



ZigBee Meter Integration Guide

D0.5002-0

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Introduction

This document describes how to communicate with Saturn South ZigBee meter products, and includes all information required to develop an interface that can control a [Saturn South](#) Emeter (SSE). Communication with SSEs involves sending and receiving ZigBee Cluster Library (Zcl) messages to and from the SSE.

A simulation of a typical SSE can be found [here](#).

An understanding of the ZigBee Specification is helpful when developing ZigBee products, however this document presents enough information to develop at the Zcl level (i.e. at the application layer) without significant additional reading. This guide does not include specific details for sending and receiving messages from specific vendors' ZigBee coordinators.

It is assumed that you have hardware that provides a ZigBee Coordinator (Zc) node. This could be in the form of a gateway product you are developing or updating, or for example a USB ZigBee Module such as Telegesis or similar on your PC.

A Qt C++ SSE demonstration application SSX.exe (Win) using a Telegesis ZigBee module (we have tested against the ETRX357USB and ETRX357USB-LRS) can be downloaded [here](#). The application can execute all possible SSE commands including OTA code updates for SSE devices. Source code for this application can be supplied on request.

It is assumed you can enable Permit Joining on the ZigBee Network and can join the SSE to your ZigBee network.

Your software needs to be able send and receive ZigBee Zcl and Zdp messages to and from the SSE to control it. This document describes the structure of the required messages to allow you to develop your application in your development environment with your selected language.

Some references are made to 'C' language structures used in ZigBee , as examples, but the Zcl data is described here as byte arrays, to allow a script language such as Python to assemble or unpack the SSE Zcl data.

Getting Started

It is assumed that you have installed your SSE in a test switchboard according to instructions provided in the relevant user manual. There are user manuals available online for the [SS9007.2.0](#) , [SS9007.3.3](#), [SS9005.0.4](#).

Pairing Procedure

First you need to associate your SSE device to the ZigBee network, as specified in the SSE's User Manual.

When the SSE first joins a ZigBee network it announces this fact by broadcasting a ZigBee Announce message to the whole network. Broadcast messages are re-transmitted by any ZigBee Router (Zr) nodes in the network to maximise the chance that all nodes will receive the message at least once. Eventually the ZigBee Announce broadcast message should be received by the network's ZigBee Coordinator (Zc), and be processed by an application-level network manager (i.e. in the case of a Telegesis implementation, this is code that you will need to write).

Once a new SSE is paired to the ZigBee network, you will need to configure and bind the SSE to generate meter and switch state reports at the required interval.

Reading Endpoint List

It's useful to read and store a local copy of the SSE Node Descriptor and the Active Endpoints list using Zdp commands using the Zdp Node Descriptor Request and Active Endpoints Request.

Reading Attributes

When a ZigBee Announce is received by your network manager, the recommended best practice is to create or update a record for the new node, and read some descriptive information from the SSE to populate this record.

EP	Cluster	Attr Id	Desc	Attr Type	Example
0x01	0x0000	0x0004	Mfg Name	0x42	Saturn South
0x01	0x0000	0x0005	Model Id	0x42	SS9005.1.1_V001_V001_SSHA_C4_R
0x01	0x0006	0xe17e	Safestate mode	0x20	4 = Safe State Disabled

Configuring Reports

Each SSE must be configured to report data by the Zc explicitly, once it has been successfully paired to the network. This report configuration process only needs to be performed once: report configuration settings will be remembered by the SSE until they are explicitly revoked or replaced, including after loss of power. The table below shows a complete set of report data from an SS9005 Three Phase Meter.

	Phase A	Phase B	Phase C	Phase D	
Voltage	240.82	240.82	240.82		V Rms
Current	0.00	0.00	0.00		I Rms
Active Power	0.000	0.000	0.000	0.000	kW
Reactive Power	0.000	0.000	0.000	0.000	kVAR
Active Import	11051.552	24.489	0.007	11051.552	kWh
Reactive Import	0.000	0.096	9.470	0.000	kVARh
Active Export	0.000	27.136	0.000	0.000	kWh
Reactive Export	0.000	0.000	0.000	0.000	kVARh
Power Factor	0.000	0.000	0.000		-
Frequency	49.91	0.00	0.00		Hz
Switch State	0				
Phase B Angle				0.00	Deg.
Phase C Angle				0.00	Deg.

You can configure reporting to include any or all the reportable attributes.

Report configuration is achieved by issuing the Zcl Configure Reporting Request command to a given Endpoint and Cluster. The Configure Reporting Request contains a list of attributes to be configured, as well as parameters governing the frequency with which reports should be generated. **Due to ZigBee packet size constraints, the maximum number of attributes per request is limited to four.** The SSE can report up to 10 attributes per endpoint, as shown in the table above. Configuring all 10 attributes for reporting requires three separate Zcl Configure Reporting Requests be transmitted for each endpoint, e.g. four attributes in each of the first two requests, and two in the final request.

When configuring reports each reported attribute is configured using three parameters:

- Minimum Report Interval (seconds): Reports will not be generated any more often than this interval.
- Maximum Report Interval (seconds): Reports will be generated no less frequently than at this interval.
- Minimum Change - the amount by which an attribute's value must change in order to generate a report more frequently than at the Maximum Report Interval.

For example your application may require that Voltage, Current and Active Power be reported every 60 seconds, but if Current changes by more than 1 Amp you may require a report within one second of the change. In that case you would set all configured attributes with Minimum Report Interval 1, Maximum Report Interval 60, Minimum Change 0 (0 in this case means 'use the Maximum Report Interval), but set the Current attribute's Minimum Change value to 100 (i.e. 1.00 Amps)..

After each Configure Reporting Request is processed by the SSE a Configure Reporting Response is transmitted back to the origin of the request. This response will indicate success (i.e. 'the request

was received and processed'), but may contain a list of attribute errors, for example if you try to configure an attribute that does not exist.

In the SS9005 three phase example above the energy cluster 0x0702 has three individual phases A, B and C, on endpoints 1, 2 and 3 respectively. The composite "phase D" endpoint 4 has attributes that provide a summation of the three phases.

It's possible to use an SS9005 as three single phase meters. In that case there is no need to configure reports for phase D.

If you plan to use the SSE's switch (Endpoint 1, Cluster 0x0006, Attribute 0x0000) to control a load you should configure the switch to report with a Minimum Report Interval of 1 second and a Maximum Report Interval at the same value used for energy attributes.

When the report configuration process is complete the SSE must be bound to initiate report generation,

Binding Endpoints

Bindings determine where information (such as reports) travel within a ZigBee network. The SSE can have its metering endpoints bound to any node in the network, however the most common binding results in reports being sent to the ZigBee Coordinator.

You must bind each Endpoint/Cluster that you wish to configure for reporting.

Binding is achieved using the ZDP Bind Request. Best practice is to issue a bind request and then wait for a ZDP Bind Response before continuing to issue the next Bind Request..

It is possible to configure and bind endpoints in any order: for example you could perform all bindings first then configure the reports, or you could configure and bind each Cluster/Endpoint individually. The order you choose may depend on your application architecture or preference.

Your site switchboard may have multiple meters, for example an SS9005 Three Phase Meter and an SS9007 Mini CT Meter (single phase). Your application will need specific configure tables defining how you wish to configure each SSE. A common approach is to configure the SSE for reporting first using a configure table, collecting a table of binding data which is then used to bind the endpoints. If your application is quite simple, you can also hard-code your bind and report configuration steps.

Basic Cluster 0000

Basic Attributes

Name	Id	Units	SS9005 EP	SS9007 EP	ZigBee Datatype	Report	Write
Zcl Version	0x0000	0..255	1	1 or 0x0A	0x20	No	No
App Version	0x0001	0..255	1	1 or 0x0A	0x20	No	No
Stack Version	0x0002	0..255	1	1 or 0x0A	0x20	No	No
Hardware Version	0x0003	0..255	1	1 or 0x0A	0x20	No	No
Manufacturer (String)	0x0004	<= 11 bytes	1	1 or 0x0A	0x42	No	No
Model Id (String)	0x0005	<= 32 bytes	1	1 or 0x0A	0x42	No	No
Build Date (String)	0x0006	<= 10 bytes	1	1 or 0x0A	0x42	No	No
Power Source	0x0007	0..3	1	1 or 0x0A	0x30	No	No
Location (String)	0x0010	<= 32 bytes	1	1 or 0x0A	0x42	No	Yes
Enabled	0x0012	0..1	1	1 or 0x0A	0x10	No	Yes

Writeable Basic Attributes

Location

The Location attribute is a 32 character string that can be used by the application to describe the function of the SSE, for example “Hot Water” or “Lighting”.

Enabled

The Enabled attribute can be set to 0 to stop all ZigBee functionality except for Read and Write Attributes and the SSE private cluster. Note that this is only true for SS9005 three phase versions greater than SS9005.0.4 and SS9007 single phase versions greater than SS9007.2.0.

Metering Cluster 0702

Meter Attributes

Name	Id	Units	SS9005 EP	SS9007 EP	ZigBee Datatype	Report	Write
Voltage RMS	0xe10A	100 = 1V	1,2,3	1 or 0x0A	0x21	Yes	No
Current RMS	0xe11c	100 = 1A	1,2,3	1 or 0x0A	0x22	Yes	No
Power Active	0xe12e	1 = 1W	1,2,3,4	1 or 0x0A	0x2a	Yes	No
Power Reactive	0xe131	1 = 1W	1,2,3,4	1 or 0x0A	0x2a	Yes	No
Import Active	0xe140	1 = 1WH	1,2,3,4	1 or 0x0A	0x2b	Yes	No
Import Reactive	0xe141	1 = 1WH	1,2,3,4	1 or 0x0A	0x2b	Yes	No
Export Active	0xe179	1 = 1WH	1,2,3,4	1 or 0x0A	0x2b	Yes	No
Export Reactive	0xe17A	1 = 1WH	1,2,3,4	1 or 0x0A	0x2b	Yes	No
Power Factor	0xe137	+-.1.000	1,2,3	1 or 0x0A	0x29	Yes	No
Frequency	0xe143	100 = 1Hz	1	1 or 0x0A	0x21	Yes	No
Phase B Angle	0xe17b	100=1Deg	4	-	0x21	Yes	No
Phase C Angle	0xe17c	100=1Deg	4	-	0x21	Yes	No
Maximum Current	0xe17d	100 = 1A	1, 2, 3	1 or 0x0A	0x22	No	No
Current Min Change	0xe21c	100 = 1A	1, 2, 3	1 or 0x0A	0x22	No	Yes

Description of Attributes here

Advanced Report Configuration.

Describe how to use Current Min Change attribute to generate reports based on current only.

24 Bit Attributes

Describe how to unpack 24bit signed attributes

Switch Cluster 0006

Switch Attributes

Name	Id	Range	SS9005 EndPoint	SS9007.2 EndPoint	SS9007.3 EndPoint	ZigBee Data type	Report	Write
Switch State	0x0000	0 or 1 *	0x01	0x0A	0x01	0x10	Yes	No
Safe State Mode	0xe17e	0 to 4	0x01	0x0A	0x01	0x20	No	Yes
Safe State Delay	0xe17f	0 to 65535	0x01	0x0A	0x01	0x21	No	Yes
Delay Remaining	0xe181	0 to 65535	0x01	0x0A	0x01	0x21	No	No

* The switch state value can optionally be set to encode information about safe state reversion. See the [Decoding Safe State section](#) for more information.

Switch Commands

Command	Result	SS9005 EndPoint	SS9007.2 EndPoint	SS9007.3 EndPoint	Cluster
0x00	Switch Off	0x01	0x0A	0x01	0x0006
0x01	Switch On	0x01	0x0A	0x01	0x0006
0x02	Switch Toggle	0x01	0x0A	0x01	0x0006
0x55	Trigger Safe State Reversion	0x01	0x0A	0x01	0x0006
0x56	Cancel Safe State Reversion	0x01	0x0A	0x01	0x0006

Switch Safe State

SSE switches can be used to control switchboard loads remotely via third-party relays/contactors. It is useful to have a safe state for the switch to which the SSE can revert if it loses contact with the ZigBee network, or if the host application loses contact with the Internet. For example an SSE may be used to shed load, but if contact is lost it may be desirable to automatically ensure the load is switched back on. This capability is provided by the SSE safe state process.

Reversion to the safe state can be triggered by two conditions:

1. Loss of contact with the ZigBee coordinator, after several attempts by the SSE to rejoin the network. This may take up to two minutes after the the coordinator goes offline.
2. Receipt of a 'Trigger Safe State Reversion' command. This would typically be sent by the ZigBee Coordinator following loss of connection to a remote / back-office control system,

instructing all SSEs in the network to revert to their safe state. There are two [Switch Cluster Safe State commands](#), one to Initiate reversion and one to cancel reversion.

In order to avoid unnecessary reversion for a short term loss of contact it's possible to set a [Safe State Delay](#) interval before actual return to safe state occurs. If contact is reestablished before the delay elapses the reversion is cancelled

If the SSE switch has reverted to its configured safe state it is still possible to override the safe state using the SSE's button. If the button is used to override the safe state then the Safe State process is disabled until contact is reestablished.

For example the ZigBee coordinator may fail or become unplugged, which results in the SSE reverting to it's safe state. The SSE button can be used to manually change the switch state, in the event that the loss of contact lasts a long time for example.

Decoding Safe State

When the SSE reverts its switch to the configured safe state this can optionally be reported via the Cluster (0x0006) Switch State attribute (0x0000). **The Switch State attribute byte uses bit zero to indicate the switch state and bit one as a flag to indicate that the SSE has reverted to it's safe state.**

The 'Safe State with reporting' mode can be selected using the 'Safe State Mode' setting.

If using Safe State with reporting your application must decode the reported Switch State attribute as follows:

```
SwitchIsOn    = (switchstate & 0x01) // mask bit zero.
Reverted      = (switchstate & 0x02) // mask bit one.
```

If the Reverted flag is set it remains set for all subsequent switch state reports until the switch state is changed, either by a remote Zcl Switch command or with the SSE button.

Safe State Mode

The Mode attribute can be written to set the mode to the following values

Mode	Safe State	Report	Description
0	Off	No	Safe State is Off, If the device reverts to safe state the report flag is not set
1	On	No	Safe State is On, If the device reverts to safe state the report flag is not set
2	Off	Yes	Safe State is Off, If the device reverts to safe state the report flag is set
3	On	Yes	Safe State is On, If the device reverts to safe state the report flag is set
4	Disabled	-	Safe State is disabled. This is the default mode when the SSE joins the network.

Safe State Delay

The Safe State Delay attribute is used to delay final reversion to safe state after safe state reversion has been triggered. It can be set to any value from 0 to 65535 seconds.

SSE Manufacturer-Specific Cluster FD12

All SSEs include a cluster that provides useful features for configuring and obtaining data from the device. Manufacturer-specific clusters utilize a [Zcl manufacturer specific frame header](#), which is slightly larger than the standard Zcl frame header and which contains the manufacturer identifier. Saturn South's manufacturer Id is 0x10B6.

SSE manufacturer-specific transactions are of two types: simple commands that may include data additional to the Zcl frame header, and proxy commands each of which contains a manufacturer-specific Zcl frame header and a proxy packet. Proxy packets always start with a proxy header that describes the type and length (in bytes) of the proxy packet.

Commands

Command	Result	SS9005 EndPoint	SS9007.2 EndPoint	SS9007.3 EndPoint	Cluster
0x00	Factory Reset	0x01	0x0A	0x01	0x0006
0x01	Zero Accumulators	0x01	0x0A	0x01	0x0006
0x02	Reboot	0x01	0x0A	0x01	0x0006
0x55	Trigger Safe State Reversion	0x01	0x0A	0x01	0x0006
0x56	Cancel Safe State Reversion	0x01	0x0A	0x01	0x0006

Factory Reset

TBA

Zero Accumulators

TBA

Reboot

TBA

Proxy Commands

Proxy commands are used to access non-standard and extended device functionality that is specific to Saturn South devices. Proxy commands have a proxy header holding the proxy command type and the length of the command. The length includes the size of the proxy header.

Proxy Header

Fragmented Packets

Some proxy messages from the SSE to the host application are too large to be transmitted in a single ZigBee packet so such packets are transmitted in several consecutive fragments. The application must defragment the incoming packets until the entire proxy command contained in the fragments has been assembled.

The Get Waveform Response is the only proxy message that is sent fragmented, so the application does not need a defragmentation process unless you wish to read voltage and current waveforms.

System Statistics

Each SSE device has a self-monitoring process that collects data describing the general operation of the device. For example the system statistics process detects and counts the number of power failures. The system statistics data can be retrieved from the SSE using the Get System Statistics proxy command.

Phase Assignments

SS9005 three phase SSE can be configured as a three phase meter or as three single phase meters. In the latter case only the Phase A voltage needs to be physically connected to the mains supply.. The Phase Assignment proxy command allows the voltage signals for Phase B and Phase C to be obtained from the Phase A voltage terminal.

CT Reverse

When an SSE is installed in a switchboard it's possible that one or more of the Current Transformers (CT) have been installed in the wrong orientation. This will be detected by the application because it may appear that the load is unexpectedly exporting energy to the grid. This may be inconvenient to correct at the site, requiring a visit from a technician to adjust the CT to their correct orientation.

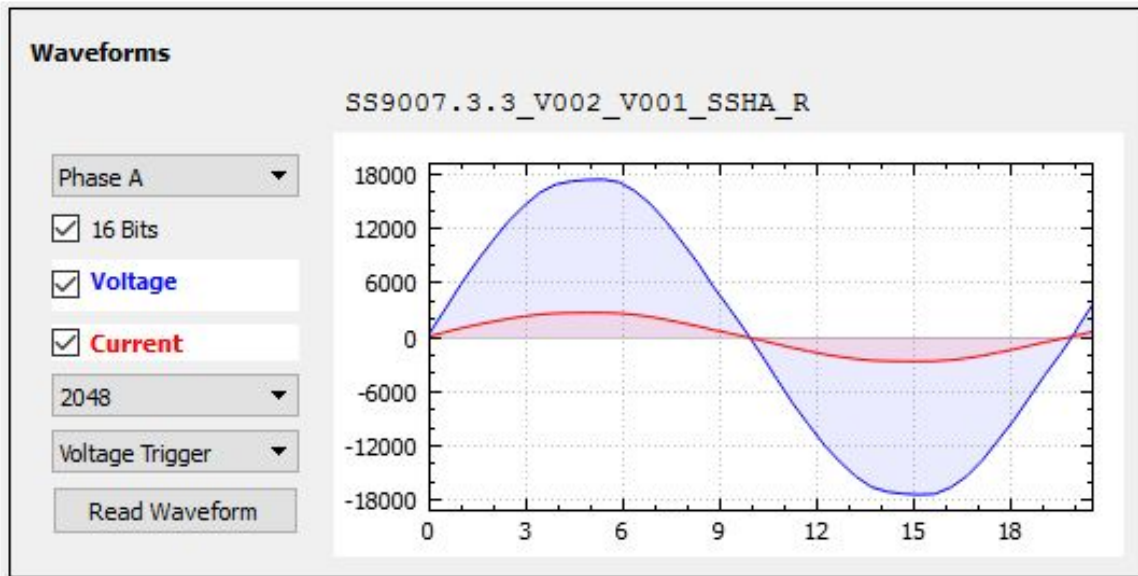
The CT Reverse command allows the CT to be reversed in software remotely.

Link Quality (LQI) Test

The Lqi test enables a precise measurement of the received LQI.

Get Waveform

SSE devices have the ability to retrieve voltage and current waveforms for each phase. For example this application can retrieve and display the voltage and current waveforms from an SSE.



SSE use 16 bit Analog to Digital Converters (ADC) to digitise voltage and current readings, at a sample rate of 4096 samples per second. The Get Waveform command has parameters to configure how the waveform data is collected from a given phase. For example it's possible to read at 8 or 16 bits resolution at various sample rates,

Resolution

Resolution can be 8 or 16 bits. If 8 bit resolution is selected it's possible to select the Least Significant Byte (Lsb) or Most Significant Byte (Msb) of the 16 bit ADC readings for the waveforms.

Sample Rate

Sample Rate can be 512, 1024, 2048 or 4096 samples per second.

Trigger

The waveform can be triggered either randomly or on the next zero cross of the voltage waveform of the chosen Phase..

Waveform Response

The Waveform Response is received as a fragmented packet. It contains a header describing the contents followed by waveform sample data. The sample data may contain either voltage or current samples or both. Voltage and current samples are ordered in pairs in voltage - current order.

Detail **TBA**

OTA Updates

TBA

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