BenchSystem™ Signal Interface, Bsi1

Tools for Scientists and Engineers

Overview

Example Applications:

- Control and monitor Sensors and Transducers for characterization and research.
- Simulate microcontroller I/O during Analog circuit development.
- Build a control panel using keypads, display modules, lamps, etc.

Signal Capabilities:

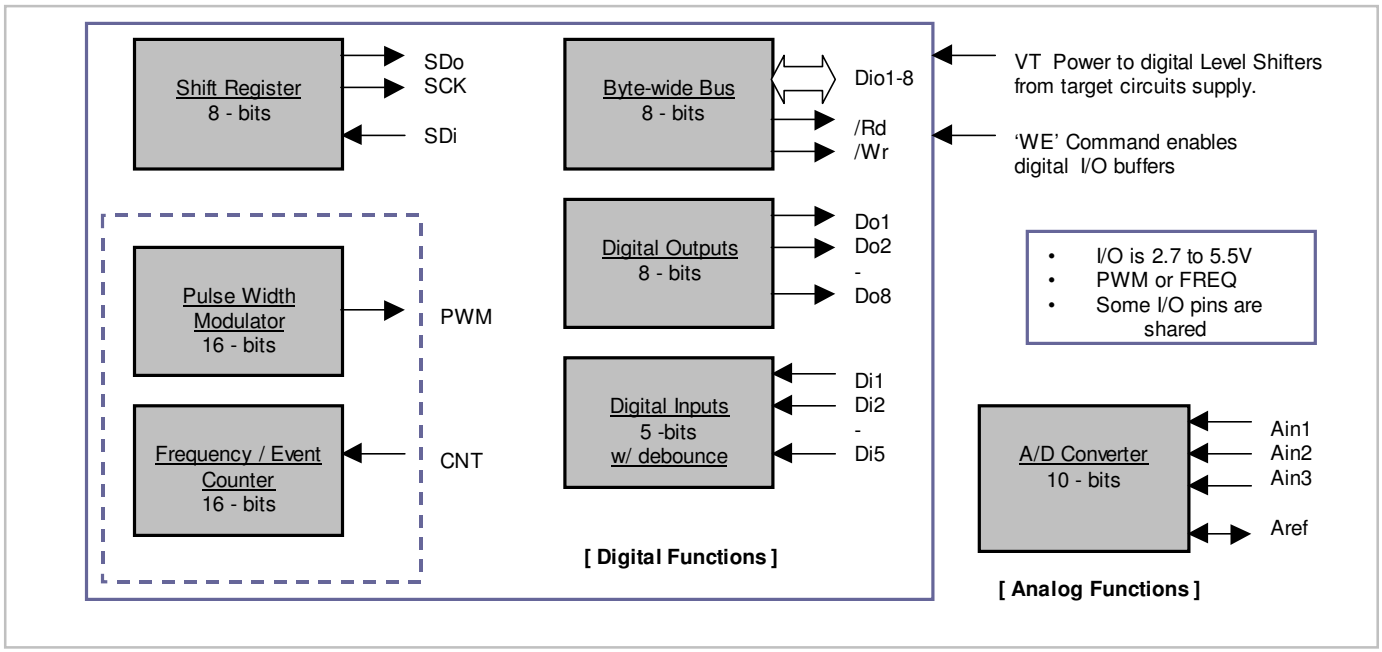
- Digital Signal Levels:
  - 2.7V - 5.5V.
- 1 Byte-wide I/O:
  - latched or with RD/WR strobes like a microprocessor data port.
- 8 Digital Outputs:
  - one optional 16 bit PWM*
  - one optional Serial Shift Register
- 5 Digital Inputs:
  - one optional Frequency / Event Counter.*
  - one optional Serial Shift Register
  - read as levels or debounced key inputs
- 3 Analog Inputs:
  - 10 bit result, 0-5V input range
  - 3 single ended or 1 DE and one SE.
  - Internal or External voltage references.

- All signals are on one pluggable connector for quick disconnects.

*Note: The counter and PWM share common hardware and can not run at the same time.

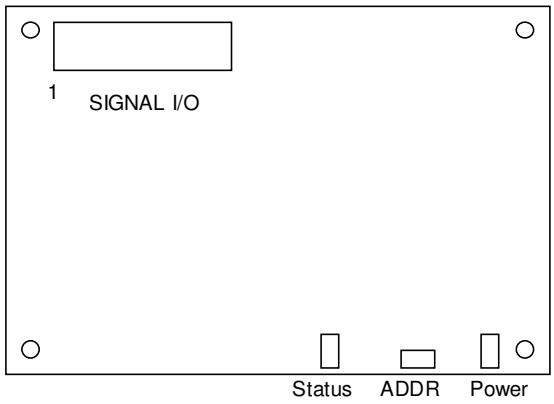
The BenchSystem Signal IO module provides an interface to various analog and/or digital devices. The unit receives commands and power from the Local Interface Bus (LIB). It is controlled by a simple set of single-letter commands.

For a discussion of the BenchSystem and the LIB bus, see the BenchSystem Controller datasheet.



Hardware Description

This section explains the operation and capabilities of the Bsi I/O card.



Connector Layout and Pin One Locataions

(To mount, wire, and program a BenchSystem see the "Bsys Getting Started.pdf" file.)

Buttons and Indicators

Power Lamp ON while 12Vdc power is applied at the LIB connector.

Status Lamp ON momentarily during the power-up memory test.
ON momentarily when a command is accepted.
ON while the ADDR button is being held in.

Addr Button Press and hold to force the card to accept any command, regardless of address, while it is being held. *This button must be held in to change the card address.* See bsys getting started.pdf.

Power-on Reset

Applying 12Vdc power at the LIB connector causes the following events:

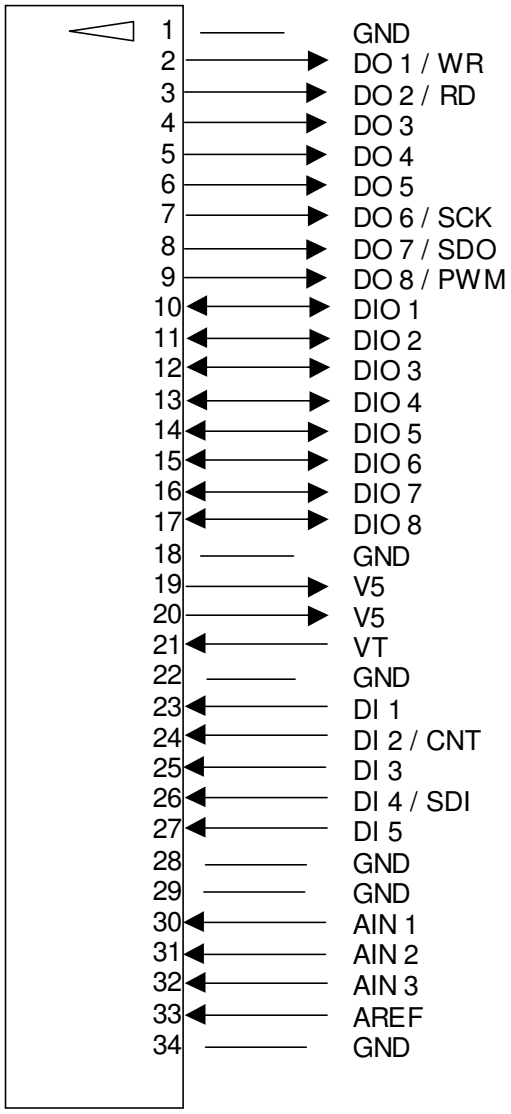
- The on-board microprocessor memory is tested
- I/O signals are initialized.
- The LIB communication port is initialized.

I/O Signals

This section explains the functions and signals of the Bsi card. Some pins have alternate function capability. All digital pins run at the target power supply level.

- All digital signals are isolated from the target until the byte-wide I/O is configured.
- An alternate function must be turned OFF in order to use the shared pin(s) for general-purpose IO.
- The digital I/O pins run between GND and VT, the target circuitry power supply.

In the following definitions: **(in)** refers to a BSI input signal, **(out)** to a BSI output and **(i/o)** can be either.



SIGNAL I/O CONNECTOR (J2)

Target Power

The target should be powered up after the Bsi card has power (12Vdc on the LIB connector).

The target circuits may derive power from the V5 pin if drawing less than 200mA, or may use an external supply between 2.7 and 5.5 Volts dc.

VT (in) Must always attach to the target power to power the target side of the digital level shifters.
V5 (out) +5 Volt power available for target hardware (<1Watt).

Byte-wide I/O

The data bus operates in either Static or Strobed modes**.** Use the **WE** command to configure the bus for either static or strobed operation. Once the bus has been configured, use the **W** command to Write data out, and **R** to Read data in.

Static Mode: Data written to the bus remains on the bus. Reading data leaves the bus in high impedance. The RD and WR strobe signals are not affected, and may be used for general purpose digital outputs.

Strobed Mode: Strobed mode behaves like a microprocessor data bus; the bus is only active during the WR and RD strobes. The target hardware latches data from the bus when it receives the WR strobe, and drives data onto the bus while it receives the RD strobe. Data must be stable by the trailing edge of the strobes.

DIO 1-8 (i/o) **W20** sets DIO 3,5 to VT volts.
WR, RD (out) Strobe signals, pulsed active low (0 volts) during **W** and **R** commands, when in strobed mode.

Digital Outputs

Digital outputs are treated as individual signals, 1-8, which can be set or cleared.

DO 1-8 (out) Use the **S** and **C** commands to Set (VT volts) and Clear (0 volts) individual signals.

Digital Inputs

Use for reading logic levels or debouncing push buttons. Digital inputs are treated as individual signals 1-5.

Use the **B** command to read back the real-time binary state; '1' (VT volts), '0' (0 volts).

Use the **K** command to read back the debounced, falling edge detected, state; reading '1' if a falling edge has occurred, '0' if not. Reading a '1' on a signal, clears the state to '0' until the next edge occurs.

DI 1-5 (in)

Serial Shift Register

The serial shift register provides a way to shift bytes to and from the target hardware. Use **TE** to configure the phase of the data and level of the clock. The data rate is 16 microseconds / bit.

SCK (out), SDO (out), SDI (in) Use the **T** command to simultaneously shift a byte out of SDO and read a byte in from SDI, during 8 SCK cycles.

Pulse Width Modulator

The PWM provides a 16 bit resolution periodic waveform. Use **PE** to set the time base (tick) from 125 nanoseconds to 256 microseconds. The **P** command sets the number of Period ticks, and the **H** command sets the number of High (VT volts) ticks.

The PWM operates in two different modes: Phase and Frequency Correct PFC and FAST. The PFC method is preferred for motor control. PFC uses dual slope counting that keeps the 'High time' centered within the period, even during changes to H and P. The FAST method uses single slope counting and is best for power and DAC generation. Both methods incorporate any H or P changes at the end of the period for smooth transitions.

PWM (out)

Note: The Frequency Counter and PWM share hardware and cannot run concurrently..

Frequency Counter

The frequency counter has selectable sampling windows, including continuous. Use **NE** to configure a window, and **N** to read back the 16 bit count value.

CNT (in)	An **NE** command will kill the PWM, as these functions share the same timer hardware.

Note: The Frequency Counter and PWM share hardware and cannot run concurrently..

Analog Inputs

The analog inputs can be read as 3 single ended channels, or 1 differential and 1 single ended channel. The differential channel has gains of 1x, 10x or 200x. The reference can be 'on board' at 2.56V or +5V, or from the target hardware at 2- 4.5 Volts. Use the **VE** command to select the voltage reference. Offsets in the differential amplifier are calibrated out automatically. Single ended inputs have much lower input impedance than differential inputs (see electrical specs).

AIN1-3	All 3 single ended with 1x gain, or 2-3 are differential at 1x, 10x or 200x gains.
AREF	External reference 2-4.5Vdc. This pin must float if using one of the internal references.

Bsi Command Set

This section defines the commands used to control a Bsi card over the Local Interface Bus. A command line can have one or more commands; up to 126 characters per line. Commands execute from left to right and spaces are optional. Command definitions use the following arguments:

d an 8 bit Data value from 0-255.
b a Bit position of 1-8.
t a list of bit numbers 1-8. For example: "1-4,8,7" is channels 1,2,3,4, 8,and 7. The list executes from left to right.
n an integer number between 65535 and –65536.
x text characters, including numbers and punctuation.

Function level commands

These commands are used to control the IO systems on the Bsi.

Byte-wide I/O

W d Write a byte to the Data Bus.
R Read a byte from the Data Bus. Returns an integer from 0-255.
WE n Configure the Data Bus mode. WE0 = Static, WE1 = Strobed

Digital Outputs

C t Clear signal(s) of the Digital Output Port to 0 volts.
S t Set signal(s) of the Digital Output Port to VT volts.

Digital Inputs

B b Read signal b of the Digital Input Port. Return a '0' if the signal is at 0 volts, '1' if it's at VT volts.
K b Read the 'key state' of signal b of the Digital Input Port. Return a '1' if a VT-to-0 volt transition has occurred since the last 'K' query of the same signal.

Pulse Width Modulator

P n Set the number of ticks that defines the waveform Period, n = 3 to 65535. (1).
H n Set the number of ticks that the pulse is High (VT volts) within the period, n = 0 to 65535. (1).
PE n Configure the time base and generation mode for the PWM.

PEn	Time base Clock 'tick'	Waveform Generation Method
0	OFF (default)	OFF
1	250 nanoseconds	PFC Phase Frequency Correct
2	2 microseconds	PFC
3	16 microseconds	PFC
4	64 microseconds	PFC
5	256 microseconds	PFC
6	125 nanoseconds	FAST
7	1 microseconds	FAST
8	8 microseconds	FAST
9	32 microseconds	FAST
10	128 microseconds	FAST

note 1. In FAST mode the actual output is (n + 1) ticks.

Serial Shift Register

T d Shift data byte 'd' to the target hardware. Return the data byte that was shifted in concurrently.

TE n Configure the shift register clock and phase. Select data direction as shifting either MSB or LSB first.

'n'	Data Direction	Clock Idle Level	Data Sampled on Clock Edge	Data Setup on Clock Edge
0	OFF (default)			
1	MSB first	0 volts	Leading	Trailing
2	MSB first	0 volts	Trailing	Leading
3	MSB first	VT volts	Leading	Trailing
4	MSB first	VT volts	Trailing	Leading
5	LSB first	0 volts	Leading	Trailing
6	LSB first	0 volts	Trailing	Leading
7	LSB first	VT volts	Leading	Trailing
8	LSB first	VT volts	Trailing	Leading

Frequency / Event Counter

N Return the latest number of counts. Counting can be gated for a specified time period. The 16-bit counter can rollover if the sample period is longer than 65535 cycles.

NE n Configure the sample period and reset the counter.

n	Sample Period	Max Frequency
0	OFF (default)	
1	10 milliseconds	3.200 MHz
2	100 milliseconds	655.35 KHz
3	1 second	65.535 KHz
4	Continuous	Watch for rollover

Analog Inputs

V n Return the measured AD converter counts of input configuration n.

n	Input high	Input low	Gain	(Vin High – Vin Low) =
1	AIN 1	Ground	1	VREF *(counts / 1024)
2	AIN 2	Ground	1	VREF *(counts / 1024)
3	AIN 3	Ground	1	VREF *(counts / 1024)
4	AIN 1	Ain 2	1	VREF *(counts / 512)
5	AIN 2	Ain 1	10	VREF *(counts / 5120)
6	AIN 2	Ain 1	200	VREF *(counts / 102400)

VE n Select the Voltage Reference.

n	Source of Reference	Voltage
0 (default)	Internal (*)	= V5 Signal Pin
1	Internal (*)	= 2.56 Volts
2	AREF Signal Pin	2.0 to 4.5 Volts

Note: (*) An Internal reference will be affected by any loading on the AREF signal pin.

System level commands

These commands are used for overall system configuration.

idxxx Set a **unit id** of xxx where xxx is up to 14 characters of text (including spaces), terminated by the end of the command line. The ID is stored in non-volatile memory.

a n Set the **unit address** to a value 1-31, keeping it unique in your system. The Address is stored in non-volatile memory onboard the BSI.

? Read back the **unit Status**. An example status string is: 80,06,Bsi1a,Unit_Id, where:

- 80 is the card Error status in hexadecimal format b8-b1 where:
  - b8 = Power UP has occurred
  - b7 = A non-volatile memory error has occurred. The address and unit ID must be redefined.
  - b6 = 0.
  - b5 = Response message Oflo (>100 characters).
  - b4 = Received message Oflo (>100 characters).
  - b3 = LIB communication errors. Check termination rules.
  - b2 = Unrecognized Command.
  - b1 = Illegal Command Argument.
- 06 is the Unit Address.
- Bsi1a is the Unit Revision as set by the factory.
- Unit_Id is any user programmable text string.

Programming Examples

There are 2 ways to communicate with the Local Interface Bus I/O cards from a BTC1 controller card:

1. Type a **putlib** command directly from the Console terminal when an BSOP program is not running.
2. From an BSOP program, using a **lib** command.

Console example

Console commands are interactive and work only when typed directly at the console terminal.

Type and Enter:	**putlib 2,V1**	to read the voltage level at AIN1

BSOP Program example

Program commands work only from within a program file that has been "uploaded" to the controller and "run".

Code Sample

```
/ Set a DIO pattern and read a DI bit back.  Illustrates optional in-line: the output of lib becomes the argument of console.

int     x;                          / save results of port read-back.

start:
        lib 2  "WE0" ;              / Enable the entire digital interface and configure the port as latched.

        lib 2  "W3" ;               / set DIO Bits 1 and 2 to the VT level.
        x = lib 2 "B4";             / read the DI bit 4 and save the result as an integer.
        console x;                  / send the result to the console terminal.

        console lib 2  "W3B4" ;     / same as above, but coded in-line for efficiency and clarity. Doesn't need x.
```

Specifications

Electrical

Parameter	Conditions	VT	Min	Typical	Max	Units
+12V	I target=0.2A 0-40deg C		8.5	12	17.5	V (1)
V5	0 <= target load <= 200 mA	---	4.8		5.2	V
VT	target power supply		2.7		5.5	V
VOL (for DIO, DO)	IOL = 24 mA (sinking)	2.7 4.5		0.22 0.18	0.5 0.44	V
VOH (for DIO, DO)	IOL = -24 mA (sourcing)	2.7 4.5	2.1 3.76	2.3 4.25		V
VIL (for DIO, DI)		2.7 - 3.6 5.5	0.8 1.65			V
VIH (for DIO, DI)		2.7 - 3.6 5.5	2 3.85			V
VREF (external)	Use 'VE 2' command	---	2.0		4.5	V
VREF (2.5V internal)	AREF pin floating	---	2.3	2.56	2.7	V (2)
VREF Zin				32 K		ohms
VIN 1,2,3	Single Ended	---	GND		VREF	V
VIN 1-2	Differential g = gain	---	-VREF /g		VREF/g	V
AIN Zin		---		100 M		ohms

Notes: 1. Derate max from 40-70 degC: 17.5V – 140mV/degC
2. Temperature Coefficient is 60ppm / degC

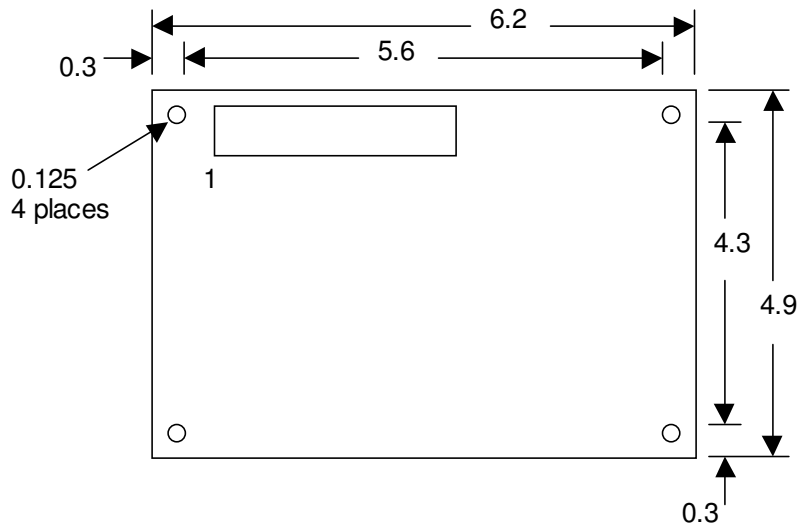
Timing

Parameter	Min	Typical	Max	Units
Key debounce time ('K' command)		20		mS
Shift register data rate ('T' command)		16		uS / bit
PWM FAST mode period ('P' command)	0.00025		8388	mS
PWM PFC mode period	0.0005		16777	mS
Data valid to strobe trailing edge ('R' and 'W' commands)	^^5			uS
Individual command execution time.		^^500		uS

Environmental

Operating Temperature: 0 to 70 degrees C.
Storage Temperature: -20 to 85 degrees C.^^

Mechanical



Revisions

Preliminary:	6/18/03.
Beta:	11/12/03
Beta2	12/26/03

Troubleshooting

Power led is not ON.

The 12Vdc is not present at the LIB connector, it is reversed, or the fuse on the card is blown. Measure 11Vdc on both sides of the fuse, F1. Verify that the LIB bus RJ11 plugs are wired one-to-one.

Status led remains ON.

"He's dead, Jim". Contact the factory.

The status led does not blink when a command is sent. It could be:

1. CommA and CommB wiring on the LIB bus is reversed. Verify that the phone connectors are wired one-to-one.
2. The address is incorrect. Enter "putlib 31,?" from the console while holding in the address button, to see the actual address. This will always return a status unless there is a card on the bus with an address of 31.

There's no digital output voltage and the digital inputs read incorrectly.

1. The WE command needs to run initially to enable all digital signals.
2. The VT connector signal needs to be connected to the target circuit Vcc.

Known Issues

Board Revision History

7/27/3 Beta for board and spec sheet.

Future Changes

ExacTest Corporation may make changes to or discontinue the availability of its products and literature at any time.