

Designing a SPA-1 ASIM

Introduction

Hardware Requirements

SPA-1 ASIMs require the ability to do both master and slave I2C communication. A SPA-1 host which interfaces to a SPA network needs only the ability to do master I2C communication. Sufficient memory to hold the program code and the xTEDS is also required.

Protocol

The SPA-1 Protocol has been split into 3 phases. Address Resolution Protocol (ARP), Enumeration, and Round Robin.

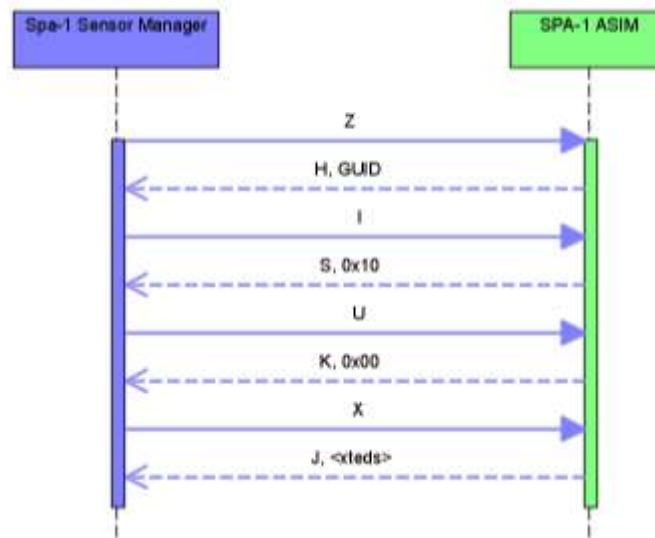
Address Resolution Protocol

SPA-1 ASIMs use a peer to peer scheme for self organizing their address space. When an ASIM comes online, it starts at the default address of 0x11 and tries to send a message to that address. If it gets an I2C ACK back, then it should increment its address and try again. Once it gets a NACK, signifying that no one is on that address, it should stop probing and use that address.



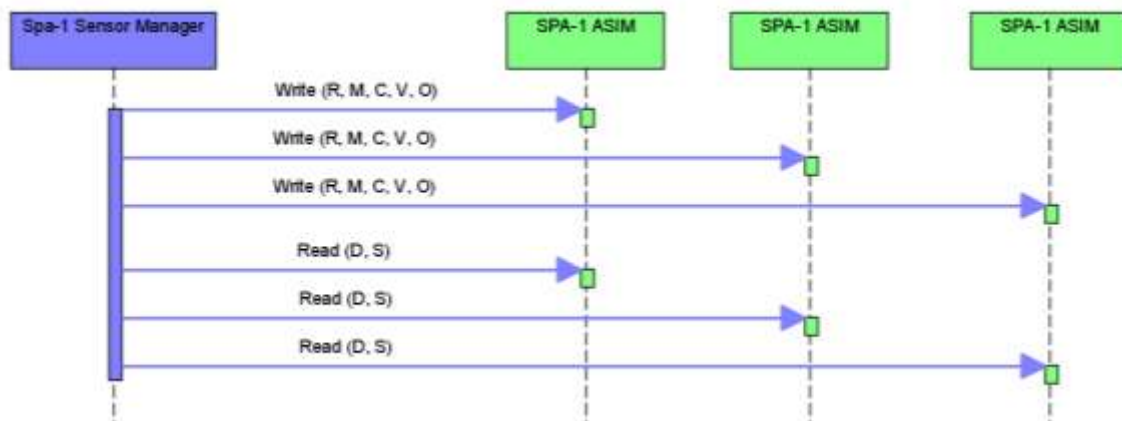
Enumeration

Once an ASIM has an address it should respond to any Enumerate (Z) messages that it receives. During enumeration the SPA-1 Manager will request the xTEDS from the ASIM and add it into the Round Robin communication loop.



Round Robin

The SPA-1 Manager uses a round robin algorithm for communicating with the SPA-1 ASIMs. This method allows the ASIMs time to process commands received from the SPA-1 Manager. It also guarantees that each ASIM will be written to and read from without any starvation issues.



Implementation Notes

Global Unique Identifier (GUID)

Each SPA-1 ASIM needs to provide a global unique identifier (GUID) for I2C arbitration purposes. This GUID is a 4 byte integer that should be randomly assigned.

When an ASIM has no data for the SPA-1 Manager to read it should leave a value of 0xFF in the output register. The SPA-1 Manager uses this to know that the ASIM is still active but has no data at that time. If a 0xFF is not left in the register unknown behavior could happen.

All messages on a SPA-1 Network are limited to a 3 byte header and a 253 byte payload. xTEDS should be chunked into packets of this size. For more information on the xTEDS see the xTEDS (J) message definition.

Differences from SPA-U

Removed Power-on and Power-off messages.

Removed xTEDS and PID message.

Added P2P ARP messages.

Message formats

Generic format

All messages follow a generic format. The first byte is the opcode. The next two bytes are the length of the payload. While none of the payloads can be over 253 bytes, the payload length is still two bytes. This is because the xTEDS length is often (probably always) larger than 256. The following bytes are the payload. The byte order for SPA-1 messages is all little endian.

opcode (1 byte)	payload length (2 bytes)	payload (x bytes)
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Commands

Commands are message that are sent from the SPA-1 Sensor Manager to the ASIM.

Self test (T)

Purpose: Tells the ASIM and sensor to perform a self test.

Expected Reply: Status (S)

Notes: The length field is always 0.

Diagram:

T (1 byte)	0 (2 bytes)
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Reset (R)

Purpose: Perform a reset of the sensor device(s) (if defined), and perform a warm boot reset of the ASIM code. This will cause the ASIM to go into an un-enumerated state. The ASIM should start the registration process anew after receiving a reset. This command will be given following the detection of an anomalous communication or activity.

Expected Reply: Status (S)

Notes: The length field is always 0.

Diagram:

R (1 byte)	0 (2 bytes)
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Initialize (I)

Purpose: Perform any required initialization operations for the sensor(s). This command will always be given immediately following a power on command.

Expected Reply: Status (S)

Notes: Length field is always 0.

Diagram:

I (1 byte)	0 (2 bytes)
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Request Version (U)

Purpose: Request the version number of this SPA-1 ASIM Protocol.

Expected Reply: Version (V)

Notes: Length field is always 0.

Diagram:

U (1 byte)	0 (2 bytes)
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Request xTEDS (X)

Purpose: Read xTEDS from the ASIM.

Expected Reply: xTEDS (J), or Status (S) if the request cannot be honored.

Notes: Length field is always 0.

Diagram:

X (1 byte)	0 (2 bytes)
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Request data subscription (M)

Purpose: Request data from the sensor.

Expected Reply: Data (D) or Status (S) if request cannot be honored.

Notes: Length field is always 2. The data portion consists of an interface ID byte (1 .. 255) followed by a message ID byte (1 .. 255) both defined in the xTEDS document. If the associated message is specified in the xTEDS as a event (msgArrival="EVENT") message, this request will result in a single Data (D) reply each time that event occurs, but does not happen at some specified interval. If the associated message is specified in the xTEDS as a stream (msgArrival="PERIODIC") message, this request will result in a continuous stream of Data (D) replies at the rate chosen by the ASIM and specified in the xTEDS (e.g. msgRate="1.0") in Hertz. All messages that have been requested must be cancelled with a Cancel (C) command.

Diagram:

M (1 byte)	2 (2 bytes)	Interface ID (1 byte)	Message ID (1 byte)
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Cancel data subscription (C)

Purpose: Cancel a previous data message subscription.

Expected Reply: None.

Notes: Length field is always 2. The data portion consists of an interface ID (1 byte) followed by a message ID (1 byte). If no current message stream is associated with this interface ID and message ID from a previous Request (M) message, this command has no effect.

Diagram:

C (1 byte)	2 (2 bytes)	Interface ID (1 byte)	Message ID (1 byte)
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Command (V)

Purpose: Device command message.

Expected Reply: Status (S)

Notes: The payload consists of the interface ID (1 byte) followed by the message ID (1 byte) followed by parameter bytes as defined in the xTEDS document. If a command message has no parameter bytes, the length will be 2, otherwise the length will be the length of all parameter bytes as defined in the xTEDS document plus two (for the interface and message ids).

Diagram:

V (1 byte)	2 + n (2 bytes)	Interface ID (1 byte)	Message ID (1 byte)	Parameters (n bytes)
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Time at tone (O)

Purpose: Used to synchronize ASIMs with the system time.

Expected Reply: Status (S)

Notes: The time at the next sync pulse is given in the data field in 8 bytes: time(sec) (4 bytes) + time (usec) (4 bytes). When the next sync is received the current time is to be replaced with the time at the tone. Length is always 8.

Diagram:

O (1 byte)	8 (2 bytes)	Seconds (4 byte)	u seconds (4 byte)
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Enumerate (Z)

Purpose: Starts the enumeration process for an ASIM.

Expected Reply: Hello (H)

Notes: Length is always 0. An ASIM should not respond to this message until it has completed the Address Resolution phase. This prevents ASIMs that are still resolving their addresses from responding to an enumeration message intended for another ASIM.

Diagram:

Z (1 byte)	0 (2 bytes)
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Responses

Response messages are always sent from the ASIM to the SPA-1 Manager. There are no expected replies for response messages since they are the replies.

Status (S)

Purpose: Contains a byte representing the status of the ASIM and sensor(s).

Notes: Length is always 1. The status bits and their description are shown below. Below, MSB refers to the Most Significant Bit within the status byte. Also, LSB refers to the Least Significant Bit within the status byte.

Bit	Description
7 (MSB)	Error
6	Illegal opcode
5	Unknown Interface ID and / or Message ID
4	Self test failure
3	(user defined)
2	(user defined)
1	(user defined)
0 (LSB)	(user defined)

Diagram:

S (1 byte)	1 (2 bytes)	Status (1 byte)
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Data (D)

Purpose: Contains a data product from the sensor.

Notes: In a data message, length is the length of the data reply message plus two bytes and data represents two components: The first two data bytes are the interface ID (1..255) and the message ID (1..255). The remaining message content is as defined in the xTEDS definition for the message. For example, if an xTEDS-defined message consists of 8 data bytes, the length field of this reply would be 10 bytes; two bytes for the interface and message IDs and 8 data bytes.

Diagram:

D (1 byte)	2 + n (2 bytes)	Interface ID (1 byte)	Message ID (1 byte)	Data (n bytes)
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xTEDS (J)

Purpose: Contains the xTEDS for the sensor(s) attached to the ASIM.

Notes: Because SPA-1 messages have a 253 byte payload limit the xTEDS has to be handled in a special way. When sending the xTEDS to the SPA-1 Manager the ASIM should chunk the xTEDS into multiple packets. In each packet, the length field of the header should be the total length of the xTEDS. The payload will be the next 253 bytes or less of the xTEDS.

Diagram:

J	n	xTEDS
(1 byte)	(2 bytes)	(n bytes)

Version (K)

Purpose: A version reply contains an 8-bit (one byte) version.

Notes: Length is always 1. Current versions are shown in the table below.

Version	Date	Notes
0x00	Jan 1, 2010	First version.

Diagram:

K	1	Version
(1 byte)	(2 bytes)	(1 byte)

Hello (H)

Purpose: Alerts the SPA-1 Manager that the ASIM is ready to be enumerated.

Notes: Length is always 4. The GUID is an integer and should be randomly assigned. For more details on the GUID see the implementation notes.

Diagram:

H	4	GUID
(1 byte)	(2 bytes)	(4 bytes)

P2P Messages

P2P messages are sent between ASIMs and are used to do address resolution.

Address Probe (W)

Purpose: Used to see if anyone is on an address.

Notes: Length is always 4. The GUID is an integer and should be randomly assigned. For more details on the GUID see the implementation notes. If an ASIM receives this message it should ignore it. The I2C detects if there is a response or not. If there is a response the sending ASIM should increment its address and try again.

Diagram:

W (1 byte)	4 (2 bytes)	GUID (4 bytes)
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