

# GASTRACK – Gas Analyser Probe (GAP) RS485 (Modbus RTU) Register Set

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This document details the Modbus register set developed to control and analyse data from the GAP oxygen analyser.



**NOTE:** Register set valid for product configuration **GAP-B2**.

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## 1 DEFINITIONS

The following definitions apply to WARNINGS, CAUTIONS, ACTIONS and NOTES used throughout this manual.



### WARNING:

The warning symbol is used to indicate instructions that, if they are not followed, can result in minor, serious or even fatal injuries to personnel.



### CAUTION:

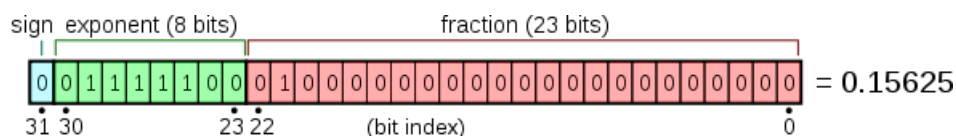
The caution symbol is used to indicate instructions that, if they are not followed, can result in damage to the equipment (hardware and/or software), or a system failure occurring.

**ACTION:** How data from the device should be used during normal operation.

**NOTE:** Operating conditions or statements pertaining to the recommended action.

The following terminology and acronyms are used throughout this manual:

- **Input registers** – are read only 16-bit registers. Valid address range starts at 30001.
- **Holding registers** – are read / write 16-bit registers. Valid address range starts at 40001.
- **MSB** – Most Significant Bits.
- **LSB** – Least Significant Bits.
- **EEPROM** - Electrically Erasable Programmable Read-Only Memory.
- **32-bit Integers** – Unsigned 32-bit integers are split over two 16-bit registers where the MSB and LSB are identified.
- **Floating point numbers** – are digitally represented using the IEEE–754 format. Single precision floating point numbers are used throughout and they require 32-bits of data. Since a Modbus register holds 16-bits, it takes two registers to represent a floating point number. The IEEE 754 standard specifies a binary32 as having:
  - Sign bit: 1 bit
  - Exponent width: 8 bits
  - Significand precision: 24 bits (23 explicitly stored)



For example, 20.7 in IEEE 754 format is: 0 10000011 01001011001100110011010

## 2 MODBUS SETUP

The half-duplex RS485 interface allows multiple sensors or systems to be connected on a single bus and individually addressed following the Modbus RTU protocol.

**NOTE:** Background reading is strongly recommended if there is no prior knowledge of Modbus. A good place to start is [www.modbus.org](http://www.modbus.org), where the specification and resources can be obtained in the technical resources page.

The Modbus interface is configured using the following setup:

- **Modbus mode:** RTU
- **Address:** One
- **Baudrate:** 9600
- **Parity:** None
- **Stopbits:** Two

## 3 MODBUS REGISTERS

**NOTE:** Default values are shown in **bold**.

**NOTE:** Values shown in grey are reserved, not applicable or indicate that they should not be changed.

### 3.1 System Information and Communication Registers

#### 3.1.1 System Information Registers

Table 3-1 –System Information - Input Registers

Name	Register Address	Description	Actions / Notes
<b>Modbus Register Set Revision</b>	0x7531 (30001)	32-bit Integer (MSB 16-bits)	<b>ACTION:</b> For reference <b>NOTE:</b> Used for diagnostic purposes
	0x7532 (30002)	32-bit Integer (LSB 16-bits)	
<b>Software Revision</b>	0x7533 (30003)	32-bit Integer (MSB 16-bits)	
	0x7534 (30004)	32-bit Integer (LSB 16-bits)	

#### 3.1.2 System Information File Registers

Table 3-2 - System Information - File Records

Name	File Number	Record Number	Actions / Notes
<b>Part Number</b>	0x000 (0x000)	0	<b>ACTION:</b> For reference <b>NOTE:</b> Read only – Used for system identification
<b>Serial number</b>	0x000 (0x000)	1	
<b>Date Code</b>	0x000 (0x000)	2	

#### 3.1.3 Serial Registers

Table 3-3 – Serial - Input Registers

Name	Register Address	Description	Actions / Notes
<b>Serial Status</b>	0x7535 (30005)	0 = Unavailable Serial parameters are fixed 1 = Not Ready Serial changes are currently not permitted <b>2 = Ready</b> Serial changes are permitted 3 = Busy Serial changes in process 4 = Complete Serial changes committed to memory, system will restart in 1s with the new communication settings 5 = Error Error committing serial changes to memory	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.1.4 on page 3-2.

Table 3-4 – Serial - Holding Registers

Name	Register Address	Description / Valid Values	Actions / Notes
<b>Serial Address</b>	0x9C41 (40001)	<b>1-247</b>	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any committed changes are saved in EEPROM and retained on power loss. Any invalid requests are ignored.  Used in <a href="#">Section 3.1.4</a> on <a href="#">page 3-2</a> .
<b>Serial Baudrate</b>	0x9C42 (40002)	0 = 2400 1 = 4800 <b>2 = 9600</b> 3 = 19200 4 = 38400 5 = 57600 6 = 115200	
<b>Serial Parity</b>	0x9C43 (40003)	<b>0 = None</b> 1 = Even 2 = Odd	
<b>Serial Control</b>	0x9C44 (40004)	<b>0 = Idle</b> 1 = Save and reset	

#### 3.1.4 Changing Communication Settings

1. Confirm *Serial Status* = *Ready* (30005 = 2).
2. Set *Serial Address* (40001), *Baudrate* (40002) and/or *Parity* (40003) as required.
3. Set *Serial Control* to *Save and Reset* (40004 = 1).
4. Monitor *Serial Status* input register which will change to *Busy* momentarily then *Complete* for 1s before the system resets and communication to the master is lost. (30005 = 3 → 4 → 1s delay → reset).

To restore communications, the master should now be configured to the new communication settings.

## 3.2 Sensor Registers

In addition to the zirconia dioxide oxygen sensor, the GAP has a pressure sensor and Pt-100 temperature sensor fitted.

### 3.2.1 O<sub>2</sub> Sensor Registers

Table 3-5 – O<sub>2</sub> Sensor - Input Registers

Name	Register Address	Description	Actions / Notes
<b>O<sub>2</sub> ID</b>	0x7536 (30006)	-	<b>ACTION:</b> For reference <b>NOTE:</b> Unique sensor identifier
<b>O<sub>2</sub> Warning</b>	0x7537 (30007)	16-bit bitmask Each bit represents an individual warning state	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Warnings are not retained on power loss.  Refer to list of Warnings given in <b>UG-003-B2, GAP User's Guide.</b>
<b>O<sub>2</sub> Error</b>	0x7538 (30008)	16-bit bitmask Each bit represents an individual error state	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Errors are not retained on power loss.  Refer to list of Errors given in <b>UG-003-B2, GAP User's Guide.</b>
<b>O<sub>2</sub> Uncalibrated Value</b>	0x7539 (30009)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub>	<b>ACTION:</b> Monitor in system <b>NOTES:</b> This value can be greater than or less than the 0 – 25% O <sub>2</sub> sensor range and is used to determine measurement stability during the calibration process.  Used in <a href="#">Section 3.2.2</a> on <a href="#">page 3-8</a> .
	0x753A (30010)	Floating point IEEE 754 (LSB 16-bits)  Unit = % O <sub>2</sub>	
<b>O<sub>2</sub> Calibrated Value</b>	0x753B (30011)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to 25.00	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in <a href="#">Section 3.2.2</a> on <a href="#">page 3-8</a> .
	0x753C (30012)	Floating point IEEE 754 (LSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to 25.00	

Name	Register Address	Description	Actions / Notes
<b>O<sub>2</sub> Status</b>	0x753D (30013)	0 = Loading System initialising, no O <sub>2</sub> measurements, sensor heater off 1 = OFF No O <sub>2</sub> measurements, sensor heater off 2 = Standby No O <sub>2</sub> measurements, sensor heater on at half power 3 = Warm-up No O <sub>2</sub> measurements, sensor heater on at full power Warm-up time = 60s coming from <i>OFF</i> Warm-up time = 20s coming from <i>Standby</i> <b>4 = ON</b> Valid O <sub>2</sub> measurements, sensor heater on at full power 5 = Cool-down No O <sub>2</sub> measurements, sensor heater on at full power 6 = Calibration Invalid O <sub>2</sub> measurements, calibration in process, sensor heater on at full power	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.2.2 on page 3-8.
<b>O<sub>2</sub> Calibration Status</b>	0x753E (30014)	0 = Reserved 1 = Not Ready Calibration is currently disabled <b>2 = Ready</b> Calibration enabled 3 = Busy Calibration in progress 4 = Complete Calibration complete 5 = Error Error during the calibration process	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Calibration is only enabled when O <sub>2</sub> Control = ON (40005 = 2) for greater than 5 minutes. This delay is required to allow the sensor to stabilise at the correct operating temperature.  Used in Section 3.2.2 on page 3-8.
<b>O<sub>2</sub> Configuration Value Type</b>	0x753F (30015)	0 = Invalid <b>1 = 32-bit integer</b> 2 = Floating point IEEE 754	<b>ACTION:</b> For reference <b>NOTES:</b> O <sub>2</sub> Configuration Value data format (40015 and 40016)  Used in Section 3.2.3 on page 3-8.
<b>O<sub>2</sub> Configuration Status</b>	0x7540 (30016)	0 = Reserved 1 = Not Ready Configuration is currently disabled <b>2 = Ready</b> Configuration enabled 3 = Busy Configuration in progress 4 = Complete Configuration complete 5 = Error Error during the configuration process	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.2.3 on page 3-8.



Name	Register Address	Description / Valid Values	Actions / Notes
<b>O<sub>2</sub> Diagnostic Value Type</b>	0x7541 (30017)	0 = Invalid 1 = 32-bit integer 2 = Floating point IEEE 754	<b>ACTION:</b> For reference <b>NOTES:</b> <i>O<sub>2</sub> Diagnostic Value</i> data format (30018 and 30019)  Used in <a href="#">Section 3.2.4</a> on <a href="#">page 3-9</a> .
<b>O<sub>2</sub> Diagnostic Value</b>	0x7542 (30018)	MSB 16-bits	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Returned diagnostic value of currently selected <i>O<sub>2</sub> Diagnostic Index</i> (40016). See <i>O<sub>2</sub> Diagnostic Value Type</i> (30017) for data format.  Used in <a href="#">Section 3.2.4</a> on <a href="#">page 3-9</a> .
	0x7543 (30019)	LSB 16-bits	
<b>O<sub>2</sub> Diagnostic Status</b>	0x7544 (30020)	0 = Reserved 1 = Not Ready <i>Diagnostic values are currently disabled</i> <b>2 = Ready</b> <i>Diagnostic values enabled</i> 3 = Busy <i>Diagnostic index change in progress</i> 4 = Complete <i>Diagnostic index change complete</i> 5 = Error <i>Error during the diagnostic index change process</i>	<b>ACTION:</b> Monitor in system <b>NOTES:</b> After a successful diagnostic index change the updated value will be available in <i>O<sub>2</sub> Diagnostic Value</i> (30018 and 30019).  Used in <a href="#">Section 3.2.4</a> on <a href="#">page 3-9</a> .

Table 3-6 – O<sub>2</sub> Sensor - Holding Registers

Name	Register Address	Description / Valid Values	Actions / Notes
<b>O<sub>2</sub> Control</b>	0x9C45 (40005)	<p>0 = OFF Turns the O<sub>2</sub> measurement off and then the sensor heater off after the set cool-down delay</p> <p>1 = Standby Turns the O<sub>2</sub> measurement off and reduces the heater voltage to half power</p> <p>2 = ON Turns the O<sub>2</sub> measurement on and increases the heater voltage to full power</p> <p>Warm-up time = 60s coming from <i>OFF</i> Warm-up time = 20s coming from <i>Standby</i></p>	<p><b>ACTION:</b> Set/Monitor in system</p> <p><b>NOTES:</b> Standby protects the sensor from condensation. It is recommended that this state should be used when no O<sub>2</sub> measurements are required. If this register is forced to <i>OFF</i> by the device then it is due to a system error. This can be confirmed by reading the <i>O<sub>2</sub> error</i> (30008).</p>
<b>Clear O<sub>2</sub> Warning</b>	0x9C46 (40006)	<p>0 = Idle 1 = Reserved</p>	<p><b>ACTION:</b> None</p> <p><b>NOTE:</b> Any warning present in <i>O<sub>2</sub> Warning</i> (30007) will auto clear if the condition that caused the warning is removed.</p>
<b>Clear O<sub>2</sub> Error</b>	0x9C47 (40007)	<p>0 = Idle 1 = Clear Error</p>	<p><b>ACTION:</b> Set in system</p> <p><b>NOTE:</b> If an error present in <i>O<sub>2</sub> Error</i> (30008) has forced <i>O<sub>2</sub> Status</i> to <i>OFF</i> (30015 = 1) the error may be cleared using this register and an attempt made to restart the sensor by setting the <i>O<sub>2</sub> Control</i> to <i>ON</i> (40005 = 2). If the error persists, contact <a href="mailto:technical@sstsensing.com">technical@sstsensing.com</a> for guidance.</p>
<b>O<sub>2</sub> Calibration Type</b>	0x9C48 (40008)	<p>0 = Gain</p>	<p><b>ACTION:</b> None</p> <p><b>NOTE:</b> Due to the O<sub>2</sub> sensor technology, no “zero” calibration is required and only a “Gain” (or span) calibration needs to be performed.</p>

Name	Register Address	Description / Valid Values	Actions / Notes
<b>O<sub>2</sub> Calibration Value</b>	0x9C49 (40009)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to 25.00 Recommended Range = 5.00 to 25.00	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. Default = <b>20.70%</b> for fresh air.  Used in <a href="#">Section 3.2.2</a> on page 3-8.
	0x9C4A (40010)	Floating point IEEE 754 (LSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to 25.00 Recommended Range = 5.00 to 25.00	
<b>O<sub>2</sub> Calibration Control</b>	0x9C4B (40011)	<b>0 = Idle</b> 1 = Reserved 2 = Apply Calibration 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in <a href="#">Section 3.2.2</a> on page 3-8.
<b>O<sub>2</sub> Configuration Index</b>	0x9C4C (40012)	<b>0 = Cool-down Delay</b>	<b>ACTION:</b> None <b>NOTE:</b> Cool-down is the only configurable option available.
<b>O<sub>2</sub> Configuration Value</b>	0x9C4D (40013)	MSB 16-bits  Unit = seconds Valid Range = 0 to 43200 (12hrs)	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. See <i>O<sub>2</sub> Configuration Value Type</i> (30015) for data format. Default = <b>0s</b>  Used in <a href="#">Section 3.2.3</a> on page 3-8.
	0x9C4E (40014)	LSB 16-bits  Unit = seconds Valid Range = 0 to 43200 (12hrs)	
<b>O<sub>2</sub> Configuration Control</b>	0x9C4F (40015)	<b>0 = Idle</b> 1 = Reserved 2 = Apply Configuration 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in <a href="#">Section 3.2.3</a> on page 3-8.
<b>O<sub>2</sub> Diagnostic Index</b>	0x9C50 (40016)	<b>0 = TD</b> 1 = Asymmetry 2 = TP 3 = T1 4 = T2 5 = T4 6 = T5 7 = Heater Voltage	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Sensor diagnostics are read only; they are available to assist in fault-finding if there is a warning condition present. Contact <a href="mailto:technical@sstsensing.com">technical@sstsensing.com</a> for assistance when using this feature.  Used in <a href="#">Section 3.2.4</a> on page 3-9.
<b>O<sub>2</sub> Diagnostic Control</b>	0x9C51 (40017)	<b>0 = Idle</b> 1 = Change Index 2 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in <a href="#">Section 3.2.4</a> on page 3-9.

### 3.2.2 Calibrating the O<sub>2</sub> Sensor

1. Confirm *O<sub>2</sub> Calibration Status = Ready* (30014 = 2).
2. Apply the calibration gas for a minimum of 5 minutes. The calibration gas used must be within the 0 – 25% O<sub>2</sub> sensor range and gain calibrations below 5% O<sub>2</sub> are not recommended. When calibrating in fresh air it is assumed that the O<sub>2</sub> concentration is 20.7%.
3. Monitor *O<sub>2</sub> Uncalibrated Value* (30009 and 30010) and wait until the value has been stable to  $\pm 0.1\%$  O<sub>2</sub> for a minimum of 30s.
4. Input the O<sub>2</sub>% of the calibration gas into *O<sub>2</sub> Calibration Value* (40009 and 40010).
5. Set *O<sub>2</sub> Calibration Control* to *Apply Calibration* (40011 = 2).
6. During the calibration routine *O<sub>2</sub> Calibration Status* will change to *Busy* (30014 = 3) and *O<sub>2</sub> Status* will change to *Calibration* (30013 = 6). O<sub>2</sub> measurements are not valid during this phase.
7. When the calibration routine is complete *O<sub>2</sub> Calibration Status* will change to *Complete* (30014 = 4) and *O<sub>2</sub> Status* will return to *ON* (30013 = 4).
8. Set *O<sub>2</sub> Calibration Control* to *Reset Status* (40011 = 3) to return *O<sub>2</sub> Calibration Status* to *Ready* (30014 = 2).
9. Confirm the *O<sub>2</sub> Calibrated Value* (30011 and 30012) is within  $\pm 0.1\%$  O<sub>2</sub> of the calibration gas applied. If not, repeat [Steps 3 to 8](#) and allow the *O<sub>2</sub> Uncalibrated Value* (30009 and 30010) to stabilise for a longer period. If multiple calibration attempts do not result in an accurate calibration, contact [technical@sstsensing.com](mailto:technical@sstsensing.com) for guidance.

### 3.2.3 Configuring the O<sub>2</sub> Sensor – Cooldown Delay

When operating in warm, humid environments it is important the sensor remains at a higher temperature than its surroundings, especially if there are corrosive components in the measurement gas. During operation this is not an issue as the heater operates at 700°C, however this means when the sensor or application is being powered down the sensor heater must be the last thing to be turned off after the temperature of the surroundings have suitably cooled.

1. Confirm *O<sub>2</sub> Configuration Status = Ready* (30016 = 2).
2. Change *O<sub>2</sub> Configuration Value* (40013 and 40014) to the new cool-down delay, see *O<sub>2</sub> Configuration Value Type* (30015) for the required data format.
3. Set *O<sub>2</sub> Configuration Control* to *Apply Configuration* to commit the change (40015 = 2).
4. Monitor *O<sub>2</sub> Configuration Status* which will change to *Busy* momentarily then *Complete* (30016 = 3 → 4).
5. Set *O<sub>2</sub> Configuration Control* to *Reset Status* (40015 = 3) to return *O<sub>2</sub> Configuration Status* to *Ready* (30016 = 2).

The newly saved cool-down delay will be applied the next time the *O<sub>2</sub> Control* is set to *OFF* (40005 = 0) when the current state of *O<sub>2</sub> Status* = *ON* (30013 = 4).

### 3.2.4 Changing the O<sub>2</sub> Sensor Diagnostic Value

1. Confirm *O<sub>2</sub> Diagnostic Status* = *Ready* (30020 = 2).
2. Change *O<sub>2</sub> Diagnostic Index* (40016) to the new diagnostic value you would like to view
3. Set *O<sub>2</sub> Diagnostic Control* to *Change Index* to commit the change (40017 = 1).
4. Monitor *O<sub>2</sub> Diagnostic Status* which will change to *Busy* momentarily then *Complete* (30020 = 3 → 4).
5. Set *O<sub>2</sub> Diagnostic Control* to *Reset Status* (40017 = 2) to return *O<sub>2</sub> Diagnostic Status* to *Ready* (30020 = 2).
6. Read the new value in *O<sub>2</sub> Diagnostic Value* (30018 and 30019). See *O<sub>2</sub> Diagnostic Value Type* (30017) for the data format.

### 3.2.5 Temperature Sensor Registers

Table 3-7 – Temperature Sensor - Input Register

Name	Register Address	Description	Actions / Notes
<b>Temperature ID</b>	0x7545 (30021)	-	<b>ACTION:</b> For reference <b>NOTE:</b> Unique sensor identifier
<b>Temperature Warning</b>	0x7546 (30022)	16-bit bitmask Each bit represents an individual warning state	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Warnings are not retained on power loss.  Refer to list of Warnings given in <b>UG-003-B2, GAP User's Guide.</b>
<b>Temperature Error</b>	0x7547 (30023)	16-bit bitmask Each bit represents an individual error state	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Errors are not retained on power loss.  Refer to list of Errors given in <b>UG-003-B2, GAP User's Guide.</b>
<b>Temperature Uncalibrated Value</b>	0x7548 (30024)	Reserved	<b>ACTION:</b> None
	0x7549 (30025)	Reserved	
<b>Temperature Calibrated Value</b>	0x754A (30026)	Floating point IEEE 754 (MSB 16-bits)  Unit = °C Valid Range = -50 to 600	<b>ACTION:</b> Monitor in system
	0x754B (30027)	Floating point IEEE 754 (LSB 16-bits)  Unit = °C Valid Range = -50 to 600	
<b>Temperature Status</b>	0x754C (30028)	0 = Loading System initialising, no temperature measurements 1 = OFF No temperature measurements 2 = Reserved 3 = Reserved <b>4 = ON</b> Valid temperature measurements 5 = Reserved 6 = Reserved	<b>ACTION:</b> Monitor in system

Name	Register Address	Description	Actions / Notes
Temperature Calibration Status	0x754D (30029)	<b>0 = Unavailable</b> Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None
Temperature Configuration Value Type	0x754E (30030)	<b>0 = Invalid</b> 1 = Reserved 2 = Reserved	<b>ACTION:</b> None
Temperature Configuration Status	0x754F (30031)	<b>0 = Unavailable</b> Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None
Temperature Diagnostic Value Type	0x7550 (30032)	0 = Invalid 1 = 32-bit integer <b>2 = Floating point IEEE 754</b>	<b>ACTION:</b> For reference <b>NOTES:</b> Temperature Diagnostic Value data format (30033 and 30034).
Temperature Diagnostic Value	0x7551 (30033)	MSB 16-bits  Unit = $\Omega$	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Pt100 resistance measurement. See Temperature Diagnostic Value Type (30032) for data format.
	0x7552 (30034)	LSB 16-bits  Unit = $\Omega$	
Temperature Diagnostic Status	0x7553 (30035)	0 = Reserved 1 = Not Ready Diagnostic value is currently disabled <b>2 = Ready</b> Diagnostic value enabled 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> Monitor in system

Table 3-8 – Temperature Sensor - Holding Registers

Name	Register Address	Description / Valid Values	Actions / Notes
Temperature Control	0x9C52 (40018)	0 = Reserved	<b>ACTION:</b> Monitor in system <b>NOTE:</b> The temperature measurement cannot be switched off.
Clear Temperature Warning	0x9C53 (40019)	<b>0 = Idle</b> 1 = Reserved	<b>ACTION:</b> None <b>NOTE:</b> Any warning present in <i>Temperature Warning</i> (30022) will auto clear if the condition that caused the warning is removed.
Clear Temperature Error	0x9C54 (40020)	<b>0 = Idle</b> 1 = Reserved	<b>ACTION:</b> None <b>NOTE:</b> If an error is present in <i>Temperature Error</i> (30023) contact <a href="mailto:technical@sstsensing.com">technical@sstsensing.com</a> for guidance.
Temperature Calibration Type	0x9C55 (40021)	Reserved	<b>ACTION:</b> None
Temperature Calibration Value	0x9C56 (40022)	Reserved	<b>ACTION:</b> None
	0x9C57 (40023)	Reserved	
Temperature Calibration Control	0x9C58 (40024)	Reserved	<b>ACTION:</b> None <b>NOTE:</b> Calibration of the temperature sensor is not allowed.
Temperature Configuration Index	0x9C59 (40025)	Reserved	<b>ACTION:</b> None
Temperature Configuration Value	0x9C5A (40026)	Reserved	<b>ACTION:</b> None
	0x9C5B (40027)	Reserved	
Temperature Configuration Control	0x9C5C (40028)	Reserved	<b>ACTION:</b> None
Temperature Diagnostic Index	0x9C5D (40029)	<b>0 = Pt100 Resistance</b>	<b>ACTION:</b> None
Temperature Diagnostic Control	0x9C5E (40030)	Reserved	<b>ACTION:</b> None



### 3.2.6 Pressure Sensor Registers

Table 3-9 – Pressure Sensor - Input Registers

Name	Register Address	Description	Actions / Notes
Pressure ID	0x7554 (30036)	-	<b>ACTION:</b> For reference <b>NOTE:</b> Unique sensor identifier
Pressure Warning	0x7555 (30037)	16-bit bitmask Each bit represents an individual warning state	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Warnings are not retained on power loss.  Refer to list of Warnings given in <b>UG-003-B2, GAP User's Guide.</b>
Pressure Error	0x7556 (30038)	16-bit bitmask Each bit represents an individual error state	<b>ACTION:</b> Monitor in system <b>NOTES:</b> Errors are not retained on power loss.  Refer to list of Errors given in <b>UG-003-B2, GAP User's Guide.</b>
Pressure Uncalibrated Value	0x7557 (30039)	Reserved	<b>ACTION:</b> None
	0x7558 (30040)	Reserved	
Pressure Calibrated Value	0x7559 (30041)	Floating point IEEE 754 (MSB 16-bits) Unit = mbar Valid Range = 260 to 1260	<b>ACTION:</b> Monitor in system
	0x755A (30042)	Floating point IEEE 754 (LSB 16-bits) Unit = mbar Valid Range = 260 to 1260	
Pressure Status	0x755B (30043)	0 = Loading System initialising, no pressure measurements 1 = OFF No pressure measurements 2 = Reserved 3 = Reserved <b>4 = ON</b> Valid pressure measurements 5 = Reserved 6 = Reserved	<b>ACTION:</b> Monitor in system
Pressure Calibration Status	0x755C (30044)	<b>0 = Unavailable</b> Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None

Name	Register Address	Description	Actions / Notes
Pressure Configuration Value Type	0x755D (30045)	<b>0 = Invalid</b> 1 = Reserved 2 = Reserved	<b>ACTION:</b> None
Pressure Configuration Status	0x755E (30046)	<b>0 = Unavailable</b> Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None
Pressure Diagnostic Value Type	0x755F (30047)	Reserved	<b>ACTION:</b> None
Pressure Diagnostic Value	0x7560 (30048)	Reserved	<b>ACTION:</b> None
	0x7561 (30049)	Reserved	
Pressure Diagnostic Status	0x7562 (3000)	<b>0 = Unavailable</b> Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None

Table 3-10 – Pressure Sensor - Holding Registers

Name	Register Address	Description / Valid Values	Actions / Notes
Pressure Control	0x9C5F (40031)	0 = Reserved	<b>ACTION:</b> Monitor in system <b>NOTE:</b> The pressure measurement cannot be switched off.
Clear Pressure Warning	0x9C60 (40032)	<b>0 = Idle</b> 1 = Reserved	<b>ACTION:</b> None <b>NOTE:</b> Any warning present in <i>Pressure Warning</i> (30037) will auto clear if the condition that caused the warning is removed.
Clear Pressure Error	0x9C61 (40033)	<b>0 = Idle</b> 1 = Reserved	<b>ACTION:</b> None <b>NOTE:</b> If an error is present in <i>Pressure Error</i> (30038) contact <a href="mailto:technical@sstsensing.com">technical@sstsensing.com</a> for guidance.
Pressure Calibration Type	0x9C62 (40034)	Reserved	<b>ACTION:</b> None
Pressure Calibration Value	0x9C63 (40035)	Reserved	<b>ACTION:</b> None
	0x9C64 (40036)	Reserved	
Pressure Calibration Control	0x9C65 (40037)	Reserved	<b>ACTION:</b> None <b>NOTE:</b> Calibration of the pressure sensor is not allowed.
Pressure Configuration Index	0x9C66 (40038)	Reserved	<b>ACTION:</b> None
Pressure Configuration Value	0x9C67 (40039)	Reserved	<b>ACTION:</b> None
	0x9C68 (40040)	Reserved	
Pressure Configuration Control	0x9C69 (40041)	Reserved	<b>ACTION:</b> None
Pressure Diagnostic Index	0x9C6A (40042)	Reserved	<b>ACTION:</b> None
Pressure Diagnostic Control	0x9C6B (40043)	Reserved	<b>ACTION:</b> None

## 3.3 Relay and 4-20mA Registers

### 3.3.1 Relay Registers

Relays provide Single Pole Single Throw (SPST) contact outputs; unless otherwise specified, relays are normally open as standard.

- Relay 1 – User configurable O<sub>2</sub> measurement alarm
- Relay 2 – O<sub>2</sub> sensor fault indication

Table 3-11 – Relay 1 – Input Registers

Name	Register Address	Description	Actions / Notes
Relay 1 ID	0x7562 (30050)	-	<b>ACTION:</b> For reference <b>NOTE:</b> Unique output identifier
Relay 1 Warning	0x7563 (30051)	Reserved	<b>ACTION:</b> None
Relay 1 Error	0x7564 (30052)	Reserved	<b>ACTION:</b> None
Relay 1 Value	0x7565 (30053)	32-bit integer (MSB 16-bits)	<b>ACTION:</b> Monitor in system
	0x7566 (30054)	32-bit integer (LSB 16-bits) 0 = Open 1 = Closed	
Relay 1 Status	0x7567 (30055)	0 = Loading System initialising, Relay 1 in start-up state 1 = Reserved 2 = Standby O <sub>2</sub> sensor measurements off, Relay 1 in standby state <b>3 = ON</b> O <sub>2</sub> sensor measurements on, Relay 1 state depends the O <sub>2</sub> measurement and the set switch points	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Relay 1 Mode = Override (40046 =1) allows the relay state in Standby and ON to be overridden for test purposes.
Relay 1 Switch Points Status	0x7568 (30056)	0 = Reserved 1 = Not Ready Modification of the switch points is currently disabled <b>2 = Ready</b> Modification of the switch points enabled 3 = Busy Modification of the switch points in progress 4 = Complete Modification of the switch points complete 5 = Error Error during the modification of the switch points	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.3.2 on page 3-20.

Name	Register Address	Description / Valid Values	Actions / Notes
Relay 1 Configuration Value Type	0x7569 (30057)	0 = Invalid 1 = 32-bit integer 2 = Floating point IEEE 754	<b>ACTION:</b> For reference <b>NOTES:</b> Relay 1 Configuration Value data format (40059 and 40060).  Used in Section 3.3.3 on page 3-21.
Relay 1 Configuration Status	0x756A (30058)	0 = Reserved 1 = Not Ready Configuration is currently disabled 2 = Ready Configuration enabled 3 = Busy Configuration in progress 4 = Complete Configuration complete 5 = Error Error during the configuration process	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.3.3 on page 3-21.
Relay 1 Diagnostic Value Type	0x756B (30059)	Reserved	<b>ACTION:</b> None
Relay 1 Diagnostic Value	0x756C (30060)	Reserved	<b>ACTION:</b> None
	0x756D (30061)	Reserved	
Relay 1 Diagnostic Status	0x756E (30062)	0 = Unavailable Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None

Table 3-12 – Relay 1 - Holding Registers

Name	Register Address	Description / Valid Values	Actions / Notes
<b>Relay 1 Warning</b>	0x9C6C (40044)	Reserved	<b>ACTION:</b> None
<b>Relay 1 Error</b>	0x9C6D (40045)	Reserved	<b>ACTION:</b> None
<b>Relay 1 Mode</b>	0x9C6E (40046)	<b>0 = Normal</b> Relay 1 state depends on O <sub>2</sub> sensor value 1 = Override User controls the relay state for test purposes	<b>ACTION:</b> Set in system <b>NOTE:</b> When <i>Override</i> is selected, the relay state is set by changing the value in <i>Relay 1 Override Value</i> (40047 and 40048).
<b>Relay 1 Override Value</b>	0x9C6F (40047)	32-bit integer (MSB 16-bits)  <b>0</b>	<b>ACTION:</b> Set/Monitor in system
	0x9C70 (40048)	32-bit integer (LSB 16-bits)  0 = Open 1 = Closed	
<b>Relay 1 Switch Points Type</b>	0x9C71 (40049)	<b>0 = Window</b> The relay will switch from the set normal state to the opposite state within the window	<b>ACTION:</b> None <b>NOTE:</b> Window function is the only option available.
<b>Relay 1 Switch Points - Input Sensor ID</b>	0x9C72 (40050)	-	<b>ACTION:</b> For reference <b>NOTE:</b> O <sub>2</sub> sensor unique identifier that Relay 1 function is linked to.
<b>Relay 1 Lower Switch Point</b>	0x9C73 (40051)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to ( <i>Relay 1 Upper Switch Point</i> – 2*( <i>Relay 1 Switch Points Hysteresis</i> )	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. This value must be less than <i>Relay 1 Upper Switch Point</i> (40053 and 40054) minus 2 x <i>Relay 1 Switch Points Hysteresis</i> (40055 and 40056).  Used in <a href="#">Section 3.3.2</a> on <a href="#">page 3-20</a> .
	0x9C74 (40052)	Floating point IEEE 754 (LSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to ( <i>Relay 1 Upper Switch Point</i> – 2*( <i>Relay 1 Switch Points Hysteresis</i> )	

Name	Register Address	Description / Valid Values	Actions / Notes
Relay 1 Upper Switch Point	0x9C75 (40053)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to (Relay 1 Lower Switch Point + 2*(Relay 1 Switch Points Hysteresis))	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. This value must be greater than Relay 1 Lower Switch Point (40051 and 40052) plus 2 x Relay 1 Switch Points Hysteresis (40055 and 40056). Used in <a href="#">Section 3.3.2</a> on <a href="#">page 3-20</a> .
	0x9C76 (40054)	Floating point IEEE 754 (LSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to (Relay 1 Lower Switch Point + 2*(Relay 1 Switch Points Hysteresis))	
Relay 1 Switch Points Hysteresis	0x9C77 (40055)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to 25.00 Recommended Range = 0.00 to 1.00	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. Used in <a href="#">Section 3.3.2</a> on <a href="#">page 3-20</a> .
	0x9C78 (40056)	Floating point IEEE 754 (LSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to 25.00 Recommended Range = 0.00 to 1.00	
Relay 1 Switch Points Control	0x9C79 (40057)	<b>0 = Nothing</b> 1 = Reserved 2 = Apply Switch Points 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in <a href="#">Section 3.3.2</a> on <a href="#">page 3-20</a> .
Relay 1 Configuration Index	0x9C7A (40058)	<b>0 = Start-up</b> State of the relay when the system is initialising 1 = Standby State of the relay when O <sub>2</sub> measurements are off 2 = Error State of the relay during an error condition 3 = Normal Normal state of the relay when O <sub>2</sub> sensor measurement is outside the set switch points window and the O <sub>2</sub> sensor is not in an error state	<b>ACTION:</b> Set/Monitor in system <b>NOTE:</b> Used in <a href="#">Section 3.3.3</a> on <a href="#">page 3-21</a> .
Relay 1 Configuration Value	0x9C7B (40059)	MSB 16-bits  <b>0</b>	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. See Relay 1 Configuration Value Type (30057) for data format. Used in <a href="#">Section 3.3.3</a> on <a href="#">page 3-21</a> .
	0x9C7C (40060)	LSB 16-bits  0 = Open 1 = Closed	

Name	Register Address	Description / Valid Values	Actions / Notes
<b>Relay 1 Configuration Control</b>	0x9C7D (40061)	<b>0 = Nothing</b> 1 = Change Index 2 = Apply Configuration 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in Section 3.3.3 on page 3-21.
<b>Relay 1 Diagnostic Index</b>	0x9C7E (40062)	Reserved	<b>ACTION:</b> None
<b>Relay 1 Diagnostic Control</b>	0x9C7F (40063)	Reserved	<b>ACTION:</b> None

### 3.3.2 Configuring Relay 1 Switch Points and Hysteresis

The relay switch points set where the relay will change state depending on the current O<sub>2</sub> sensor measurement. When the O<sub>2</sub> measurement is within the set window (between the upper and lower switch points) the relay will switch to the opposite state from the configured normal state. For example, if the relay is configured as normally open it will be open above and below the set window and closed within the set window. If only one switch point is required set the upper or lower switch point to the maximum or minimum of the sensor measurement range respectively.

Hysteresis may be added to the upper and lower switch points to avoid relay jitter when the measured O<sub>2</sub> value is fluctuating around one of the switch points. This value is also a function of the sensor measurement range, for example, if the hysteresis was set to 0.5 the relay switch points would have  $\pm 0.5\%$  O<sub>2</sub> hysteresis.

1. Confirm *Relay 1 Switch Points Status* = *Ready* (30056 = 2).
2. Change *Relay 1 Lower Switch Point* (40051 and 40052), *Relay 1 Upper Switch Point* (40053 and 40054) and *Relay 1 Switch Points Hysteresis* (40055 and 40056) as required.
3. Set *Relay 1 Switch Points Control* to *Apply Switch Points* to commit the change/s (40057 = 2).
4. Monitor *Relay 1 Switch Points Status* which will change to *Busy* momentarily then *Complete* (30056 = 3 → 4).
5. Set *Relay 1 Switch Points Control* to *Reset Status* (40057 = 3) to return *Relay 1 Switch Points Status* to *Ready* (30056 = 2).

The example given on [page 3-21](#) demonstrates the relay opening and closing as the O<sub>2</sub> measurement fluctuates, the relay is configured to be normally open, the lower switch point has been set to 8% O<sub>2</sub> and the upper to 13% O<sub>2</sub> with 1% O<sub>2</sub> hysteresis.



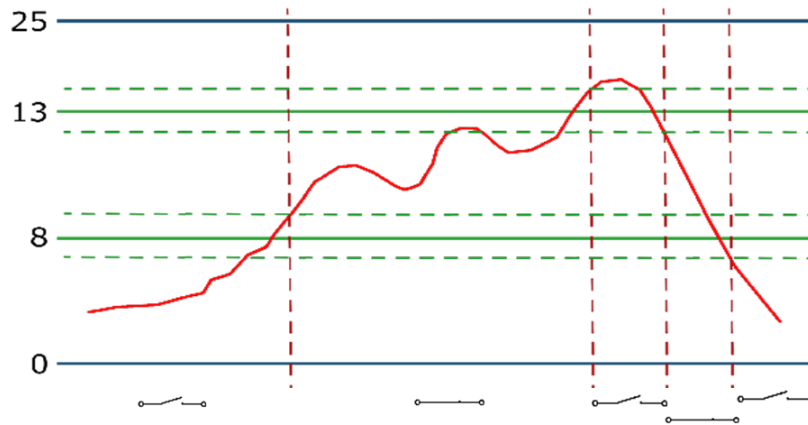


Figure 3-1

1. To begin with the sensor measurement is  $<7\%$   $O_2$  so the relay is open.
2. When the measurement exceeds  $9\%$   $O_2$  ( $8\% + 1\%$  hysteresis) the relay will close.
3. The relay will remain closed until the  $O_2$  measurement increases to above  $14\%$  ( $13\% + 1\%$  hysteresis) at which point it will open again.
4. The relay will remain open until the  $O_2$  reading falls below  $12\%$  ( $13\% - 1\%$  hysteresis) at which point it will close again.
5. The relay will remain closed until the  $O_2$  reading falls below  $7\%$  ( $8\% - 1\%$  hysteresis) at which point it will open again.

### 3.3.3 Configuring Relay 1 System States

Configure the relay state during each of the system conditions:

1. Confirm *Relay 1 Configuration Status* = *Ready* ( $30058 = 2$ ).
2. Change *Relay 1 Configuration Index* ( $40058$ ) to the system state to be configured
3. Set *Relay 1 Configuration Control* to *Change Index* to load the selected system state ( $40061 = 1$ ).
4. Change *Relay 1 Configuration Value* to the desired relay state.
5. Set *Relay 1 Configuration Control* to *Apply Configuration* to save the change ( $40061 = 2$ ).
6. Monitor *Relay 1 Configuration Status* which will change to *Busy* momentarily then *Complete* ( $30058 = 3 \rightarrow 4$ ).
7. Set *Relay 1 Configuration Control* to *Reset Status* ( $40061 = 3$ ) to return *Relay 1 Configuration Status* to *Ready* ( $30058 = 2$ ).
8. Repeat [Steps 1](#) to [7](#) for each system state as required.

Table 3-13 - Relay 2 - Input Registers

Name	Register Address	Description	Actions / Notes
Relay 2 ID	0x756F (30063)	-	<b>ACTION:</b> For reference <b>NOTE:</b> Unique output identifier.
Relay 2 Warning	0x7570 (30064)	Reserved	<b>ACTION:</b> None
Relay 2 Error	0x7571 (30065)	Reserved	<b>ACTION:</b> None
Relay 2 Value	0x7572 (30066)	32-bit integer (MSB 16-bits)	<b>ACTION:</b> Monitor in system
	0x7573 (30067)	32-bit integer (LSB 16-bits) 0 = Open 1 = Closed	
Relay 2 Status	0x7574 (30068)	0 = Loading System initialising, Relay 2 in start-up state 1 = Reserved 2 = Standby O <sub>2</sub> sensor measurements off, Relay 2 in standby state <b>3 = ON</b> O <sub>2</sub> sensor measurements on, Relay 2 state depends the O <sub>2</sub> error state	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Relay 2 Mode = Override (40066 =1) allows the relay state in Standby and ON to be overridden for test purposes.
Relay 2 Switch Points Status	0x7575 (30069)	<b>0 = Unavailable</b> Not applicable to this output 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None
Relay 2 Configuration Value Type	0x7576 (30070)	0 = Invalid <b>1 = 32-bit integer</b> 2 = Floating point IEEE 754	<b>ACTION:</b> For reference <b>NOTES:</b> Relay 2 Configuration Value data format (40079 and 40080).  Used in Section 3.3.4 on page 3-25.
Relay 2 Configuration Status	0x7577 (30071)	0 = Reserved 1 = Not Ready Configuration is currently disabled <b>2 = Ready</b> Configuration enabled 3 = Busy Configuration in progress 4 = Complete Configuration complete 5 = Error Error during the configuration process	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.3.4 on page 3-25.

Name	Register Address	Description	Actions / Notes
Relay 2 Diagnostic Value Type	0x7578 (30072)	Reserved	<b>ACTION:</b> None
Relay 2 Diagnostic Value	0x7579 (30073)	Reserved	<b>ACTION:</b> None
	0x757A (30074)	Reserved	
Relay 2 Diagnostic Status	0x757B (30075)	<b>0 = Unavailable</b> Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None

Table 3-14 - Relay 2 - Holding Registers

Name	Register Address	Description / Valid Values	Actions / Notes
Relay 2 Warning	0x9C80 (40064)	Reserved	<b>ACTION:</b> None
Relay 2 Error	0x9C81 (40065)	Reserved	<b>ACTION:</b> None
Relay 2 Mode	0x9C82 (40066)	<b>0 = Normal</b> Relay 2 state depends on O <sub>2</sub> sensor error state 1 = Override User controls the relay state for test purposes	<b>ACTION:</b> Set in system <b>NOTE:</b> When <i>Override</i> is selected the relay state is set by changing the value in <i>Relay 2 Override Value</i> (40067 and 40068).
Relay 2 Override Value	0x9C83 (40067)	32-bit integer (MSB 16-bits)  <b>0</b>	<b>ACTION:</b> Set/Monitor in system
	0x9C84 (40068)	32-bit integer (LSB 16-bits)  0 = Open 1 = Closed	
Relay 2 Switch Points Type	0x9C85 (40069)	Reserved	<b>ACTION:</b> None
Relay 2 Switch Points - Input Sensor ID	0x9C86 (40070)	-	<b>ACTION:</b> For reference <b>NOTE:</b> O <sub>2</sub> sensor unique identifier that Relay 2 function is linked to.
Relay 2 Lower Switch Point	0x9C87 (40071)	Reserved	<b>ACTION:</b> None
	0x9C88 (40072)	Reserved	
Relay 2 Upper Switch Point	0x9C89 (40073)	Reserved	<b>ACTION:</b> None
	0x9C8A (40074)	Reserved	
Relay 2 Switch Points Hysteresis	0x9C8B (40075)	Reserved	<b>ACTION:</b> None
	0x9C8C (40076)	Reserved	
Relay 2 Switch Points Control	0x9C8D (40077)	Reserved	<b>ACTION:</b> None

Name	Register Address	Description	Actions / Notes
<b>Relay 2 Configuration Index</b>	0x9C8E (40078)	<b>0 = Start-up</b> State of the relay when the system is initialising 1 = Standby State of the relay when O <sub>2</sub> measurements are off 2 = Error State of the relay during an error condition 3 = Normal Normal state of the relay when O <sub>2</sub> sensor measurement is outside the set switch points window and the O <sub>2</sub> sensor is not in an error state	<b>ACTION:</b> Set/Monitor in system <b>NOTE:</b> Used in Section 3.3.4 on page 3-25.
<b>Relay 2 Configuration Value</b>	0x9C8F (40079)	MSB 16-bits <b>0</b>	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. See <i>Relay 2 Configuration Value Type</i> (30070) for data format. Used in Section 3.3.4 on page 3-25.
	0x9C90 (40080)	LSB 16-bits 0 = Open 1 = Closed	
<b>Relay 2 Configuration Control</b>	0x9C91 (40081)	<b>0 = Nothing</b> 1 = Change Index 2 = Apply Configuration 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in Section 3.3.4 on page 3-25.
<b>Relay 2 Diagnostic Index</b>	0x9C92 (40082)	Reserved	<b>ACTION:</b> None
<b>Relay 2 Diagnostic Control</b>	0x9C93 (40083)	Reserved	<b>ACTION:</b> None

### 3.3.4 Configuring Relay 2 System States

Configure the relay state during each of the system conditions:

1. Confirm *Relay 2 Configuration Status = Ready* (30071 = 2).
2. Change *Relay 2 Configuration Index* (40078) to the system state to be configured.
3. Set *Relay 2 Configuration Control* to *Change Index* to load the selected system state (40081 = 1).
4. Change *Relay 2 Configuration Value* to the desired relay state.
5. Set *Relay 2 Configuration Control* to *Apply Configuration* to save the change (40081 = 2).
6. Monitor *Relay 2 Configuration Status* which will change to *Busy* momentarily then *Complete* (30071 = 3 → 4).
7. Set *Relay 2 Configuration Control* to *Reset Status* (40081 = 3) to return *Relay 2 Configuration Status* to *Ready* (30071 = 2).
8. Repeat [Steps 1 to 7](#) for each system state as required.

### 3.3.5 4 – 20mA Registers

The device has two factory set 4 – 20mA analogue outputs fitted;

- Analogue Out1 – set to output a range of 0 – 25% O<sub>2</sub> (4 – 20mA 1)
- Analogue Out2 – set to output a range of 260 to 1260mbar (gas pressure) (4 – 20mA 2)

Table 3-15 – Analogue Out1 (O<sub>2</sub>%) – 4-20mA 1 - Input Registers

Name	Register Address	Description	Actions / Notes
<b>4-20mA 1 ID</b>	0x757C (30076)	-	<b>ACTION:</b> For reference <b>NOTE:</b> Unique output identifier.
<b>4-20mA 1 Warning</b>	0x757D (30077)	Reserved	<b>ACTION:</b> None
<b>4-20mA 1 Error</b>	0x757E (30078)	Reserved	<b>ACTION:</b> None
<b>4-20mA 1 Value</b>	0x757F (30079)	Floating point IEEE 754 (MSB 16-bits)  Unit = mA Valid Range = 2.00 to 20.00	<b>ACTION:</b> Monitor in system
	0x7580 (30080)	Floating point IEEE 754 (LSB 16-bits)  Unit = mA Valid Range = 2.00 to 20.00	
<b>4-20mA 1 Status</b>	0x7581 (30081)	0 = Loading System initialising, 4-20mA 1 in start-up state 1 = Reserved 2 = Standby O <sub>2</sub> sensor measurements off, 4-20mA 1 in standby state <b>3 = ON</b> O <sub>2</sub> sensor measurements on, 4-20mA 1 value depends the O <sub>2</sub> measurement and the set sensor range	<b>ACTION:</b> Monitor in system <b>NOTE:</b> 4-20mA 1 Mode = Override (40086 =1) allows the Current value in <i>Standby</i> and <i>ON</i> to be overridden for test purposes.
<b>4-20mA 1 Sensor Range Status</b>	0x7582 (30082)	0 = Reserved 1 = Not Ready Modification of the sensor range is currently disabled <b>2 = Ready</b> Modification of the sensor range enabled 3 = Busy Modification of the sensor range in progress 4 = Complete Modification of the sensor range complete 5 = Error Error during the modification of the sensor range	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.3.6 on page 3-30.
<b>4-20mA 1 Configuration Value Type</b>	0x7583 (30083)	0 = Invalid 1 = 32-bit integer <b>2 = Floating point IEEE 754</b>	<b>ACTION:</b> For reference <b>NOTES:</b> 4-20mA 1 Configuration Value data format (40099 and 40100).  Used in Section 3.3.7 on page 3-30.

Name	Register Address	Description	Actions / Notes
<b>4-20mA 1 Configuration Status</b>	0x7584 (30084)	0 = Reserved 1 = Not Ready Configuration is currently disabled <b>2 = Ready</b> Configuration enabled 3 = Busy Configuration in progress 4 = Complete Configuration complete 5 = Error Error during the configuration process	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.3.7 on page 3-30.
<b>4-20mA 1 Diagnostic Value Type</b>	0x7585 (30085)	Reserved	<b>ACTION:</b> None
<b>4-20mA 1 Diagnostic Value</b>	0x7586 (30086)	Reserved	<b>ACTION:</b> None
	0x7587 (30087)	Reserved	
<b>4-20mA 1 Diagnostic Status</b>	0x7588 (30088)	<b>0 = Unavailable</b> Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None

Table 3-16 – Analogue Out1 (O<sub>2</sub>%) – 4-20mA 1 – Holding Registers

Name	Register Address	Description / Valid Values	Actions / Notes
<b>4-20mA 1 Warning</b>	0x9C94 (40084)	Reserved	<b>ACTION:</b> None
<b>4-20mA 1 Error</b>	0x9C95 (40085)	Reserved	<b>ACTION:</b> None
<b>4-20mA 1 Mode</b>	0x9C96 (40086)	<b>0 = Normal</b> 4-20mA 1 value depends on O <sub>2</sub> sensor value <b>1 = Override</b> User controls the 4-20mA 1 value for test purposes	<b>ACTION:</b> Set in system <b>NOTE:</b> When <i>Override</i> is selected the 4-20mA 1 state is set by changing the value in <i>4-20mA 1 Override Value</i> (40087 and 40088).
<b>4-20mA 1 Override Value</b>	0x9C97 (40087)	Floating point IEEE 754 (MSB 16-bits)  Unit = mA Valid Range = 2.00 to 20.00	<b>ACTION:</b> Set/Monitor in system
	0x9C98 (40088)	Floating point IEEE 754 (LSB 16-bits)  Unit = mA Valid Range = 2.00 to 20.00	
<b>4-20mA 1 Sensor Range Type</b>	0x9C99 (40089)	<b>0 = Sensor Range</b> The 4-20mA 1 value will vary linearly between the minimum and maximum set sensor range	<b>ACTION:</b> None <b>NOTE:</b> Sensor range is the only option available.
<b>4-20mA 1 Sensor Range - Input Sensor ID</b>	0x9C9A (40090)	-	<b>ACTION:</b> For reference <b>NOTE:</b> O <sub>2</sub> sensor unique identifier that the 4-20mA 1 function is linked to.
<b>4-20mA 1 Lower Sensor Range</b>	0x9C9B (40091)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to (4-20mA 1 Upper Sensor Range – 0.01) Recommended Range = 0.00 to (4-20mA 1 Upper Sensor Range – 1.00)	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. This value must be less than 4-20mA 1 Upper Sensor Range (40093 and 40094).  Used in <a href="#">Section 3.3.6</a> on <a href="#">page 3-30</a> .
	0x9C9C (40092)	Floating point IEEE 754 (LSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = 0.00 to (4-20mA 1 Upper Sensor Range – 0.01) Recommended Range = 0.00 to (4-20mA 1 Upper Sensor Range – 1.00)	



Name	Register Address	Description / Valid Values	Actions / Notes
<b>4-20mA 1 Upper Sensor Range</b>	0x9C9D (40093)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = (4-20mA 1 Lower Sensor Range + 0.01) to 25.00 Recommended Range = (4-20mA 1 Lower Sensor Range + 1.00) to 25.00	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. This value must be less than 4-20mA 1 Lower Sensor Range (40091 and 40092).  Used in <a href="#">Section 3.3.6</a> on <a href="#">page 3-30</a> .
	0x9C9E (40094)	Floating point IEEE 754 (MSB 16-bits)  Unit = % O <sub>2</sub> Valid Range = (4-20mA 1 Lower Sensor Range + 0.01) to 25.00 Recommended Range = (4-20mA 1 Lower Sensor Range + 1.00) to 25.00	
<b>4-20mA 1 Sensor Range Hysteresis</b>	0x9C9F (40095)	Reserved	<b>ACTION:</b> None
	0x9CA0 (40096)	Reserved	
<b>4-20mA 1 Sensor Range Control</b>	0x9CA1 (40097)	<b>0 = Nothing</b> 1 = Reserved 2 = Apply Sensor Range 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in <a href="#">Section 3.3.6</a> on <a href="#">page 3-30</a> .
<b>4-20mA 1 Configuration Index</b>	0x9CA2 (40098)	<b>0 = Start-up</b> 4-20mA 1 value when the system is initialising 1 = Standby 4-20mA 1 value when O <sub>2</sub> measurements are off 2 = Error 4-20mA 1 value during an error condition	<b>ACTION:</b> Set/Monitor in system <b>NOTE:</b> Used in <a href="#">Section 3.3.7</a> on <a href="#">page 3-30</a> .
<b>4-20mA 1 Configuration Value</b>	0x9CA3 (40099)	MSB 16-bits  Unit = mA Valid Range = 2.00 to 20.00	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. See 4-20mA 1 Configuration Value Type (30083) for data format.  Used in <a href="#">Section 3.3.7</a> on <a href="#">page 3-30</a> .
	0x9CA4 (40100)	LSB 16-bits  Unit = mA Valid Range = 2.00 to 20.00	
<b>4-20mA 1 Configuration Control</b>	0x9CA5 (40101)	<b>0 = Nothing</b> 1 = Change Index 2 = Apply Configuration 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in <a href="#">Section 3.3.7</a> on <a href="#">page 3-30</a> .
<b>4-20mA 1 Diagnostic Index</b>	0x9CA6 (40102)	Reserved	<b>ACTION:</b> None
<b>4-20mA 1 Diagnostic Control</b>	0x9CA7 (40103)	Reserved	<b>ACTION:</b> None

### 3.3.6 Configuring the Sensor Range Applied to 4-20mA 1

The 4-20mA 1 output is factory set to represent a sensor range of 0 – 25% O<sub>2</sub>; where 0% O<sub>2</sub> is equal to 4mA and 25% O<sub>2</sub> is equal to 20mA.

This applied sensor range is configurable; an example of changing the lower and upper sensor ranges would be in a combustion atmosphere where the O<sub>2</sub> range is between 5 – 21%. The user could set the lower output range to 4% and the upper output range to 22% and the 4-20mA 1 output would vary linearly in between.

**NOTE:** The lower and upper ranges lock out the output at the set limits so in the example above, 4% O<sub>2</sub> or below would clamp the output to 4mA and 22% O<sub>2</sub> or above would clamp the output to 20mA.

1. Confirm *4-20mA 1 Sensor Range Status = Ready* (30082 = 2).
2. Change *4-20mA 1 Lower Sensor Range* (40091 and 40092) and *4-20mA 1 Upper Sensor Range* (40093 and 40094) as required.
3. Set *4-20mA 1 Sensor Range Control* to *Apply Sensor Range* to commit the change/s (40097 = 2).
4. Monitor *4-20mA 1 Sensor Range Status* which will change to *Busy* momentarily then *Complete* (30082 = 3 → 4).
5. Set *4-20mA 1 Sensor Range Control* to *Reset Status* (40097 = 3) to *4-20mA 1 Sensor Range Status* to *Ready* (30082 = 2).

### 3.3.7 Configuring 4-20mA 1 Value During Other System States

Configure 4-20mA 1 output during each of the other system conditions when the output is not proportional to the O<sub>2</sub> sensor output.

1. Confirm *4-20mA 1 Configuration Status = Ready* (30084 = 2).
2. Change *4-20mA 1 Configuration Index* (40098) to the system state to be configured.
3. Set *4-20mA 1 Configuration Control* to *Change Index* to load the selected system state (40101 = 1).
4. Change *4-20mA 1 Configuration Value* to the desired 4-20mA 1 output.
5. Set *4-20mA 1 Configuration Control* to *Apply Configuration* to save the change (40101 = 2).
6. Monitor *4-20mA 1 Configuration Status* which will change to *Busy* momentarily then *Complete* (30084 = 3 → 4).
7. Set *4-20mA 1 Configuration Control* to *Reset Status* (40101 = 3) to return *4-20mA 1 Configuration Status* to *Ready* (30084 = 2).
8. Repeat [Steps 1 to 7](#) for each system state as required.

Table 3-16 – Analogue Out2 (pressure) – 4-20mA 2 - Input Registers

Name	Register Address	Description	Actions / Notes
<b>4-20mA 2 ID</b>	0x7589 (30089)	-	<b>ACTION:</b> For reference <b>NOTE:</b> Unique output identifier.
<b>4-20mA 2 Warning</b>	0x758A (30090)	Reserved	<b>ACTION:</b> None
<b>4-20mA 2 Error</b>	0x758B (30091)	Reserved	<b>ACTION:</b> None
<b>4-20mA 2 Value</b>	0x758C (30092)	Floating point IEEE 754 (MSB 16-bits)  Unit = mA Valid Range = 2.00 to 20.00	<b>ACTION:</b> Monitor in system
	0x758D (30093)	Floating point IEEE 754 (LSB 16-bits)  Unit = mA Valid Range = 2.00 to 20.00	
<b>4-20mA 2 Status</b>	0x758E (30094)	0 = Loading System initialising, 4-20mA 2 in start-up state 1 = Reserved 2 = Standby Pressure sensor measurements off, 4-20mA 2 in standby state <b>3 = ON</b> Pressure sensor measurements on, 4-20mA 2 value depends the pressure measurement and the set sensor range	<b>ACTION:</b> Monitor in system <b>NOTE:</b> 4-20mA 2 Mode = <i>Override</i> (40106 =1) allows the Current value in <i>Standby</i> and <i>ON</i> to be overridden for test purposes.
<b>4-20mA 2 Sensor Range Status</b>	0x758F (30095)	0 = Reserved 1 = Not Ready Modification of the sensor range is currently disabled <b>2 = Ready</b> Modification of the sensor range enabled 3 = Busy Modification of the sensor range in progress 4 = Complete Modification of the sensor range complete 5 = Error Error during the modification of the sensor range	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.3.8 on page 3-35.
<b>4-20mA 2 Configuration Value Type</b>	0x7590 (30096)	0 = Invalid 1 = 32-bit integer <b>2 = Floating point IEEE 754</b>	<b>ACTION:</b> For reference <b>NOTES:</b> 4-20mA 2 Configuration Value data format (40119 and 40120).  Used in Section 3.3.9 on page 3-35.

Name	Register Address	Description	Actions / Notes
<b>4-20mA 2 Configuration Status</b>	0x7591 (30097)	0 = Reserved 1 = Not Ready Configuration is currently disabled <b>2 = Ready</b> Configuration enabled 3 = Busy Configuration in progress 4 = Complete Configuration complete 5 = Error Error during the configuration process	<b>ACTION:</b> Monitor in system <b>NOTE:</b> Used in Section 3.3.7 on page 3-30.
<b>4-20mA 2 Diagnostic Value Type</b>	0x7592 (30098)	Reserved	<b>ACTION:</b> None
<b>4-20mA 2 Diagnostic Value</b>	0x7593 (30099)	Reserved	<b>ACTION:</b> None
	0x7594 (30100)	Reserved	
<b>4-20mA 2 Diagnostic Status</b>	0x7595 (30101)	<b>0 = Unavailable</b> Not applicable to this sensor 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Reserved	<b>ACTION:</b> None

Table 3-17 – Analogue Out2 (temp) – 4-20mA 2 - Holding Registers

Name	Register Address	Description / Valid Values	Actions / Notes
<b>4-20mA 2 Warning</b>	0x9CA8 (40104)	Reserved	<b>ACTION:</b> None
<b>4-20mA 2 Error</b>	0x9CA9 (40105)	Reserved	<b>ACTION:</b> None
<b>4-20mA 2 Mode</b>	0x9CAA (40106)	<b>0 = Normal</b> 4-20mA 2 value depends on gas pressure value <b>1 = Override</b> User controls the 4-20mA 2 value for test purposes	<b>ACTION:</b> Set in system <b>NOTE:</b> When <i>Override</i> is selected the 4-20mA 2 state is set by changing the value in <i>4-20mA 2 Override Value</i> (40107 and 40108).
<b>4-20mA 2 Override Value</b>	0x9CAB (40107)	Floating point IEEE 754 (MSB 16-bits)  Unit = mA Valid Range = 2.00 to 20.00	<b>ACTION:</b> Set/Monitor in system
	0x9CAC (40108)	Floating point IEEE 754 (LSB 16-bits)  Unit = mA Valid Range = 2.00 to 20.00	
<b>4-20mA 2 Sensor Range Type</b>	0x9CAD (40109)	<b>0 = Sensor Range</b> The 4-20mA 2 value will vary linearly between the minimum and maximum set temperature range	<b>ACTION:</b> None <b>NOTE:</b> Sensor range is the only option available.
<b>4-20mA 2 Sensor Range - Input Sensor ID</b>	0x9CAE (40110)	-	<b>ACTION:</b> For reference <b>NOTE:</b> Pressure sensor unique identifier that the 4-20mA 2 function is linked to.
<b>4-20mA 2 Lower Sensor Range</b>	0x9CAF (40111)	Floating point IEEE 754 (MSB 16-bits)  Unit = mbar Valid Range = 260 to (4-20mA 2 Upper Sensor Range – 0.01) Recommended Range = 260 to (4-20mA 2 Upper Sensor Range – 1.00)	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. This value must be less than 4-20mA 2 Upper Sensor Range (40113 and 40114).  Used in <a href="#">Section 3.3.8</a> on <a href="#">page 3-35</a> .
	0x9CB0 (40112)	Floating point IEEE 754 (LSB 16-bits)  Unit = mbar Valid Range = 260 to (4-20mA 2 Upper Sensor Range – 0.01) Recommended Range = 260 to (4-20mA 2 Upper Sensor Range – 1.00)	

Name	Register Address	Description / Valid Values	Actions / Notes
<b>4-20mA 2 Upper Sensor Range</b>	0x9CB1 (40113)	Floating point IEEE 754 (MSB 16-bits)  Unit = mbar Valid Range = (4-20mA 2 Lower Sensor Range + 0.01) to 1260 Recommended Range = (4-20mA 2 Lower Sensor Range + 1.00) to 1260	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. This value must be less than 4-20mA 2 Lower Sensor Range (40111 and 40112).  Used in <a href="#">Section 3.3.8</a> on <a href="#">page 3-35</a> .
	0x9CB2 (40114)	Floating point IEEE 754 (MSB 16-bits)  Unit = mbar Valid Range = (4-20mA 2 Lower Sensor Range + 0.01) to 1260 Recommended Range = (4-20mA 2 Lower Sensor Range + 1.00) to 1260	
<b>4-20mA 2 Sensor Range Hysteresis</b>	0x9CB3 (40115)	Reserved	<b>ACTION:</b> None
	0x9CB4 (40116)	Reserved	
<b>4-20mA 2 Sensor Range Control</b>	0x9CB5 (40117)	<b>0 = Nothing</b> 1 = Reserved 2 = Apply Sensor Range 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in <a href="#">Section 3.3.8</a> on <a href="#">page 3-35</a> .
<b>4-20mA 2 Configuration Index</b>	0x9CB6 (40118)	<b>0 = Start-up</b> 4-20mA 2 value when the system is initialising 1 = Standby 4-20mA 2 value when pressure measurements are off 2 = Error 4-20mA 2 value during an error condition	<b>ACTION:</b> Set/Monitor in system <b>NOTE:</b> Used in <a href="#">Section 3.3.9</a> on <a href="#">page 3-35</a> .
<b>4-20mA 2 Configuration Value</b>	0x9CB7 (40119)	MSB 16-bits  Unit = mA Valid Range = 2.00 to 20.00	<b>ACTION:</b> Set/Monitor in system <b>NOTES:</b> Any changes are saved in EEPROM and retained on power loss. See 4-20mA 2 Configuration Value Type (30096) for data format.  Used in <a href="#">Section 3.3.9</a> on <a href="#">page 3-35</a> .
	0x9CB8 (40120)	LSB 16-bits  Unit = mA Valid Range = 2.00 to 20.00	
<b>4-20mA 2 Configuration Control</b>	0x9CB9 (40121)	<b>0 = Nothing</b> 1 = Change Index 2 = Apply Configuration 3 = Reset Status	<b>ACTION:</b> Set in system <b>NOTE:</b> Used in <a href="#">Section 3.3.9</a> on <a href="#">page 3-35</a> .
<b>4-20mA 2 Diagnostic Index</b>	0x9CBA (40122)	Reserved	<b>ACTION:</b> None
<b>4-20mA 2 Diagnostic Control</b>	0x9CBB (40123)	Reserved	<b>ACTION:</b> None

### 3.3.8 Configuring the Sensor Range Applied to 4-20mA 2

The 4-20mA 2 output is factory set to represent a pressure range of 260 – 1260mbar; where 260mbar is equal to 4mA and 1260mbar is equal to 20mA.

**NOTE:** If you wish to change the range values, follow the process below.

1. Confirm *4-20mA 2 Sensor Range Status = Ready* (30095 = 2).
2. Change *4-20mA 2 Lower Sensor Range* (40111 and 40112) and *4-20mA 2 Upper Sensor Range* (40113 and 40114) as required.
3. Set *4-20mA 2 Sensor Range Control* to *Apply Sensor Range* to commit the change/s (40117 = 2).
4. Monitor *4-20mA 2 Sensor Range Status* which will change to *Busy* momentarily then *Complete* (30095 = 3 → 4).
5. Set *4-20mA 2 Sensor Range Control* to *Reset Status* (40117 = 3) to *4-20mA 2 Sensor Range Status* to *Ready* (30095 = 2).

### 3.3.9 Configuring 4-20mA 2 Value During Other System States

Configure 4-20mA 2 output during each of the other system conditions when the output is not proportional to the pressure sensor output.

1. Confirm *4-20mA 2 Configuration Status = Ready* (30097 = 2).
2. Change *4-20mA 2 Configuration Index* (40118) to the system state to be configured.
3. Set *4-20mA 2 Configuration Control* to *Change Index* to load the selected system state (40121 = 1).
4. Change *4-20mA 2 Configuration Value* to the desired 4-20mA 2 output.
5. Set *4-20mA 2 Configuration Control* to *Apply Configuration* to save the change (40121 = 2).
6. Monitor *4-20mA 2 Configuration Status* which will change to *Busy* momentarily then *Complete* (30097 = 3 → 4).
7. Set *4-20mA 2 Configuration Control* to *Reset Status* (40121 = 3) to return *4-20mA 2 Configuration Status* to *Ready* (30097 = 2).
8. Repeat [Steps 1 to 7](#) for each system state as required.

## REFERENCE DOCUMENTS

Reference documents are listed below. The SST documentation list is not exhaustive, always refer to the [SST website](#) for the latest information.

**NOTE:** Any industry standards referenced, always refer to the appropriate website to ensure the most up-to-date version is used.

Part Number	Title
UG-003-B2	Gastrack Gas Analyser Probe (GAP) – Installation, Operation and Maintenance Guide
QS-004	Gastrack Gas Analyser Probe (GAP) – Quick Start Guide
DS-0137	Gastrack Gas Analyser Probe (GAP) – Datasheet



### INFORMATION

As customer applications are outside of SST Sensing Limited's control, the information provided is given without legal responsibility. Customers should test under their own conditions to ensure that the equipment is suitable for their intended application.

For technical assistance or advice, please contact [technical@sstsensing.com](mailto:technical@sstsensing.com).

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