

# SS9005 Mini Three Phase Meter

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*User Manual – Version 1.2 – Std HA Release (build 8554+)*



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# 1 Safety Notices

This manual does not comprehensively cover all safety measures for installation and operation of the device, since local code requirements and special operating conditions may necessitate further measures. This manual does however contain important safety information pertaining to the correct installation and usage of the device, and should be read carefully before attempting to install and use the device.

## **Qualified Personnel**

This device should be installed by technically qualified personnel. Failure to install in compliance with national and local electrical codes and according to Saturn South recommendations may result in electrical shock or fire hazard, unsatisfactory performance, or equipment failure.

This product is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience or knowledge, unless they have been given supervision or instruction concerning use of the product by a person responsible for their safety.

Children should be supervised to ensure that they do not play with the product.

## **Maintenance**

Do not rely on this product to provide galvanic isolation to a circuit. If maintenance is being performed on the connected circuit, disconnect the power by means of a primary protection device such as a circuit breaker or mains switch in accordance with local regulations.

Servicing of this device in the field is not possible and should not be attempted. If servicing is required, please return this device to Saturn South or an authorised distributor. Opening the product enclosure, for any reason, will render the Product Warranty void.

## 2 Quick Reference

SS9005 Mini Three Phase Meter – Std HA Release



Green	Red	Connectivity	Switch	Comment
Fast, continuous blinking between green and red.		N/A	N/A	When device is in the Factory Reset state
Four blinks of red, four blinks of green, repeating.		Connected	N/A	When device is set to <i>Locate</i> Mode
Off	Off	Not connected	Open	Not Connected, switch open
Off	On	Not connected	Closed	Not Connected, switch closed
Short blink every 4s	Off	Connected	Open	Connected, switch open
Short blink every 4s	On	Connected	Closed	Connected, switch closed
On (up to 10s)	Off	Attempting to connect	N/A	While device is attempting to join network
Fast Blink (3s)	Off	Joined or re-joined successfully	N/A	Indicates successful network join or re-join attempt
Off	Fast Blink (3s)	Failed to join or re-join	N/A	Indicates unsuccessful network join or re-join attempt
Slow blink between green and red at ~1Hz		Connected	N/A	Indicates that the device is being remotely updated

### Button LED Indication Quick Reference

*Note: The LEDs will automatically dim to one third brightness after 15 seconds of inactivity.*

Feature Name	Button Action	Resulting Action
<b>Association Join</b>	5 second press and release	Device will join any ZigBee HA network with 'Permit Joining' mode enabled. When the button is pressed the button colour will change to yellow, and then begin to rapidly blink green once it has been held long enough to trigger an Association Join. At this point the button should be released, and the button will shine solid green while it scans for a suitable network. The button will then blink green if the join operation is successful, or blink red on failure.
<b>Factory Reset</b>	Press and hold button for at least 10 seconds	Returns the device to its factory reset state. When the button is pressed, the button colour will change to yellow, and after 10 seconds the button will begin to rapidly blink red indicating that the device will return to factory reset state. The user should wait about 5 seconds before attempting another Association Join following a Factory Reset.
<b>Manual Switch</b>	Press the button briefly (<1 second)	Manually switches the device relay. Has no effect on non-switching variants of this device.

### Button Command Quick Reference

### 3 Product Overview

The SS9005 Mini Three Phase Meter is a compact power metering and load switching device that can be used to monitor three phase electrical loads or up to three individual single phase circuits. Designed to sit on a standard switchboard DIN rail, the SS9005 has the same form factor as a standard Residual Current Device, and accepts a wide range of external Current Transformers.

The SS9005 Mini Three Phase Meter is suitable for a range of applications including sub-metering, Demand Management, autonomous load shedding, and site automation.

The SS9005 Mini Three Phase Meter is designed to meter and switch a wide range of single and three-phase loads at up to 240VAC. Load switching is performed by an internal isolated relay that can be used to trigger an external third-party contactor or relay. Designed to function in all major electrical networks, the Mini Three Phase Meter boasts a high measurement accuracy (<1% error) with a customizable reporting frequency of up to 1Hz. Import/export energy accumulations and true signed active and reactive power measurements make the SS9005 an ideal choice for monitoring renewable generation sources and energy storage devices.

Three phase consumption is tracked independently to provide instantaneous three phase power and accurate three phase import/export energy readings. In addition to providing power factor information for each monitored circuit, voltage phase separation angles are reported to enable back-office reconstruction of full polar plots for three phase circuits.

High-resolution waveform sampling features provide unique insight into the behaviour and condition of monitored loads, yielding detailed information for load profiling and classification purposes.

Once installed, the Mini Three Phase Meter can receive important software updates over the network, reducing the cost of network maintenance and guaranteeing an up-to-date feature set for all devices in the field.

The SS9005 Mini Three Phase Meter communicates to other Saturn Energy devices using the ZigBee communications standard in the 2.4GHz ISM band. All wireless communications to and from the device are secured with AES-128 encryption using standards based technologies to ensure privacy and data integrity.

#### **Important:**

**The SS9005 Mini Three Phase Meter is not rated as a protection device, and must be placed downstream of an approved protection device.**

## 4 Technical Specifications

**Type:** Three Phase Meter and Switch with External Current Transformers

**Model:** SS9005

**Operational Voltage Range:** 240/415 VAC

**Operational Frequency Range:** 50Hz

**Operating Temperature Range:**

-20°C to +70°C for non-switching variant

-20°C to +50°C for switching variant

**Storage Temperature Range:** -25°C to +80°C

**Relative Humidity:** 10-95% non-condensing

**Average Power Consumption:** <2W

**Mass:** 0.103kg

**Dimensions:** 60.5 x 90 x 35.5mm

**Wire gauge:** 0.1mm<sup>2</sup> min - 2.5mm<sup>2</sup> (stranded) or 2.5mm<sup>2</sup> (solid core) max

**IP Rating:** IP20

**Switch Rating:** 5A, 240V (isolated bi-stable relay installed on switching variant)

**Measurement Accuracy:** Class 1

**Number of Switching Operations:** > 10,000 cycles (5A, resistive load) on switching variant

**Standards and Approvals:**

- AS/NZS 3100
- AS/NZS 61000.6.3:2007 and AS/NZS 4268:2003
- Certificate of Suitability

## 5 Commissioning and Installation Instructions

### 5.1 Before Installation

The individual performing the installation must have access to the commissioning tools provided by the Energy Services Company (ESCo).

An SS9002 ESBox or other compatible ZigBee network coordinator device must be present at the site, and be authorised to communicate with a control server provided by the ESCo.

The radio environment at the location of installation may be tested to ensure the new device will be able to connect to the existing ZigBee network. For more information on radio environment test equipment and procedures, please contact Saturn South.

There are two stages to device installation:

1. **Installation** - Identify the circuit(s) and phase(s) on which the device will be used, confirm that there is sufficient space to mount the device.
2. **Commissioning** - Wire the device into the switchboard as per the guidelines below and apply power.

### 5.2 Installation

The SS9005 Mini Three Phase Meter is designed to be straightforward to install into a standard domestic or commercial switchboard.

The following steps should be followed to install the device:

1. Identify the circuits that are to be monitored by the device. Note the major appliance(s) or load(s) that the circuits are connected to for future reference, and if necessary make a note of the device's HAN address.
2. Ensure that there is adequate mounting space for the device within the switchboard.

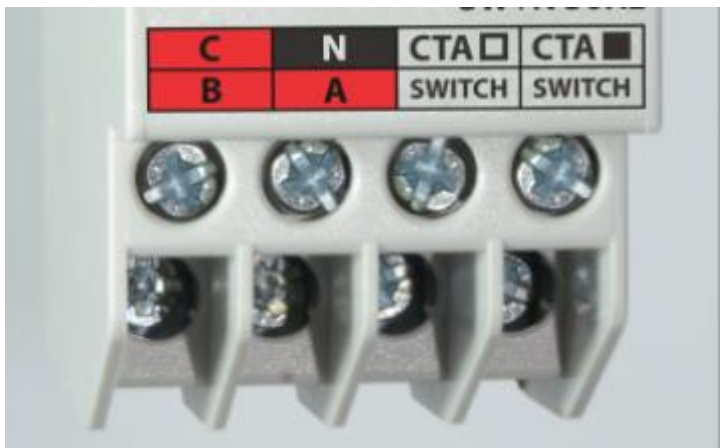
The SS9005 Mini Three Phase Meter draws power from the phase connected to the 'A' terminal, and requires at least 70VAC on terminal 'A' relative to Neutral (terminal 'N') to operate. A connection to each phase being monitored is required to provide a reference for high accuracy voltage measurements.

The reference phase connected to the each **phase input terminal** must be the same phase from which the load current is to be sensed by the corresponding clip-on Current Transformer (i.e. CTA must be monitoring a load on the same phase that is connected to the 'A' phase input terminal), and must be drawn downstream from an existing or dedicated protection device (e.g. MCB or RCD).

**IMPORTANT:**

- The phase connected to each *phase input terminal* must match the phase being monitored by the respective CT, or the meter will not generate accurate measurements.

Upstream protection devices must be selected such that the cable gauge for the reference inputs to the SS9005 do not exceed the maximum gauge indicated in the technical specifications.



The three **phase input terminals**, marked 'A', 'B' and 'C', are shown in the image above.

**IMPORTANT:**

- Ensure the sources of the reference phases are isolated before performing these steps.
- The SS9005 Mini Three Phase Meter is not rated as a protection device and may only be connected to a circuit that is protected up-stream by an approved circuit breaker.
- The maximum voltage permitted between the Neutral ('N') terminal and any of the phase input terminals ('A', 'B', or 'C') is 240VAC. Exceeding this limit may cause permanent damage to the product. Ensure that the Neutral wire is connected correctly before powering on the device.

1. Mount the device in the switchboard.
2. Wire the Current Transformers (CTs) to the device, taking care to match the coloured CT leads with the appropriate "CTX ■" (black) and "CTX □" (white) terminals.
3. Clip each CT on to the target load conductor, ensuring that the arrow on the CT points *towards* the load (away from the grid). If monitoring a generator, ensure the arrow points *towards* the generator (away from the grid).
4. Connect the output of a MCB, RCD, or other protection device to each of the required phase reference terminals of the Mini Three Phase Meter, and a neutral line to the "Neutral"



terminal. The protection devices used for this purpose need not necessarily be on the same circuit that the device will be monitoring (i.e. the circuit to which the CT is connected), although care should be taken to ensure the current sources and voltages **share the same phase**.

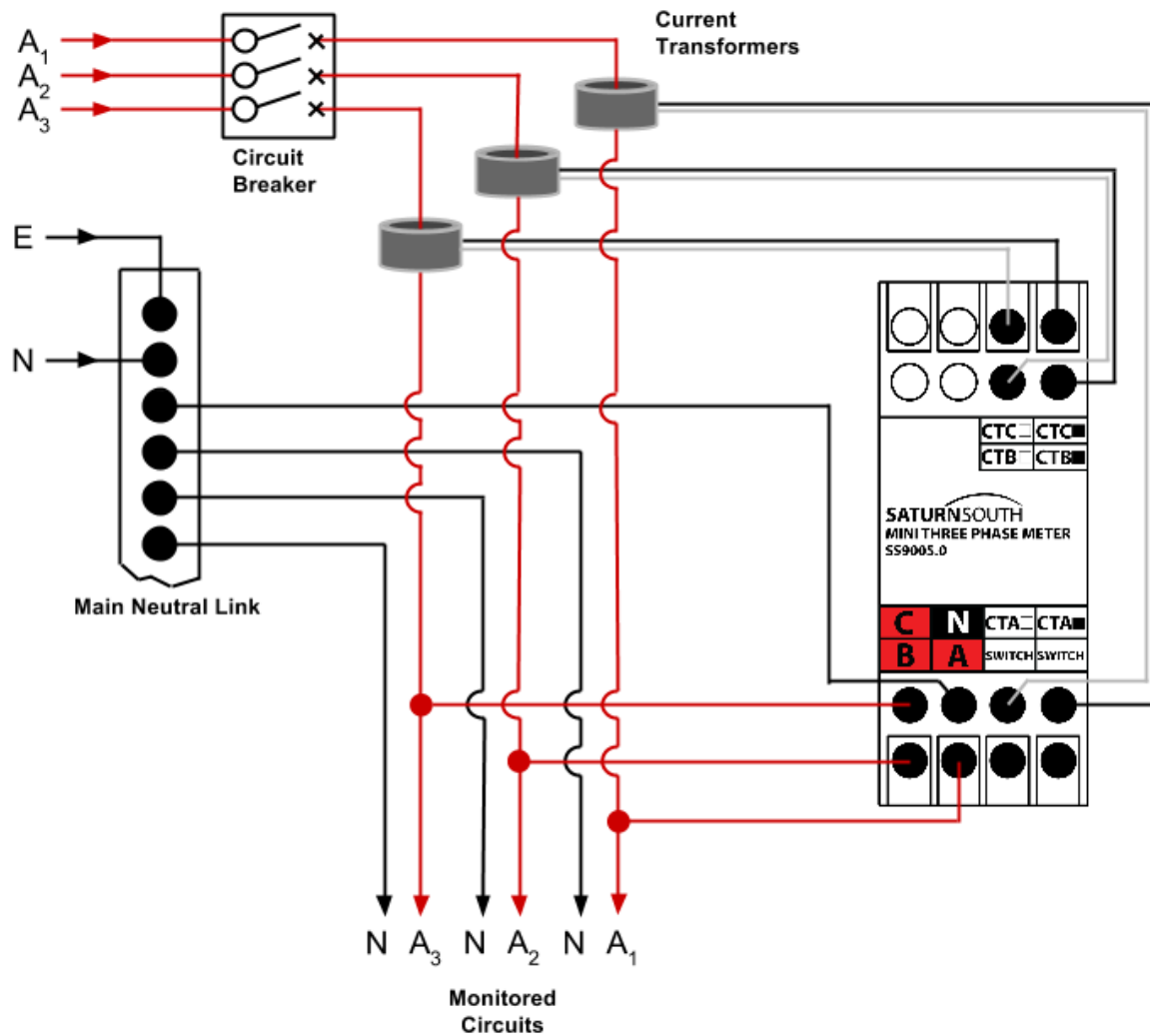


Figure 1: Mini Three Phase Meter monitoring a Three Phase load

Cable of minimum cross section  $0.1\text{mm}^2$  and maximum cross section  $1.5\text{mm}^2$  (stranded) or  $2.5\text{mm}^2$  (solid core) may be used.

**IMPORTANT:**

- If the circuits being monitored are connected to a protected neutral (e.g. via an RCD), ensure that the Mini Three Phase Meter is also connected to the same protected neutral, and not to the main neutral link.

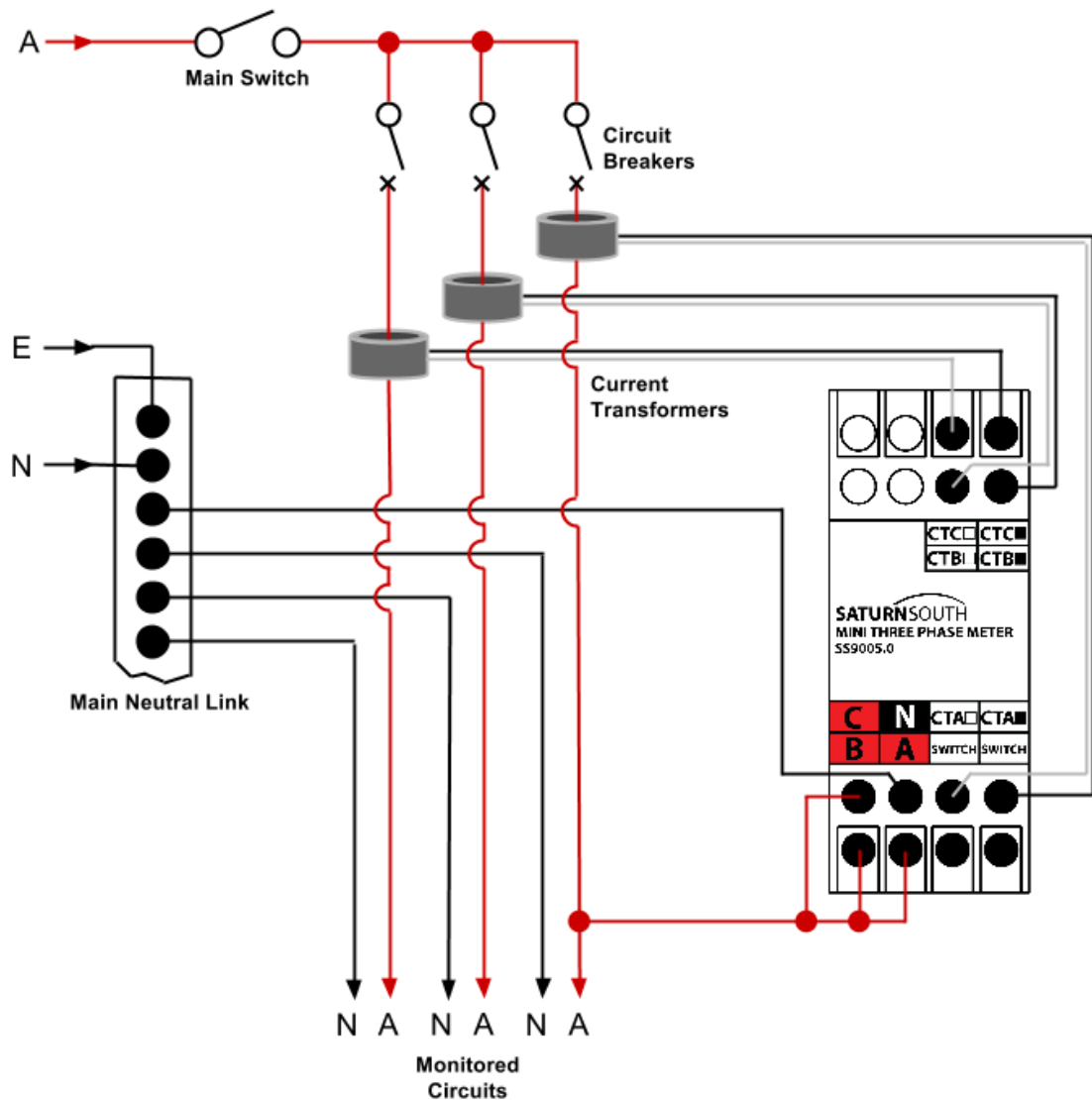


Figure 2: Mini Three Phase Meter monitoring three individual single phase loads

5. If your Mini Three Phase Meter has switching capability, the two terminals marked 'SWITCH' are connected internally to an isolated relay rated for 5A at 240V. The front panel button will glow red to indicate that the relay is closed. This relay can be used to switch an external relay, contactor, or control system. Refer to the relevant documentation when connecting this Mini Three Phase Meter to a third party control device. See Section **6 Switching** for more information.
6. Apply power to the device. The button will blink continuously between green and red to indicate that the device is in factory reset state. If the device is not in its factory reset state when it is initially powered up, it can be reset by pressing and holding the front panel button for at least 10 seconds, until the button starts to blink continuously between green and red.

## 5.3 Commissioning

To complete the installation process, the SS9005 Mini Three Phase Meter must be joined to an existing ZigBee network. The following instructions apply specifically to networks based on the Saturn South ESBox Ethernet-ZigBee Gateway device, however the process will be very similar when using third party ZigBee coordinators.

1. Set the site's ESBox to 'Permit Joining' mode using the LSSS button sequence on the button on the back panel of the ESBox (see the SS9002 ESBox LT documentation for more information). When Permit Joining mode is successfully enabled, the EBox's ZigBee LED will blink green for 120 seconds. During this 120 second window devices may be joined to the network by repeating step 2.

If this site is being commissioned for the first time it is recommended that a factory reset be performed on the ESBox before activating the first device using the Factory Reset (LLLSS) button sequence.

2. Instruct the new Mini Three Phase Meter to join the network by pressing and holding the front panel button for 5 seconds and then releasing it. The button will glow solid green to indicate that the device is scanning for available networks. The device will then spend up to 10 seconds attempting to join the ZigBee network. If the device joins the network successfully, the button will flash green for 6 seconds. If the device fails to join the network, the button will flash red for 3 seconds. Please see the Troubleshooting section for more information on debugging connection issues.

When joining multiple devices, perform the Association Join button sequence on each device in turn, rather than entering the sequence on multiple devices at once.

3. If the device successfully joins the network, as indicated in step 2, verify that the device appears as 'connected' in the out-of-band secure EScO web management interface, and that it is reporting power metrics.

## 6 Switching

Switching variants of the SS9005 Mini Three Phase Meter can be used to switch loads of arbitrary size indirectly using an inbuilt 5A 240VAC latching relay. If your device is marked with an R on its variant label (e.g. “120A/R”), the two terminals marked 'SWITCH' are connected internally to an isolated relay.

The internal relay would typically be used to control a third party external contactor or to signal a control system. Because the relay contacts are isolated, the SS9005 Mini Three Phase Meter can be connected directly to a digital IO on a control device such as a PLC.

The example below shows a SS9005 Mini Three Phase Meter being used to control an external contactor with a 240V coil by switching the active input to the contactor’s control coil.

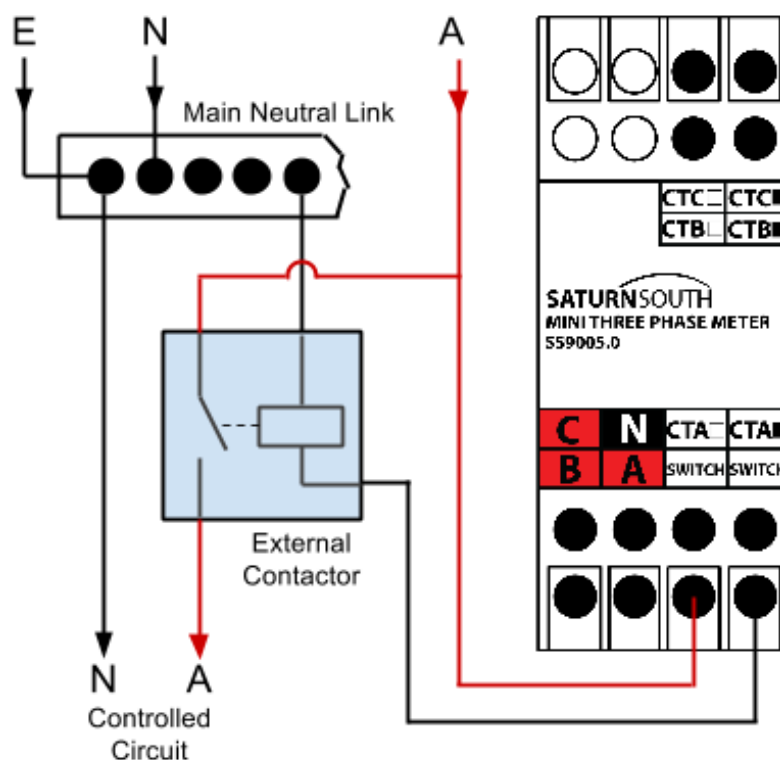


Figure 3: Mini Three Phase Meter connected to an external single-phase contactor

The internal relay in the SS9005 Mini Three Phase Meter is rated for over 10000 switching operations of a 5A load at unity power factor. The relay is limited to one switch state transition per second (e.g. the device cannot be switched on and off at a rate faster than 0.5Hz).

A value of 1 in the 'Switch State' attribute of the On/Off Cluster indicates that the relay is closed (connected), and a value of 0 indicates that the relay is open (disconnected).

## 7 Metering

As shown in Section 5, phase voltages are monitored by connecting reference signals directly to the three phase input terminals, providing a power supply for the device as well as enabling high accuracy voltage measurements. Current is measured using clip-on current transformers (CTs), with nominal primary current ratings of 60A, 120A and 200A available as standard.

Each individual Saturn South meter is calibrated in the final stage of the production process. The calibration procedure matches each device to a particular CT variant, meaning that measurements will not be accurate if a device calibrated for a 120A CT is used with a 40A CT. Furthermore, given the wide range of secondary current ratings available for CTs, the SS9005 Mini Three Phase Meter must only be used with the supplied CTs.

**IMPORTANT: Attaching a third party CT to the device can damage the device and will void the product warranty.**

SS9005 Mini Three Phase Meter devices have a 'variant label' on the front panel that describes the rated primary current (and hence the CT variant to use), as well as indicating whether or not the device has an internal relay. For example:

**"120A"** – Device is rated for a 120A nominal primary current.

**"60A/R"** – Device is rated for a 60A nominal primary current and includes an internal relay.

Max calibrated voltage error	<b>0.1%</b>
Max calibrated current error	<b>0.5%</b>
Typical absolute transfer ratio error for 120A CT	<b>&lt; 0.5%</b>
Typical absolute transfer ratio error for 60A CT	<b>&lt; 0.5%</b>
Region of linearity for 120A CT (<1% error)	<b>8% to &gt;110% of rated primary current</b>
Region of linearity for 60A CT (<1% error)	<b>15% to &gt;150% of rated primary current</b>

**Figure 4: Measurement accuracy specification**

For a full list of measured attributes delivered by the SS9005 Mini Three Phase Meter, please refer to Section 8.

## 8 Device Clusters and Attributes

The following Clusters are supported in the Std HA release of the SS9005 Mini Three Phase Meter:

- Basic
- On/Off
- Simple Metering

This section lists the available attributes in each supported cluster.

A maximum of 11 attributes can be configured for reporting at once. There is only one timer for attribute reports, and attributes will be reported at the interval specified in the most recent report configuration message. Because ZigBee attributes have a variable size however, it may not be possible for a device to send 11 attributes in a single report. If the total size of the report exceeds the maximum payload size (60 bytes), some attributes will be excluded from the report. The device will not automatically follow up with the remaining attributes if this is the case, and any missing attributes must be requested separately.

### 8.1 Basic Cluster

*Cluster ID: 0x0000 (0)*

*Manufacturer ID: 0x0000 (0)*

Attr ID	Attr ID (Hex)	Attribute Name	Writeable
0	0	ZigBee Cluster Library Version	N
1	1	Application Version	N
2	2	Stack Version	N
3	3	Hardware Version	N
4	4	Manufacturer Name	N
5	5	Model Identifier	N
6	6	Date Code	N
7	7	Power Source	N
16	10	Location Description	Y
18	12	Device Enabled	N

## 8.2 On/Off Cluster

Cluster ID: 0x0006 (6)

Manufacturer ID: 0x0000 (0)

Standard ‘turn on’, ‘turn off’, and ‘toggle’ functionality is provided by the On/Off Cluster.

Attr ID	Attr ID (Hex)	Attribute Name	Writeable
0	0	Switch State	N
57726	e17e	Switch State Safe State	Y

### Safe State Mechanism

If the SS9005 is equipped with a switch there is provision for the switch to be automatically returned to a user-specified safe state in the event that the device loses contact with the Zigbee network. If the device reverts to safe state due to loss of contact with network it is possible to report this via the Switch State attribute 0.

If safe state reversion reporting is enabled, bit 1 of the Switch State attribute will be set to 1 if a reversion to safe state was the cause of the most recent switch state transition.

There are 5 possible user-settable values for the Switch Safe State attribute:

0. Switch reverts to Off state with no report.
1. Switch reverts to On state with no report.
2. Switch reverts to Off state with report.
3. Switch reverts to On state with report.
4. Switch reversion to safe state is Disabled.

The default factory state for Switch Safe State is 4 – Disabled.

Example: The Switch Safe State attribute is set to 3, and the relay is currently OFF (Switch State = 0). The SS9005 loses contact with the ZigBee network, causing the switch state to revert to the selected safe state (ON). The Switch State attribute (attribute 0) will be set to 3, indicating that the switch is on (bit 0 ==1) and a reversion has occurred (bit 1 = 1).

The reversion to safe state report bit in the Switch State attribute will be cleared the next time the switch state is changed, either remotely or using the front panel button on the SS9005.

## 8.3 Simple Metering Cluster

Cluster ID: 0x0702 (1794)

Manufacturer ID: 0x0000 (0)

Saturn South devices expose an expanded set of attributes in a non-standard range within the Simple Metering Cluster.

The following attributes are available on endpoint 1, 2, and 3 (Phase A, Phase B, and Phase C). Any or all of the Phase A, B, and C attributes can be configured for reporting using the ZigBee report configuration/bind process on endpoints 1, 2, and 3 respectively.

Attr ID	Attr ID (Hex)	Attribute Name	Units	Divisor	Writeable
57610	e10a	Voltage 1 RMS Mean	"V"	100	N
57628	e11c	Current 1 RMS Mean	"A"	100	N
57646	e12e	Power 1 Active Mean	"W"	1	N
57649	e131	Power 1 Reactive Mean	"var"	1	N
57655	e137	Power Factor 1 Mean		1000	N
57664	e140	Accumulated Energy 1 Active Import	"Wh"	1	N
57665	e141	Accumulated Energy 1 Reactive Import	"varh"	1	N
57721	e179	Accumulated Energy 1 Active Export	"Wh"	1	N
57722	e17a	Accumulated Energy 1 Reactive Export	"varh"	1	N

The following attributes are available on endpoint 4 (Phase D / Three-Phase Aggregate). Any or all of the Phase D attributes can be configured for reporting using the ZigBee report configuration/bind process on endpoints 1, 2, and 3 respectively.

Attr ID	Attr ID (Hex)	Attribute Name	Units	Divisor	Writeable
57646	e12e	Power 1 Active Mean	"W"	1	N
57649	e131	Power 1 Reactive Mean	"var"	1	N
57664	e140	Accumulated Energy 1 Active Import	"Wh"	1	N
57665	e141	Accumulated Energy 1 Reactive Import	"varh"	1	N
57721	e179	Accumulated Energy 1 Active Export	"Wh"	1	N
57722	e17a	Accumulated Energy 1 Reactive Export	"varh"	1	N
57723	e17b	Phase Angle A->B	"deg"	100	N
57724	e17c	Phase Angle B->C	"deg"	100	N



The following attribute is available on endpoint 1 (Phase A) only

Attr ID	Attr ID (Hex)	Attribute Name	Units	Divisor	Writeable
57667	e143	Frequency 1 Mean	"Hz"	100	N
57725	e17d	Maximum Current	"A"	100	N

Note that the Maximum Current attribute **cannot** be configured for reporting. All SS9005 phases are calibrated for the same CT type. The Maximum Current attribute specifies the rating of the supplied current transformers.

The frequency value reported in this endpoint is derived from the signal measured on the Phase A voltage input. Only one frequency measurement is made on the SS9005 (it is assumed that all input signals have the same frequency).

## 9 Troubleshooting

### Issue:

***There is no indication from the device when power is applied, and no response to pressing the front panel button.***

### Actions:

- Verify that the device is wired according to the instructions in Section 5.2. Ensure that the live source is disconnected before connecting the meter.
- Verify that all upstream switches and protection devices are in their closed configuration.
- If one or more other devices are to be installed in the same location, install another device to compare. If other devices function correctly, remove the non-functioning device.

### Issue:

***When performing the steps outlined in the Commissioning section of the Commissioning and Installation Instructions, the device does not successfully connect (indicated by button flashing red for several seconds).***

### Actions:

- Ensure that 'Permit Joining' mode is enabled on the ZigBee Coordinator (If using an ESBox, use the LSSS button sequence on the ESBox to enable 'Permit Joining' mode).
- Try to join the device again – Saturn South metering devices will initially scan a reduced subset of the full range of available ZigBee channels. If the network is on a channel that is not in the 'preferred channels' list, the meter will initially fail to locate the network. A second join attempt will then cause the meter to scan the full set of channels.
- Check the RF environment to ensure the ESBox and Mini Three Phase Meter can communicate - contact Saturn South for more information.

### Issue:

***Device stops communicating to the site ESBox.***

### Actions:

- Verify that other nearby devices are still communicating successfully with the site ESBox (normally, this can be done by checking for recent data in the EScO client or management tools)
- If this is a standalone device, or if other nearby devices are also not functioning, perform a radio test in the deployment environment to verify that the device is in range of the ESBox radio.
- **If the device exhibits abnormal behaviour (e.g. device does not respond to button presses, does not give button LED indications described in the Quick Reference guides in this manual) please contact Saturn South.**