TMDXRM46CNCD
Hercules™ ARM® Safety MCU controlCARD (CNCD)

USER GUIDE

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About This Manual

This document describes the board level operations of the RM46 controlCARD (CNCD). The CNCD is based on the Texas Instruments RM46L852 337 BGA Microcontroller. While the 'L852 device is capable of running at 220MHz, this control card has been configured for the nominal speed of this family/package combo of 180MHz. The RM46 CNCD is a DIMM form factor card built for use in existing TI motor control EVMs. It is designed allow engineers and software developers to evaluate certain characteristics of the RM46 microcontroller in motor control applications. Evaluators can create software to execute on board or expand the system in a variety of ways. Please note that some the CNCD requirements, power supply requirements for example, may not be compatible with every DIMM100 based EVM available from TI. Please consult the respective EVM documents to determine if the Hercules CNCDs are compatible. This CNCD has been tested primarily with the DRV8301 EVM.

Notational Conventions

This document uses the following conventions:
The RM46 CNCD will sometimes be referred to as the RM46 CNCD or simply CNCD.

Program listings, program examples, and interactive displays are shown in a special italic typeface. Here is a sample program listing.

equations
!rd = !strobe&rw;

Information About Cautions

This book may contain cautions.
This is an example of a caution statement.
A caution statement describes a situation that could potentially damage your software, or hardware, or other equipment. The information in a caution is provided for your protection. Please read each caution carefully.

Related Documents, Application Notes and User Guides

Information regarding this device can be found at the following Texas Instruments websites:

http://www.ti.com/hercules
http://www.ti.com/rm4

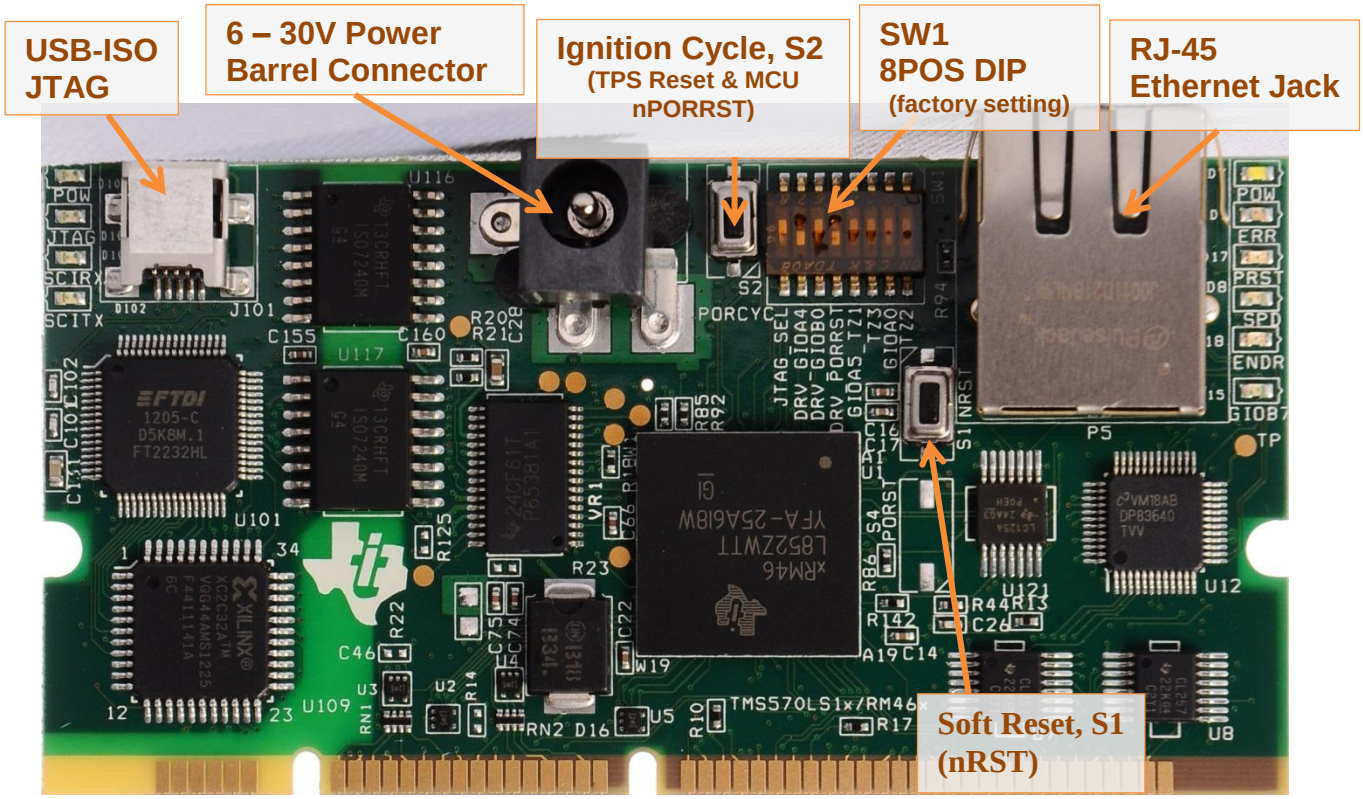
1. Introduction

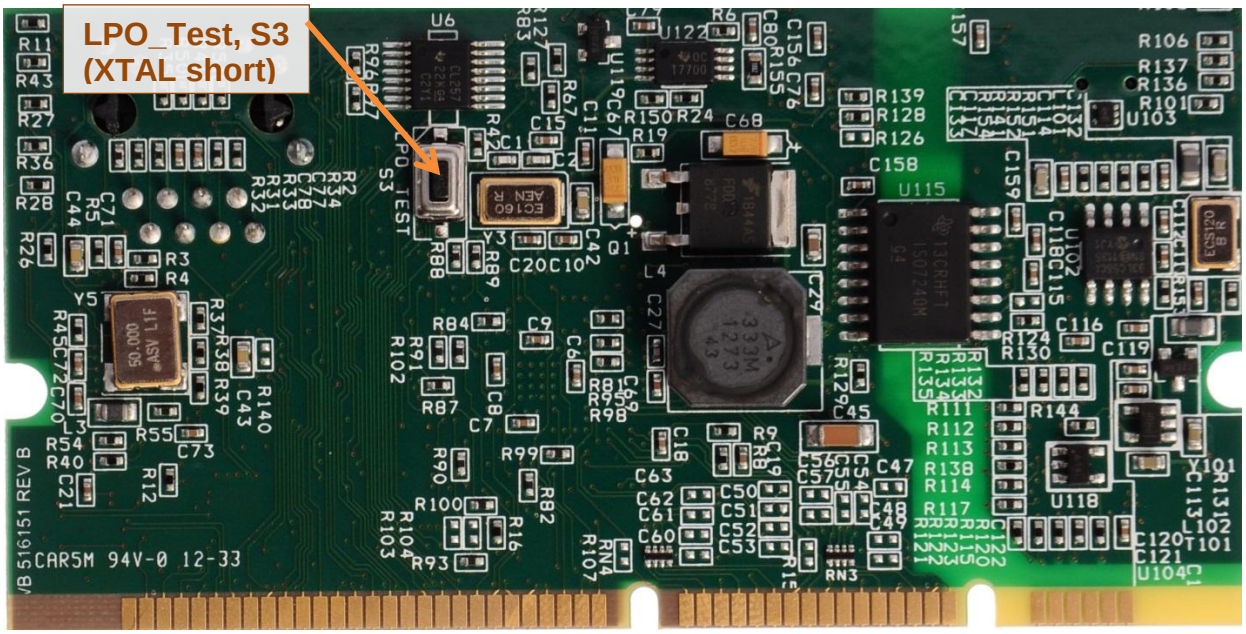
The Hercules™ controlCARDs from Texas Instruments are ideal products for initial software development and short run builds for system prototypes, test stands, and many other projects that require easy access to high-performance controllers. The controlCARDs are board-level modules that utilize an industry-standard 100 pin DIMM form-factor to provide a low-profile single-board controller solution. All of the Hercules controlCARDs use the same 100-pin connector footprint to provide basic analog and digital I/Os on-board the MCU and are generally interchangeable with other controlCARDs from TI. Please note that not all of the MCUs IO may be available on the DIMM connector.

All software, documentation, and hardware documents, including schematics, list of materials, and PCB layout, are included on the DVDs in the kits or are available from the Hercules product web pages.

Scope of Document

This user guide will list the contents of the development kit, point out the features of the major components, and provide the instructions necessary to verify your development kit is in working order. Any additional usage instructions or details fall outside the scope of this document. Additional resources will be listed at the end of this user guide.

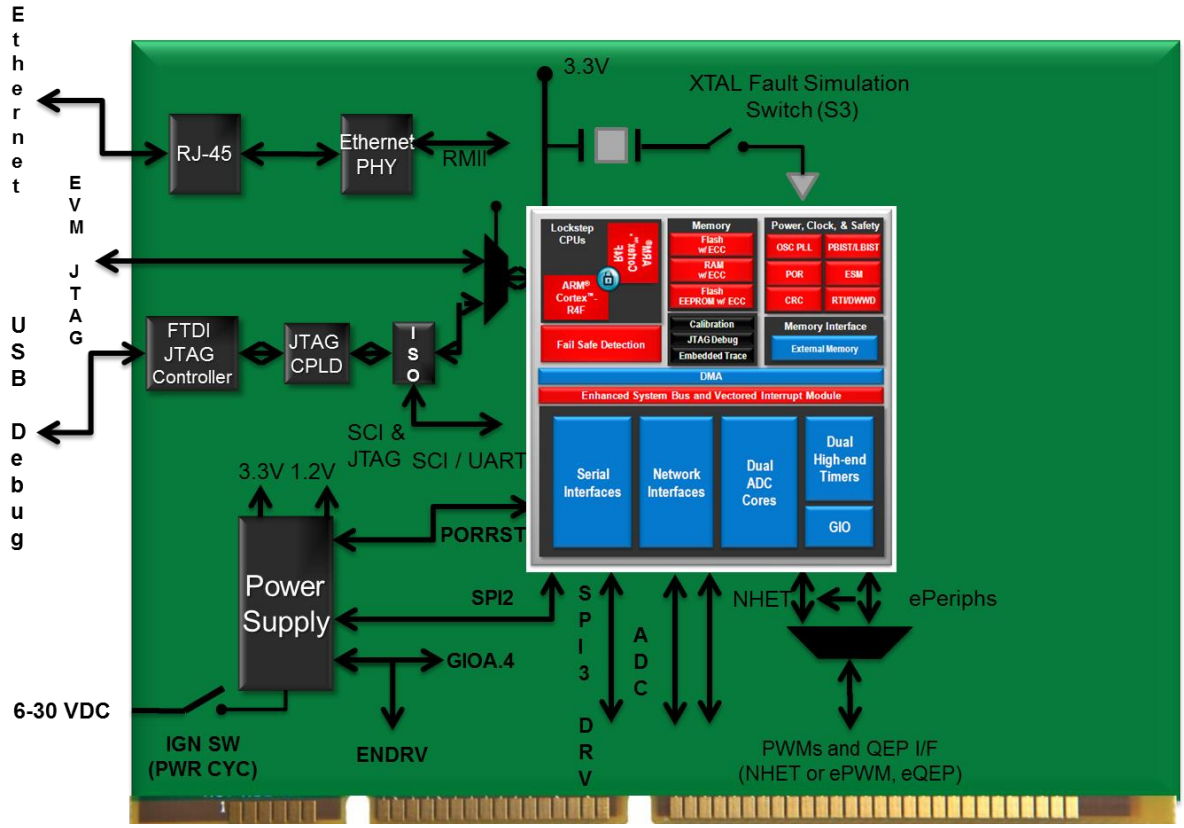




1. *RM46 ControlCARD (CNCD) Features*

The TMDXRM46CNCD is meant for use as part of a motor control kit and offers additional control, connectivity and safety evaluation features. Key features include:

- A Texas Instruments RM46L852 337-ball BGA microcontroller
- A Texas Instruments TPS65381 Safety-Integrated Power Companion
- *On board, isolated* USB XDS100v2 JTAG emulator
- Optional path to EVM JTAG connector (via DIMM)
- Hardware option for routing N2HET timers or ePeripherals to the DIMM interface – includes HET monitoring of ePeripheral outputs
- 10/100 Mbps Ethernet interface via RJ-45 with same PHY as on the TMDXRM46HDK
- Isolated UART/SCI accessible through a USB Virtual Port (VCP)
- Ignition cycle simulator switch S2 – serves as system reset of TPS and MCU
- LPO_TEST (SW3) push button switch (causes CLKDET hardware fault on MCU)
- LED indicators for xds100 power, activity, target/MCU power, GIOB7 pin activity, Ethernet link and activity, Ethernet speed, and nERROR.
- Soft Reset pushbutton (nRST)
- On board power supply supporting a 6V – 30V DC input and producing the 6V, 3.3V and 1.2V for the MCU



1. RM46 CNCD Contents

The CNCD is made available as part of the DRV8301-RM46-KIT or orderable standalone as TMDXRM46CNCD. The kit contains everything needed to develop and run applications brushless DC motor control applications utilizing Hercules Safety MCUs. For more information on the kit, please see www.ti.com\tool\drv8301-RM46-kit. The stand-alone card is shipped with a DVD containing:

DVD Containing

- TI GUIComposer runtime environment
- TI MotorWare motor control CCS5 example projects for:
  - Redundant SMO and Encoder based FOC as well as
  - InstaSPIN™-BLDC
- GUI applications demonstrating the MotorWare projects (as tested on the DRV8301)
- MotorWare Documentation
- Hardware Documentation
- HALCoGen
- nowFlash
- nowECC

2. CNCD Specifications

- Board supply voltage: 6V–30V VDC (Per TPS65381 spec)
- Board supply current: 260mA @ 6V typ (fully active, CPU at 180 MHz)
- Dimensions: 3.90” x 1.80” x 0.85” (LxHxW)
- RoHS status: Compliant

3. Basic Operation

The CNCD is designed to work with TI’s Code Composer Studio and other ARM IDE development tools. The IDE communicates with the board through the embedded xds100 emulator or an external JTAG emulator plugged into the EVM. To start, follow the instructions in the Quick Start Guide to install Code Composer and the Hercules Motor Kit software. This process will install all of the necessary development tools, documentation and drivers.

4. Memory Map

The RM46 family of MCUs have a large byte addressable address space. The memory map table shows the address space of a RM46 microcontroller on the left with specific details of how each region is used by the CNCD on the right. By default, the internal memory sits at the beginning of the address space.

Table 1, RM46 Memory Map

Start Address	End Address	CNCD
0x0000 0000	0x0017 FFFF	Flash
0x0800 0000	0x0801 FFFF	RAM
0x0840 0000	0x0841 FFFF	RAM-ECC

5. Power Supply

The RM46CNCD board operates from an external power supply provided via the barrel connector located on the top-front of the card. The expected voltage for the control card is 6.0V to 30.0V as per the input capability of the TPS65381 and provides regulated 3.3 and 1.2 volts to the IO and core of the MCU, respectively. Please note that the 24V power supply that is shipped with the kit can also supply the RM46 control card.

NOTE: In the event that an alternate supply is desired for your kit and it exceeds the operating input voltage of the card, please supply the control card independently. The power supply that comes with the DRV8301-RM46-KIT can supply the card directly in this case, if so desired.

The CNCD utilizes the new TPS65381 safety companion device that includes several safety features along with integrated power management and monitoring. The integrated watchdog on the TPS requires special handling in order to achieve an active safety state for the TPS MCU and DRV device. The Hercules motorware project includes an example of how to achieve the active “safety state” during/after loading and system initialization.

2. Physical Description

This chapter describes the physical layout of the RM46 CNCD board and its interfaces.

1. Board Layout

The RM46 CNCD board is a 3.9 x 1.8 inch, six (6) layer printed circuit board. Please see the included files RM46CNCD_XDS100P-5top and RM46CNCD_XDS100P-5bot.pdf which show the layout of the RM46 CNCD board.

2. LEDs and Switches

Table 2. Summary of LED Indicators

Num	LED	Color
D1	nERROR	RED
D102	XDS100V2 SCI RX	Blue
D103	XDS100V2 SCI TX	Blue
D104	FTDI TDI	Blue
D8	Ethernet Speed	Blue
D7	VCC_5V	White
D105	VCC_3V3 (xds100v2)	Blue
D15	GIOB7 Activity	Blue
D17	PORRST	Orange
D19	Enable DRV (TPS Watch-dog is in Active Safety mode when this LED is NOT lit.)	Orange

3. S1 Warm Reset Switch

Switch S1 asserts a warm reset the RM46 device. However, a warm reset does not reset any on-chip test or emulation logic. This can useful in cases where you do not want to lose the debugging channel into the MCU. The reset signal from the windowed watchdog will also assert a warm reset to MCU. TMS570 MCU has two resets: Warm Reset (nRST) and Power On Reset (nPORRST. The POR can be invoked by pushing POR_CYC button.

4. S2, Power Cycle (MCU Power On Reset) Switch

Switch S2 is a momentary switch that removes power to the TPS65381 device momentarily. In doing so, the TPS65381 asserts a power on reset (nPORRST) to the RM46 device. In this way, the entire subsystem is goes through a forced power cycle similar to what may be experienced during an ignition cycle. It has the added benefit of keeping the MCU and TPS device in synch with each other regarding their respective reset/restart states. The POR condition is intended to reset all logic on the device including the test/emulation circuitry.

5. S3, LPO_Test Switch

Switch S3 is a momentary switch that will short the OSCIN pin of the crystal to ground through a current limiting resistor. Pushing this button will simulate a crystal failure and causes a CLKDET hardware fault on MCU. By default this detection will trigger the Error Signaling Module (ESM) to drive the nERROR pin. On the CNCD, the red LED will then light. The error can be cleared by a PORRST (S2), cycling the power to the MCU or via safety software executed on the MCU.

6. 8 Position SPST DIP Switch (SW1)

The 8 position DIP Switch serves two purposes: ePWM1 trip zone configuration selection (A-D) and helpful MCU-TPS debug options:

- Switch E can be used to disable the TPS capability to reset the MCU.
- Switches F and G select which MCU GIO is used to monitor the DRV Enable signal.
- Switch H selects whether the JTAG emulation path uses the on-chip xds100 or the emulation header used on the EVM. As shipped, SW1-H is OFF and the on-board xds100 emulator is used. If Switch SW1-H is ON, the on-board emulator is disabled and debug, flashing etc. will require an emulator to be attached to the JTAG emulator on the EVM.

Switch Position	H	G	F	E	D	C	B	A
Signal	3.3V	ENDRV	ENDRV	DRV	ETPWM1A_GIOA5	ETPWM1A_GIOA5	ETPWM1A_GIOA5	ETPWM1A_GIOA5
Connected to:	JTAG_D	GIOA4	GIOB0	PORRST	2CSCL_nTZ1	nTZ3	GIOA0	2CSDA_nTZ2
Default Factory Position	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF

7. Connectors

The CNCD board has several interfaces to various peripherals. These interfaces are described in the following sections.

Table 3, Connectors on CNCD Board

Connector	Size	Function
P3	RJ45	Ethernet
J101	4pin, Mini-B USB	XDS100V2 USB

8. J101, XDS100V2 USB JTAG Interface

The USB connector J101 is used to connect to the host development system which is running the software development IDE (CCS). The signals on this connector are shown in the table below.

Table 4, J7, XDS100V2 USB JTAG Interface

Pin #	Signal Name
1	USBVDD
2	D-
3	D+
4	NC
5	USBVSS

Before the board is shipped, the XDS100v2 port1 is configured as JTAG, and port2 is configured as SCI. There is also a CPLD on the board that is programmed to route JTAG signals to the MCU.

9. Ethernet Interface

Several configurations of the RM46x MCUs integrate an Ethernet MAC on chip. Please consult the family datasheets for availability. The controlCARD uses a DP83640 PHY. The interface is isolated and brought out to an RJ-45 connector with integrated magnetics, P3. The ***cable end*** pinout for the J1 connector is shown in the table below.

Table 5; J1, Ethernet Interface

Pin #	Signal	Pin #	Signal
1	D0+	2	D0-
3	D1-	4	D2+
5	D2-	6	D1-
7	D3+	8	D3-

Two LEDs are embedded into the connector to report link status (green LED) and transmit/receive status of the PHY (yellow LED).

10. SCI Interface

The internal SCI on the RM46 device is routed to the 2nd port of the XDS100v2. The XDS100v2 USB driver makes the FT2232H 2nd channel appear as a virtual COM port (VCP) on the PC. This allows the user to also have standard PC serial communications with the CNCD using the same USB interface as the on-board emulator

11. DIMM100 Card Interface

Pin #	Description	Description	Pin #
1	3V3_ISO	3V3_ISO	51
2	RX_ISO	TX_ISO	52
3	3-NC	53-NC	53
4	4-NC	54-NC	54
5	5-NC	55-NC	55
6	GND_ISO	GND_ISO	56
7	ADC_B0	ADC_A0	57
8	GND_BL	GND_AL	58
9	ADC_B1	ADC_A1	59
10	GND	GND	60
11	ADC_B2	ADC_A2	61
12	GND	GND	62
13	ADC_B3	ADC_A3	63
14	GND_BH	GND_AH	64
15	ADC_B4	ADC_A4	65
16	NC	66-NC	66
17	ADC_B5	ADC_A5	67
18	GPIO58/MCLKRA/XD21/EPWM7A	GPIO59/MFSRA/XD20/EPWM7B	68
19	ADC_B6	ADC_A6	69
20	GPIO60/MCLKRB/XD19/EPWM8A	GPIO61/MFSRB/XD18/EPWM8B	70
21	ADC_B7	ADC_A7	71
22	GPIO62/SCIRXDC/XD17/EPWM9A	GPIO63/SCITXDC/XD16/EPWM9B	72
23	GPIO0/EPWM1A	GPIO1/EPWM1B/ECAP6/MFSRB	73
24	GPIO2/EPWM2A	GPIO3/EPWM2B/ECAP5/MCLKRB	74
25	GPIO4/EPWM3A	GPIO5/EPWM3B/MFSRA/ECAP1	75
26	GPIO6/EPWM4A/EPWMSYNCI/EPWMSYNCO	GPIO7/EPWM4B/MCLKRA/ECAP2	76
27	EXTSOC3B	5V	77
28	GPIO8/EPWM5A/CANTXB/ADCSOCAOn	GPIO9/EPWM5B/SCITXDB/ECAP3	78
29	GPIO10/EPWM6A/CANRXB/ADCSOCBOn	GPIO11/EPWM6B/SCIRXDB/ECAP4	79
30	GPIO48/ECAP5/XD31/SPISIMOD	GPIO49/ECAP6/XD30/SPISOMID	80
31	GPIO84/XA12	GPIO85/XA13	81
32	GPIO86/XA14	5V	82
33	GPIO12/TZ1n/CANTXB/MDXB	GPIO13/TZ2n/CANRXB/MDRB	83
34	GPIO15/TZ4n/XHOLDAn/SCIRXDB/MFSXB	GPIO14/TZ3n/XHOLDn/SCITXDB/MCLKXB	84
35	GPIO24/ECAP1/EQEP2A/MDXB	GPIO25/ECAP2/EQEP2B/MDRB	85
36	GPIO26/ECAP3/EQEP2I/MCLKXB	GPIO27/ECAP4/EQEP2S/MFSXB	86
37	EXTSOC3B	5V	87
38	GPIO16/SPISIMOA/CANTXB/TZ5n	GPIO17/SPISOMIA/CANRXB/TZ6n	88
39	GPIO18/SPICLKA/SCITXDB/CANRXA	GPIO19/SPISTEA/SCIRXDB/CANTXA	89
40	GPIO20/EQEP1A/MDXA/CANTXB	GPIO21/EQEP1B/MDRA/CANRXB	90
41	GPIO22/EQEP1S/MCLKXA/SCITXDB	GPIO23/EQEP1I/MFSXA/SCIRXDB	91
42	GPIO87/XA15	5V	92
43	GPIO28/SCIRXDA/XZCS6n	GPIO29/SCITXDA/XA19	93
44	GPIO30/CANRXA/XA18	GPIO31/CANTXA/XA17	94
45	GPIO32/SDAA/EPWMSYNCI /ADCSOCAOn	GPIO33/SCLA/EPWMSYNCO/ADCSOCBOn	95
46	GPIO34/ECAP1/XREADY	5V	96
47	GND	TDI	97
48	TCK	TDO	98
49	TMS	TRSTn	99
50	EMU1	EMU0	100

3. Support Resources

1. If you have problems or need additional information regarding the embedded emulation please refer to the XDS100 USB wiki on the TI web site. The URL for this site is:
   http://tiexpressdsp.com/index.php?title=XDS100

2. Code Composer Studio support is available via a forum at:
   http://community.ti.com/forums/138.aspx

3. Hercules Processor and Kit Support is available at:
   http://www.ti.com/hercules-support

Appendix A: **Supporting Files**

The following files accompany the DRV8301-RM46-KIT on the DVD for reference.

File name	Description
RM46CNCD_iso_revd	Pdf of schematics
RM46CNCD_XDS100P-5top	Pdf of top side layout
RM46CNCD_XDS100P-5bot	Pdf of bottom side layout
RM46CNCD_ISO_CPLD	Cadence Schematic
RM46CtrlCard_BOM_RevB	Excel Bill of Material
RM46CNCD Production Gerbers	Production Gerber Files

Operation Notices

The user assumes all responsibility and liability for proper and safe handling of the boards. It is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.