

# ***T/SBDIO-16***

16-bit Digital I/O SIOX/SIOX-Bus rev.B DCM  
for *TORNADO* DSP Systems, Controllers and Coprocessors

## ***User's Guide***

covers:  
*T/SBDIO-16* rev.1A

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## About this Document

This user's guide contains description for *T/SBDIO-16* digital I/O SIOX daughter-card DCM (DCM) for *TORNADO* DSP systems/controllers/coprocessors from MicroLAB Systems Ltd.

This document does not include detail description neither for *TORNADO* systems, nor for TI DSP and corresponding software and hardware applications. To get the corresponding information please refer to the following documentation:

1. ***TMS320C3x User's Guide.*** Texas Instruments Inc, SPRU031C, USA, 1992.
2. ***TMS320C54x. CPU and Peripherals. Reference Guide.*** Texas Instruments Inc, SPRU131D, USA, 1997.
3. ***TMS320C6x. CPU and Instruction Set. Reference Guide.*** Texas Instruments Inc, SPRU189C, USA, 1998.
4. ***TORNADO-3x. User's Guide.*** MicroLAB Systems, 1998.
5. ***TORNADO-P33. User's Guide.*** MicroLAB Systems, 2000.
6. ***TORNADO-54x. User's Guide.*** MicroLAB Systems, 1998.
7. ***TORNADO-6x. User's Guide.*** MicroLAB Systems, 1998.
8. ***TORNADO-P6x. User's Guide.*** MicroLAB Systems, 1999.
9. ***TORNADO-PX31DP. User's Guide.*** MicroLAB Systems, 1996.
10. ***TORNADO-SX30. User's Guide.*** MicroLAB Systems, 1996.
11. ***TORNADO-E31. User's Guide.*** MicroLAB Systems, 1996.
12. ***TORNADO-E33. User's Guide.*** MicroLAB Systems, 2000.
13. ***TORNADO-EL31. User's Guide.*** MicroLAB Systems, 1996.
14. ***TORNADO-E6x. User's Guide.*** MicroLAB Systems, 1998.

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# Chapter 1. Introduction

This chapter contains general description for *T/SBDIO-16* SIOX (serial I/O expansion) daughter-card module (DCM) for *TORNADO* DSP systems/controllers/coprocessors.

## 1.1 General Information

*T/SBDIO-16* (fig.1-1) is 16-bit general purpose digital I/O SIOX DCM for *TORNADO* DSP systems (*TORNADO-3x/54x/6x/P6x/P33/etc*), *TORNADO-E/EL* stand-alone DSP controllers (*TORNADO-E3x/E54x/E6x/etc*) and *TORNADO-PX/SX* DSP coprocessors (*TORNADO-PX31DP/SX30/etc*) from MicroLAB Systems Ltd.



Fig. 1-1. *T/SBDIO-16* DCM.

### Installation

*T/SBDIO-16* DCM installs as SIOX DCM (fig.1-2) into the SIOX rev.B site onto *TORNADO* mainboard. If required, *T/SU-X* SIOX extender can be used either for remote connection to SIOX interface of *TORNADO* mainboard or for parallel connection of eight SIOX-Bus DCMs to one SIOX site.



Fig. 1-2. T/SBDIO-16 DCM installed onto TORNADO-6x mainboard.

### Overview

T/SBDIO-16 DCM comprises of four groups of general purpose digital I/O signals. Each group comprises of four digital I/O signals, which have common programmable direction control and individual I/O control. T/SBDIO-16 DCM can generate interrupt to TORNADO host SIOX interface.

### External signal I/O

Connection of T/SBDIO-16 DCM to external digital I/O world is performed via the on-board I/O JP2 connector, which is available via rear panel of host PC (if T/SBDIO-16 DCM is installed onto TORNADO DSP system for PC).

### Expansion facilities

T/SBDIO-16 DCM meets MicroLAB Systems SIOX and SIOX-Bus specifications and allows expansion via SIOX-Bus to totally eight DCMs per one serial port.

### Applications

T/SBDIO-16 DCM been designed for general purpose control and instrumentation scalable applications and supports parallel connection up to eight different SIOX-Bus DCMs to one host SIOX interface.

## 1.2 Technical Specifications

The following are technical specifications for T/SBDIO-16 DCM for temperature of external environment +25°C.

<u>parameter description</u>	<u>parameter value</u>
<i>digital I/O</i>	
number of digital I/O signals	4 groups of 4 signals each
programmable direction control	one common direction per one group
expansion facilities	SIOX-Bus (up to 8 DCMs per one SIO-port of host SIOX interface)
I/O logical low level	TTL ( $\leq 0.6\text{ V}$ )
I/O logical high level	TTL ( $\geq 2.4\text{ V}$ )
<i>host SIOX interface</i>	
host SIOX interface	SIOX rev.B SIOX-Bus rev.B
maximum clock frequency of host SIOX interface	$\leq 25\text{ MHz}$
<i>physical and power:</i>	
dimensions	55mm (2.16") x 56mm (2.2")
power consumption via SIOX I/F	+5v @ 50mA



## Chapter 2. Technical Description

This chapter contains detail technical description for architecture and construction of *T/SBDIO-16* SIOX DCM.

### 2.1 Operation Details

Basic configuration and connectivity of *T/SBDIO-16* DCM is presented at fig.2-1.

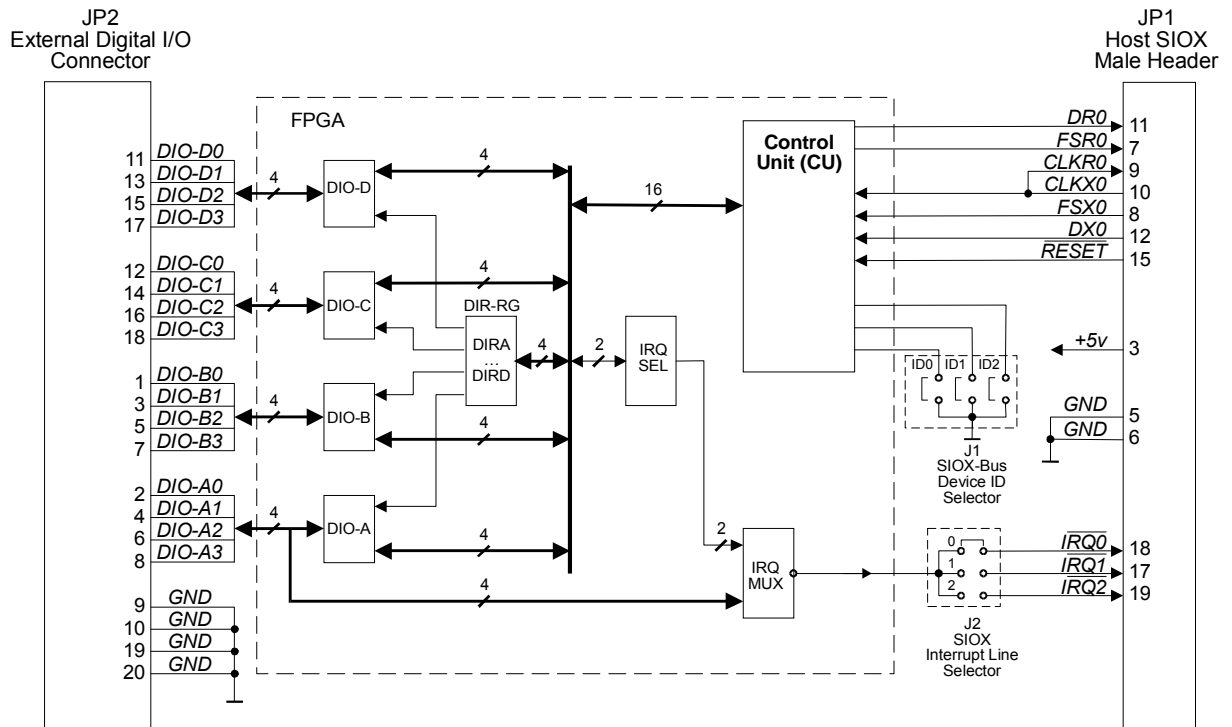


Fig. 2-1. Block diagram of *T/SBDIO-16* DCM.

*T/SBDIO-16* DCM installs as SIOX (serial I/O expansion interface) DCM onto *TORNADO* mainboard and assumes that communication with *TORNADO* on-board DSP is provided via the DSP on-chip serial port, which is routed to SIO-0 port of *TORNADO* host SIOX interface.

*T/SBDIO-16* DCM comprises of:

- four I/O signal groups (**DIO-A..D**) each comprising of four digital I/O signals for totally 16 digital I/O signals, which are directly routed to external data I/O pins
- 4-bit direction control register (**DIR\_RG**), which defines individual direction for each signal group **DIO-A..D**
- 2-bit interrupt selector register (**IRQ\_SEL\_RG**) and interrupt multiplexer (**IRQ\_MUX**), which select the particular signal of signal group **DIO-A** that can generate interrupt request to host SIOX interface

- control unit (CU)
- host SIOX interface header for installation onto *TORNADO* DSP systems.

### **I/O signal groups**

Each of four I/O signal groups *DIO-A..D* comprises of four bits for general purpose digital I/O from/to external TTL-compatible signal sources. Four I/O signal groups deliver totally 16 bits of general purpose I/O, which are directly routed to external I/O pins (*DIO-A0..3*, *DIO-B0..3*, *DIO-C0..3*, *DIO-D0..3*) of *T/SBDIO-16* DCM.

Each I/O signal group has its own output and input data registers, which combine to 16-bit *DATA\_OUT\_RG* data output register and to 16-bit *DATA\_IN\_RG* data input register correspondingly for all I/O signal groups.

#### **CAUTION**

In case external I/O pin is configured as 'OUTPUT', then its output value is defined by the corresponding bit of *DATA\_OUT\_RG* data output register.

In case external I/O pin is configured as 'INPUT', then its current status is available via the corresponding bit of *DATA\_IN\_RG* data input register.

*DATA\_OUT\_RG* data output register can be programmed by host DSP software using *DATA\_WR\_CMND* command, whereas *DATA\_IN\_RG* data input register can be read back to host DSP by means of *DATA\_RD\_CMND* command.

#### **CAUTION**

Default output data for *DATA\_OUT\_RG* data output register is set to 0000H on host SIOX reset condition.

### **direction control register**

Direction control (INPUT or OUTPUT) for external I/O pins is defined by the contents of direction control register (*DIR\_RG*) of *T/SBDIO-16* DCM, which comprises of direction control bits *DIR-A..D* for each *DIO-A..D* signal group.

#### **CAUTION**

All four external I/O pins within one I/O signal group feature the same direction (INPUT or OUTPUT), which is defined by the corresponding bit (*DIR-A..D*) of direction control register *DIR\_RG*.

**CAUTION**

Logical ‘0’ value of direction control bit corresponds to the ‘INPUT’ direction of the corresponding I/O signal group.

Default contents of direction control register *DIR\_RG* is set to {0,0,0,0} on host SIOX reset condition that corresponds to the ‘INPUT’ direction for each I/O signal group.

Direction control register *DIR\_RG* can be programmed by host DSP software using *DIR\_WR\_CMND* command, whereas current contents of direction control register *DIR\_RG* can be read back to host DSP by means of *DATA\_RD\_CMND* command.

**host SIOX interrupt control**

Interrupt selector register *IRQ\_SEL\_RG* of *T/SBDIO-16* DCM comprises of two bits *IRQ\_SEL-0..1* and defines which particular pin (*DIO-A0..3*) within *DIO-A* I/O signal group, which can generate interrupt request to host SIOX interface via interrupt request multiplexer *IRQ\_MUX* in accordance with table 2-1.

Table 2-1. Interrupt source selection for host SIOX interface via *IRQ\_SEL\_RG* register.

<i>IRQ_SEL_RG</i> register bits		Interrupt source for host SIOX interface
<i>IRQ_SEL-1</i>	<i>IRQ_SEL-0</i>	
0	0	<i>DIO-A0</i> I/O pin is used as host SIOX interrupt source.
0	1	<i>DIO-A1</i> I/O pin is used as host SIOX interrupt source.
1	0	<i>DIO-A1</i> I/O pin is used as host SIOX interrupt source.
1	1	<i>DIO-A1</i> I/O pin is used as host SIOX interrupt source.

Notes: 1. Highlighted configuration corresponds to default value on host SIOX reset condition.

**CAUTION**

Default contents of interrupt selector register *IRQ\_SEL\_RG* is set to {0,0} on host SIOX reset condition, which corresponds to *DIO-A0* external I/O pin as interrupt request source for host SIOX interface.

Output signal of interrupt request multiplexer *IRQ\_MUX* can be routed to either of *IRQ-0..3* SIOX interrupt request inputs via on-board jumper set J2, which comprises of three jumpers J2-0..2 (refer to fig.2-1 and A-1). Correspondence between host SIOX interrupt request line and J2 jumper configuration is presented in table 2-2.

Table 2-2. Host SIOX interrupt line selection.

J2 jumper set			Host SIOX interrupt line
J2-2	J2-1	J2-0	
OFF	OFF	OFF	Host SIOX interrupt is not used.
OFF	OFF	ON	IRQ-0 host SIOX interrupt line is used.
OFF	ON	OFF	IRQ-1 host SIOX interrupt line is used.
ON	OFF	OFF	IRQ-2 host SIOX interrupt line is used.

Notes:

1. Jumper setting: 'OFF' - jumper not installed; 'ON' - jumper installed.
2. Highlighted configurations correspond to the factory setting.

**CAUTION**

Active low host SIOX interrupt is generated on logical '1' value for the corresponding *DIO-A0..3* I/O signal, which is used as source for host SIOX interrupt request in accordance with table 2-1.

**SIOX-Bus compliance**

*T/SBDIO-16* DCM meets MicroLAB Systems SIOX-Bus specifications and allows parallel connection of up to eight SIOX-Bus compliant DCMs to one SIO port of host SIOX interface.

SIOX-Bus is software superset for serial data communication protocol, which is used for data transmission via SIO ports of host SIOX interface, and has been designed in order to extend number of SIOX DCMs, which can connect to one SIO port of host SIOX interface. SIOX-Bus concept assumes that installed DCMs are a command-oriented devices and are controlled by software commands, which are transmitted from host DSP via transmitter of SIO port of host SIOX interface. Three most significant bits of transmitted data frame are interpreted as SIOX-Bus device ID and are used to select the particular SIOX-Bus DCM, which will execute the transmitted command. Once DCM recognizes that the received SIOX-Bus device ID matches its unique device ID, which is set by on-board jumpers, then this DCMs executes this command. In case this command is data read-back, then addressed DCM activates output transmitter and sends requested data to the receiver of SIO port of host SIOX interface. Unique SIOX-Bus device ID for every installed DCM must be defined by the on-board jumpers and it is not allowed to have two SIOX-Bus DCMs installed with equal SIOX-Bus device ID.

SIOX-Bus device ID for *T/SBDIO-16* DCM is defined by means of on-board J1 jumper set and comprises of three jumpers *J1-ID0..ID2* (refer to fig.2-1 and A-1) in accordance with table 2-3.



Table 2-3. SIOX-Bus Device ID definition.

J1 jumper set			SIOX-Bus device ID
J1-ID2	J1-ID1	J1-ID0	
OFF	OFF	OFF	SIOX-Bus device ID is 7.
OFF	OFF	ON	SIOX-Bus device ID is 6.
OFF	ON	OFF	SIOX-Bus device ID is 5.
OFF	ON	ON	SIOX-Bus device ID is 4.
ON	OFF	OFF	SIOX-Bus device ID is 3.
ON	OFF	ON	SIOX-Bus device ID is 2.
ON	ON	OFF	SIOX-Bus device ID is 1.
ON	ON	ON	SIOX-Bus device ID is 0.

Notes:

1. Jumper setting: 'OFF' - jumper not installed; 'ON' - jumper installed.

2. Highlighted configurations correspond to the factory setting.

CAUTION

Even in case *T/SBDIO-16* DCM is the only DCM connected to host SIOX interface (i.e. actual multi-DCM SIOX-Bus expansion facility is not used), then host DSP software must still provide appropriate *SIOX-Bus\_DEV\_ID* code in three most significant bits of transmitted data frame in order to address *T/SBDIO-16* DCM.

**control unit (CU)**

On-board Control Unit (CU) of *T/SBDIO-16* DCM decodes SIOX-Bus protocol and provides all required synchronization for data reception and transmission.

**2.2 Software Control**

*T/SBDIO-16* DCM operation is controlled by host *TORNADO* DSP software using set of software commands transmitted via the DSP on-chip serial port transmitter, which is wired to the SIO-0 port of the corresponding SIOX interface site. The software command set for *T/SBDIO-16* DCM comprises of commands for data read/write for all on-board registers.

**CAUTION**

*T/SBDIO-16* DCM assumes that the received data words from SIO-0 port of host SIOX interface have 24-bit data format and the output transmitted data words to the receiver of SIO-0 port of host SIOX interface have 16-bit data format.

**input command data word format**

Input 24-bit command data word, which is received by *T/SBDIO-16* DCM from the transmitter of SIO-0 port of host SIOX interface, must meet the following format:

**command data word**

D23	D22	D21	D20	D19	D18	D17	D16	D15..D0
<i>DEV_ID-2</i>	<i>DEV_ID-1</i>	<i>DEV_ID-0</i>	0	<i>RD_SEL-1</i>	<i>RD_SEL-0</i>	<i>WR_SEL-1</i>	<i>WR_SEL-0</i>	<i>DATA-15..DATA-0</i>

**Table 2-4.** Data bits description for command data word.

register bit(s)	description
<i>DEV_ID-2..0</i>	SIOX-Bus device ID code. In order to address <i>T/SBDIO-16</i> DCM this received SIOX-Bus device ID code must match device ID, which is defined by the on-board jumper J1 in accordance with table 2-3.
<i>RD_SEL-1..0</i>	2-bit register selector for register read back commands in accordance with table 2-6. {0,0} combination corresponds to read miss command.
<i>WR_SEL-1..0</i>	2-bit register selector for register write commands in accordance with table 2-5. {0,0} combination corresponds to write miss command.
<i>DATA-15..0</i>	16-bit data for register write commands.

**register write commands**

Once *T/SBDIO-16* DCM has received the command data word from host DSP with the SIOX-Bus device ID being perfectly matched the on-board configured device ID, then the on-board control unit will interpret {*WR\_SEL-1*, *WR\_SEL-0*} bits of command data word in accordance with table 2-5 in order to define what particular register will be involved into the write operation.

Table 2-5. Write register selection for register write commands.

<b>WR_SEL-0/1 bits of command data word</b>		<b>Description</b>
<b>WR_SEL-1</b>	<b>WR_SEL-0</b>	
0	0	No write operation. Used when read-only operation is required.
0	1	16-bit <i>DATA-0..15</i> data will be written to <i>DATA_OUT_RG</i> data output register.
1	0	4-bit <i>DATA-0..3</i> data will be written to the <i>DIR_RG</i> direction control register. Logical '0' value in the corresponding bit denotes that the particular I/O signal group is configured for 'INPUT', and logical '1' value denotes that this I/O signal group is configured for 'OUTPUT'.
1	1	2-bit <i>DATA-0..1</i> data will be written to the <i>IRQ_SEL_RG</i> interrupt selector register. Refer to table 2-1 for details.

The following are data formats for different register write commands:

**command for write to *DATA\_OUT\_RG* data output register**

D23	D22	D21	D20	D19	D18	D17	D16	D15..D12	D11..D8	D7..D4	D3..D0
<i>DEV_ID-2</i>	<i>DEV_ID-1</i>	<i>DEV_ID-0</i>	0	x	x	0	1	<i>DIO-D3.. DIO-D0</i>	<i>DIO-C3.. DIO-C0</i>	<i>DIO-B3.. DIO-B0</i>	<i>DIO-A3.. DIO-A0</i>

**command for write to *DIR\_RG* direction control register**

D23	D22	D21	D20	D19	D18	D17	D16	D15..D4	D3	D2	D1	D0
<i>DEV_ID-2</i>	<i>DEV_ID-1</i>	<i>DEV_ID-0</i>	0	x	x	0	1	x	<i>DIR-D</i>	<i>DIR-C</i>	<i>DIR-B</i>	<i>DIR-A</i>

**command for write to *IRQ\_SEL\_RG* interrupt selector register**

D23	D22	D21	D20	D19	D18	D17	D16	D15..D2	D1	D0
<i>DEV_ID-2</i>	<i>DEV_ID-1</i>	<i>DEV_ID-0</i>	0	x	x	0	1	x	<i>IRQ_SEL-1</i>	<i>IRQ_SEL-0</i>

### register read commands

Once *T/SBDIO-16* DCM has received the command data word from host DSP with the SIOX-Bus device ID being perfectly matched the on-board configured device ID, then the on-board control unit will interpret the {*RD\_SEL-1*, *RD\_SEL-0*} bits of command data word in accordance with table 2-6 in order to define what particular register will be involved into the read operation.

Table 2-6. Read-back register selection for register read commands.

<i>RD_SEL-0/1</i> bits of command data word		Description
<i>RD_SEL-1</i>	<i>RD_SEL-0</i>	
0	0	No read operation. Used when write-only operation is required.
0	1	16-bit contents of <i>DATA_IN_RG</i> data input register will be routed to <i>DATA-0..15</i> bits of read-back data word.
1	0	4-bit contents of <i>DIR_RG</i> direction control register will be routed to <i>DATA-0..3</i> bits of read-back data word.
1	1	2-bit contents of <i>IRQ_SEL_RG</i> interrupt selector register will be routed to <i>DATA-0..1</i> bits of read-back data word.

The following are data formats for different register read-back commands:

#### read-back command for *DATA\_IN\_RG* data input register

D23	D22	D21	D20	D19	D18	D17	D16	D15..D0
<i>DEV_ID-2</i>	<i>DEV_ID-1</i>	<i>DEV_ID-0</i>	0	0	1	x	x	x

#### read-back command for *DIR\_RG* direction control register

D23	D22	D21	D20	D19	D18	D17	D16	D15..D0
<i>DEV_ID-2</i>	<i>DEV_ID-1</i>	<i>DEV_ID-0</i>	0	1	0	x	x	x

#### read-back command for *IRQ\_SEL\_RG* interrupt selector register

D23	D22	D21	D20	D19	D18	D17	D16	D15..D0
<i>DEV_ID-2</i>	<i>DEV_ID-1</i>	<i>DEV_ID-0</i>	0	1	1	x	x	x

Each register read-back command initiates 16-bit data transmission from *T/SBDIO-16* DCM to the receiver of SIO-0 port of host SIOX interface. The following are data formats for different register read-back data words, which are transmitted from *T/SBDIO-16* DCM to the receiver of SIO-0 port of host SIOX interface after reception of register read-back command.

***read-back data word for DATA\_IN\_RG data input register***

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
DIO-D3	DIO-D2	DIO-D1	DIO-D0	DIO-C3	DIO-C2	DIO-C1	DIO-C0	DIO-B3	DIO-B2	DIO-B1	DIO-B0	DIO-A3	DIO-A2	DIO-A1	DIO-A0

***read-back data word for DIR\_RG direction control register***

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
x	x	x	x	x	x	x	x	x	x	x	x	DIR-D	DIR-C	DIR-B	DIR-A

***read-back data word for IRQ\_SEL\_RG interrupt selector register***

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
x	x	x	x	x	x	x	x	x	x	x	x	x	x	IRQ_SEL-1	IRQ_SEL-0

## 2.3 Host SIOX Timing and Configuration

Transmitter of SIO-0 port of host SIOX interface is used to transmit software commands to *T/SBDIO-16* DCM, whereas the receiver of SIO-0 port of host SIOX interface is used to receive read-back register data during execution of read-back commands.

### ***SIOX SIO-0 port transmitter timing and configuration***

Transmitter of SIO-0 port of host SIOX interface is used for transmission command data words from host DSP to *T/SBDIO-16* DCM.

Timing diagram for transmission of command data words from host DSP via transmitter of SIO-0 port of host *TORNADO* SIOX interface to *T/SBDIO-16* DCM is presented at fig.2-2.

**CAUTION**

*T/SBDIO-16* DCM assumes that data frames, which are transmitted from host DSP via transmitter of SIO-0 SIOX port to *T/SBDIO-16* DCM, must have 24-bit data format.

Transmitter frame sync pulse (FSX) and serial clock (CLKX) for DSP on-chip serial port, which is wired to SIO-0 port of host SIOX interface on *TORNADO* board, shall be generated by the DSP on-chip serial port.

Transmitter of DSP on-chip serial port must be configured for active high data, internal active low serial clock (active falling edge) and internal active low advanced frame sync pulse (advance feature for FSX must be configured to one CLKX cycle).

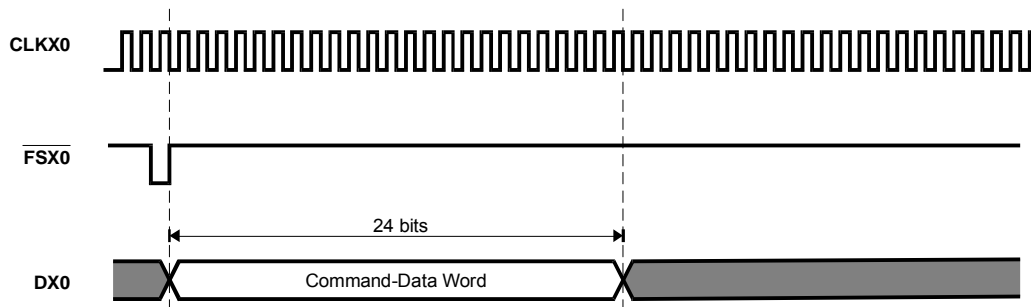


Fig. 2-2. Timing diagram for transmission of command data words from host DSP to *T/SBDIO-16* DCM via transmitter of SIOX SIO-0 port.

**CAUTION**

Maximum serial clock frequency for transmitter of SIO-0 port of host SIOX interface is 25 MHz. The higher transmitter serial clock values may result in incorrect functionality of on-board hardware.

Transmitter of SIO-0 port of host SIOX interface must provide data transmission with the most significant bit first.

### ***SIOX SIO-0 port receiver timing and configuration***

Receiver of SIO-0 port of host SIOX interface is used for transmission read-back data from *T/SBDIO-16* DCM to host DSP after reception of read-back register commands.

Timing diagram for transmission of read-back data from *T/SBDIO-16* DCM to host DSP via receiver of SIO-0 port of host *TORNADO* SIOX interface is presented at fig.2-3.

**CAUTION**

*T/SBDIO-16* DCM assumes that data frames, which are transmitted from *T/SBDIO-16* DCM to host DSP via receiver of SIO-0 SIOX port, have 16-bit data format.

Receiver frame sync pulse (FSR) and serial clock (CLKR) for DSP on-chip serial port, which is wired to SIO-0 port of host SIOX interface on *TORNADO* board, are generated by *T/SBDIO-16* DCM.

Receiver of DSP on-chip serial port must be configured for active high data, external active high serial clock (active rising edge) and external active low frame sync pulse (advance feature for FSR must be disabled).

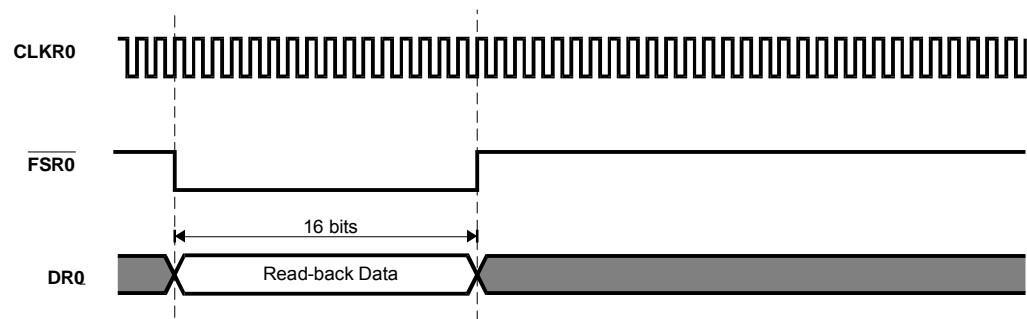


Fig. 2-3. Timing diagram for transmission of read-back data from *T/SBDIO-16* DCM to host DSP via receiver of SIOX SIO-0 port.

## 2.4 Construction

*T/SBDIO-16* DCM (fig.1-1, fig.A-1) meets standard SIOX rev.B daughter-card form-factor. Construction of *T/SBDIO-16* DCM assumes that host *TORNADO* DSP system with *T/SBDIO-16* DCM installed fits into one ISA-bus slot of PC chassis.

Connection of *T/SBDIO-16* DCM to external digital I/O world is performed via the on-board JP2 connector, which is available via rear panel of host PC (if *T/SBDIO-16* is installed onto *TORNADO* DSP system for PC). Compatible plug-in connector assembly is provided as standard with *T/SBDIO-16* DCM.





## Chapter 3. Installation

This chapter contains information for installation and configuration of *T/SBDIO-16* DCM.

### 3.1 Installation

*T/SBDIO-16* DCM installs as SIOX daughter-card DCM onto *TORNADO* DSP system mainboard.

For installation of *T/SBDIO-16* DCM into SIOX site of *TORNADO* DSP system follow the recommendations below (fig.3-1):

1. Switch off the power of host PC.
2. Remove *TORNADO* mainboard from PC slot.
3. Take *T/SBDIO-16* DCM and slant it for about 30°..40° degrees refer to *TORNADO* mainboard. Insert JP2 external I/O connector of *T/SBDIO-16* DCM into the corresponding hole of mounting bracket of *TORNADO* DSP system.

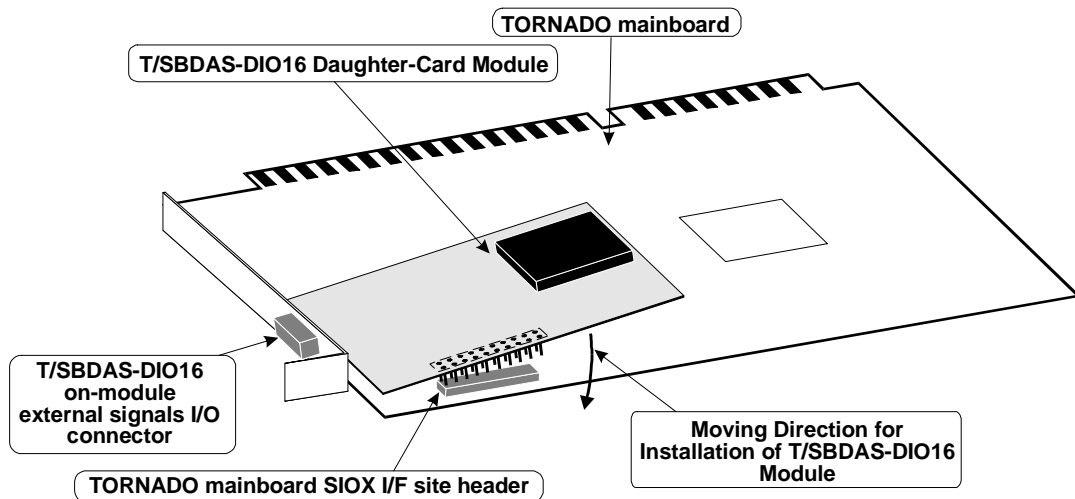


Fig. 3-1. Installation of *T/SBDIO-16* DCM into SIOX site of *TORNADO* DSP system.

4. Rotate *T/SBDIO-16* DCM around mounting bracket and allocate pin #1 of JP1 connector of *T/SBDIO-16* DCM against pin #1 of SIOX interface header on *TORNADO* mainboard.

**CAUTION**

Female connector of host SIOX interface has 20 pins for *TORNADO-31/31Z/31M/32L/32LX/E31* DSP systems and controllers and 26 pins for *TORNADO-30/54x/6x/E6x/E54x* DSP systems and controllers. Pin #1 of host SIOX site connectors always fit into the same physical position on *TORNADO* DSP systems and controllers.

Pin #1 of SIOX connector of *T/SBDIO-16* DCM must always plug into pin #1 of host SIOX site connector not regarding type of host *TORNADO* DSP systems or controller.

Missing doing this will result in damage of *T/SBDIO-16* DCM and/or host *TORNADO* hardware.

5. Safely plug-in SIOX male header of *T/SBDIO-16* DCM into SIOX female header of *TORNADO* DSP system.
6. Screw external I/O connector shell of *T/SBDIO-16* DCM to the mounting bracket of *TORNADO* DSP system.
7. Configure on-board jumper J1 in order to set desired SIOX-Bus device ID to match your software provided SIOX-Bus device ID for addressing this *T/SBDIO-16* DCM (refer to table 2-3).
8. Configure on-board jumper J2 in order to select particular host SIOX interrupt request line to meet requirements of your software (refer to table 2-2).
9. Install *TORNADO* board into PC slot and screw it to rear panel of PC.
10. Connect the plug to external I/O connector of *T/SBDIO-16* DCM.
11. Switch on power of host PC.

## 3.2 Connection to external signal I/O equipment

Connection of *T/SBDIO-16* DCM to external I/O equipment is performed by means of on-board JP2 connector (fig.1-1, 2-1 and A-1).

**CAUTION**

It is highly recommended to plug-in and unplug external I/O cable set into/from on-board JP2 connector of *T/SBDIO-16* DCM when host *TORNADO* power is switched off.

The ground signal of *T/SBDIO-16* DCM has no galvanic isolation from host *TORNADO* and/or PC ground signal and chassis.

## Appendix A. On-board Connectors and Jumpers

This appendix contains a summary for the on-board connectors and configuration jumpers for *T/SBDIO-16* DCM.

The on-board connectors and configuration jumpers are presented at fig.A-1.

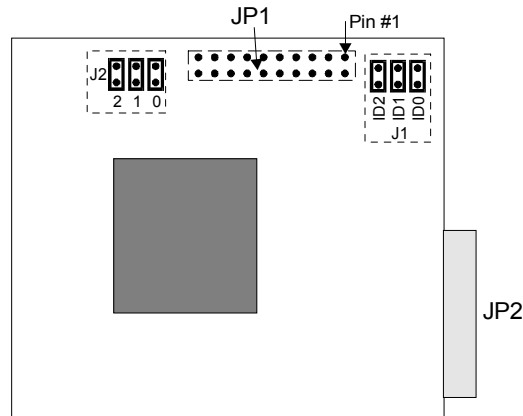


Fig. A-1. On-board connectors and configuration jumpers for *T/SBDIO-16* DCM.

### A.1 Configuration Jumpers

Table A-1 specifies how to set on-board configuration jumpers.

Table A-1. Configuration jumpers for *T/SBDIO-16* DCM.

Jumper	Description
J1	Defines SIOX-Bus device ID for <i>T/SBDIO-16</i> DCM. Refer to table 2-3 for more details.
J2	Selects host SIOX interrupt request line for generating interrupt to host DSP. Refer to table 2-2 for more details.

### A.2 On-board Connectors

Table A-2 contain the list of on-board connectors.

Table A-2. On-board connectors of T/SBDIO-16 DCM.

Connector	description
JP1	SIOX interface site male header.
JP2	External digital I/O connector.

Pinout of JP1 host SIOX connector is presented in the user’s guide of host *TORNADO* DSP system and in Appendix B of this databook.

**Pinout for external I/O connector**

Pinout of JP2 external I/O connector for *T/SBDIO-16* DCM is presented at fig.A-2, and description of signals is presented in table A-3.

The connector p/n for JP2 is DHA-RA20 female half-pitch connector from DDK Ltd manufacturer. P/n for compatible plug-in connector is DHA-PC20.

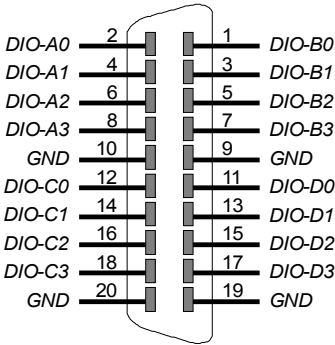


Fig. A-2. Pinout for JP2 external I/O connector of T/SBDIO-16 DCM.

Table A-3. Signal description for JP2 external I/O connector of T/SBDIO-16 DCM.

Signal name	type	description
DIO-A0..A3 DIO-B0..B3 DIO-C0..C3 DIO-D0..D3	TTL I/O	Digital I/O signals, which correspond to DIO-A, DIO-B, DIO-C and DIO-D I/O signal groups.
GND	-	Ground.

Notes: 1. Signal types: TTL I/O - 5v TTL compatible digital input/output.

## Appendix B. SIOX Rev.B Interface Site

This appendix contains information about *TORNADO* SIOX rev.B interface site specifications. This description is general to all *TORNADO* DSP systems/controllers/coprocessors, whereas different *TORNADO* boards with different DSP platforms may differ in the number and in the on-board routing of SIOX serial ports, timer/IO pin specifications. Refer to your particular *TORNADO* user's guide for more details.

### B.1 General Description

*TORNADO* architecture provides expansion of the on-board DSP I/O resources via on-board serial I/O expansion interface sites (SIOX-A and SIOX-B) (fig.B-1), which are designed to carry compatible DCMs (DCM).



Fig.B-1. *TORNADO*-54x board with two SIOX sites.

Some *TORNADO* boards (typically *TORNADO* DSP systems for PC) provide two SIOX interface sites, whereas other *TORNADO* boards (typically *TORNADO* stand-alone DSP controllers and DSP coprocessors) provide only one SIOX site.

*TORNADO* SIOX rev.B interface site comprises of signals for one or two SIO-0/SIO-1 logical serial ports, timers/IO pins, DSP interrupts, and host power supplies.

**CAUTION**

In case *TORNADO* on-board DSP features two or more on-chip serial ports (TMS320C30, TMS320C54x, TMS320C6x), then *TORNADO* on-board SIOX sites provides two SIO-0 and SIO-1 serial ports and the SIOX site headers are 26-pin headers.

In case *TORNADO* on-board DSP features only one on-chip serial ports (TMS320C31, TMS320C32), then *TORNADO* on-board SIOX sites provides only one SIO-0 serial port and the SIOX site headers are 20-pin headers.

Both *TORNADO* on-board SIOX-A and SIOX-B interface sites feature identical pinout control and may only differ in the routing of DSP physical serial ports to SIO-0 and SIO-1 logical serial ports. If *TORNADO* on-board DSP features two or more on-chip serial ports (TMS320C30, TMS320C54x, TMS320C6x), then DSP serial ports routing is performed on *TORNADO* mainboard, and allows simultaneous operation of two or more SIOX DCM, which are routed to different DSP serial ports.

B.2 SIOX Site Connector and Signals

*TORNADO* SIOX rev.B interface site comprises of signals for SIO-0 and SIO-1 logical serial ports, DSP on-chip TM/XIO-0/1 timers/IO pins, three DSP interrupts, SIOX reset control, and power  $\pm 5V/\pm 12V$  host power supplies.

*TORNADO on-board SIOX site connector with two serial ports*

*TORNADO* on-board SIOX site connector with two serial ports is an industry standard dual-row 26-pin female header with 0.1"x0.1" pin pattern. Compatible SIOX plug-in part on SIOX DCM should be the industry standard either 26-pin 0.1"x0.1"male header (in case both SIO-0 and SIO-1 serial ports are utilized on SIOX plugged-in DCM) or 20-pin 0.1"x0.1"male header (in case only SIO-0 serial port is utilized on SIOX plugged-in DCM).

SIOX site connector pinout with two serial ports is shown at fig.B-2 and signal specifications are listed in table B-1.

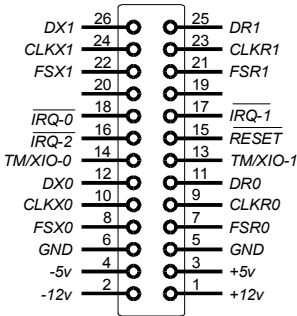


Fig.B-2. *TORNADO* on-board SIOX connector pinout with two serial ports (top view).

**TORNADO on-board SIOX site connector with one serial port**

TORNADO on-board SIOX site connector with one serial port is an industry standard dual-row 20-pin female header with 0.1"x0.1" pin pattern. Compatible SIOX plug-in part on SIOX DCM should be the industry standard 20-pin 0.1"x0.1"male header.

SIOX site connector pinout with one serial ports is shown at fig.B-3 and signal specifications are listed in table B-1.

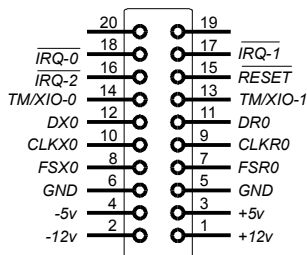


Fig.B-3. TORNADO on-board SIOX connector pinout with one serial port (top view).

**SIOX site signal description**

Description for SIOX interface site signals is presented in table B-1.

Table B-1. SIOX interface signal description.

SIOX signal name	signal type	description
<b>SIO-0 port control</b>		
DX0 FSX0 CLKX0	O/Z I/O/Z I/O/Z	Data, frame synchronization and serial clock signals for transmitter of SIO-0 port of SIOX site..
DR0 FSR0 CLKR0	I I/O/Z I/O/Z	Data, frame synchronization and serial clock signals for receiver of SIO-0 port of SIOX site..
<b>SIO-1 port control</b> (available in SIOX site connector with two serial ports only)		
DX1 FSX1 CLKX1	O/Z I/O/Z I/O/Z	Data, frame synchronization and serial clock signals for transmitter of SIO-1 port of SIOX site..
DR1 FSR1 CLKR1	I I/O/Z I/O/Z	Data, frame synchronization and serial clock signals for receiver of SIO-1 port of SIOX site..

<b>DSP Timers/IO, DSP Interrupt Requests and SIOX Reset</b>		
<i>TM/XIO-0</i>	I/O/Z	This signal is typically connected to the DSP on-chip timer-0 I/O pin and can be software configured by DSP as either timer or I/O pin.
<i>TM/XIO-1</i>	I/O/Z	This signal is typically connected to the DSP on-chip timer-1 I/O pin and can be software configured by DSP as either timer or I/O pin.
$\overline{RESET}$	O	Active low SIOX reset signal. Some <i>TORNADO</i> boards (for example <i>TORNADO-3x</i> boards) wires this signal directly from the DSP reset signal and SIOX plugged-in DCM reset is performed simultaneously with <i>TORNADO</i> on-board DSP reset, however other <i>TORNADO</i> boards (for example <i>TORNADO-54x/6x</i> etc. boards) features dedicated SIOX site reset signal, which is controlled by <i>TORNADO</i> on-board DSP for better synchronization between the DSP software and SIOX DCM operation.
$\overline{IRQ-0}$ , $\overline{IRQ-1}$ , $\overline{IRQ-2}$	I	Active low external interrupt request lines for <i>TORNADO</i> on-board DSP. These line are pulled up.
<b>Power Supplies</b>		
<i>GND</i>		Ground.
<i>+5v</i>		+5v
<i>+12v</i>		+12v
<i>-5v</i>		-5v
<i>-12v</i>		-12v

Note:

1. Signal type is denoted as the following: I - input, O - output, Z - high impedance.
1. All logical signal levels and load currents correspond to that for CMOS/TTL signals.

### **SIOX site signal levels**

Signal levels for SIOX interface signals correspond to that for the CMOS/TTL signals with  $I_{OL}=2\text{ma}$  and  $I_{OH}=-0.3\text{ma}$  load currents.

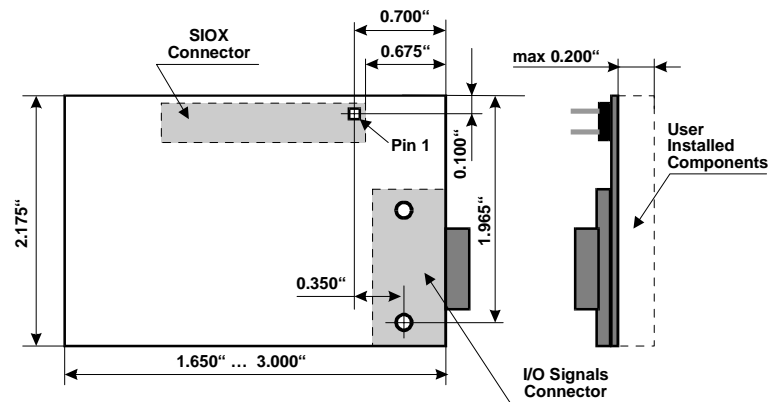


**CAUTION**

Some *TORNADO* boards (*TORNADO-3x/542L/E31*) provide SIOX interface signal levels for CMOS/TTL only, whereas other *TORNADO* boards (*TORNADO-54xx/6x/E6x/P6x*) provide SIOX interface signal levels universal for both 3V TTL and standard TTL. Refer to documentation for your particular *TORNADO* board for information about SIOX interface signal levels.

## B.3 Physical Dimensions for SIOX DCM

Physical dimensions for SIOX DCM are presented at fig.B-4. This information is intended for those customers, who need to design customized SIOX DCMs.



SIOX connector: 20-pin or 26-pin straight dual-row mail header  
(0.025" Sq., 0.1"x0.1" pattern)

Recommended connector for Analog I/O: DDK DHA-RC14-R122N  
DDK DHA-RC20-R122N  
DDK DHA-RC26-R122N

Fig.B-4. Physical dimensions for SIOX DCM.