T/SDAS-SCOM2

Dual-channel Speech/Fax/Modem AD/DA SIOX Daughter-card Module
for *TORNADO* DSP Systems, Controllers and Coprocessors

User's Guide

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About this Document

This user's guide contains description for *T/SDAS-SCOM2* AD/DA SIOX daughter-card module 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. ***TLC320AC01 AIC User's Guide.*** Texas Instruments Inc, SLAS057B, 1996.
2. ***TMS320C3x User's Guide.*** Texas Instruments Inc, SPRU031C, USA, 1992.
3. ***TMS320C54x. CPU and Peripherals. Reference Guide.*** Texas Instruments Inc, SPRU131D, USA, 1997.
4. ***TMS320C6x. CPU and Instruction Set. Reference Guide.*** Texas Instruments Inc, SPRU189C, USA, 1998.
5. ***TORNADO-31. User's Guide.*** MicroLAB Systems, 1994.
6. ***TORNADO-30. User's Guide.*** MicroLAB Systems, 1994.
7. ***TORNADO-31Z. User's Guide.*** MicroLAB Systems, 1994.
8. ***TORNADO-54x. User's Guide.*** MicroLAB Systems, 1998.
9. ***TORNADO-6x. User's Guide.*** MicroLAB Systems, 1998.
10. ***TORNADO-PX31DP. User's Guide.*** MicroLAB Systems, 1996.
11. ***TORNADO-SX30. User's Guide.*** MicroLAB Systems, 1996.
12. ***TORNADO-E31. User's Guide.*** MicroLAB Systems, 1996.
13. ***TORNADO-EL31. User's Guide.*** MicroLAB Systems, 1996.
14. ***TORNADO-E62. User's Guide.*** MicroLAB Systems, 1998.

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Chapter 1. Introduction

This chapter contains general description for *T/SDAS-SCOM2* SIOX daughter-card module.

1.1   General Information

T/SDAS-SCOM2 is dual-channel AD/DA front-end SIOX (serial I/O expansion) daughter-card module (fig.1-1) for *TORNADO* DSP systems (*TORNADO-3x/54x/6x/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.

T/SDAS-SCOM2 module provides speech/fax/modem AD/DA quality and can connect to external microphones, phones, audio equipment, PSTN phone lines, telephones, fax machines and computer modems.
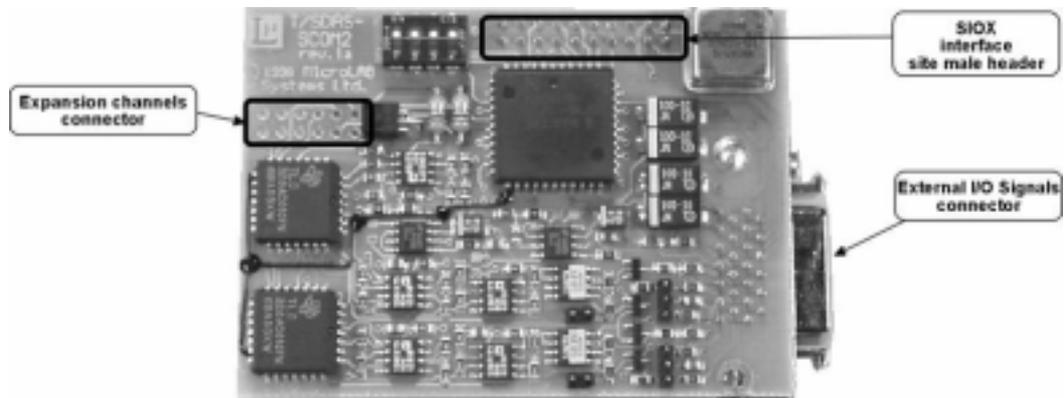
Fig. 1-1.   T/SDAS-SCOM2 daughter-card module.

Installation

T/SDAS-SCOM2 module installs as SIOX daughter-card module (fig.1-2) into the SIOX site onto *TORNADO* DSP mainboard. If required, the *T/SU-X* SIOX extender can be used for remote connection to SIOX interface of *TORNADO* mainboard.
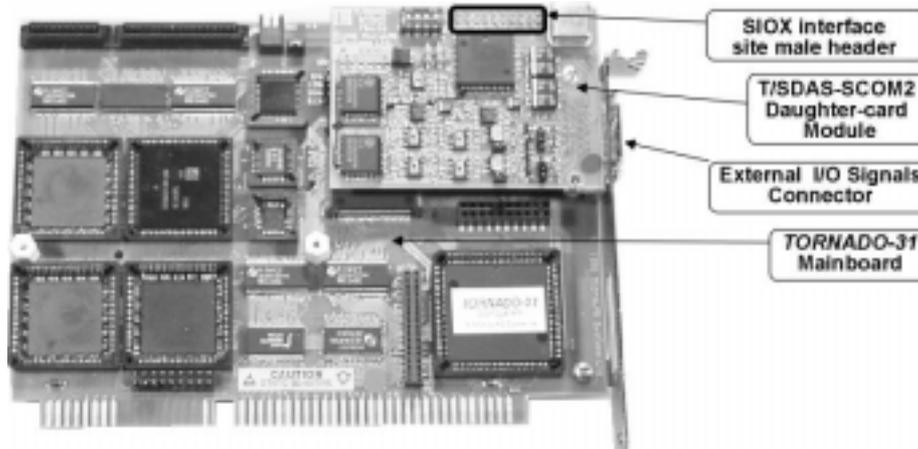
Fig. 1-2.   T/SDAS-SCOM2 daughter-card module installed onto *TORNADO-31* mainboard.

Overview

T/SDAS-SCOM2 module comprises of two AD/DA channels of speech/fax/modem quality using two TLC320AC01 AIC chips from Texas Instruments Inc, and features:
- two A/D-channels each providing line-in and microphone inputs, programmable input multiplexer, programmable gain amplifier, programmable antialiasing filter and 14-bit ADC
- two D/A-channels with 14-bit DAC, programmable low-pass filter, reconstruction filter, output amplifiers for line-out and headphones/speakers
- four (4) digital inputs and four (4) digital outputs.

Sampling frequency for *T/SDAS-SCOM2* module might be software programmed for any value below 25 kHz, and, moreover, the phase shift for sampling frequency can be programmed in every sampling cycle. The latter feature is very important for fax/modem communication, which require run-time adjustment of sampling frequency.

Communication between *T/SDAS-SCOM2* module and *TORNADO* on-board DSP is performed via DSP on-chip serial port (SIO), which is part of *TORNADO* on-board SIOX daughter-card interface site.

T/SDAS-SCOM2 module allows expansion of analog I/O channels via on-module channel expansion connector.

External signal I/O

Connection of *T/SDAS-SCOM2* module to external analog I/O world is performed via the on-board I/O JP2 connector, which is available via rear panel of host PC (if *T/SDAS-SCOM2* is installed onto *TORNADO* DSP system for PC).

The ultimate feature of *T/SDAS-SCOM2* module is modular design of external I/O facilities in order to meet multiple application configurations. Below is a list of available external I/O options:
- *T/X-XCSMP* stereo analog I/O cable set (fig.1-3) for connection of stereo MIC/Line-in/Line-out/Phone set

- *T/X-XCMP/2* dual-channel analog I/O cable set (fig.1-4) for connection of two MIC/Line-in/Line-out/Phone sets
- *T/X-X2C* dual-channel splitter (see Appendix B and fig.1-5) in order to convert dual-channel I/O connector to two single-channel I/O connectors, which are compatible with that for *T/SDAS-SCOM1* single-channel speech/fax/modem module
- up to two *T/X-XCMP* single-channel analog signal I/O cable sets, which connect to *T/X-X2C* dual-channel splitter (fig.1-6), and allow connection of MIC/Line-in/Line-out/Phone sets to any channel
- up to two *T/X-XTLI* external telephone line interface options, which connect to *T/X-X2C* dual-channel splitter (see subsection below and fig.1-7), and allow direct connection to PSTN (public switch telephone network) subscriber lines
- up to two *T/X-XTSI* external telephone station interface options, which connect to *T/X-X2C* dual-channel splitter (see subsection below and fig.1-8), and provides emulation of PSTN (public switch telephone network) subscriber lines and direct connection to external telephones, fax machines and computer modems.

Once the *T/X-X2C* dual-channel splitter is connected to *T/SDAS-SCOM2* module, then any of *T/X-XCMP* single-channel analog signal I/O cable set, *T/X-XTLI* external telephone line interface option or *T/X-XTSI* external telephone station interface option can connect to any channel of *T/X-X2C* dual-channel splitter, thus delivering multiple dual-channel external signal I/O interface configurations in order to meet virtually any application requirements.
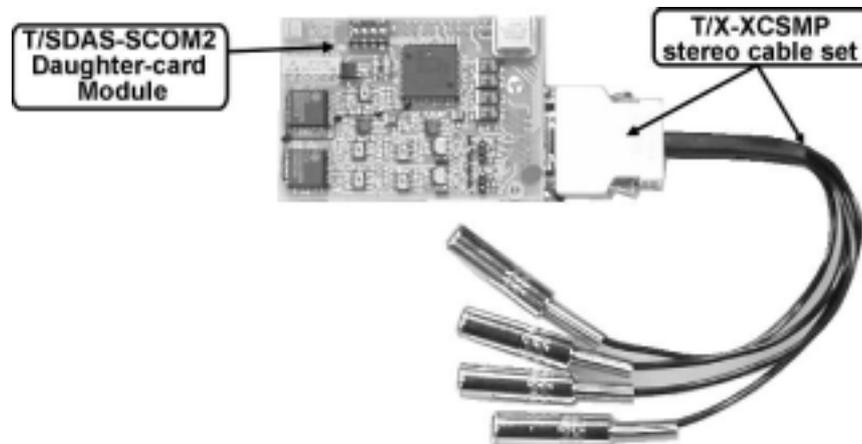
Fig. 1-3.   T/SDAS-SCOM2 daughter-card module with *T/X-XCSMP* stereo cable set.
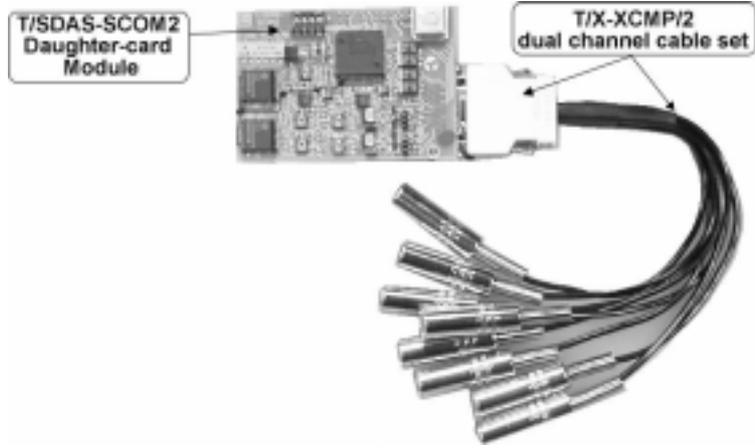
Fig. 1-4.   T/SDAS-SCOM2 daughter-card module with T/X-XCMP/2 dual-channel cable set.
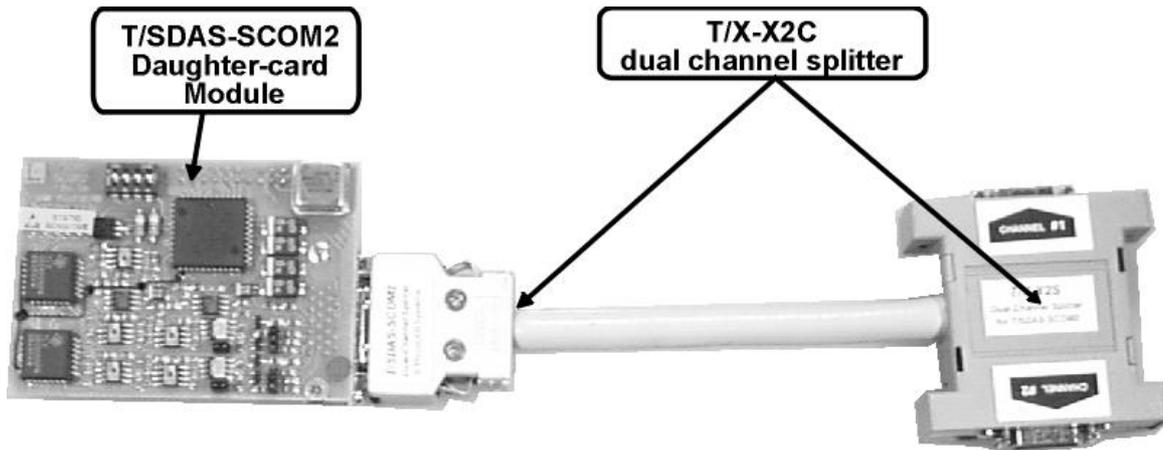
Fig. 1-5.   T/SDAS-SCOM2 daughter-card module with T/X-X2C dual-channel splitter.

Fig. 1-6.   T/SDAS-SCOM2 daughter-card module with *T/X-X2C* dual-channel splitter and two *T/X-XCMP* single-channel cable sets.

External telephone line interface option

T/X-XTLI external telephone line interface option (fig.1-7) (also known as DAA (digital access arrangement) based passive telephone line interface) is designed as the end-user PSTN (public switched telephone network) equipment and offers direct access to available PSTN subscriber lines. In case appropriate DSP software is supplied, this converts *TORNADO* DSP system or controller with installed *T/SDAS-SCOM2* module and external *T/X-XTLI* telephone line interface into automatic answering machine, fax machine or modem with data transmission over PSTN telephone lines.

T/X-XTLI external telephone line interface can be also used with *T/SDAS-SCOM1* single-channel speech/fax/modem module and with *T/SDAS-ATEL2* stereo-audio/fax/modem module.

External *T/X-XTLI* telephone line interface connects to any channel of *T/SDAS-SCOM2* module via *T/X-X2C* dual-channel splitter and is similar to phone line interface of automatic answering machine, fax machines and computer modems. Line outlet of *T/X-XTLI* telephone line interface plugs directly to the phone line wall-outlet.

T/X-XTLI option operates under the DSP software control and detects incoming line calls/rings, picks up the phone and provides dialing either using DTMF or pulse dialing.
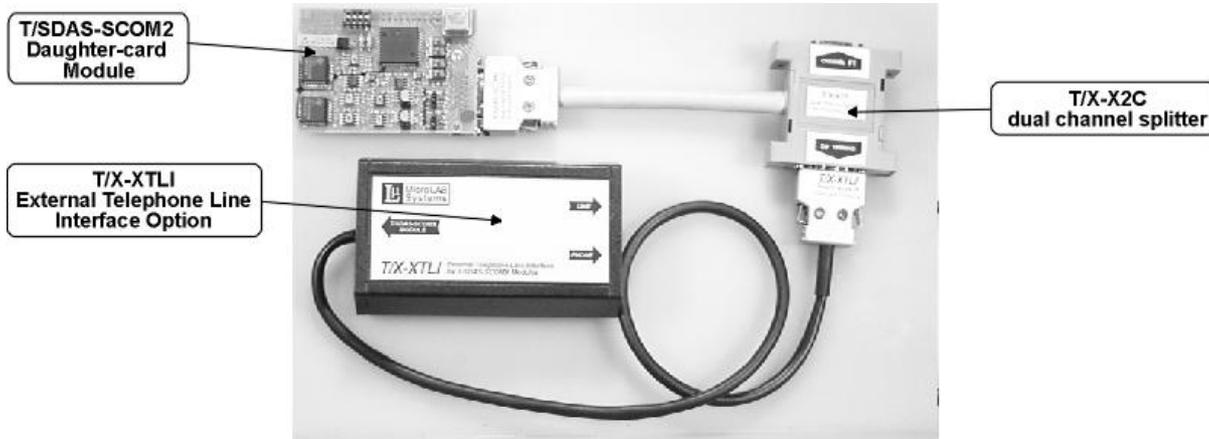
Fig. 1-7.   T/SDAS-SCOM2 daughter-card module with external dual-channel splitter (*T/X-X2C*) and one external *T/X-XTLI* external telephone line interface option.

External telephone station interface option

T/X-XTSI external telephone station interface option (also known as SLIC (subscriber line interface circuit) based active telephone line interface) for *T/SDAS-SCOM2* module (and fig.1-8) is functionally opposite to *T/X-XTLI* external telephone line interface option, and is designed for emulation of subscriber line equipment of typical PSTN telephone station.

External *T/X-XTSI* telephone station interface option connects to any channel of *T/SDAS-SCOM2* module via *T/X-X2C* dual-channel splitter and is similar to subscriber line equipment of typical PSTN telephone station.

Line outlet of *T/X-XTSI* option directly connects to telephone, automatic answering machine, fax machine or computer modem, but it cannot plug to the PSTN phone line wall-outlet.

T/X-XTSI option operates under the DSP software control and provides required voltage shift for output phone line, generates line calls/rings, detects phone pick-up and receives dialing signals either for DTMF or pulse dialing.

Fig. 1-8. *T/SDAS-SCOM2* daughter-card module with external dual-channel splitter (*T/X-X2C*) and one external *T/X-XTSI* external telephone station interface option.

applications

T/SDAS-SCOM2 AD/DA module is designed for dual-channel speech/fax/modem signal processing applications as well as for other general signal processing applications (biomedical, instrumentation, etc), which apply for AD/DA requirement similar to that of *T/SDAS-SCOM2* AD/DA module.

1.2   Technical Specifications

The following are technical specifications for *T/SDAS-SCOM2* AD/DA module for temperature of external environment +25°C.

parameter description	*parameter value*
A/D channel:	
ADC type	ADC section of TLC320AC01 AIC from Texas Instruments Inc
number of channels	2
resolution	14 bits
input signal range for A-IN inputs	±3V, ±1.5V, ±0.75V
input signal range for AUX-IN input	±3V, ±1.5V, ±0.75V, ±0.3V, ±0.15V, ±0.075V

input impedance for A-IN and AUX-IN inputs	≥1 MOhm
optional input voltage bias for electret microphones at AUX-IN input	+5V@15kOhm
maximum cut-off frequency of low-pass antialiasing filter	10.8 kHz (see TLC320AC01 AIC chip documentation)
cut-off frequency of optional high-pass filter	approx. 75 Hz (see TLC320AC01 AIC chip documentation)
THD	-68 dB (typ)
sampling frequency	43.2 kHz

D/A channel

DAC type	DAC section of TLC320AC01 AIC from Texas Instruments Inc
number of channels	2
resolution	14 bits
THD	-68 dB (typ)
cut-off frequency of low-pass filter	10.8 kHz (see TLC320AC01 AIC chip documentation)
output signal range for LINE-OUT output	±3V, ±1.5V, ±0.75V
output signal range for HEADPHONE-OUT output	± 4 V
external load impedance for LINE-OUT output	≥600 Ohm
external load impedance for HEADPHONE-OUT output	>8 Ohm
maximum output power for HEADPHONE-OUT output	0.8 W
sampling frequency	25 kHz

common parameters:

| On-board MCLK master clock frequency for TLC320AC01 chip | 9.216 MHz |

Maximum external master clock frequency for TLC320AC01 AIC chip from either TM-0/1 SIOX pins or external XMCLK pin of JP2 connector	15 MHz
external clock frequency for SIO port	≤ 2.5 MHz
number of bits in data packet via SIO-port	16 bits
logical low level for external clock frequency input and digital I/O signals external JP2 connector	≤ 0.6 V
logical high level for external clock frequency input and digital I/O signal at external JP2 connector	≥ 2.4 V

Chapter 2. Construction

This chapter contains description of architecture and construction for *T/SDAS-SCOM2* SIOX daughter-card module.

2.1   Block Diagram

Basic configuration and connectivity of *T/SDAS-SCOM2* module is presented at fig.2-1.
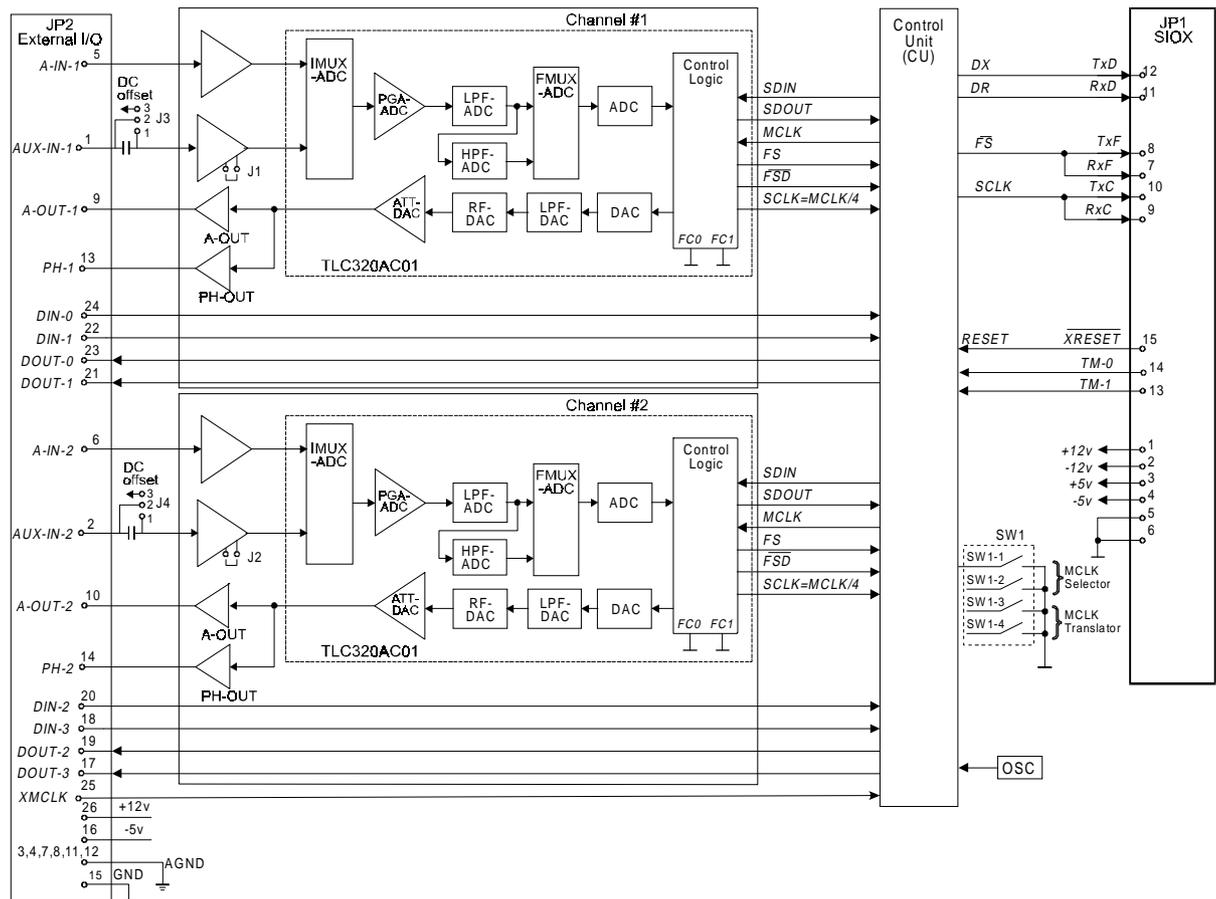
Fig. 2-1.   Block diagram of *T/SDAS-SCOM2* module.

T/SDAS-SCOM2 module installs as SIOX (serial I/O expansion interface) daughter-card module onto *TORNADO* mainboard and assumes communication with the on-board *TORNADO* DSP via the DSP on-chip serial port.

T/SDAS-SCOM2 module comprises of:
- two analog I/O channels (#1 and #2), each based around one TLC320AC01 AIC chip from Texas Instruments Inc.
- control unit (CU)
- SIOX interface header for installation onto *TORNADO* DSP systems.

CAUTION

This manual does not contain detail description for TLC320AC01 AIC chip. Refer to the corresponding technical information from Texas Instruments Inc (SLAS057B), which is enclosed with this manual either in electronic or paper form.

CAUTION

AD/DA channel #1 provides the TLC320AC01 AIC chip running
in "MASTER" mode.

AD/DA channel #2 provides the TLC320AC01 AIC chip running
in "SLAVE" mode.

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analog input section

Analog input section of *T/SDAS-SCOM2* module comprises of two identical A/D channels (#1 and #2), and is designed for analog-to-digital conversion of input analog signals from either of inputs A-IN and AUX-IN and further transmission of digital code to the receiver of SIO-0 port of SIOX interface of *TORNADO* DSP system.

Each A/D channel of analog input section comprises of the following components:
- A-IN input amplifier (A-IN-Amp) with gain factor 0dB
- AUX-IN input amplifier (AUX-IN-Amp) with gain factor 0dB or +20dB. The gain factor for AUX-IN input of each A/D channel is set independently for every A/D channel with jumpers J1 (channel #1)) and J2 (channel #2). AUX-IN input of each A/D channel also features optional voltage offset circuit, which must be used when connecting external electret microphone, and which is enabled by on-board jumpers J3 (channel #1) and J4 (channel #2).
- programmable input multiplexer (IMUX-ADC)
- programmable gain amplifier (PGA-ADC) with gain factors 0dB, +6dB and +12dB
- programmable low-pass antialiasing filter (LPF-ADC)
- programmable high-pass filter (HPF-ADC)
- 14-bit analog-to-digital converter (ADC).

The A-IN and AUX-IN input amplifiers are designed for interfacing and scaling of external analog signals. Both A-IN and AUX-IN input amplifiers feature high input impedance. Both A-IN and AUX-IN inputs feature over-voltage protection.

The A-IN input amplifier provides 0dB gain factor and is designed for interfacing to external line-level signals, whereas the AUX-IN input amplifier provides either 0dB or +20dB in order to interface either to external line-level signals or to microphone. The gain factor for AUX-IN input is set independently for every A/D channel using J1 (A/D channel #1) and J2 (A/D channel #1) on-board jumpers (see Appendix A).

The AUX-IN input of every A/D channel features optional voltage shift circuit, which can provide +5V@15kOhm voltage bias for connection to electret microphones. This option is enabled by J3 (A/D channel #1) and J4 (A/D channel #1) on-board jumpers (see Appendix A). When the voltage shift circuit is enabled, then the AUX-IN input is DC decoupled.

The A-IN input of every A/D channel is DC coupled and can process external DC/AC analog signals within the frequency range below the cutoff frequency of the antialiasing filter.

The AUX-IN input of every A/D channel might be either DC coupled or DC decoupled. The decoupling feature is set by J3 (A/D channel #1) and J4 (A/D channel #1) on-board jumpers (see Appendix A), which are also used for enabling optional voltage shift feature. The AUX-IN input can process external DC/AC analog signals within the frequency range below the cutoff frequency of the antialiasing filter.

Input multiplexer IMUX-ADC, programmable gain amplifier PGA-ADC, programmable high-order low-pass antialiasing filter (LPF-ADC), optional high-order low-frequency high-pass filter (HPF-ADC), and 14-bit analog-to-digital converter (ADC) are internal components of A/D section of TLC320AC01 AIC chip from Texas Instruments Inc. Refer to original TI documentation for details.

analog output section

Analog output section of *T/SDAS-SCOM2* module comprises of two identical D/A channels (#1 and #2), and is designed for conversion of digital code from transmitter of SIO-0 port of SIOX INTERFACE of *TORNADO* DSP system into output analog signals at line output (A-OUT) and speaker/headphone output (PH-OUT).

Each D/A channel analog output section comprises of the following components:
- 14-bit digital-to-analog converter (DAC)
- programmable low-pass filter (LPF-DAC)
- *SIN(X)/X* reconstruction filter (RF-DAC)
- output attenuator ATTN-DAC
- A-OUT output buffer
- PH-OUT amplifier for external headphones or speaker.

The 14-bit DAC, programmable low-pass filter LPF-DAC, *SIN(x)/X* reconstruction filter RF-DAC and programmable output attenuator ATTN-DAC (0dB/-6dB/-12dB/OFF) are internal components of D/A section of TLC320AC01 AIC chip from Texas Instruments Inc. Refer to original TI documentation for details.

The A-OUT and PH-OUT buffers are used for interfacing to external low-impedance loads and provide minimum signal distortions.

A/D and D/A control logic

The A/D and D/A control logic are internal components of TLC320AC01 AIC chip from Texas Instruments Inc and both runs with FC0 and FC1 external hardware control signals set both to logical '0' value. Refer to original TI documentation for details.

Control Unit (CU)

T/SDAS-SCOM2 on-board Control Unit (CU) is implemented using FPGA chip and offers selector of master clock source frequency for TLC320AC01 AIC chips and optional external digital I/O facility, which is used by external telephone line/station interface options.

External digital I/O

On-board control unit CU provides four external digital inputs (*DIN-0..DIN-3*) and four external digital outputs (*DOUT-0..DOUT-3*) in order to control external telephone line/station interface options, which may connect to any or both channels of *T/SDAS-SCOM2* module.

CAUTION

Each external telephone line/station interface option requires two digital inputs and two digital outputs for hardware control.

External digital inputs *DIN-0..DIN-1* and external digital outputs *DOUT-0..DOUT-1* correspond to external telephone line/station interface option, which is connected to channel #1 of *T/SDAS-SCOM2* module.

External digital inputs *DIN-2..DIN-3* and external digital outputs *DOUT-2..DOUT-3* correspond to external telephone line/station interface option, which is connected to channel #2 of *T/SDAS-SCOM2* module.

External digital inputs *DIN-0..DIN-3* and outputs *DOUT-0..DOUT-3* are available during secondary AIC communication when writing/reading to/from pseudo-register #15 for MASTER AIC chip. Master AIC pseudo-register #15 is called as *EXTERNAL DIGITAL I/O CONTROL REGISTER* (*XDIO_RG*).

CAUTION

TLC320AC01 AIC chip supports on-chip configuration registers #0..#8 only.

When writing/reading to/from Configuration pseudo-register #15 of MASTER AIC, this is recognized by on-board control unit (CU) as access to external digital I/O control register (*XDIO_RG*), and MASTER AIC is excluded from data-path.

In order to set external digital outputs *DOUT-0..DOUT-3*, the *XDIO_RG* register must be written during secondary communication for MASTER AIC chip using AIC register write command:

XDIO_RG Register Write Command
(pseudo-register #15 of MASTER AIC only)

DS15	DS14	DS13	DS12	DS11	DS10	DS9	DS8	DS7	DS6	DS5	DS4	DS3	DS2	DS1	DS0
Control Bits		*0*	0	1	1	1	1	DOUT -3	DOUT -2	DOUT -1	DOUT -0	0	0	0	0

CAUTION

External digital outputs *DOUT-0..DOUT-3* default to '0' state when reset signal of SIOX-module (pin *XRESET* of SIOX interface connector) is active (after host power-on and when *TORNADO* on-board DSP is set to the RESET state).

In order to read current state of external data outputs *DOUT-0..DOUT-3* and external data inputs *DIN-0..DIN-3*, the read command for *XDIO_RG* register must be used as the following:

XDIO_RG Register Read Command
(pseudo-register #15 of MASTER AIC only)

DS15	DS14	DS13	DS12	DS11	DS10	DS9	DS8	DS7	DS6	DS5	DS4	DS3	DS2	DS1	DS0
Control Bits		*1*	0	1	1	1	1	0	0	0	0	0	0	0	0

The above read command for *XDIO_RG* register will result in the following secondary transmission Data-Out word format:

Secondary Communication Data-Out Word during XDIO_RG Register Read
(pseudo-register #15 of MASTER AIC only)

DS15	DS14	DS13	DS12	DS11	DS10	DS9	DS8	DS7	DS6	DS5	DS4	DS3	DS2	DS1	DS0
DIN-3	*DIN-2*	*DIN-1*	*DIN-0*	0	0	0	0	DOUT -3	DOUT -2	DOUT -1	DOUT -0	0	0	1	0

Note, that current state of external data inputs *DIN-0..DIN-3* is also always available via bits #12..#15 of secondary communication Data-Out word from *T/SDAS-SCOM2* module during any of the following conditions:

- when writing to AIC registers #0..#8 of either MASTER AIC or SLAVE AIC chips and to pseudo-register #15 (*XDIO_RG*) of MASTER AIC chip
- when reading AIC registers #0..#8 from either MASTER AIC or SLAVE AIC chips.

Secondary Communication Data-Out Word during AIC Register #0..#8,#15 Write
(MASTER and SLAVE AIC)

DS15	DS14	DS13	DS12	DS11	DS10	DS9	DS8	DS7	DS6	DS5	DS4	DS3	DS2	DS1	DS0
DIN-3	*DIN-2*	*DIN-1*	*DIN-0*	0	0	0	0	0	0	0	0	0	0	*ID-1*	*ID-0*

Note: 1. {ID-1, ID-0} identifies Data-Out word during write operations from MASTER AIC ({ID-1, ID-0}={1,0}) or
                            from SLAVE AIC ({ID-1, ID-0}={1,1}).

CAUTION

Two least significant bits (DS1 and DS0) of secondary communication Data-Out word from *T/SDAS-SCOM2* module during AIC register write command for either MASTER or SLAVE AIC chip contains the source AIC chip identifier {ID-1,ID-0}, which is inserted by on-board control unit (CU) in order to synchronize with DSP software.

The {1,0} value of {ID-1,ID-0} identifier corresponds to Data-Out word from MASTER AIC chip, whereas {1,1} value of {ID-1,ID-0} identifier corresponds to Data-Out word from SLAVE AIC chip.

The AIC chip identifier {ID-1,ID-0} in two least significant bits (DS1 and DS0) of secondary communication Data-Out word from *T/SDAS-SCOM2* module is not available during AIC register read command.

Secondary Communication Data-Out Word during Register #0..#8 Read
(MASTER and SLAVE AIC)

DS15	DS14	DS13	DS12	DS11	DS10	DS9	DS8	DS7	DS6	DS5	DS4	DS3	DS2	DS1	DS0
DIN-3	*DIN-2*	*DIN-1*	*DIN-0*	0	0	0	0	0	*Register #0..#8 Data*						

Data word formats for primary communication

Data-In and Data-Out words format for primary AIC communication contain DAC data from DSP to AIC and ADC data from AIC to DSP, and correspond to that described in TLC320AC01 AIC documentation:

Primary Communication Data-In Word for TLC320AC01 AIC
(DAC data)

DAC-13	DAC-12	DAC-11	DAC-10	DAC-9	DAC-8	DAC-7	DAC-6	DAC-5	DAC-4	DAC-3	DAC-2	DAC-1	DAC-0	CB-1	CB-0
bit-15	bit-14	bit-13	bit-12	bit-11	bit-10	bit-9	bit-8	bit-7	bit-6	bit-5	bit-4	bit-3	bit-2	bit-1	bit-0

Notes: 1.   1. *DAC-0..DAC-13* are data bits transmitted from DSP to AIC and contains DAC data.
2. Two least significant bits {CB-0,CB-1} are Control Bits, which request secondary communication and phase adjustment. Refer to TLC320AC01 AIC documentation for details.

Primary Communication Data-Out Word for TLC320AC01 AIC
(ADC data)

ADC-13	ADC-12	ADC-11	ADC-10	ADC-9	ADC-8	ADC-7	ADC-6	ADC-5	ADC-4	ADC-3	ADC-2	ADC-1	ADC-0	ID-1	ID-0
bit-15	bit-14	bit-13	bit-12	bit-11	bit-10	bit-9	bit-8	bit-7	bit-6	bit-5	bit-4	bit-3	bit-2	bit-1	bit-0

Notes: 1. *ADC-0..ADC-13* are data bits transmitted from AIC to DSP and contains ADC data.
2. Two least significant bits {ID-1,ID-0} contain MASTER/SLAVE AIC identifier for primary Data-Out word. If {ID-1,ID-0} identifier equals to {0,0}, then this is the ADC data from MASTER AIC. If {ID-1,ID-0} identifier equals to {0,1}, then this is the ADC data from SLAVE AIC. Refer to TLC320AC01 AIC documentation for details.

Data word formats for secondary communication

Data-In word format for secondary AIC communication contains either "AIC REGISTER READ" or "AIC REGISTER WRITE" command from DSP to AIC, and correspond to that described in TLC320AC01 AIC documentation:

Secondary Communication Data-In Word for TLC320AC01 AIC
(AIC Register Read/Write Command)

DS15	DS14	DS13	DS12	DS11	DS10	DS9	DS8	DS7	DS6	DS5	DS4	DS3	DS2	DS1	DS0
Control Bits		1 (r) 0 (w)	Register Address (0..8)					Register Write Data Ignored for Read Command							

CAUTION

Format of secondary communication Data-Out words, which are transmitted from *T/SDAS-SCOM2* module to DSP during AIC register read and write commands, differ from that described in TLC320AC01 AIC documentation.

The on-board control unit (CU) intercepts secondary Data-Out stream from TLC320AC01 AIC chip and inserts current status of external digital inputs *DIN-0..DIN-3* into four most significant bits DS12..DS15 of AIC Data-Out word, as well as MASTER/SLAVE AIC identifier {ID-0,ID-1} into two least significant bits {DS0,DS-1} of AIC Data-Out word during AIC register write command.

Secondary Communication Data-Out Word during Register #0..#8 Read
(MASTER and SLAVE AIC)

DS15	DS14	DS13	DS12	DS11	DS10	DS9	DS8	DS7	DS6	DS5	DS4	DS3	DS2	DS1	DS0
DIN-3	*DIN-2*	*DIN-1*	*DIN-0*	0	0	0	0	0	*Register #0..#8 Data*						

Secondary Communication Data-Out Word during Register #0..#8,#15 Write
(MASTER and SLAVE AIC)

DS15	DS14	DS13	DS12	DS11	DS10	DS9	DS8	DS7	DS6	DS5	DS4	DS3	DS2	DS1	DS0
DIN-3	*DIN-2*	*DIN-1*	*DIN-0*	0	0	0	0	0	0	0	0	0	0	*ID-1*	*ID-0*

Note: 1. {ID-1, ID-0} identifies Data-Out word during write operations from MASTER AIC ({ID-1, ID-0}={1,0}) or from SLAVE AIC ({ID-1, ID-0}={1,1}).

CAUTION

MASTER/SLAVE AIC chip identifier {ID-1,ID-0} for secondary communication Data-Out word during AIC register write command should be used for synchronization with DSP software.

The {1,0} value of {ID-1,ID-0} identifier corresponds to Data-Out word from MASTER AIC chip, whereas {1,1} value of {ID-1,ID-0} identifier corresponds to Data-Out word from SLAVE AIC chip.

Master Clock (MCLK) source selector for TLC320AC01 AIC

The on-board clocking, sampling frequency and serial clock are generated by TLC320AC01 AIC chips from master clock (*MCLK*) source clock, which is common for both MASTER and SLAVE AIC chips. Refer to TLC320AC01 AIC chip documentation for details.

It is important to have AIC master clock to be synchronous with clocking of particular signal processing application (fax/modem baud rate, vocoder clocking, etc) in order to provide perfect signal processing functionality.

T/SDAS-SCOM2 module offers different AIC master clock (*MCLK*) source configurations as the following in order to meet different signal processing applications:

- on-board 9.216 MHz crystal oscillator, which delivers compatible master clock frequency for most telecommunication and speech processing applications
- host SIOX *TM-0* or *TM-1* timer/IO signals from host *TORNADO* on-board DSP, which might be used when perfect synchronization with DSP clock is required
- external master clock (*XMCLK*) source signal from external I/O connector JP2, which might be used for non-standard AIC master clocking and for external master clock PLL functions.

In case AIC master clock (*MCLK*) is sourced either from either on-board 9.216 MHz crystal oscillator or external master clock (*XMCLK*) source signal from external I/O connector JP2, then on-board hardware may be configured for "translation" (forwarding) of AIC master clock to either *TM-0* or *TM-1* timer/IO signals of host SIOX interface site of host *TORNADO* DSP system or controller. In some signal processing applications this will allow perfect synchronization between DSP timer interrupts and AIC sampling frequency.

AIC master clock source and "translation" feature is selected by *T/SDAS-SCOM2* on-board switch SW1 (refer to Appendix A).

sampling frequency

Sampling frequency is generated by TLC320AC01 AIC identical for both A/D and D/A sections and for both channels of *T/SDAS-SCOM2* module. Refer to TLC320AC01 AIC chip documentation for details.

Maximum sampling frequency value for D/A section is 25 kHz, whereas maximum sampling frequency value for D/A section is 43 kHz. In case both D/A and A/D sections are involved into signal processing, then maxim value of sampling frequency is 25 kHz.

Sampling frequency value is configured by DSP software by means of programming AIC configurations registers #1 and #2 for both MASTER and SLAVE TLC320AC01 AIC chips.

communication with host SIOX interface

Communication between *T/SDAS-SCOM2* module and *TORNADO* on-board DSP is performed via SIO-0 port of SIOX interface site using 16-bit serial data words. Refer to TLC320AC01 AIC chip documentation for details.

All *TORNADO* DSP systems and controllers with SIOX interface site support communication with *T/SDAS-SCOM2* daughter-card module.

2.2   Construction

T/SDAS-SCOM2 module (fig.1-1, fig.A-1) meets standard SIOX rev.B daughter-card form-factor. Construction of *T/SDAS-SCOM2* module assumes that host *TORNADO* DSP system with *T/SDAS-SCOM2* module installed fits into one ISA-bus slot of PC chassis.

Connection of *T/SDAS-SCOM2* module to external analog I/O world is performed via the on-board JP2 connector, which is available via rear panel of host PC (if *T/SDAS-SCOM2* is installed onto *TORNADO* DSP system for PC).

Different sets of external signal I/O cables, dual-channel splitter and external telephone line and station interface options are available for *T/SDAS-SCOM2* module in order to meet different signal processing applications (refer to Appendix B, C, D for details).

Chapter 3. Installation

This chapter contains information for installation and configuration of *T/SDAS-SCOM2* module.

3.1   Installation

T/SDAS-SCOM2 module installs as SIOX daughter-card module onto *TORNADO* DSP system mainboard.

For installation of *T/SDAS-SCOM2* module 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/SDAS-SCOM2* module and slant it for about 30°..40° degrees refer to *TORNADO* mainboard. Insert JP2 external I/O connector of *T/SDAS-SCOM2* module into the corresponding hole of mounting bracket of *TORNADO* DSP system.
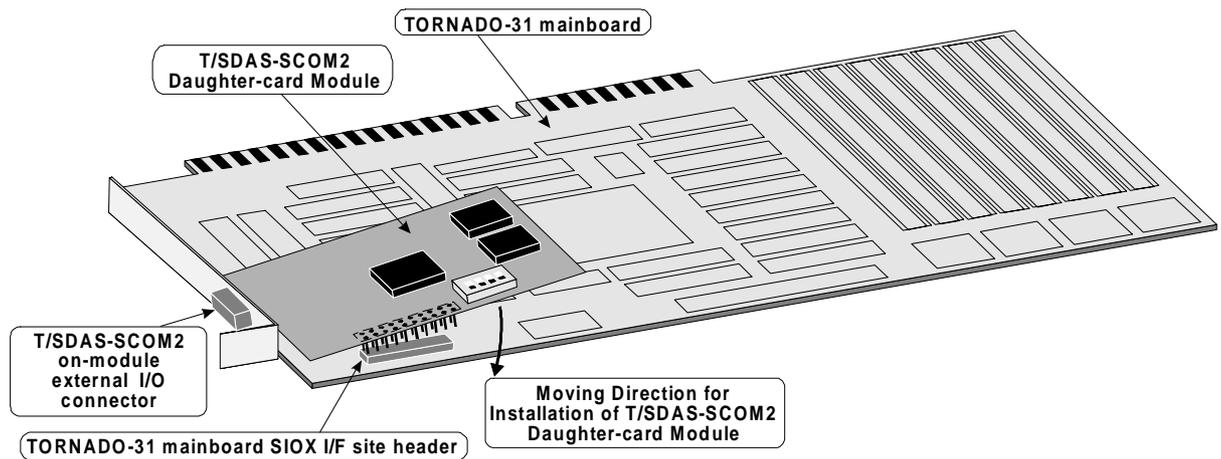

Fig. 3-1.   Installation of *T/SDAS-SCOM2* module into SIOX site of *TORNADO* DSP system.

4. Rotate *T/SDAS-SCOM2* module around mounting bracket and allocate pin #1 of JP1 connector of *T/SDAS-SCOM2* module 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/SDAS-SCOM2* module 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/SDAS-SCOM2* module and/or host *TORNADO* hardware.

5. Safely plug-in SIOX male header of *T/SDAS-SCOM2* module into SIOX female header of *TORNADO* DSP system.
6. Screw external analog I/O connector shell of *T/SDAS-SCOM2* module to the mounting bracket of *TORNADO* DSP system.
7. Configure on-board jumpers J1 and J2 for selection the gain factor of AUX-IN input amplifiers (see Appendix A).
8. Configure on-board jumpers J3 and J4 for selection the DC coupling and voltage offset for AUX-IN inputs (see Appendix A).
9. Configure on-board switch SW1 for selection of master clock source for on-board AIC (see Appendix A).
10. Install *TORNADO* board into PC slot and screw it to rear panel of PC.
11. Connect the plug to external analog I/O connector of *T/SDAS-SCOM2* module.
12. Switch on power of host PC.

3.2   Connection to external signal I/O equipment

Connection of *T/SDAS-SCOM2* module to external audio equipment is performed by means of on-board JP2 connector (fig.A-1) and a variety of standard audio cable sets and external telephone line/station interface options.

CAUTION

It is highly recommended to plug-in and unplug external I/O cable set or external telephone line/station interface options into/from on-board JP2 connector of *T/SDAS-SCOM2* module when host *TORNADO* power is switched off.

The ground signal of *T/SDAS-SCOM2* module has no halvanic isolation from host *TORNADO* and/or PC ground signal and chassis.

> **CAUTION**
>
> When connecting external audio equipment to *T/SDAS-SCOM2* module you should be aware that A-IN/AUX-IN analog inputs and A-OUT analog outputs of *T/SDAS-SCOM2* module are DC coupled (except for several configurations for AUX-IN inputs). If required, external DC isolation capacitors should be used.

connection to external stereo-audio equipment

T/SDAS-SCOM2 module allows direct connection to external stereo-audio equipment via *T/X-XCSMP* stereo-audio cable set, which plugs directly into on-board JP2 connector (fig.1-3).

Stereo-audio cable set for *T/SDAS-SCOM2* module uses ¼" standard miniature phone jacks for connection to external consumer audio equipment with single-ended I/O signals. This set comprises of 4 jacks:
- A-IN (audio line-in) input (left/right channels with common ground signal)
- AUX-IN (microphone) input (left/right channels with common ground signal)
- OUT (audio line-out) output (left/right channels with common ground signal)
- HPH (speaker/headphones) output (left/right channels with common ground signal)

connection to external dual-channel audio/speech equipment

T/SDAS-SCOM2 module allows direct connection to external dual-channel (dual monophonic) audio/speech equipment via *T/X-XCMP/2* dual-channel cable set, which plugs directly into on-board JP2 connector (fig.1-4).

Dual-channel cable set *T/SDAS-SCOM2* module uses ¼" standard miniature phone jacks for connection to external consumer audio/speech equipment with single-ended I/O signals. This set comprises of 8 jacks:
- A-IN-1 and A-IN-2 (audio line-in) inputs (mono-jack with ground signal)
- AUX-IN-1 and AUX-IN-2 (microphone) inputs (mono-jack with ground signal)
- OUT-1 and OUT-2 (audio line-out) outputs (mono-jack with ground signal)
- HPH-1 and HPH-2 (speaker/headphones) output (mono-jack with ground signal)

connection to microphones

T/SDAS-SCOM2 module provides optional on-board +5v DC offset voltage on AUX-IN inputs of channels #1 and #2 for direct connection to electret microphones. Please refer to your microphone operation guide in order to learn whether your microphone requires external DC offset voltage.

The on-board +5v DC offset voltage for AUX-IN inputs is enabled with the on-board J3 and J4 jumpers (refer to Appendix A).

connection to headphones

T/SDAS-SCOM2 module allows direct connection of 32 Ohm and 600 Ohm headphones and 8 Ohm speakers with max power output below 0.8W. The value of signal distortions for headphones is not specified and may be higher than that for standard A-OUT outputs.

converting dual-channel external I/O connector to two single-channel external I/O connectors

T/SDAS-SCOM2 module may convert on-board dual-channel JP2 external I/O connector to two single-channel external I/O connectors, which are compatible with that for *T/SDAS-SCOM1* module and which allow connection to external telephone line/station interface options and to single-channel audio/speech equipment.

This function is performed by means of *T/X-X2C* external dual-channel splitter for *T/SDAS-SCOM2* module (fig.1-5). *T/X-X2C* dual-channel splitter connects directly to JP2 external I/O connector of *T/SDAS-SCOM2* module and splits JP2 connector signals into two single-channel connectors, which are compatible with that for *T/SDAS-SCOM1* module and each comprising of analog and digital I/O signals for channels #1 and #2 correspondingly.

Once the *T/X-X2C* dual-channel splitter is connected to *T/SDAS-SCOM2* module, then any of *T/X-XCMP* single-channel analog signal I/O cable set, *T/X-XTLI* external telephone line interface option or *T/X-XTSI* external telephone station interface option can connect to any channel of *T/X-X2C* dual-channel splitter, thus delivering multiple dual-channel external signal I/O interface configurations in order to meet virtually any application requirements.

external telephone line/station interface options

T/SDAS-SCOM2 module allows connection of any or both of its channels to external *T/X-XTLI* telephone line interface (fig.1-7) or external *T/X-XTSI* telephone station interface (see fig.1-8 and Appendix D) options via *T/X-X2C* dual-channel splitter.

T/X-XTLI external telephone line interface option offers direct access to available PSTN (public switched telephone network) subscriber lines for conversion *TORNADO* DSP system or controller with installed *T/SDAS-SCOM2* module into automatic answering machine, fax device or modem with data transmission over telephone lines.

T/X-XTSI external telephone station interface option offers direct connection of telephone, fax machine or computer modem to *TORNADO* DSP system or controller with installed *T/SDAS-SCOM2* module in order to emulate standard PSTN subscriber lines.

Both *T/X-XTLI* and *T/X-XTSI* telephone line/station interface options connects to any channel of *T/X-X2C* dual-channel splitter and allows multiple external I/O configurations for *T/SDAS-SCOM2* module.

3.3   Software Configuration for SIO Port of Host *TORNADO* DSP

When programming the *TORNADO* DSP systems for communication with *T/SDAS-SCOM2* module it is recommended to follow the recommendations below:

- *SIO port transmitter* of *TORNADO* on-board DSP must be configured as the following:
    - *CLKX* signal must be configured as input, active high
    - *FSX* signal must be configured as input, active low, no advance setting feature
    - *DX* signal must be configured as active high
    - *data format* must be 16 bits per frame

- transmitter must be configured for STANDARD MODE and VARIABLE DATA RATE (TMS320C3x only)
- *SIO port receiver* of *TORNADO* on-board DSP must be configured as the following:
  - *CLKR* signal must be configured as input, active high
  - *FSR* signal must be configured as input, active low, no advance seting feature
  - *DR* signal must be configured as active high
  - *data format* must be 16 bits per frame
  - receiver must be configured for STANDARD MODE and VARIABLE DATA RATE (TMS320C3x only).

Appendix A.   On-board Connectors, Jumpers and Switches

This appendix contains a summary for the on-board connectors, configuration jumpers and configuration switches for *T/SDAS-SCOM2* module.

The on-board connectors, configuration jumpers and switches are presented at fig.A-1.
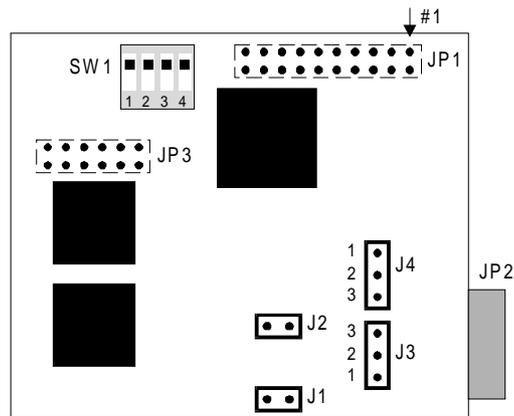
Fig. A-1.   On-board connectors, configuration jumpers and switches for *T/SDAS-SCOM2* module.

A.1   Configuration Jumpers

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

Table A-1.   Configuration jumpers for *T/SDAS-SCOM2* module.

Jumper	Description
J1	Gain factor for AUX-IN input amplifier of A/D section of channel #1:
	ON - gain +20 dB
	OFF - gain 0 dB
J2	Gain factor for AUX-IN input amplifier of A/D section of channel #2:
	ON - gain +20 dB
	OFF - gain 0 dB
J3	DC voltage offset and DC coupling feature for AUX-IN input of A/D section of channel #1:
	1-2 - DC coupled input, no DC voltage offset
	2-3 - DC decoupled input, DC voltage offset is on for electret microphone
	OFF - DC decoupled input, no DC voltage offset
J4	DC coupling feature and DC voltage offset for AUX-IN input of A/D section of channel #2:
	1-2 - DC coupled input, no DC voltage offset
	2-3 - DC decoupled input, DC voltage offset is on for electret microphone
	OFF - DC decoupled input, no DC voltage offset

Notes: 1. Highlighted configurations correspond to the factory setting.

A.2   Configuration Switches

Table A-2 specifies how to set on-board configuration switches.

Table A-2.   Configuration switches for *T/SDAS-SCOM2* module.

Switch button	Description
SW1-1/SW1-2	Master clock (*MCLK*) source selector for on-board TLC320AC01 AIC chips: *OFF/OFF* — host SIOX *TM-0* timer/IO is used as AIC master clock *ON/OFF* — host SIOX *TM-1* timer/IO is used as AIC master clock *OFF/ON* — on-board 9.216 MHz crystal oscillator is used as AIC master clock *ON/ON* — external *XMCLK* input from external I/O connector JP2 is used as AIC master clock
SW1-3/SW1-4	"Translation" (forwarding) control of AIC master clock *MCLK* to host SIOX *TM-0/TM-1* timer/IO signals in case AIC master clock *MCLK* is sourced either from on-board 9.216 MHz crystal oscillator or from external *XMCLK* input from external I/O connector JP2: *ON/OFF* *ON/ON* — "translation" of AIC master clock to host SIOX *TM-0/TM-1* timer/IO signals is disabled *OFF/OFF* — AIC master clock is "translated" to host SIOX *TM-0* timer/IO signal *OFF/ON* — AIC master clock is "translated" to host SIOX *TM-1* timer/IO signal

Notes: 1. Highlighted configurations correspond to the factory setting.

A.3   On-board Connectors

Table A-3 contain the list of on-board connectors.

Table A-3.   On-board connectors of *T/SDAS-SCOM2* module.

Connector	description
JP1	SIOX interface site male header.
JP2	External analog I/O connector.
JP3	Expansion channels connector, which is used for connection to external I/O channel expansion module.

Pinout of JP1 host SIOX connector is presented in the user's guide of host *TORNADO* DSP system or controller, which is used for installation of *T/SDAS-SCOM2* module.

Pinout of JP3 expansion channels connector is not presented since this connector should not be used for any customer designs and maintenance.

Pinout for external I/O connector

Pinout of JP2 external I/O connector for *T/SDAS-SCOM2* module is presented at fig.A-2, and description of signals is presented in table A-4.

The connector p/n for JP2 is DHA-RA26 female half-pitch connector from DDK Ltd manufacturer. P/n for compatible plug-in connector is DHA-PC26. In case customer needs to design his own application specific cable for connection to *T/SDAS-SCOM2* module, then compatible plug-in connectors for JP2 are available from MicroLAB Systems upon request.

```
+12v   26 ┌─┐ 25   XMCLK
DIN-0  24 │ │ 23   DOUT-0
DIN-1  22 │ │ 21   DOUT-1
DIN-2  20 │ │ 19   DOUT-2
DIN-3  18 │ │ 17   DOUT-3
 -5v   16 │ │ 15   GND
PH-2   14 │ │ 13   PH-1
AGND   12 │ │ 11   AGND
A-OUT-2 10 │ │  9   A-OUT-1
AGND    8 │ │  7   AGND
A-IN-2  6 │ │  5   A-IN-1
A-GND   4 │ │  3   AGND
AUX-IN-2 2 └─┘  1   AUX-IN-1
```
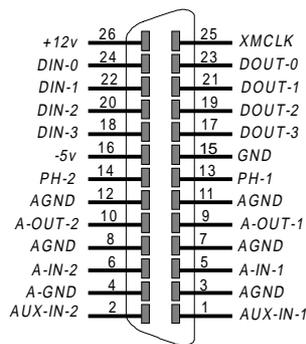
Fig. A-2.   Pinout for JP2 external I/O connector of *T/SDAS-SCOM2* module.

Table A-4.   Signal description for JP2 external I/O connector of *T/SDAS-SCOM2* module.

Signal name	type	description
A-IN-1 A-IN-2	AI	DC coupled A-IN inputs (audio line-level compatible) for A/D sections of channels #1 and #2.
AUX-IN-1 AUX-IN-2	AI	AUX-IN inputs (audio line-level and MIC-level compatible) for A/D sections of channels #1 and #2. Can be configured as either DC coupled or DC decoupled with optional DC voltage offset for connection to electret microphones.
A-OUT-1 A-OUT-2	AO	DC coupled main A-OUT outputs (audio line-level compatible) from D/A sections of channels #1 and #2.
PH-1 PH-2	AO	Outputs for connection to external speakers or headphones from D/A sections of channels #1 and #2.
XMCLK	TTL/IN	External master clock input for TLC320AC01 AIC chips.
DIN-0..DIN-3	TTL/IN	External digital inputs. Used for control of external telephone line/station interface options or as general purpose digital inputs.
DOUT-0..DOUT-3	TTL/OUT	External digital outputs. Used for control of external telephone line/station interface options or as general purpose digital outputs.

GND	-	Ground.
+12v *-5v*	-	Power supply outputs from *TORNADO* mainboard for external telephone line/station interface options or other connected general purpose analog/digital front-end devices.

Notes: 1. Signal types: *AI* - analog input; *AO* - analog output; *TTL/IN* - TTL compatible digital input; *TTL/OUT* - TTL compatible digital output.

Appendix B.   *T/X-X2C* External Dual-channel Splitter

This appendix contains information about *T/X-X2C* dual-channel splitter for *T/SDAS-SCOM2* module. Note, that *T/X-X2C* dual-channel splitter can be also used with *T/SDAS-ATEL2* stereo-audio/fax/modem module.

B.1   General Description

T/X-X2C external dual-channel splitter (fig.B-1) converts on-board dual-channel JP2 external I/O connector of *T/SDAS-SCOM2* module into two single-channel external I/O connectors, which are compatible with that for *T/SDAS-SCOM1* module and which allow connection to external telephone line/station interface options and to single-channel audio/speech equipment.
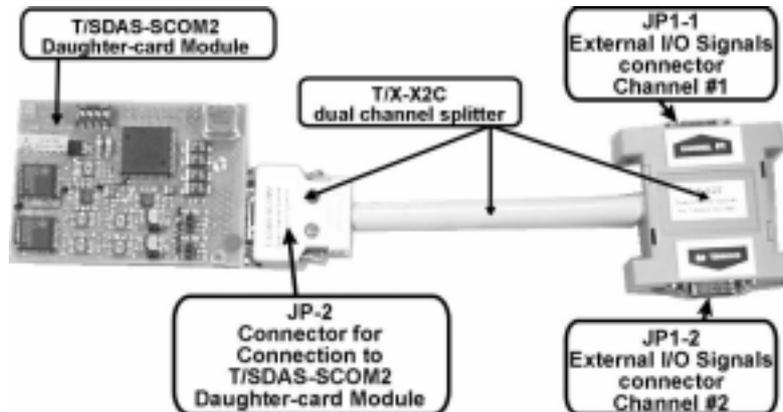

Fig. B-1.   T/SDAS-SCOM2 module with *T/X-X2C* dual-channel splitter.

T/X-X2C dual-channel splitter plugs directly into JP2 external I/O connector of *T/SDAS-SCOM2* module and splits JP2 connector signals into two single-channel connectors, each comprising of analog and digital I/O signals for channels #1 and #2 correspondingly.

Once the *T/X-X2C* dual-channel splitter is connected either to *T/SDAS-SCOM2* module, then any of *T/X-XCMP* single-channel analog signal I/O cable set, *T/X-XTLI* external telephone line interface option or *T/X-XTSI* external telephone station interface option can connect to any channel of *T/X-X2C* dual-channel splitter, thus delivering multiple dual-channel external signal I/O interface configurations in order to meet virtually any application requirements.

B.2   Connection Diagram and Connectors Pinout

Connection diagram for *T/X-X2C* dual-channel splitter and connectors pinout is presented at fig. B-2.

The 26-pin JP2 connector of *T/X-X2C* dual-channel splitter plugs into JP2 external I/O connector of *T/SDAS-SCOM2* module, whereas 20-pin JP1-1 and JP1-2 connectors are available for connection to external single-channel audio/speech equipment and/or external telephone line/station interface options.

JP1-1 and JP1-2 connectors for output channels #1 and #2 of *T/X-X2C* dual-channel splitter comprise of analog and digital I/O signals for channels #1 and #2 of *T/SDAS-SCOM2* module correspondingly.

JP1-1 and JP1-2 connectors of *T/X-X2C* dual-channel splitter are 20-pin female half-pitch connector from DDK Ltd manufacturer, which have the p/n DHA-RA20. P/n for compatible plug-in connector is DHA-PC20. In case customer needs to design his own application specific cable for connection either to *T/SDAS-SCOM2* module or *T/X-X2C* dual-channel splitter then compatible plug-in connectors for JP1-1/JP1-2 connectors of *T/X-X2C* dual-channel splitter are available from MicroLAB Systems upon request.
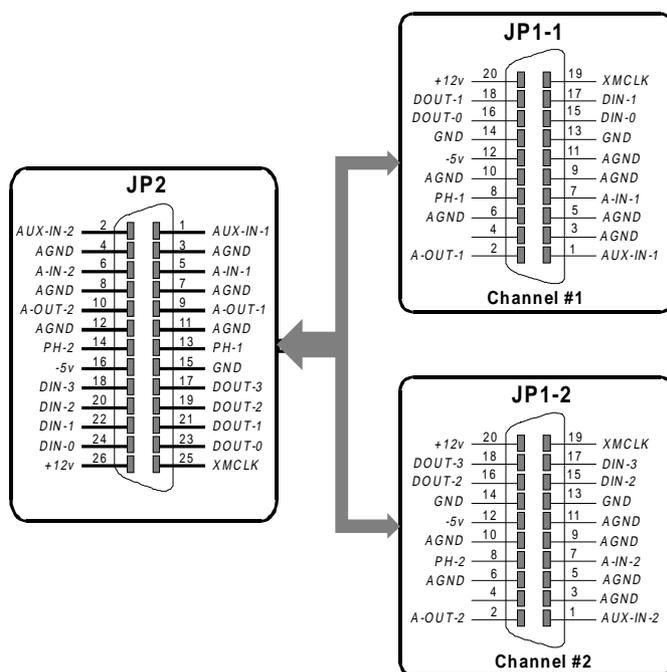

Fig. B-2. Connection diagram and connectors pinout for *T/X-X2C* dual-channel splitter.