DSP Interface User Guide

T-UG014 (v1.1) October 10, 2015

Abstract

This document provides information about interface board that allows user to connect Texas Instruments DIM100 control card to Typhoon HIL emulator.

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1 Overview

DSP Interface for TI DIM100 DSP cards is the way to go for those who want to accelerate the development of Power Electronics applications for Texas Instrument family of DSPs.
Typhoon HIL emulates power stage of a PE device that includes power converters, electrical machinery, filters, electrical grid, PV cells, passive elements, etc. with 1μs overall time resolution.
In this way users can develop and immediately test their control applications without worrying about safety measures required in the power laboratory environment.

2 Features

- DIMM100 socket for TI Control Cards (DIMM180 available with converter card)
- Power switch (3.3V and 5V) with LED indication
- Onboard XDS100v1 emulator and UART port (all accessible over 1 USB port)
- JTAG connector for external emulator (voltage supply 3.3V)
- LEDs for monitoring UART port status
- 16 HIL Digital Inputs (including DSP's 12 PWM signals)
- 16 HIL Digital Outputs (including DSP's 3 encoder signals)
- 16 HIL Analog Outputs (scaled to DSP's ADC 0-3V)
- All HIL signals available through measurement terminals
- DSP CAN bus (RJ45 connector)
- DSP SPI DAC (Digital to Analog Converter)
- Dimensions: 225mm (8.8 inch) by 80mm (3.2 inch)

3 Blok diagram

DSP Interface functional block diagram is shown in Figure 3.1.

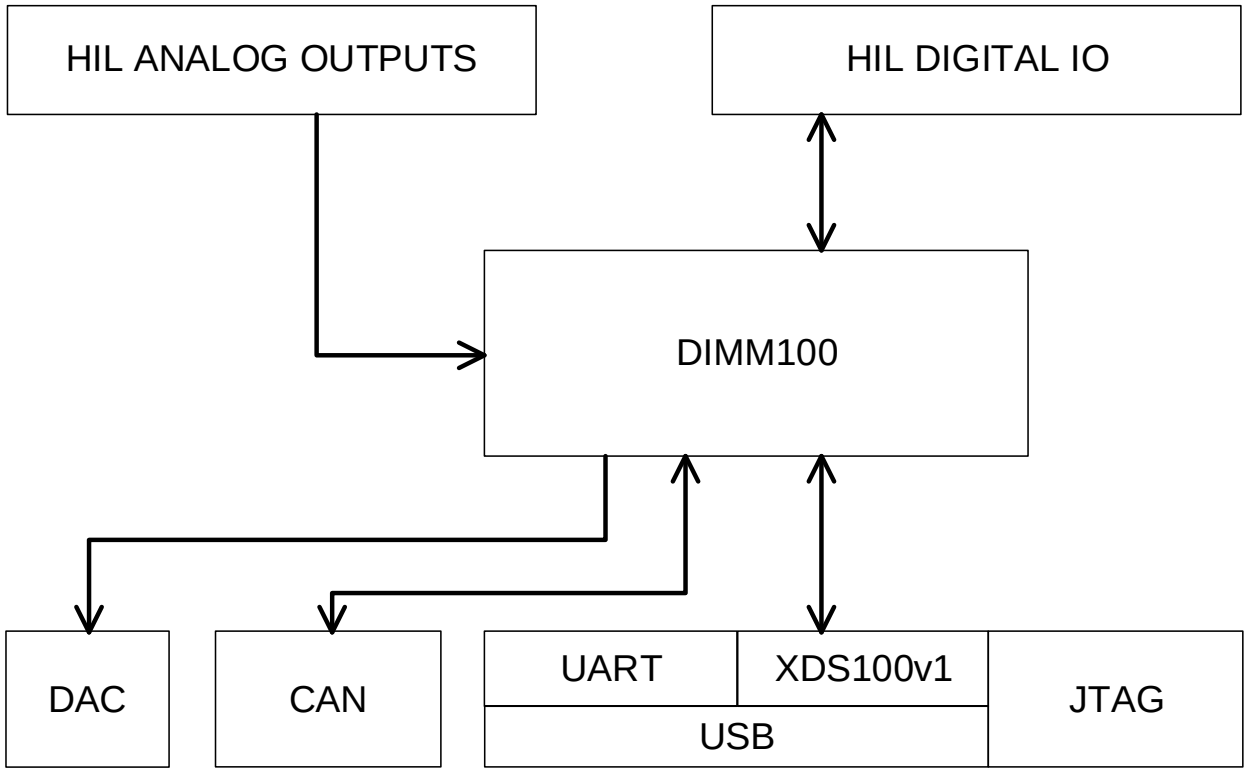

Figure 3.1 - DSP Interface functional block diagram

4 Detailed Description

DSP Interface is shown in Figure 4.1. Numbers in white circles represents the sections of chapter 4 that describe the marked components of board.

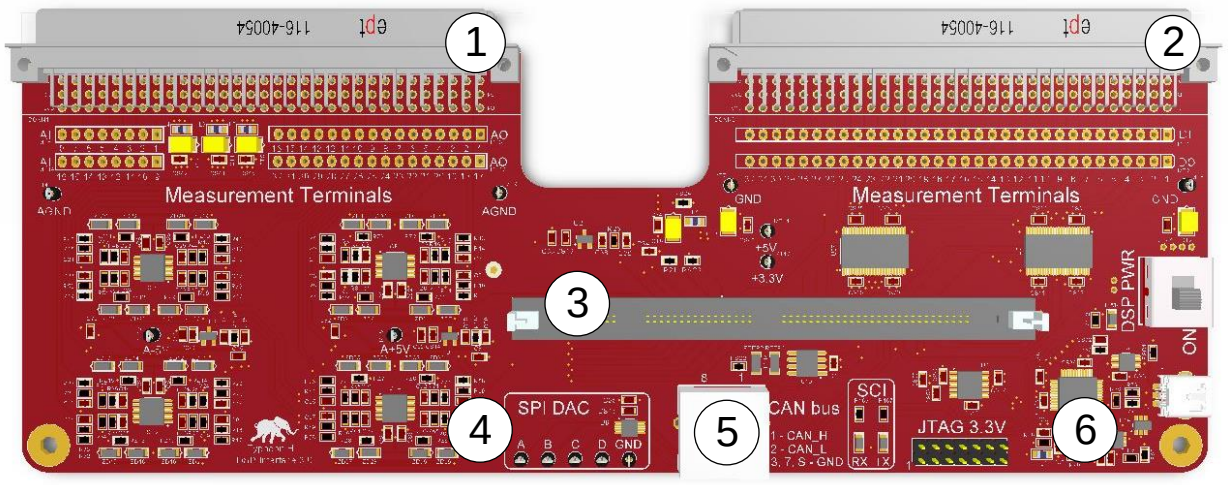

Figure 4.1 – DSP Interface layout

4.1 Analog signal connector

This is a 96 pin DIN 41612/IEC receptacle connector that is directly pluggable into analog connector of the Typhoon HIL emulators. Table 1 shows how 16 analog signals from Typhoon HIL emulator are connected to DIMM100 socket (DSP's ADCIN).

Table 1: Analog signals routing

Typhoon HIL Analog Output	DSP Analog Input
AO1	ADCIN – A0
AO2	ADCIN – A1
AO3	ADCIN – A2
AO4	ADCIN – A3
AO5	ADCIN – A4
AO6	ADCIN – A5
AO7	ADCIN – A6
AO8	ADCIN – A7
AO9	ADCIN – B0
AO10	ADCIN – B1
AO11	ADCIN – B2
AO12	ADCIN – B3
AO13	ADCIN – B4
AO14	ADCIN – B5
AO15	ADCIN – B6
AO16	ADCIN – B7

HIL Analog Outputs are scaled onboard from ±5V to DSP's ADCIN 0-3V. For example: HIL AO of 0V is seen as 1.5V at DSP ADCIN, HIL AO of +5V is seen as 3V at DSP ADCIN, HIL AO of -5V is seen as 0V at DSP ADCIN.
DIMM100 pins 16 and 66 (available as VREFLO and VREFHI on some DSP control cards) are connected to GND and 3V, signaling to DSP that ADCIN voltage ranges from 0 to 3V.

4.2 Digital signal connector

This is a 96 pin DIN 41612/IEC receptacle connector that is directly pluggable into digital connector of the Typhoon HIL emulators. Table 2 shows how 32 digital signals (16 outputs and 16 inputs) from Typhoon HIL emulator are routed to the DIM100 (DSP).

Table 2: Digital signals routing

Typhoon HIL Digital Output	DSP Digital Input	Typhoon HIL Digital Input	DSP Digital Output
DO1	GPIO-24 / EQEPA-2	DI1	GPIO-00/EPWM-1A
DO2	GPIO-25 / EQEPB-2	DI2	GPIO-02/EPWM-2A
DO3	GPIO-26 / EQEPI-2	DI3	GPIO-04/EPWM-3A
DO4	GPIO-20	DI4	GPIO-06/EPWM-4A
DO5	GPIO-21	DI5	GPIO-08/EPWM-5A
DO6	GPIO-22	DI6	GPIO-10/EPWM-6A
DO7	GPIO-23	DI7	GPIO-01/EPWM-1B
DO8	GPIO-27	DI8	GPIO-03/EPWM-2B
DO9	GPIO-32	DI9	GPIO-05/EPWM-3B
DO10	GPIO-33	DI10	GPIO-07/EPWM-4B
DO11	GPIO-48/40**	DI11	GPIO-09/EPWM-5B
DO12	GPIO-49/41**	DI12	GPIO-11/EPWM-6B
DO13	GPIO-60/44**	DI13	GPIO-14/EPWM-8A*
DO14	GPIO-61/45**	DI14	GPIO-12/EPWM-7A*
DO15	GPIO-62/46**	DI15	GPIO-15/EPWM-8B*
DO16	GPIO-63/47**	DI16	GPIO-13/EPWM-7B*

* EPWM available on F28377 depending on SW1, SW2, SW3 and SW4 on Adapter board.
** GPIO available on F28335/F28377

4.3 DIM100 control card connector

DIM100 connector is a standardized connector for Texas Instruments control cards. DIMM180 control cards can also be inserted in DIMM100 socket with Adapter board card supplied by Texas Instruments (http://www.ti.com/tool/tmdsadap180to100). DSP PWR switch is controlling the 5V power supply for control cards.

Some of DSP Interface supported TI controller cards:

- Delfino F28335 Control Card
- Delfino F28377D 180 pin Control Card
- Piccolo F28035 Control Card
- Piccolo F28069 Control Card

Other control cards are also supported, but it is recommended to check the pin assignment for every card. There are slight differences between cards in the sense that some of the signal pins do not exist on every control card. Texas Instruments 100 pin Control Card is shown in Figure 4.2.

Figure 4.2 - TI 100 pin Control Card

4.4 SPI DAC

DSP's SPI-A port is connected to onboard 12-bit quad DAC7554 from Texas Instruments. Table 3 shows how SPI signals are routed to DAC. DAC outputs have voltage range from 0 to 3.3V and are available on test points A, B, C and D. Figure 4.3 shows SPI DAC section on DSP Interface.

Table 3: SPI DAC routing table

DSP SPI	DAC
GPIO-16/SPISIMO-A	DIN
GPIO-18/SPICLK-A	SCLK
GPIO-19/SPISTE-A	SYNC

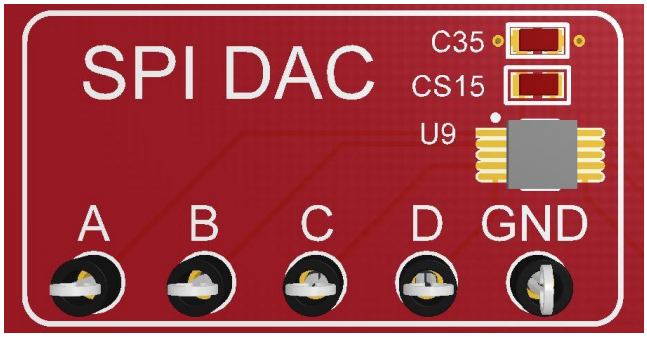

Figure 4.3 - SPI DAC

4.5 CAN bus

DSP's CAN-A module (GPIO-30/CANRX-A and GPIO-31/CANTX-A) is connected to onboard CAN trans-receiver, SN65HVD232D from Texas Instruments, which is connected to 3.3V CAN bus as shown in Figure 4.4. CAN bus is accessible over RJ45 connector and is terminated with two 120Ω resistors. CAN connector routing is shown in Table 4. If external 3.3V CAN bus is connected to DSP Interface CAN bus then care must be taken to remove the redundant terminating resistors on both buses. On DSP Interface CAN bus this is done by removing RSC2 (0Ω) resistor. Figure 4.5 shows CAN bus section on DSP Interface.

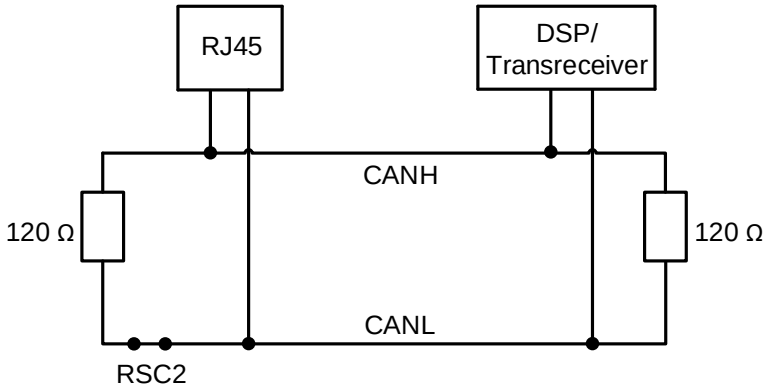

Figure 4.4 - CAN bus schematic

Table 4: CAN bus connector routing table

RJ45 pins	CAN signals
1	CAN_H
2	CAN_L
3, 7, Shield	GND

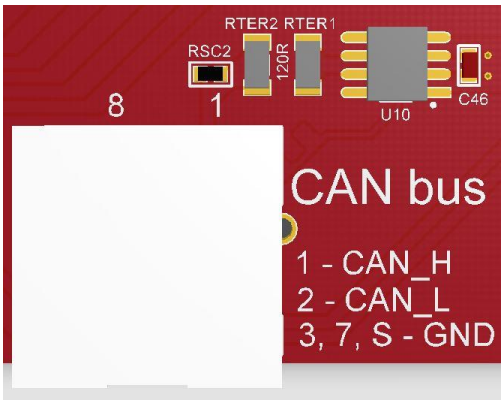

Figure 4.5 - CAN bus

4.6 XDS100v1 and UART

Onboard XDS100v1 emulator and UART are all implemented via FTDI chip. Drivers for XDS100v1 are included in Code Composer Studio, UniFlash, or XDS Emulation Software Package (http://processors.wiki.ti.com/index.php/XDS_Emulation_Software_Package). FTDI drivers can be found as VCP (Virtual Communication Port) drivers on official FTDI website (http://www.ftdichip.com/FTDrivers.htm). It is not recommended to use any USB Hub devices on the way towards PC. DSP PWR switch is controlling 3.3V and 5V power supply for XDS100v1 and UART port. USB interface structure is shown in Figure 4.6. Onboard USB is connected to PC via USB mini B cable. 14 pin JTAG connector can be used for external emulator. 14 pin JTAG header signals are shown in Figure 4.7. EMU0 and EMU1 pins are not connected to onboard XDS100v1 emulator; they are routed directly from JTAG connector to DSPs. All other JTAG signals are connected to onboard XDS100v1 and buffered. There are 2 LEDs signaling UART (SCI) port activity. RX LED blinks when DSP is receiving data via SCI port, TX LED blinks when DSP is transmitting data over SCI port. UART ports are connected to TI Control Card pins 2 and 52 (ISO-RX-RS232 and ISO-TX-RS232). Figure 4.8 shows XDS100v1 and UART section on DSP Interface.

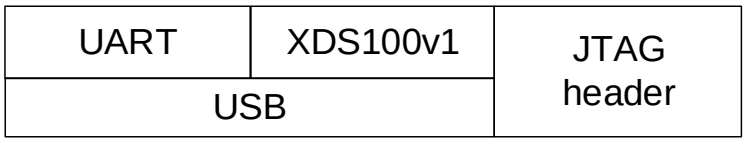

Figure 4.6 - USB interface structure

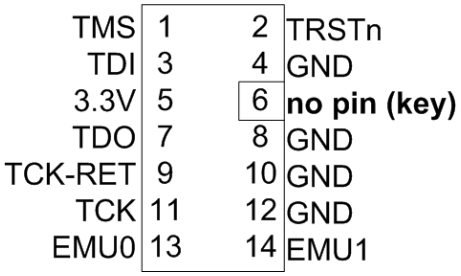

Figure 4.7 - 14 pin JTAG header signals

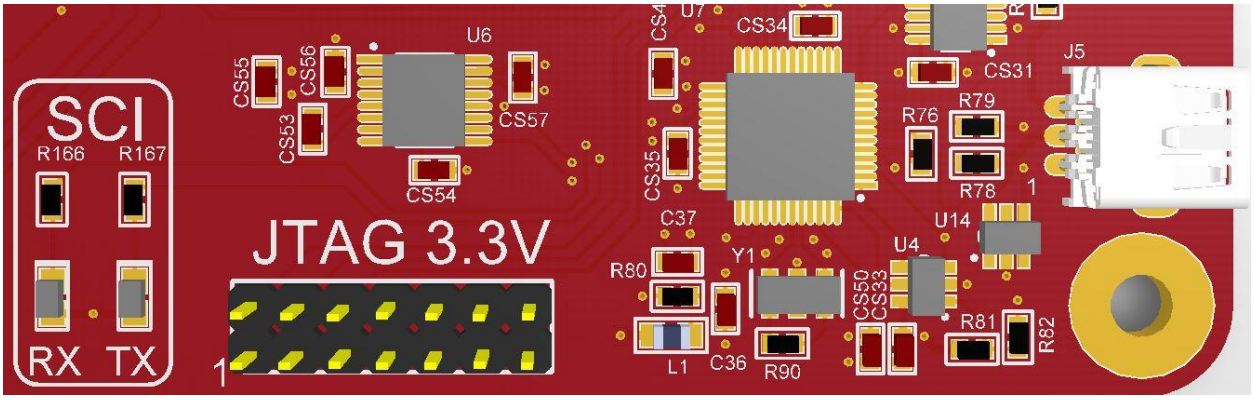

Figure 4.8 - XDS100v1 and UART

5 Product Images.

3D model and picture of DSP Interface are shown in Figure 5.1 and Figure 5.2.

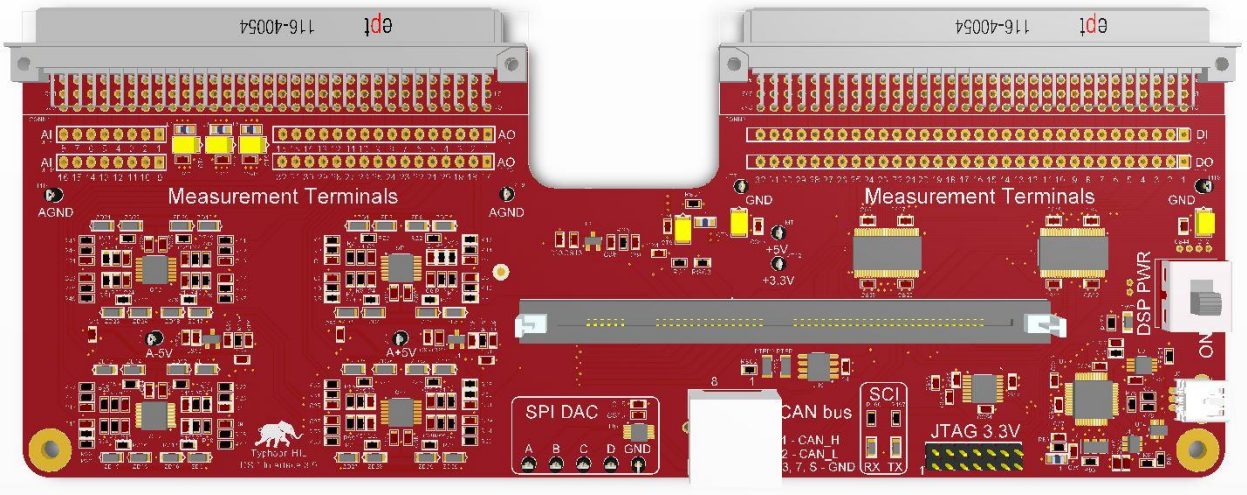

Figure 5.1 -3D model of DSP Interface

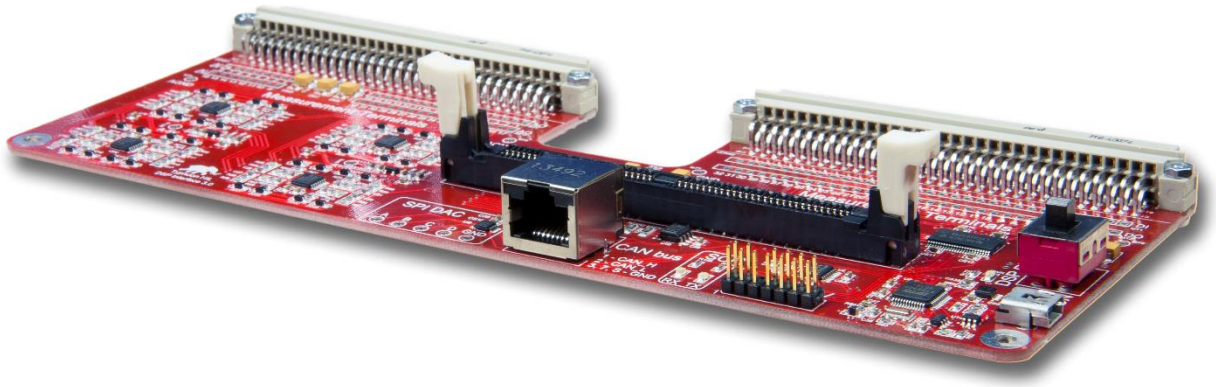

Figure 5.2 - DSP Interface

6 Errata

Issue: Reference voltage ICs (U1, U8) of 1.5V (used for scaling HIL AO to DSP ADC IN) have low sink/source current capability, causing the 1.5V reference to be unstable when majority of HIL AOs are relatively high/low or have a square form.

Affected boards: Revision 3.0.

Workaround:
In software, set the unused HIL AOs in a way that provides additional sink/source current or set the scaling of unused HIL AOs to very high value. In hardware, contact Typhoon HIL for instructions.

7 Revision history

Date	Version	Revision
27-07-2015	1.0	Initial release.
10-10-2015	1.1	1.5V reference errata added.