TMS320F28M36 Concerto controlCARD R1.1 Information Guide

Version 1.3 – May 2016 *C2000 Systems and Applications Team*

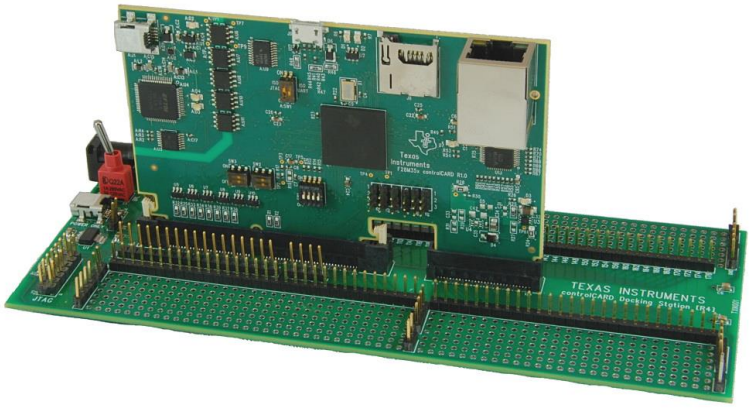

Fig 1: TMDSDOCK28M36 Experimenter's Kit

1 Introduction

The Concerto F28M36x controlCARD (TMDSCNCD28M36) from Texas Instruments (TI) provides a great way to learn and experiment with the F28M36x device family within TI's C2000 family of microcontrollers (MCUs). This 180-pin controlCARD is intended to provide a well-filtered robust design capable of working in most environments. This document goes over the hardware details of the F28M36 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 deploy a C2000 device. These files include:

- Schematics
- Bill of Materials (BOM)
- Gerber files

NOTE: this kit is designed to be a kit to explore the functionality of the F28M36 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 26-May-2016: PCB rev - R1.1, ASSY rev - none

2.1 Warnings/Notes/Errata –

1. The F28M36x controlCARD supports USB host/device connectivity. However, the micro-USB port, J9, 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. According to the revised TLK110 datasheet (October 2012), the TLK110's TRSTn pin is required to be connected to an approximately 2.2Kohm pull-down resistor. This was not done on the F28M36 controlCARDs as of hardware revision 1.1. As a result, the Ethernet PHY may not respond as expected. Note that the C2000 group has not seen this issue happen on the F28M36 controlCARD. This erratum is simply mentioned as a warning.
3. It can be difficult to connect to the MCU via JTAG when using the Boot-to-Flash boot mode if no code is already loaded into the device. It is recommended to use Boot-from-Ethernet boot mode (or other boot mode) until valid code is loaded into FLASH.
4. TLK110 pins 23, 18, and 37 (PFBOUT, PFBIN1, and PFBIN2) have been connected to the 3.3V rail on the F28M36x controlCARD. This is incorrect and should be avoided in future designs. This issue can be corrected by disconnecting the effected pins from the 3.3V rail. Note that all other connections to these pins should remain unchanged. For more information please refer to the TLK110 datasheet.
5. In the "F28M36x Reset Pins" block of the F28M36x controlCARD, R17 and C8 should not be populated in future designs in order to align with datasheet specifications. Refer to sheet 3 of the F28M36x controlCARD (R1.1) schematic.

3 Getting Familiar with the controlCARD

3.1 F28M36 controlCARD Features

- **Concerto F28M36P63C2 Microcontroller** – high performance microcontroller located on the controlCARD.
    - Device documentation can be found at the F28M36 product folder: http://www.ti.com/product/f28m36p63c2
- **180pin HSEC8 Edge Card Interface** – Allows for compatibility with all of C2000's 180pin controlCARD based application kits and controlCARDs. Compatibility with 100pin controlCARDs can be accomplished using the TMDSADAP180TO100 adapter card (sold separately).
- **Built-in Isolated JTAG Emulation –** 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 Ethernet, microSD card, USB and isolated UART/SCI with the F28M36x 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 clamped with diode protection
- **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: F28M36P63C2 device with an xds100v2 emulator	---	---
Baseboard's JTAG connector **(J2 on the Docking Station baseboard)**	---	Connect an external emulator	---

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 Concerto and CCS, the following videos may be helpful. Please note that the videos show the F28M35 MCU which is functionally similar to the F28M36 MCU.
http://www.ti.com/mcu/docs/mcuorphan.tsp?contentId=129766

The following PDF documents are provided to describe where each of the F28M36x MCU's pins will appear on the controlCARD connector/Docking Station:

TMDSCNCD28M36_180cCARD_pinout – tells where each MCU pin will go on the HSEC controlCARD connector or the 120/180-pin controlCARD Docking Station.

TMDSCNCD28M36_100DIMmap – 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 each of these pieces of hardware can be found under ~controlCARDs or ~ExperimentersKits in controlSUITE.

3.4 Experimentation Software

All software for the TMS320F28M36 family of MCUs can be found within controlSUITE (http://www.ti.com/controlsuite). Once installed the key examples can be found at:

\controlSUITE\device_support\f28m36x\

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

4 Special Notes on Connectivity

4.1 xds100v2 Emulator and SCI/UART Connectivity

The F28M36x controlCARD provides emulation and USB-to-UART adapter functionality on the controlCARD. This allows for a convenient method to debug and demo the F28M36x 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 F28M36x controlCARD's xds100v2 is programmed with a fixed serial numbr. If a debug session needs to involve 2 or more F28M36x controlCARD, each controlCARDs 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, and whether the device can boot from FLASH/peripherals. See Table 1.

Fig2: xds100v2 Emulation circuitry and isolation circuitry is denonted by an A:

4.2 Ethernet MAC address

All Concerto F28M36x Ethernet examples assign a fixed MAC address: A8-63-F2-00-00-80 at run-time. As the controlCARDs were produced, a unique MAC address has been assigned to each controlCARD produced and was written to a board label near the Enet connector (J10). If desired, the MAC address in the examples can be modified to be the unique address on the board label. User applications can also program a fixed MAC address in non-volatile memory reserved for the MAC address. Refer to the device documention for more details.

5 Hardware References

Table 1 on the next page shows the various connections available on the board. Fig 3, below, illustrates the location of many of these components on the board:

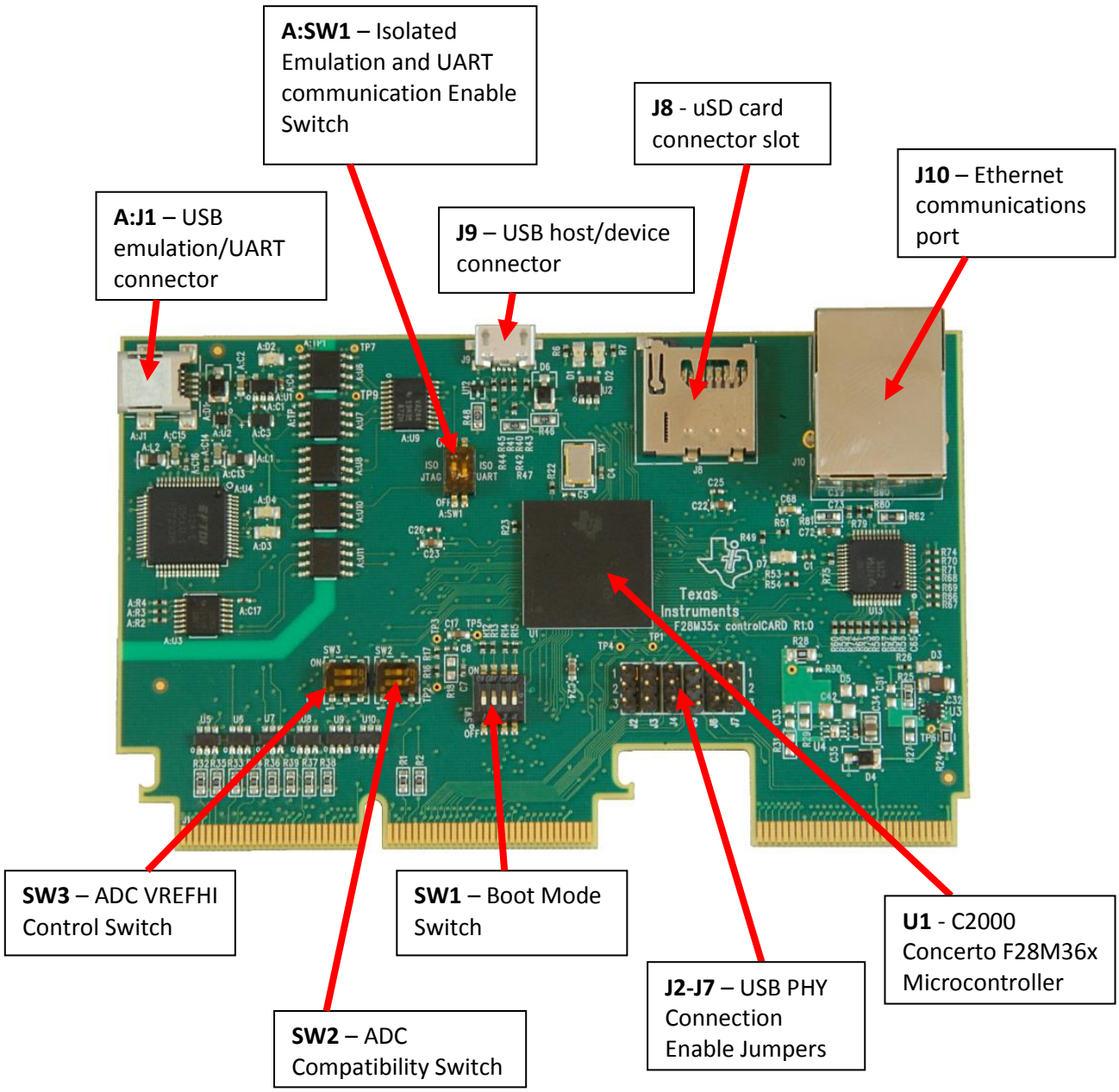

Fig3: Key components on the controlCARD

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 what connections are enabled to the MCU.
J8	SD Micro card slot – connects to MCU via SPI
J9	USB connector – USB micro AB connector supports USB 2.0 host/device
J10	Ethernet port – Connected to TLK110 PHY and supports 10/100

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)
D7	Shows the Ethernet LED Link status. On means that there is an ethernet link.
A:D2	Turns on when ISO JTAG logic is powered on (green)
A:D3	UART/SCI RX toggle indicator (blue)
A:D4	UART/SCI TX toggle indicator (blue)

Resistors

R86-R95	Ethernet PHY Address Resistors – The default PHY address is configured to be 0x00h. See TLK110 documentation for more details.

Switches (default position in BOLD)

SW1

Boot Mode Switch:
Controls the Boot Options of the F28M36x device. See the device datasheet for more information. (0 is down, 1 is up)

Mode #	Position 1 (GPIO-34)	Position 2 (GPIO-35)	Position 3 (GPIO-47)	Position 4 (GPIO-43)	Boot from
00	0	0	0	0	Parallel I/O
02	0	0	1	0	Serial Peripherals
07	0	1	1	1	FLASH
12	**1**	**1**	**0**	**0**	**Ethernet**
15	1	1	1	1	FLASH

SW2	ADC Compatibility Switch: This switch allows ADC1-A6 of the F28M36x device to go through pin 25 of the connector instead of pin 23. Pin 25 is occasionally assumed by application motherboards as a position where a positive comparator input should be. • **In the right position,** ADC1-A6 of the MCU will be connected to pin 23 of the 180pin cCARD connector. ADC1-B0 will be connected to pin 25 of the 180pin cCARD connector. • In the left position, ADC1-A6 of the MCU will be connected to pin 25 of the 180pin cCARD connector. ADC1-B0 will be connected to pin 23 of the 180pin cCARD connector.
SW3	ADC VREFHI Control: By default, the ADC will convert from 0 to 3.3V via internal references. However, if the ADC control registers is configured to allow the ADC to use external limits, the ADC will convert its full range of resolution from VREF-LO to VREF-HI. Note that there are some limits on the valid values of VREF-LO and VREF-HI, please see the datasheet for more information. Position 1 – Controls VREF-HI for ADC1, the value that the ratio-metric ADC1 will convert as the maximum 12-bit value, which is 0x0FFF. • **In the right position,** VREF-HI will be connected to 3.3V. • In the left position, VREF-HI will be connected to pin 45 of the 180pin controlCARD connector. This will allow a connected motherboard to control the ADC1 VREF-HI value. Position 2 – Controls VREF-HI for ADC2, the value that the ratio-metric ADC2 will convert as the maximum 12-bit value, which is 0x0FFF. • **In the right position,** VREF-HI will be connected to 3.3V. • In the left position, VREF-HI will be connected to pin 45 of the 180pin controlCARD connector. This will allow a connected motherboard to control the ADC2 VREF-HI value.
A:SW1	Isolated emulation & UART communication enables: 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 an external JTAG emulator will be used.

	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.
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 38, 42, 45, 46, 102, and 103. • All jumpers down – The MCU will not connect to the USB PHY and all signals will instead go through the 180pin controlCARD connector.

Table 1: Hardware References

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Such product safety design criteria shall include but not be limited to critical circuit creepages and clearances, component selection, and required protective means (ie output fusing) depending on the specific loads being controlled.

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      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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- *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.*

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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

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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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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 AND CONDITIONS. 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 ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, 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 ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS 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.

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