536 distinct output codes when converting an analog signal to the digital domain), the translation will only be as precise as the input provided to the ADC. The typical rule of thumb when defining the source resolution to realize the full specification of an ADC is to have a 1-bit better source than the converter. In this case, that would mean that ideally the analog input should be accurate to 13 bits for a 12-bit mode and 17 bits for a 16-bit mode.

Typically, voltage supplies or regulators are not designed to be precise, but rather accommodate a wide range of current loads within a certain tolerance, and for this reason, are not ideal to show the performance of a higher bit ADC, like the one on the F28379D. This does not take into account that many times the supply in question is providing the main voltage to power the MCU itself, which also introduces noise and other artifacts into the signal.

In addition to the quality of the input signal, there is also the aspect of the load presented to the ADC when it samples the input. Ideally, an input to an ADC would have zero impedance so as not to impact the internal R/C network when the sampling event takes place. In many applications, however, the voltages that are sampled by the ADC are derived from a series of resistor networks that are often large in value to decrease the active current consumption of the system. A solution to isolate the source impedance from the ADC sampling network is to place an operational amplifier in the signal path. Not only does this isolate the impedance of the signal from the ADC, it also shields the source itself from any effects the sampling network may have on the system.

Recommended source for evaluation: The Precision Signal Injector (PSI) EVM from TI was used to validate the ADC performance on the F28379D ControlCARD. This EVM supports both single ended as well as differential ended outputs using a 16-bit digital-to-analog converter (DAC) as the signal source then passed through a high precision op-amp with post amplifier filtering. The EVM is powered and controlled through a standard USB connection from a host PC and includes a GUI to control its output. The outputs are routed through single or dual SMA type connectors. It is highly recommended to place additional female SMA connectors (Figure 5) on the controlCARD docking station to receive the signal via SMA cable for best noise immunity. For the local RC network, 30-Ω resistors and 300 pF capacitors were used. Using this setup, the ADC parameters were observed to be consistent with the published numbers in the *TMS320F2837xD Dual-Core Delfino™ Microcontrollers*.

Figure 5. Female SMA Connector

5   Hardware References

Table 2 shows the various connections available on the board. Figure 6 illustrates the location of many of these components on the board.
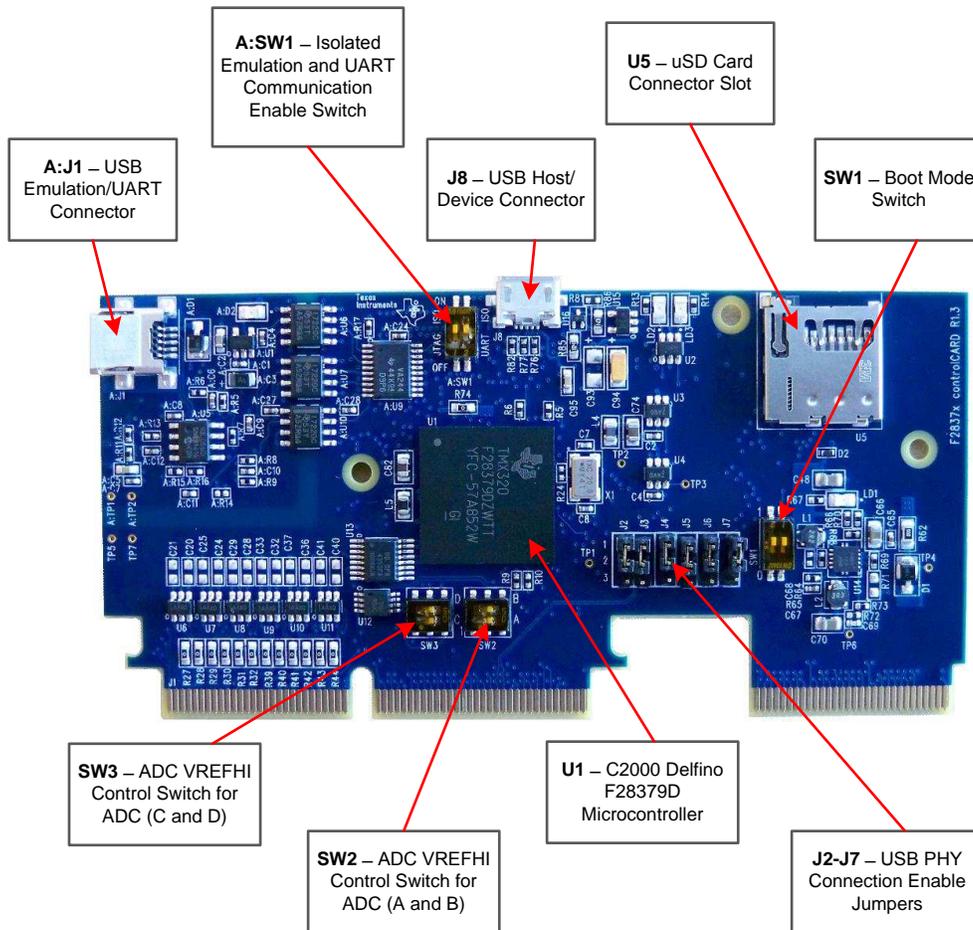

Figure 6. Key components on the controlCARD

Table 2. Hardware References

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.
U5	SD Micro card slot – connects to MCU via SPI
J8	USB connector – USB micro AB connector supports USB 2.0 host/device
J9	Enables a secondary board to have access to the F28379D's EMIF2 and several other digital signals.
Jumpers	
J2-J7	USB PHY connection enable/disable jumpers: • **All jumpers up** – The MCU will be connected to the USB PHY on the controlCARD via GPIOs 42, 43, 46, 47, 120, and 121 • .All jumpers down – The MCU will not connect to the USB PHY and all signals will instead go through the 180-pin controlCARD connector.
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)

Table 2. Hardware References (continued)

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	
R59, R60	Alternate Reference Configuration Resistors These resistors allow the user to choose whether the alternate reference for the ADCs will be given by: • If R59 is unpopulated & R60 is populated A precision 3.0V reference (REF5030) • If R59 is populated & R60 is unpopulated The reference will be given by pin 45 of the HSEC controlCARD connector. This will presumably allow the baseboard to provide the desired voltage reference.
R27-R50 and C18-C41	Optional RC input filter for all ADC inputs
Switches (default position in BOLD)	
SW1	Boot Mode Switch: Controls the Boot Options of the F2837x device. For more information. (0 is down, 1 is up), see the device-specific data sheet. Mode # Switch Position 1 (GPIO-72) Switch Position 2 (GPIO-84) Boot from 00 0 0 Parallel I/O 01 0 1 Boot from SCI 02 1 0 Wait Boot Mode 03 1 1 Get Mode (Flash by default)

Mode #	Switch Position 1 (GPIO-72)	Switch Position 2 (GPIO-84)	Boot from
00	0	0	Parallel I/O
01	0	1	Boot from SCI
02	1	0	Wait Boot Mode
03	**1**	**1**	**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 – ADC-A is configured to use VDDA (3.3 V) as the ADC's voltage reference. The full-scale range of this ADC will be 0-3.3 V, but the ADC will have reduced accuracy/precision. • **In the right position** – ADC-A is configured to either use a precise 3.0 V voltage reference or an external voltage may be used as a reference. R59 and R60 determine which setting is used (see description for R59/R60, above)
	Switch 2 (upper switch) – VREFHI Control Switch for ADC module B: • In the left position – ADC-B is configured to use VDDA (3.3 V) as the ADC's voltage reference. The full-scale range of this ADC will be 0-3.3 V, but the ADC will have reduced accuracy/precision. • **In the right position** – ADC-B is configured to either use a precise 3.0 V voltage reference or an external voltage may be used as a reference. R59 and R60 determine which setting is used (see description for R59/R60, above)
SW3	ADC VREFHI Control Switch for ADC modules C & D: Switch 1 (lower switch) – VREFHI Control Switch for ADC module C: • **In the left position** – ADC-C is configured to use VDDA (3.3 V) as the ADC's voltage reference. The full-scale range of this ADC will be 0-3.3V, but the ADC will have reduced accuracy/precision. • **In the right position** – ADC-C is configured to either use a precise 3.0 V voltage reference or an external voltage may be used as a reference. R59 and R60 determine which setting is used (see description for R59/R60, above)
	Switch 2 (upper switch) – VREFHI Control Switch for ADC module D: • **In the left position** – ADC-D is configured to use VDDA (3.3 V) as the ADC's voltage reference. The full-scale range of this ADC will be 0-3.3V, but the ADC will have reduced accuracy/precision. • **In the right position**– ADC-D is configured to either use a precise 3.0 V voltage reference or an external voltage may be used as a reference. R59 and R60 determine which setting is used (see description for R59/R60, above).

Table 2. Hardware References (continued)

A:SW1	Isolated emulation and UART communication enable switches:
	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 pin 76 of the 180-pin 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 pin 76 of the connector will be limited. • OFF – The C2000 MCU will **NOT** be connected to the FTDI USB-to-Serial adapter. Pin 76 of the 180-pin controlCARD connector will be directly connected to GPIO-28.

6   References

- Texas Instruments: *TMS320F2837xD Dual-Core Delfino™ MCUs Silicon Errata*
- Texas Instruments: *TMS320F2837xD Dual-Core Delfino™ Microcontrollers* data sheet
- E2E post: https://e2e.ti.com/support/microcontrollers/c2000/f/171/t/576301
- http://processors.wiki.ti.com/index.php/Download_CCS wiki
- http://processors.wiki.ti.com/index.php/C2000_32-bit_Real-Time_MCU_Training wiki
- http://processors.wiki.ti.com/index.php/Hands-On_Training_for_TI_Embedded_Processors wiki

Revision History

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

Changes from Original (March 2017) to A Revision   **Page**

- Added Section 4.3 to provide ADC best practices. ………………………………………………………………………… 7

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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

  3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けて

いないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの

措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用
   いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

　　　　上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 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

   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.

6. *Disclaimers:*

    6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

    6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

    8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

    8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.