TMDX570LS31CNCD
Hercules™ ARM® Safety MCU controlCARD (CNCD)

USER GUIDE

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About This Manual

This document describes the board level operations of the TMS570LS31 controlCARD (CNCD). The CNCD is based on the Texas Instruments TMS570LS3137 337 BGA Microcontroller. The TMS570LS31 CNCD is DIMM form factor card built for use in existing TI motor control EVMs and to allow engineers and software developers to evaluate certain characteristics of the TMS570LS31 microcontroller in motor control applications. Evaluators can create software to execute on board or expand the system in a variety of ways. Please note the the CNCD requirements, for power 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. The CNCD has been tested primarily with the DRV8301 EVM.

Notational Conventions

This document uses the following conventions:
The TMS570LS31 CNCD will sometimes be referred to as the TMS570 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 website:

http://www.ti.com/hercules

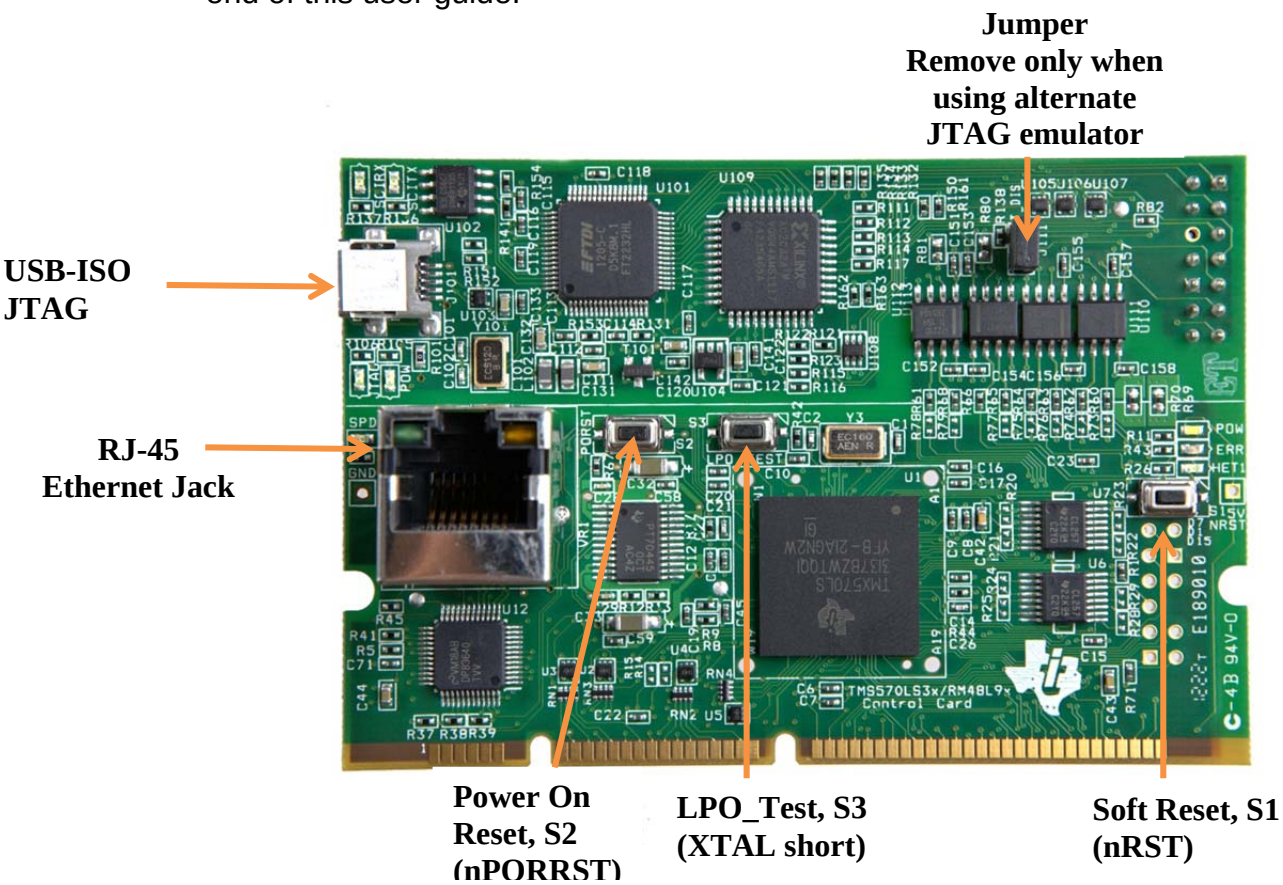
1. Introduction

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. The host system needs to provide only a single 5V power rail to the controlCARD for it to be fully functional.

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 to ease hardware development and reduce time to market. This controlCARD provides a platform for evaluating the functionality of the Texas Instruments TMS570LS31x and TMS570LS21x microcontroller family.

Scope of Document

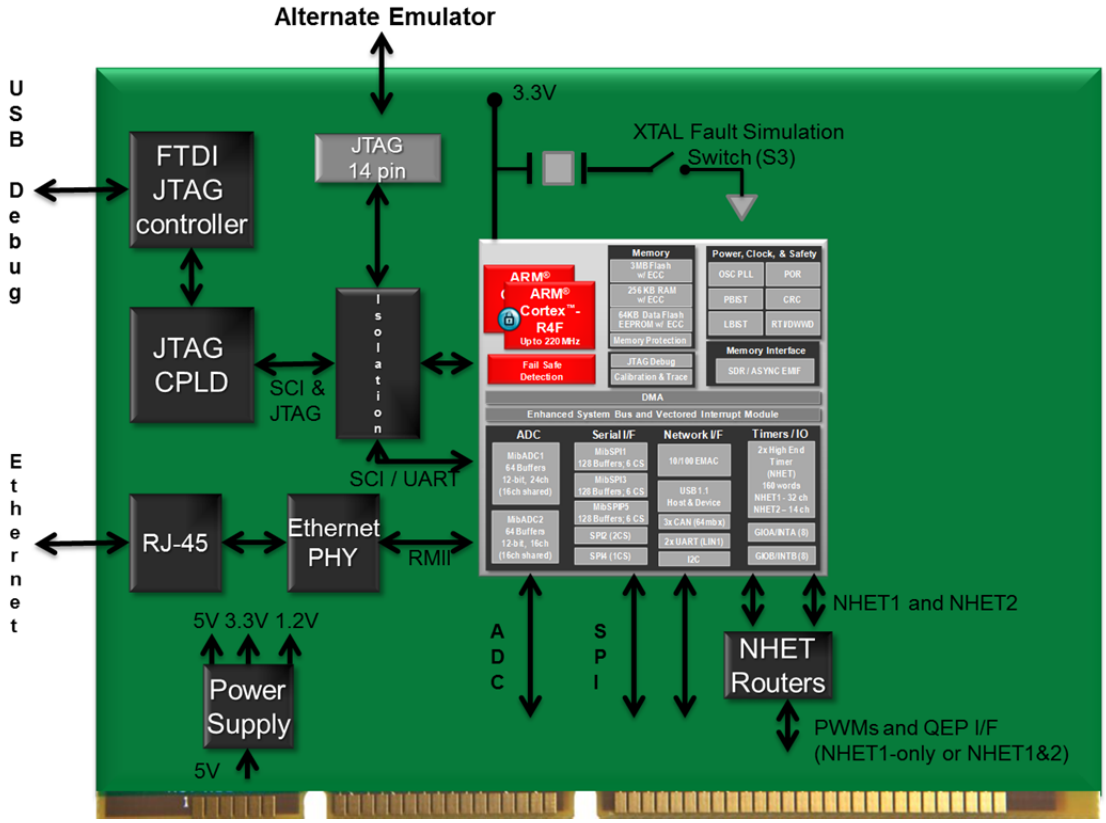
This user guide will list the contents of the development kit, point out the features of the major components, and provide the instructions necessary to verify your development kit is in working order. Any additional usage instructions or details fall outside the scope of this document. Additional resources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



1. *TMS570LS31 ControlCARD (CNCD) Features*

The TMDX570LS31CNCD 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 TMS570LS3137 337-ball BGA microcontroller
- *On board* USB XDS100v2 JTAG emulator
- TI 14 pin JTAG debug header for alternate, *external* JTAG emulator
- JTAG Isolation for either xds100 or alternate emulator
- 10/100 Mbps Ethernet interface via RJ-45 with same PHY as on the TMDX570LS31HDK
- Hardware option for routing one or both N2HET timers to the DIMM interface
- Isolated UART/SCI accessible through a USB Virtual Port (VCP)
- LPO_TEST push button switch (causes CLKDET hardware fault on MCU)
- LED indicators for xds100 power, activity, target/MCU power, HET pin activity, Ethernet link and activity, Ethernet speed, and nERROR.
- Reset pushbuttons (nPOR and nRST)
- 5V/3V ADC input configuration
- On board power supply supporting a 5V (as on the DRV8301 EVM) to 6V DC input and producing the 3.3V and 1.2V for the MCU



1. TMS570LS31 CNCD Contents

The CNCD is made available as part of the DRV8301-LS31-KIT or orderable standalone as TMDX570LS31CNCD. 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-ls31-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: 5V–6V Vdc
- Board supply current: 260mA typ (fully active, CPU at 160 MHz)
- Dimensions: 3.90” x 2.50” x 0.85” (LxWxH)
- 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 emulator or an external JTAG emulator. To start, follow the instructions in the Quick Start Guide to install Code Composer. This process will install all of the necessary development tools, documentation and drivers.

4. Memory Map

The TMS570LS31 family of MCUs have a large byte addressable address space. The memory map table shows the address space of a TMS570LS31

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, TMS570LS31 Memory Map

Start Address	End Address	CNCD
0x0000 0000	0x002F FFFF	Flash
0x0800 0000	0x0803 FFFF	RAM
0x0840 0000	0x0843 FFFF	RAM-ECC

5. Power Supply

The CNCD board operates from an external power supply provided by the main EVM via the 100 pin DIMM connector. The expected voltage from the DIMM is 5.0 although the power supply on the CNCD card is capable handling voltages up to 6V and still providing regulated 3.3 and 1.2 volts to the IO and core of the MCU, respectively.

2. Physical Description

This chapter describes the physical layout of the TMS570LS31 CNCD board and its interfaces.

1. Board Layout

The TMS570LS31 CNCD board is a 3.9 x 2.5 inch (125 x 109 mm.) eight (8) layer printed circuit board which is powered through the DIMM connector l +5 volt. Please see the included files Gladiator_DIMMP_top.pdf and Gladiator_DIMMP_bot.pdf which show the layout of the TMS570LS31 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	NHET1_01 Activity	Blue

3. S1, Warm Reset Switch

Switch S1 asserts a warm reset the TMS570LS31 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.

4. S2, Power On Reset Switch

Switch S2 is a momentary switch that asserts power on reset to the TMS570LS31 device. The POR condition is intended to reset all logic on the device including the test/emulation circuitry.

TMS570 MCU has two resets: Warm Reset (nRST) and Power On Reset (nPORRST. The POR can be invoked by pushing POR_RESET button.

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. 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
J104		TI 14 pin JTAG header
J101	4pin, Mini-B USB	XDS100V2 USB

7. 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 FTDI port1 is configured as JTAG, and port2 is configured as SCI. The CPLD is also programmed to route FTDI JTAG to MCU JTAG.

8. 14 Pin ARM JTAG Header, J104

In addition to on board XDS100V2 JTAG. One 14pin TI JTAG header, J104 is added for using external emulator. The pinout for the connector is shown in Table 4.

Table 5, 14pin TI JTAG Header

Signal Name	Pin#	Pin#	Signal Name
TMS	1	2	nTRST#
TDI	3	4	GND
TVDD	5	6	N/C (Key)
TDO	7	8	GND
TCKRET	9	10	GND
TCK	11	12	GND
EMU0	13	14	EMU1

CNCD board has one (1) jumper which is used to steer which emulation path is used on the card.

The CNCD includes a connector to attach an external emulator via the 14 pin JTAG connector, J104. The MCU can support only one emulator at a time. Jumper J11 (the only jumper on the card) dictates which emulator is used. As shipped, the jumper is in place and the on-board xds100 emulator is used. If the jumper is removed, the on-board emulator is disabled and debug, flashing etc. will require an emulator to be attached to the 14 pin connector, J104.

Table 6, Jumper

#	Off	On
J111	External 14 pin connector used	On-board xds100v2 is used

9. Ethernet Interface

Several configurations of the TMS570LS31x 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 7; 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 TMS570LS31 device is routed to the 2nd port of FTDI chip. The FTDI USB driver makes the FT2232H 2nd channel appear as a virtual COM port (VCP). 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	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-LS31-KIT on the DVD for reference.

File name	Description
tms570ls31CNCD_iso_revd	Pdf of schematics
TMDX570LS31CNCD RevD_DIMMP_top	Pdf of top side layout
TMDX570LS31CNCD RevD_DIMMP_bot	Pdf of bottom side layout
TMDX570LS31CNCD RevD_ISO_REVD	Cadence Schematic
TMDX570LS31CNCD RevD_BOM	Excel Bill of Material
TMDX570LS31CNCD RevD_DIMM_Production_Gerber	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.