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Test Instrument Module System (TIMS)

USB to I2C/SPI Interface Module

Model: TIMS-0102

Function Protocol

Software Specification

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1 INTRODUCTION

This specification provides the necessary information to design, develop, manufacture, use and maintain functional application communications software for the WireWorks West model TIMS-0102 USB to I2C/SPI Interface module.

2 SCOPE

This document shall address the module specific applications functions only.

3 CONTACT INFORMATION

3.1 SALES AND SUPPORT

WireWorks West, Inc.
965 Mission Street, Suite 600
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415-348-1400 Office
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4 REFERENCE DOCUMENTS

<i>Description</i>	<i>Doc. No</i>	<i>Company/Author</i>	<i>Rev/Date</i>
TIMS Datalink Communications Protocol	DOC-000004	WWW/GSH	2/4-11-2005

5 SPECIFICATION

5.1 GENERAL

This subsection will present certain consideration, rules, and design constraints specific for the development of software for use with the TIMS-0102 USB to I2C/SPI Interface module.

- ☐ The TIMS-0102 utilizes a single microcontroller device with a protocol address of 0xD0.

5.1.1 Protocol Layer-1: Physical Layer

The TIMS-0102 utilizes a USB serial interface device that is compliant with USB 1.1 and 2.0 full speed requirements as specified by the USB.ORG committee.

- ☐ Serial data stream characteristics: 230K Baud, 8-bit data, no parity, 1 stop bit
- ☐ The TIMS-0102 may draw up to 500 ma of 5 VDC power from the USB interface

5.2 CONTROL FUNCTIONS

TIMS-0102 Module Function Summary

Function	Control Code	Comment
fnc_EXT_5V_ON	0x0010	
fnc_EXT_5V_OFF	0x0011	
fnc_SPI_DEVICE_CONFIG_RE	0x0020	
fnc_SPI_DEVICE_CONFIG_WE	0x0021	
fnc_SPI_DEVICE_ENABLE	0x0023	
fnc_SPI_DATA_IO	0x0024	
fnc_SPI_DEVICE_IO	0x0025	
fnc_I2C_BUS_CONFIG_RE	0x0130	
fnc_I2C_BUS_CONFIG_WE	0x0131	
fnc_I2C_DEVICE_IO_A7R	0x0132	
fnc_I2C_SCRIPT_IO	0x0134	
fnc_I2C_FUNCTION_ERROR	0x013E	

5.2.1 Function: EXT 5V ON

Function Summary

Name	fnc_EXT_5V_ON
Description	Enables 5 VDC output to both the I2C and SPI connectors.
Control Code	0x0010
Supplied Variables	None
Returned Variables	None
Comments	

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0010	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x0010	
STATUS	U16	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

5.2.2 Function: EXT 5V OFF

Function Summary

Name	fnc_EXT_5V_OFF
Description	Disables 5 VDC output to both the I2C and SPI connectors
Control Code	0x0011
Supplied Variables	None
Returned Variables	None
Comments	

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0011	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x0011	
STATUS	U16	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

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5.2.3 Function: SPI DEVICE CONFIG SET

Function Summary

Name	fnc_SPI_DEVICE_CONFIG_WE
Description	Stores SPI IC device specific operating parameters.
Control Code	0x0021
Supplied Variables	Chip Enable Address – (u8) Clock Configuration – (u8) TVAR – (u8)
Returned Variables	None
Comments	Up to sixteen SPI IC devices can be accessed, each using different clock idle, clock edge, and clock timing configurations. Device selection is based on the chip enable address. This function stores the device specific clocking configuration into non-volatile memory.

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0021	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0x02	
DATA	[u8]		See content below
Data[0] Data[1] Data[2]			U8 – Chip Enable Address U8 – Clock Configuration U8 – TVAR

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x0021	
STATUS	U16	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

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5.2.3.1 SPI Clock Configuration Byte

SPI Clock Configuration Byte

Bit	Name	Description
0 1	CLKRG0 CLKRG1	SPI Clock Rate Generator 00 = 10.0 MHz / (1+TVAR); Range 5.0 MHz thru 39.0625 KHz 01 = 2.50 MHz / (1+TVAR); Range 1.25 MHz thru 9.765625 KHz 10 = 625 KHz / (1+TVAR); Range 312.5 KHz thru 2.44140625 KHz 11 = 10.0 MHz TVAR in the range of 1 through 255
2	RXCLK	SPI RX Clocking 0 = RX sampled at middle of TX output period 1 = RX sampled at end of TX output period
3 4	TXCLK0 TXCLK1	SPI TX Clocking 00 = Clock idle low, TX falling edge. 01 = Clock idle low, TX rising edge. 10 = Clock idle high, TX rising edge. 11 = Clock idle high, TX falling edge.
4		Not Assigned
5		Not Assigned
6		Not Assigned
7		Not Assigned

5.2.4 Function: SPI DEVICE CONFIG GET

Function Summary

Name	fnc_SPI_DEVICE_CONFIG_RE
Description	Returns SPI IC device specific operating parameters.
Control Code	0x0020
Supplied Variables	Chip Enable Address – (u8)
Returned Variables	Clock Configuration – (u8) TVAR – (u8)
Comments	Up to sixteen SPI IC devices can be accessed, each using different clock idle, clock edge, and clock timing configurations. Device selection is based on the chip enable address. This function returns the device specific clocking configuration from non-volatile memory.

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0020	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			U8 – Chip Enable Address

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x0020	
STATUS	U16	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0x01	
DATA	[u8]		See content below
Data[0]			U8 – Clock Configuration
Data[1]			U8 – TVAR

5.2.5 Function: SPI DEVICE ENABLE

Function Summary

Name	fnc_SPI_DEVICE_ENABLE
Description	Selects, or deselects, an SPI device based on its chip enable address
Control Code	0x0023
Supplied Variables	Device Address (u8)
Returned Variables	None
Comments	<p>Two modes of chip enable are supported; addressed, for use with user supplied decoder circuits, or direct where the module provides chip enable outputs.</p> <p>The associated SPI IC device configuration information is read from non-volatile memory and the SPI interface is configured accordingly. Refer to the SPI Device Access Table.</p> <p>If an SPI IC device is left in an enabled state and an I2C IO function is executed, the nCS outputs will be set to a high state prior to the actual I2C IO operation.</p>

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0023	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			U8 – Device Address

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x0023	
STATUS	U16	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

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5.2.5.1 SPI Device Access Table

SPI Device Access Table

Device Address	Device Config.	nCS7	nCS6	nCS5	nCS4 /nEN	nCS3 /A3	nCS2 /A2	nCS1 /A1	nCS0 /A0 /nSS
0x00	0	H	H	H	L	L	L	L	L
0x01	1	H	H	H	L	L	L	L	H
0x02	2	H	H	H	L	L	L	H	L
0x03	3	H	H	H	L	L	L	H	H
0x04	4	H	H	H	L	L	H	L	L
0x05	5	H	H	H	L	L	H	L	H
0x06	6	H	H	H	L	L	H	H	L
0x07	7	H	H	H	L	L	H	H	H
0x08	8	H	H	H	L	H	L	L	L
0x09	9	H	H	H	L	H	L	L	H
0x0A	10	H	H	H	L	H	L	H	L
0x0B	11	H	H	H	L	H	L	H	H
0x0C	12	H	H	H	L	H	H	L	L
0x0D	13	H	H	H	L	H	H	L	H
0x0E	14	H	H	H	L	H	H	H	L
0x0F	15	H	H	H	L	H	H	H	H
0x10	0	H	H	H	H	H	H	H	L
0x11	1	H	H	H	H	H	H	L	H
0x12	2	H	H	H	H	H	L	H	H
0x13	3	H	H	H	H	L	H	H	H
0x14	4	H	H	H	L	H	H	H	H
0x15	5	H	H	L	H	H	H	H	H
0x16	6	H	L	H	H	H	H	H	H
0x17	7	L	H	H	H	H	H	H	H
Else	None	H	H	H	H	H	H	H	H

Notes:

- ☐ For device address 0x00 thru 0x0F, the A3 thru A0 lines will be set prior to nEN going low.
- ☐ The nSS signal is reserved for the SPI Slave Select input.

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5.2.6 Function: SPI DATA IO

Function Summary

Name	fnc_SPI_DATA_IO
Description	Performs an SPI data input/output operation
Control Code	0x0024
Supplied Variables	TX Data ([u8])
Returned Variables	RX Data ([u8])
Comments	This function requires an SPI Device Enable call to be performed prior to this call to enable the target SPI IC device. For every data byte transmitted a data byte will be received. This call may repeated, supporting SPI IC devices or strings of devices requiring long byte streams, prior to calling the SPI Device Enable function to deselect the SPI IC device.

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0024	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0x00 0xFF	1 Byte – Minimum 256 Bytes - Maximum
DATA	[u8]		See content below
Data[0] : Data[n]			U8 – First Data Byte : U8 – Last Data Byte (Data[255] max)

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x0024	
STATUS	U16	(tbd)	
REF	U8	(tbd)	
LENGTH	U8	0x00 0xFF	1 Byte – Minimum 256 Bytes - Maximum
DATA	[u8]		See content below
Data[0] : Data[n]			U8 – First Data Byte : U8 – Last Data Byte (Data[255] max)

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5.2.7 Function: SPI DEVICE IO

Function Summary

Name	fnc_SPI_DEVICE_IO
Description	Performs a selected SPI IC device data input/output operation
Control Code	0x0025
Supplied Variables	Device Address (u8) TX Data ([u8])
Returned Variables	RX Data ([u8])
Comments	This function first enables the specified SPI IC device as defined in the SPI Device Enable function. A single data I/O transaction is performed as specified in the SPI Data IO function, except with a 255 data byte maximum transaction. Finally, the device is disabled.

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0025	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0x01 0xFF	2 Bytes, 1 Data Byte – Minimum 256 Bytes, 255 Data Bytes - Maximum
DATA	[u8]		See content below
Data[0] Data[1] : Data[n]			U8 – Device Address U8 – First Data Byte : U8 – Last Data Byte (Data[255] max)

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U8	0x0025	
STATUS	U8	(tbd)	
REF	U8	(tbd)	
LENGTH	U8	0x00 0xFE	1 Data Byte – Minimum 255 Data Bytes - Maximum
DATA	[u8]		See content below
Data[0] : Data[n]			U8 – First Data Byte : U8 – Last Data Byte (Data[254] max)

5.2.8 Function: I2C BUS CONFIG SET

Function Summary

Name	fnc_I2C_BUS_CONFIG_WE
Description	Stores the I2C Bus Configuration into non-volatile memory
Control Code	0x0131
Supplied Variables	I2C Bus Slew Rate (u8) I2C Bus Clock Rate (u8)
Returned Variables	None
Comments	<p>I2C Bus Slew Rate</p> <p>1 = Disabled for Standard Speed (100K or 1M) 0 = Enabled for High Speed (400K)</p> <p>I2C Bus Clock Rate</p> <p>Clock Frequency = 10 MHz / (1 + Rate) Where rate in the range of 1 thru 255</p> <p>For 100 KHz, Rate = 0x63 For 400 KHz, Rate = 0x18</p>

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0131	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0x01	
DATA	[u8]		See content below
Data[0]			U8 – I2C Bus Slew Rate
Data[1]			U8 – I2C Bus Clock Rate

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x0131	
STATUS	U16	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

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5.2.9 Function: I2C BUS CONFIG GET

Function Summary

Name	fnc_I2C_BUS_CONFIG_RE
Description	Returns the I2C Bus Configuration from non-volatile memory
Control Code	0x0130
Supplied Variables	None
Returned Variables	I2C Bus Slew Rate (u8) I2C Bus Clock Rate (u8)
Comments	I2C Bus Slew Rate 1 = Disabled for Standard Speed (100K or 1M) 0 = Enabled for High Speed (400K) I2C Bus Clock Rate Clock Frequency = 10 MHz / (1 + Rate)

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0130	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U8	0x0130	
STATUS	U8	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	?	
DATA	[u8]		See content below
Data[0]			U8 – I2C Bus Slew Rate
Data[1]			U8 – I2C Bus Clock Rate

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5.2.10 Function: I2C DEVICE IO

Function Summary

Name	fnc_I2C_DEVICE_IO_A7R
Description	Performs an I2C 7-Bit addressed write and/or read operation
Control Code	0x0132
Supplied Variables	Device Address (u8) Read Byte Count (u8) Write Data Array ([u8]), optional
Returned Variables	Read Data ([u8]), optional
Comments	The upper seven bits of the Device Address contain the 7-Bit I2C device address. Bit-0 will be overwritten as required by the function. Read Byte Count specifies the number of bytes to read up to 255 bytes, if any. If there is any write data passed to the function, the function shall first perform a write operation of up to 254 bytes. If the number of bytes to read is greater than zero, the function will perform a read operation following the write operation if any. If there is to be a write followed by a read then a restart condition is performed after the write phase and prior to the addressing of the read phase.

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	<i>(tbd)</i>	
CONTROL	U16	0x0132	
STATUS	U16	<i>(xxx)</i>	Don't care, ignored by receiver
REF	U8	<i>(tbd)</i>	
LENGTH	U8	0x01 0xFF	2 Bytes – Minimum (read only) 256 Bytes - Maximum
DATA	[u8]		<i>See content below</i>
Data[0] Data[1] Data[2] : Data[n]			Device Address – U8 Read Byte Count – U8 First Write Byte – U8, optional : Last Write Byte – U8, optional, 254 bytes maximum

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Response Packet (write only)

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U8	0x0132	
STATUS	U8	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

Response Packet (write/read, or read only)

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U8	0x0132	
STATUS	U8	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0x00 0xFE	1 Byte – Minimum 255 Bytes - Maximum
DATA	[u8]		See content below
Data[0] : Data[n]			First Read Byte – U8, optional : Last Read Byte – U8, optional, 255 bytes maximum

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5.2.11 Function: I2C SCRIPT IO

Function Summary

Name	fnc_I2C_SCRIPT_IO
Description	Perform an I2C device I/O operation specified by a script string
Control Code	0x0134
Supplied Variables	Write Script (String[n])
Returned Variables	Read Script (String[n])
Comments	<p>Prior to execution of the write script, the I2C Bus shall be configured based on parameters stored in non-volatile memory.</p> <p>Write script characters shall be echoed back as part of the read script.</p> <p>Note: More read characters are usually returned than write characters, so be careful not to fill a complete write buffer.</p> <p>If an I2C error is detected, the execution of the write script shall be terminated, an exclamation mark ("!") shall be returned followed by a single byte containing an I2C error code in binary.</p> <p>NOTE: Any queries made using the I2C scripting function may return more data bytes than are sent.</p> <p>The scripting function will only return 256 bytes of data, any other bytes are discarded. If the returned data from a script exceeds 256 bytes, there will be no error code returned. However, any code should check for this condition and call the TIMS_Status function immediately and inspect [bit1] Tx Overflow. If this bit is true, the function attempted to return more than 256 bytes.</p> <p>This issue is known, and will have an associated error code/warning generated in future versions of the TIMS driver.</p>

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x0134	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0x00 0xFF	1 Byte – Minimum 256 Bytes - Maximum
DATA	[u8]		See content below
Data[0:n]			String[n+1]

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x0134	

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STATUS	U16	<i>(tbd)</i>	
REF	U8	<i>(tbd)</i>	Echo of Command Packet REF
LENGTH	U8	0x00 0xFF	1 Byte – Minimum 256 Bytes - Maximum
DATA	[u8]		<i>See content below</i>
Data[0:n]			String[n+1]

5.2.11.1 I2C Script Character Table

I2C Script Character Table

ASCII	Description
~	Performs a 100 microsecond delay
@	Performs a 1 millisecond delay
0-9, A-F	Hexadecimal Character
S	Performs a START condition
R	Performs a RESTART condition
P	Performs a STOP condition
?	Initiates a Byte Read operation
K	Write an Acknowledge Bit
N	Write a Not-Acknowledge Bit
!	An I2C error was detected

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5.2.12 Function: I2C FUNCTION ERROR

Function Summary

Name	fnc_I2C_FUNCTION_ERROR
Description	Returns the last I2C function error state
Control Code	0x013E
Supplied Variables	None
Returned Variables	I2C Function Error Code (u8)
Comments	

Command Packet

Element	Type	Value	Description
TO	U8	0xD0	
FROM	U8	(tbd)	
CONTROL	U16	0x013E	
STATUS	U16	(xxx)	Don't care, ignored by receiver
REF	U8	(tbd)	
LENGTH	U8	0	
DATA	[u8]		See content below
Data[0]			Erroneous Dummy Byte

Response Packet

Element	Type	Value	Description
TO	U8	(tbd)	Echo of Command Packet FROM
FROM	U8	0xD0	
CONTROL	U16	0x013E	
STATUS	U16	(tbd)	
REF	U8	(tbd)	Echo of Command Packet REF
LENGTH	U8	0x00	1 Byte
DATA	[u8]		See content below
Data[0]			U8 – I2C Function Error Code

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5.2.12.1 I2C Function Error Codes

I2C Subroutine Error Table

Error Code	Error	Description
0x10	START Pre-Condition	SDA or SCL is Low
0x11	START Bus Collision	
0x12	START Timeout	
0x13	START Verify	
0x20	RESTART Pre-Condition	SDA or SCL is High
0x21	RESTART Bus Collision	
0x22	RESTART Timeout	
0x23	RESTART Verify	
0x30	WR Byte Pre-Condition	SDA or SCL is High
0x31	WR Byte Bus Collision	
0x32	WR Byte Timeout	
0x41	RD ACK Bus Collision	
0x42	RD ACK Timeout	
0x51	RD Byte Bus Collision	
0x52	RD Byte Timeout	
0x61	WR ACK Bus Collision	
0x62	WR ACK Timeout	
0x71	WR NAK Bus Collision	
0x72	WR NAK Timeout	
0x81	STOP Bus Collision	
0x82	STOP Timeout	
0x83	STOP Verify	