DATA SHEET

SV4E-I3C

I3C Test and Debug Module

E SERIES

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EN-D016E-E-20160

INTROSPECT.CA

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Introduction

OVERVIEW

The SV4E-I3C is an all-inclusive solution for I3C-based device interface development, test, and programming. Containing three instruments in one, this tool can act as a protocol exerciser for testing and debugging I3C slave or master devices. It can also act as a complete protocol analyzer with fine-resolution timing analysis and a full suite of conformance test capability. Finally, it contains a deep vector memory, which allows it to be used as a general purpose I3C device programmer. All three categories of instrumentation features are accessible simultaneously and in real-time using the award winning Introspect ESP Software.

KEY FEATURES

- **Device roles:** able to configure multiple devices with different roles (main master, secondary master, slave) concurrently
- **Device instances:** integrates 4 parallel devices, each with its own independent protocol stack
- **Timing resolution:** 5 ns resolution on delay generation (exerciser) and time-stamp (analyzer) logic
- **Protocol analysis:** easily trigger on CCC's and patterns for private and device to device communication, IBI, and hot-join

KEY BENEFITS

- **Complete characterization:** simultaneous protocol exercising and analysis enables complete characterization, debug and test of individual sensor/controller devices or entire multi-device systems
- **Flexible:** solution featuring I3C and I3C Basic protocol support with real-time voltage and timing controls
- **Automated:** scripting capability ideal for debug tasks, verification and full-fledged production screening of devices and system boards

BLOCK DIAGRAM

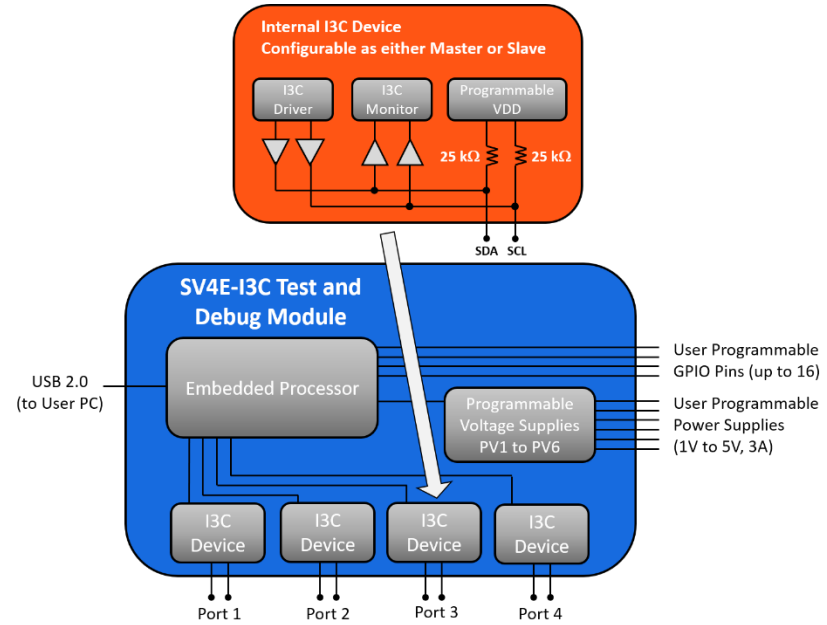


Figure 1: Block diagram of the SV4E-I3C module (blue) and detail of one of four internal I3C devices (orange).

TYPICAL APPLICATION

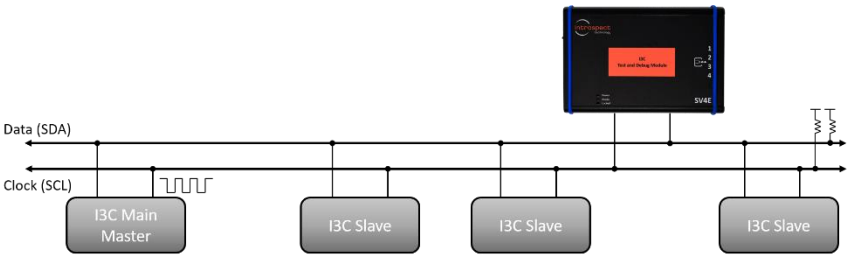
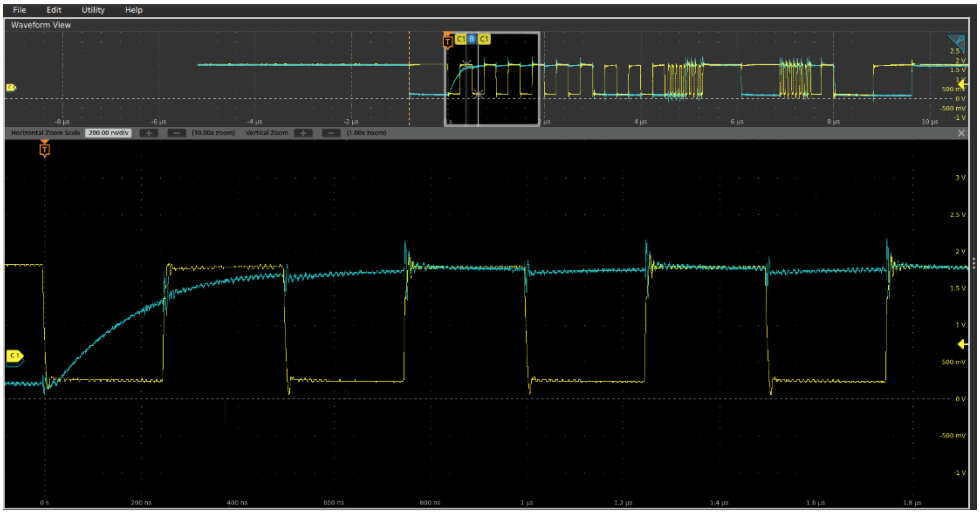
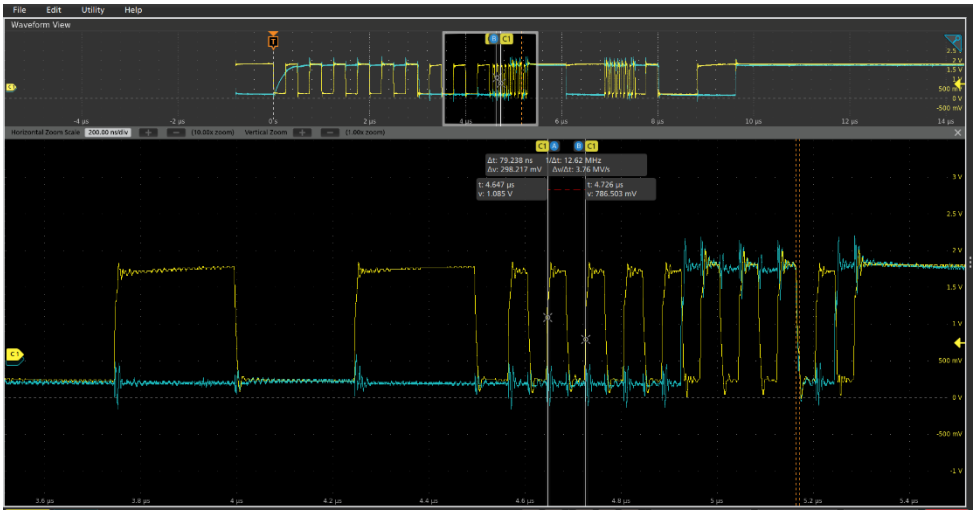


Figure 2: Typical application for an SV4E-I3C Test and Debug Module on an I3C bus.

TYPICAL WAVEFORMS



(a)



(b)

Figure 3: Typical waveform of SV4E-I3C master driving a DUT (a) Open Drain Frequency = 2 MHz (b) Push-Pull Frequency = 12.5 MHz.

Physical Connections

The physical connections on the SV4E-I3C module are as labelled below in Figure 4. The SV4E-I3C has a USB port that allows the SV4E to communicate directly with a PC through a USB mini cable connection on the left side of the module. Power is provided to the SV4E-I3C module with a 12 V DC supply through a barrel connector on the left side of the module. The recommended DC power supply, included with the SV4E-I3C module, is produced by CUI Incorporated, Part # ETSA120500U.

Figure 4: Physical Connections to the SV4E-I3C module.

The SV4E-I3C ships with an I3C interface adapter board as shown in Figure 5. This adapter board connects to the QTH connector on the right side of the module and provides a 0.1" header for access to I3C SCL and SDA signals. The full pinout of the QTH connector is provided in the following section.

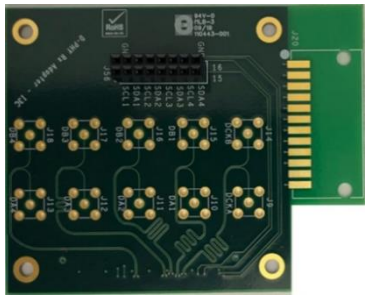


Figure 5: The SV4E-I3C interface adapter board which connects to the QTH connector on the SV4E-I3C

QTH / QSH CONNECTOR

The SV4E-I3C module has an 80 pin, high speed connector containing all connections for I3C SCL and SDA lines, programmable power supplies PV1 to PV6 and all user defined GPIOs. The connector has part number Samtec QTH-040-01-L-D-DP-A.

https://www.samtec.com/products/qth-dp

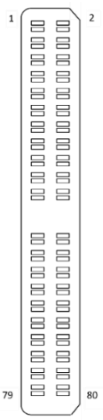
This part is designed to mate to a high speed connector on the provided interface adapter board (or customer adapter board) using the following part number: Samtec QSH-040-01-L-D-DP-A

https://www.samtec.com/products/qsh-dp

QSH I3C SIGNAL CONNECTIONS

The pinout for the I3C signals on the QSH connector is given in Table 1.

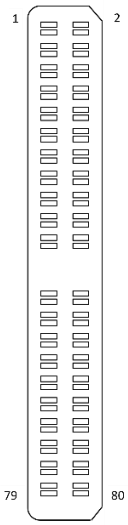
TABLE 1: SV4E I3C SIGNAL PINS

FOOTPRINT	PINS	SIGNAL NAME	DESCRIPTION
QSH-040-01-L-D-DP-A (QSH top view, placed on bottom side of adapter board) 	1	SCL1	Port 1 SCL
	13	SDA1	Port 1 SDA
	49	SCL2	Port 2 SCL
	61	SDA2	Port 2 SDA
	5	SCL3	Port 3 SCL
	17	SDA3	Port 3 SDA
	53	SCL4	Port 4 SCL
	65	SDA4	Port 4 SDA

QSH GPIO CONNECTIONS

The pinout for the general purpose I/Os (GPIOs) on the QSH connector is given in Table 2. Customers should consult with Introspect Technology if they intend to use these GPIO pins. All pins below operate with 2.5 V LVCMOS logic levels.

TABLE 2: SV4E GPIO PINS

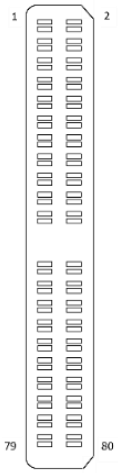
FOOTPRINT	PINS	NAME	I/O	DESCRIPTION
QSH-040-01-L-D-DP-A (QSH top view, placed on bottom side of adapter board) 	2	GPIO_0	I/O	User configurable, input or output
	4	GPIO_1	I/O	User configurable, input or output
	6	GPIO_2	I/O	User configurable, input or output
	8	GPIO_3	I/O	User configurable, input or output
	10	GPIO_4	I/O	User configurable, input or output
	12	GPIO_5	I/O	User configurable, input or output
	14	GPIO_6	I/O	User configurable, input or output
	16	GPIO_7	I/O	User configurable, input or output
	18	GPIO_8	I/O	User configurable, input or output
	20	GPIO_9	I/O	User configurable, input or output
	22	GPIO_10	I/O	User configurable, input or output
	24	GPIO_11	I/O	User configurable, input or output
	26	GPIO_12	I/O	User configurable, input or output
	28	GPIO_13	I/O	User configurable, input or output
	30	GPIO_14	I/O	User configurable, input or output
	32	GPIO_15	I/O	User configurable, input or output

QSH PROGRAMMABLE POWER SUPPLIES

The QSH connector provides access to six programmable power supplies which may be used on a customer adapter board to power the DUT. The programmable range of these supplies is between 1.0V to 5.0V, in steps of 1 mV, with a maximum supply current of 3.0 A for each supply.

The pinout for these supplies is specified in Table 3. If used, please ensure that appropriate decoupling is applied for these supplies. Please see Introspect reference designs for decoupling examples.

TABLE 3: SV4E PROGRAMMABLE POWER SUPPLIES

FOOTPRINT	PINS	NAME	DESCRIPTION
QSH-040-01-L-D-DP-A (QSH top view, placed on bottom side of adapter board) 	34	PV1_OUT	Programmable Power Supply # 1 Output Pin
	36	PV1_OUT	Programmable Power Supply # 1 Output Pin
	38	PV2_OUT	Programmable Power Supply # 2 Output Pin
	40	PV2_OUT	Programmable Power Supply # 2 Output Pin
	42	PV3_OUT	Programmable Power Supply # 3 Output Pin
	44	PV3_OUT	Programmable Power Supply # 3 Output Pin
	45	PV4_OUT	Programmable Power Supply # 4 Output Pin
	47	PV4_OUT	Programmable Power Supply # 4 Output Pin
	73	PV5_OUT	Programmable Power Supply # 5 Output Pin
	75	PV5_OUT	Programmable Power Supply # 5 Output Pin
	77	PV6_OUT	Programmable Power Supply # 6 Output Pin
	79	PV6_OUT	Programmable Power Supply # 6 Output Pin

ADDITIONAL DOCUMENTATION

SV4E-I3C Quick Start Manual

- EN-G035E-E-20100 - SV4E-I3C Quick Start Manual

SV4E-I3C Adapter Board Design Files.zip

- Includes reference schematic, layout and CAD files for an example device interface board. Please contact Introspect Technology.

ORDERING INFORMATION

TABLE 4: ITEM NUMBERS FOR THE SV4E-I3C

PART NUMBER	NAME	KEY DIFFERENTIATORS
6604	SV4E-I3C Test and Debug Module	Characterization, debug and test of I3C devices. Includes PC software license (perpetual) and interface adapter board.
5410	I3C Slave Device CTS Application	

Specifications

TABLE 5: GENERAL SPECIFICATIONS

PARAMETER	VALUE	UNITS	DESCRIPTION AND CONDITIONS
Protocol			
Physical Layer Interface	MIPI I3C		MIPI I3C version 1.0 and 1.1 MIPI I3C Basic
I3C Master Device Support	Yes		
I3C Slave Device Support	Yes		
Ports			
Number of I3C device instances	4		Each fully configurable as master, secondary master or slave.
Number of GPIO pins	16		
Programmable On-Board Power Supplies	6		
Connections to PC for Introspect ESP Software Control	1		USB 2.0
Physical Line Characteristics			
Internal SCL and SDA pull-up resistance value	25	kOhm	For compliant open-drain operation at 400 kHz, an external pull-up resistor must also be placed on the bus within the customer application
Pin Capacitance	2.5	pF	Typical
Memory			
On-board memory	1	GByte	
Power Consumption			
DC Input Voltage	12	V	DC Input Voltage
Maximum Current Draw	TBD	A	Maximum Current Draw

TABLE 6: I3C MODES AND OPERATIONS

PARAMETER	VALUE	UNITS	DESCRIPTION AND CONDITIONS
Additional supported features			
Operations	CCC Direct RW Private RW Hot-Join IBI		
Signaling Modes	SDR HDR-DDR		
Mixed Bus Mode Support	Yes		
50 ns Spike Filter	Yes		Automatic for mixed bus mode
Error Injection	Yes		ACK/NACK behavior Missing T bit Setup time and hold time violations
Protocol Analysis	Yes		
Offline Capability / Tri-State Mode	Yes		Tri-state mode for SCL/SDA pins

TABLE 7: I3C BUS SPECIFICATIONS

PARAMETER	VALUE	UNITS	DESCRIPTION AND CONDITIONS
Programmed operating voltage			
Minimum Programmed VDD voltage	1200	mV	VDD sets SCL and SDA high voltage
Maximum Programmed VDD voltage	2020	mV	VDD sets SCL and SDA high voltage Extendable to 5.0 V
VDD resolution	1	mV	
Operating Frequencies			
Minimum Open Drain Frequency	0.25	MHz	
Maximum Open Drain Frequency	5.0	MHz	
Maximum Push-Pull Frequency	0.25	MHz	
Maximum Push-Pull Frequency	12.9	MHz	
Minimum Legacy I2C Frequency	0.002	MHz	Interoperates with legacy I2C devices
Minimum Legacy I2C Frequency	1	MHz	Interoperates with legacy I2C devices
SCL / SDA Timing			
SDA Setup Time Range	1.0	UI	Specification for timing from SCL falling edge to the following SDA edge. See Figure 6 on following page
Independent SDA Setup Timing	Yes		SDA setup set independently for I3C Open Drain, I3C Push Pull, and I2C operation
Skew Injection Resolution	5	ns	Per SCL or SDA wire
Duty Cycle Timing Resolution	5	ns	
Analyzer Timing Resolution	5	ns	

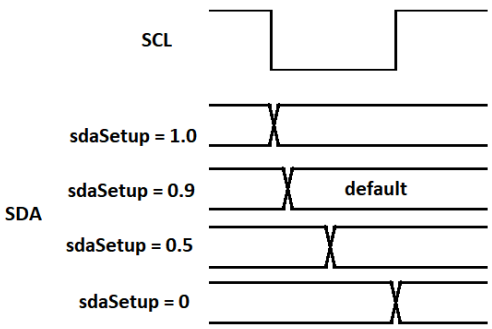


Figure 6: Timing diagram for SDA setup time.

TABLE 8: PROGRAMMABLE POWER SUPPLY SPECIFICATION

PARAMETER	VALUE	UNITS	DESCRIPTION AND CONDITIONS
General Performance			
Number of Programmable Power Supplies	6		Each supply programmed independently.
Minimum Voltage	1000	mV	
Maximum Voltage	5000	mV	
Voltage Programming Resolution	1	mV	
Maximum Output Current	3.0	A	
Current Measurement Capability	Yes		Independent measurement provided on each programmable supply.
Minimum Current Measurement	50	mA	
Current Measurement Resolution	4	mA	

TABLE 9: GPIO CHARACTERISTICS

PARAMETER	VALUE	UNITS	DESCRIPTION AND CONDITIONS
Voltage			
Voltage Level	2.5	V	All GPIOs operate at 2.5 V LVCMOS
V_{IL} minimum	-0.3	V	
V_{IL} maximum	0.7	V	
V_{IH} minimum	1.7	V	
V_{IH} maximum	3.3	V	
V_{OL} maximum	0.4	V	
V_{OH} minimum	2.0	V	

Revision Number	History	Date
1.0	Document Release	June 8, 2020

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