



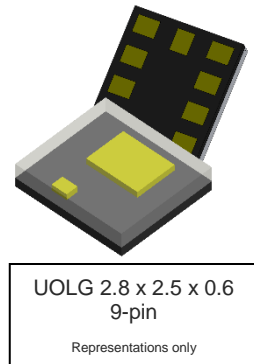
## IQS621 Datasheet

Combination sensor with ambient light sensing (ALS), capacitive proximity/touch, Hall-effect sensor & inductive sensing capabilities

The IQS621 ProxFusion® IC is a multifunctional, ambient light sensing (ALS), capacitive, Hall-effect & inductive sensor designed for applications where any or all of the technologies may be required. The IQS621 is an ultra-low power solution designed for short or long term activations through any of the sensing channels. The IQS621 is fully I<sup>2</sup>C compatible.

### Features

- **Unique combination of sensing technologies:**
  - Capacitive sensing
  - Ambient light sensing (ALS)
  - Hall-effect sensing
  - Inductive sensing
- **Capacitive sensing**
  - Full auto-tuning with adjustable sensitivity
  - 2pF to 200pF external capacitive load capability
  - Enhanced temperature stability
- **Ambient light sensing (ALS)**
  - Absolute lux output
  - Human eye response compensated
  - 4-bit ALS range output (0 - 10)
  - Dual threshold detection for day/night indication with hysteresis
- **Hall-effect sensing**
  - On-chip Hall-effect measurement plates
  - Dual direction Hall switch sensor UI
  - 2 level detection (widely variable)
  - Detection range 10mT – 200mT
- **Inductive sensing**
  - 2 Level detection and hysteresis for inductive sensing
  - Only external sense coil required (PCB trace)
- **Multiple integrated UI options** based on years of experience in sensing on fixed and mobile platforms:
  - Proximity / Touch
  - Proximity wake-up
- **Automatic Tuning Implementation (ATI)** – performance enhancement (10bit)
- **Minimal external components**
- **Standard I<sup>2</sup>C interface**
- **Optional RDY indication** for event mode operation
- **Low power consumption:**
  - 75uA (100Hz response, 1ch inductive)
  - 95uA (100Hz response, 2ch Hall)
  - 75uA (100Hz response, 3ch capacitive)
  - 60uA (100Hz response, ALS)
  - 25uA (20Hz response, 1ch inductive)
  - 25uA (20Hz response, 2ch Hall)
  - 20uA (20Hz response, 3ch capacitive)
  - 18uA (20Hz response, ALS)
  - 2.5uA (4Hz response, 1ch cap. wake-up)
- **Supply voltage:** 1.8V to 3.3V
- **Low profile UOLG - 2.8 x 2.5 x 0.6 - 9-pin package**



### Applications

- Mobile electronics (phones/tablets)
- Home automation & lighting control
- White goods and appliances
- Wearable devices
- Human Interface Devices
- Aftermarket automotive<sup>1</sup>

Available Packages	
T <sub>A</sub>	UOLG-2.8 x 2.5 x 0.6–9N
-20°C to +85°C	IQS621

<sup>1</sup> The part is not automotive qualified.



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## List of abbreviations

AC	– Alternating Current
ACK	– I <sup>2</sup> C Acknowledge condition
ALS	– Ambient Light Sensing
ATI	– Automatic Tuning Implementation
BOD	– Brown Out Detection
CS	– Sampling Capacitor
DSP	– Digital Signal Processing
ESD	– Electrostatic Discharge
FOSC	– Main Clock Frequency Oscillator
GND	– Ground
GPIO	– General Purpose Input Output
I <sup>2</sup> C	– Inter-Integrated Circuit
IC	– Integrated Circuit
LP	– Low Power
LPOSC	– Low Power Oscillator
LTA	– Long Term Average
LTX	– Inductive Transmitting electrode
MCU	– Microcontroller unit
MSL	– Moisture Sensitive Level
MOQ	– Minimum Order Quantity
NACK	– I <sup>2</sup> C Not Acknowledge condition
NC	– Not Connect
NP	– Normal Power
OTP	– One Time Programmable
PMU	– Power Management Unit
POR	– Power On Reset
PWM	– Pulse Width Modulation
QRD	– Quick Release Detection
RDY	– Ready Interrupt Signal
RX	– Receiving electrode
SAR	– Specific Absorption Rate
SCL	– I <sup>2</sup> C Clock
SDA	– I <sup>2</sup> C Data
SR	– Slew rate
THR	– Threshold
UI	– User Interface
ULP	– Ultra Low Power



# 1 Introduction

## 1.1 ProxFusion®

The ProxFusion® sensor series provide all the proven ProxSense® engine capabilities with additional sensors types. A combined sensor solution is available within a single platform.

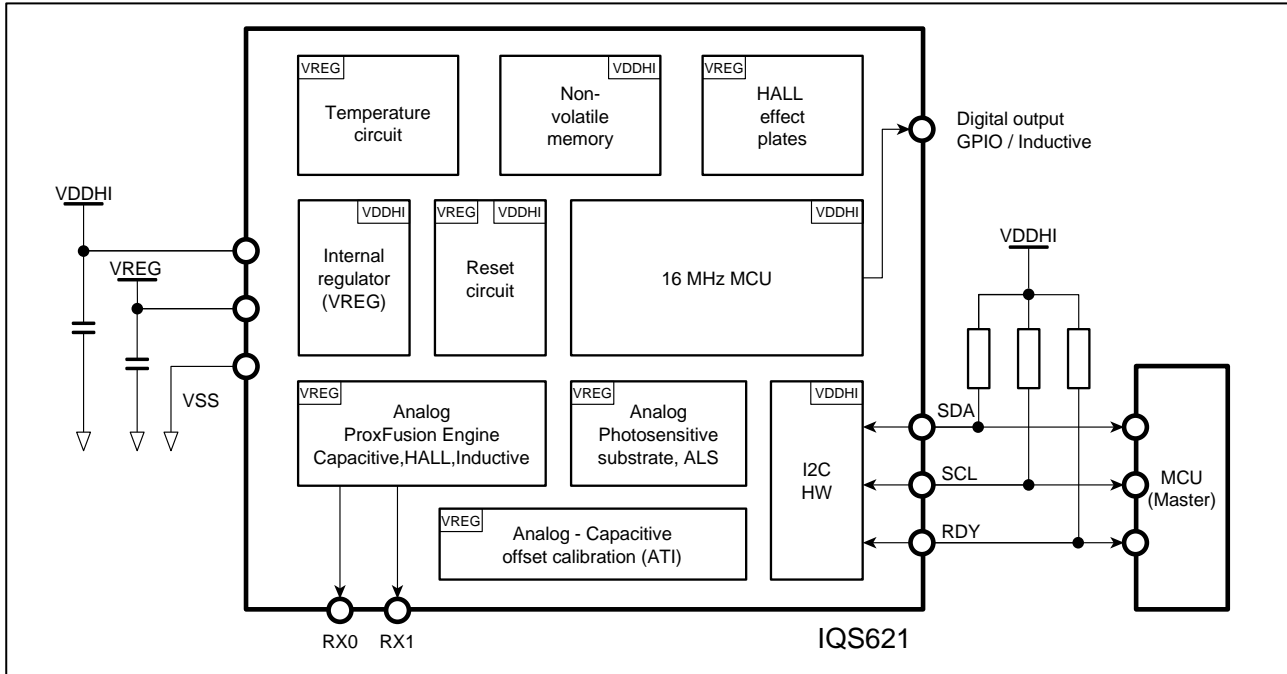
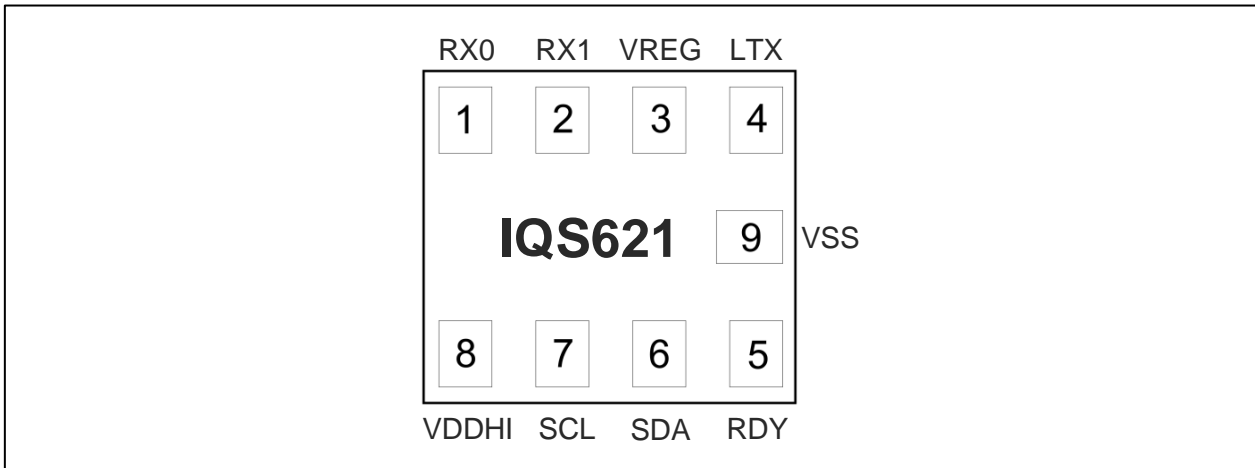


Figure 1.1 IQS621 functional block diagram

## 1.2 Packaging and Pin-Out



**Figure 1.2** IQS621 pin-out (UOLG-2.8x2.5x0.6–9-pin package top view; appearance may differ)

**Table 1.1** Pin-out description

IQS621 in UOLG-2.8 x 2.5 x 0.6 – 9-pin			
Pin	Name	Type	Function
1	RX0	Analogue receiving electrode	Connect to conductive area intended for sensor receiving
2	RX1	Analogue receiving electrode	Connect to conductive area intended for sensor receiving
3	VREG	Voltage regulator output	Regulates the system's internal voltage Requires external capacitors to ground
4	LTX	Transmitter electrode	Connect to conductive area intended for sensor transmitting
5	RDY	Digital Input / Output	<b>RDY</b> (I <sup>2</sup> C Ready interrupt signal)
6	SDA	Digital Input / Output	<b>SDA</b> (I <sup>2</sup> C Data signal)
7	SCL	Digital Input / Output	<b>SCL</b> (I <sup>2</sup> C Clock signal)
8	VDDHI	Supply Input	Supply: 1.8V – 3.3V
9	VSS	Signal GND	Common ground reference



### 1.3 Reference schematic

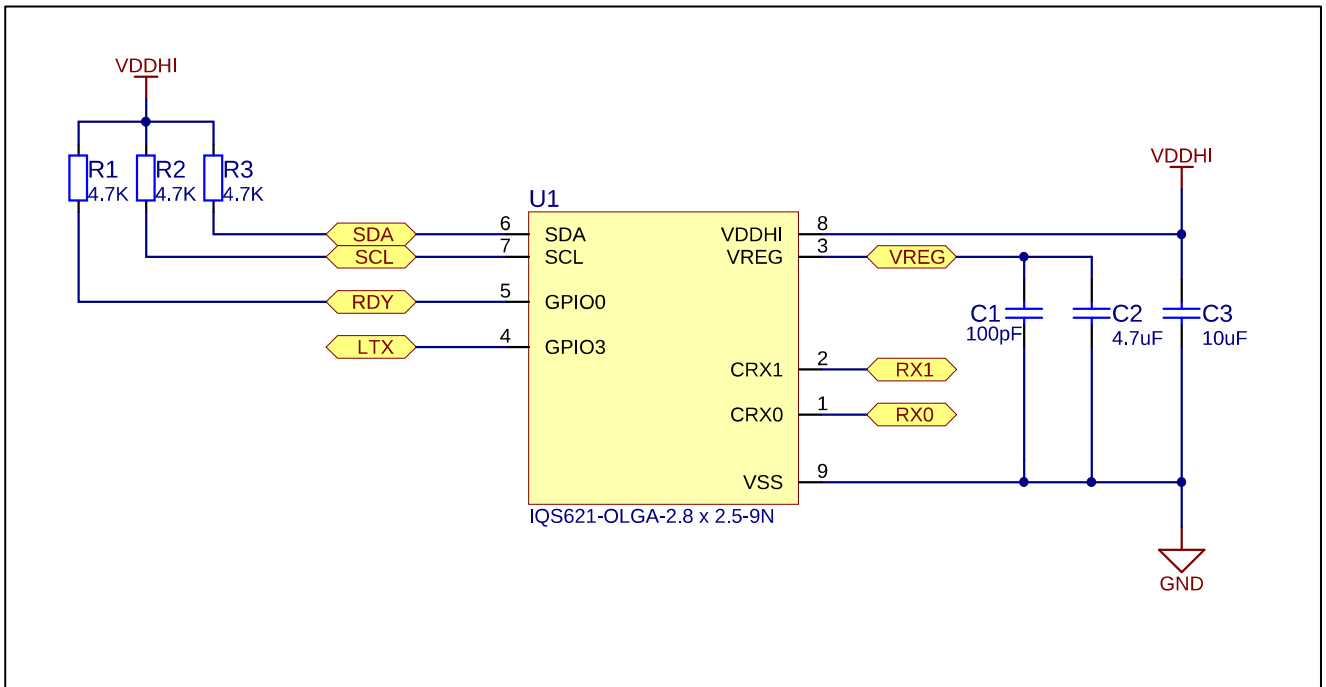


Figure 1.3 IQS621 reference schematic



## 1.4 Sensor channel combinations

The table below summarizes the IQS621 sensor and channel associations.

**Table 1.2 Sensor - channel allocation**

Sensor / UI type		CH0	CH1	CH2	CH3	CH4	CH5	CH6
Capacitive	Self capacitive	○	○	○				
	Hysteresis UI		●					
Inductive	Mutual inductive	○	○					
	Hysteresis UI		●					
ALS	Ambient light sensing				●	●		
Hall-effect	Hall-effect switch UI						● Positive	● Negative
Temperature	Temperature trip and output			●				

Key:

- - Optional implementation
- - Fixed use for UI





## 1.5 ProxFusion® Sensitivity

The measurement circuitry uses a temperature stable internal sample capacitor ( $C_S$ ) and internal regulated voltage ( $V_{REG}$ ). Internal regulation provides for more accurate measurements over temperature variation. The size  $C_S$  can be decreased to increase sensitivity on the capacitive channels of the IQS621.

$$Sensitivity \propto \frac{1}{C_S}$$

The Automatic Tuning Implementation (ATI) is a sophisticated technology implemented on the ProxFusion® series devices. It allows for optimal performance of the devices for a wide range of sense electrode capacitances, without modification or addition of external components. The ATI functionality ensures that sensor sensitivity is not affected by external influences such as temperature, parasitic capacitance and ground reference changes.

The ATI process adjusts three values (Coarse multiplier, Fine multiplier, Compensation) using two parameters (ATI base and ATI target) as inputs. A 10-bit compensation value ensures that an accurate target is reached. The base value influences the overall sensitivity of the channel and establishes a base count from where the ATI algorithm starts executing. A rough estimation of sensitivity can be calculated as:

$$Sensitivity \propto \frac{Target}{Base}$$

As seen from this equation, the sensitivity can be increased by either increasing the Target value or decreasing the Base value. A lower base value will typically result in lower multipliers and more compensation would be required. It should, however, be noted that a higher sensitivity will yield a higher noise susceptibility. Refer to Appendix B: Hall ATI for more information on Hall ATI.



## 2 Capacitive sensing

### 2.1 Introduction to ProxSense®

Building on the previous successes from the ProxSense® range of capacitive sensors, the same fundamental sensor engine has been implemented in the ProxFusion® series.

The capacitive sensing capabilities of the IQS621 include:

- Self capacitive sensing.
- Maximum of 2 capacitive channels to be individually configured.
  - Prox and touch adjustable thresholds
  - Individual sensitivity setups
  - Alternative ATI modes
- Discreet button UI (always enabled):
  - Fully configurable 2 level threshold setups for prox & touch activation levels.
  - Customizable filter halt time.
- Hysteresis UI:
  - 4 Optional prox and touch activation hysteresis selections
  - Fully configurable 2 level threshold setups for prox & touch activation levels.
  - Configurable filter halt threshold.

### 2.2 Channel specifications

The IQS621 provides a maximum of 2 channels available to be configured for capacitive sensing. Each channel can be setup separately according to the channel's associated settings registers.

There are two distinct capacitive user interfaces available to be used.

- a) Discreet proximity/touch UI (always enabled)
- b) Hysteresis UI (fixed use of channel 1)

**Table 2.1 Capacitive sensing - channel allocation**

Sensor/UI type	CH0	CH1	CH2	CH3	CH4	CH5	CH6
Self capacitive	○	○					
Hysteresis UI		•					

Key:

- - Optional implementation
- - Fixed use for UI

### 2.3 Hardware configuration

In the table below are multiple options of configuring sensing (RX) and transmitting (LTX) electrodes to realize different implementations (combinations not shown).

**Table 2.2    Capacitive sensing hardware description**

	Self capacitive
<b>1 button</b>	
<b>2 buttons</b>	



## 2.4 Software configuration

### 2.4.1 Registers to configure for capacitive sensing:

**Table 2.3 Capacitive sensing settings registers**

Address	Name	Description	Recommended setting
<b>0x40</b> <b>0x41</b>	ProxFusion Settings 0	Sensor mode and configuration of each channel.	Sensor mode should be set to capacitive mode An appropriate RX and TX should be chosen
<b>0x42</b> <b>0x43</b>	ProxFusion Settings 1	Channel settings for the ProxSense sensors	Full ATI is recommended for fully automated sensor tuning.
<b>0x44</b> <b>0x45</b>	ProxFusion Settings 2	ATI settings for ProxSense sensors	ATI target should be more than ATI base to achieve an ATI
<b>0x46</b> <b>0x47</b>	ProxFusion Settings 3	Additional Global settings for ProxSense sensors	None
<b>0x48</b>	ProxFusion Settings 4	Filter settings	Keep AC filter enabled
<b>0x49</b>	ProxFusion Settings 5	Advance sensor settings	None
<b>0x50</b> <b>0x52</b>	Proximity threshold	Proximity Thresholds for all capacitive channels (except for SAR active on channel 0)	Preferably more than touch threshold
<b>0x51</b> <b>0x53</b>	Touch threshold	Touch Thresholds for all capacitive channels	None
<b>0x54</b>	ProxFusion discrete UI halt time	Halt timeout setting for all capacitive channels	None

### 2.4.2 Registers to configure for the hysteresis UI:

**Table 2.4 Hysteresis UI settings registers**

Address	Name	Description
<b>0x48</b>	ProxFusion settings 4	Hysteresis UI enable command
<b>0x60</b>	Hysteresis UI Settings	Hysteresis settings for the prox and touch thresholds
<b>0x61</b>	Hysteresis UI filter halt threshold	Threshold setting to trigger a filter halt for on channel 1
<b>0x62</b>	Hysteresis UI proximity threshold	Proximity threshold used for hysteresis UI detections on channel 1
<b>0x63</b>	Hysteresis UI touch threshold	Touch threshold used for hysteresis UI detections on channel 1

### 2.4.3 Example code:

Example code for an Arduino Uno can be downloaded at:

[www.azoteq.com/images/stories/software/IQS62x\\_Demo.zip](http://www.azoteq.com/images/stories/software/IQS62x_Demo.zip)



## 2.5 Sensor data output and flags

The following registers should be monitored by the master to detect capacitive sensor activations:

- a) The **Global events register (0x11)** will show the IQS621's main events. Bit0 is dedicated to the ProxFusion activations.

Global events (0x11)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R	R	R	R	R	R	R
Name	-	POWER MODE EVENT	SYS EVENT	TEMP EVENT	HYSTERESIS UI EVENT	ALS EVENT	HALL EVENT	PROX SENSE EVENT

- b) The **ProxFusion UI flags (0x12)** provide more detail regarding the capacitive sensor outputs. An individual prox and touch output bit for channel 0 and 1 is provided in the ProxFusion UI flags register.

ProxFusion UI flags (0x12)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	R	R	-	-	R	R
Name	-	-	CH1_T	CH0_T	-	-	CH1_P	CH0_P

- c) The **Hysteresis UI flags (0x12)** provide more detail regarding the capacitive sensor outputs for the Hysteresis UI. An individual prox and touch output bit for channel 1 is provided in the Hysteresis UI flags register.

Hysteresis UI flags (0x13)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	-	-	-	R	R	R
Name	-	-	-	-	-	Signed output	TOUCH	PROX

- a) The **Hysteresis UI output (0x14 & 0x15)** provide the exact Hysteresis UI output value.

Hysteresis UI output (0x14/0x15)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Hysteresis UI output low byte							
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Hysteresis UI output high byte							



### 3 Inductive sensing

#### 3.1 Introduction to inductive sensing

The IQS621 provides inductive sensing capabilities in order to detect the presence of metal/metal-type objects. Prox and touch thresholds are widely adjustable and individual hysteresis settings are definable for each using the Hysteresis UI.

#### 3.2 Channel specifications

The IQS621 requires both Rx sensing pins as well as the Tx pin for mutual inductive sensing. Channel 1 is dedicated to the Hysteresis UI.

There are two distinct inductive user interfaces available to be used.

- Discreet button UI (always enabled):
  - Fully configurable 2 level threshold Prox & Touch activation.
  - Customizable UI halt time.
- Hysteresis UI:
  - Fully configurable 2 level threshold Prox & Touch activation.
  - 4 Hysteresis selection options
  - Customizable UI halt time.
  - Configurable filter halt threshold.

**Table 3.1 Mutual inductive sensor – channel allocation**

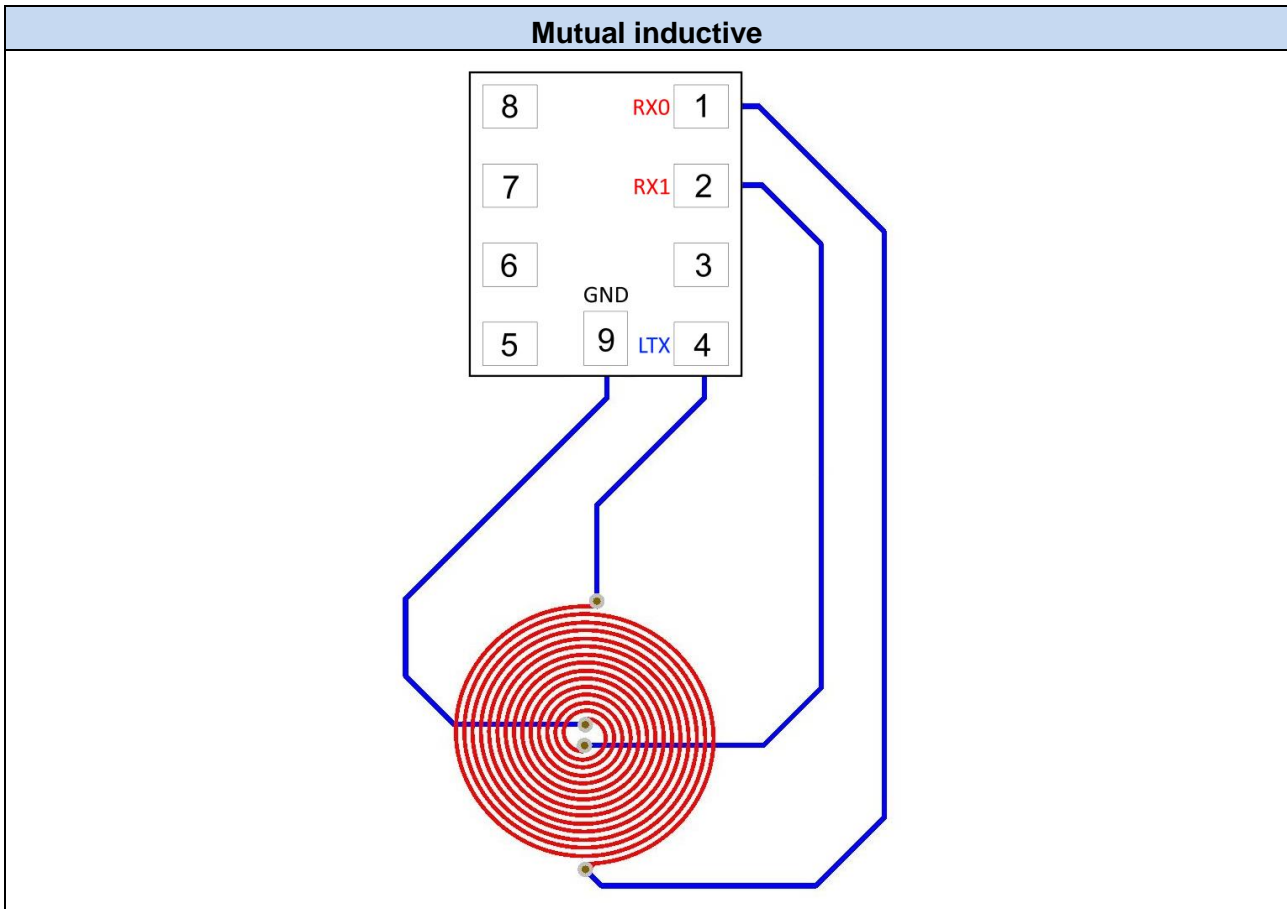
Mode	CH0	CH1	CH2	CH3	CH4	CH5	CH6
<b>Mutual inductive</b>	○	○					
<b>Hysteresis UI</b>		•					

Key:

- - Optional implementation
- - Fixed use for UI

### 3.3 Hardware configuration

**Table 3.2 Mutual inductive hardware description**



### 3.4 Software configuration

#### 3.4.1 Registers to configure for inductive sensing:

**Table 3.3 Inductive sensing settings registers**

Address	Name	Description	Recommended setting
<b>0x41</b>	ProxFusion Settings 0	Sensor mode and configuration of channel 1.	Sensor mode should be set to inductive mode Both RX0 and RX1 should be active on channel 1
<b>0x43</b>	ProxFusion Settings 1	Channel 1 settings for the inductive sensor	Full ATI is recommended for fully automated sensor tuning.
<b>0x45</b>	ProxFusion Settings 2	ATI settings for the inductive sensor	ATI target should be more than ATI base to achieve an ATI
<b>0x47</b>	ProxFusion Settings 3	Additional settings for the inductive sensor	None
<b>0x48</b>	ProxFusion Settings 4	UI enable command and filter settings	Enable the Hysteresis UI. Filter according to application.



### 3.4.2 Registers to configure for the hysteresis UI:

**Table 3.4 Hysteresis UI settings registers**

Address	Name	Description
0x48	ProxFusion settings 4	Hysteresis UI enable command
0x60	Hysteresis UI Settings	Hysteresis settings for the prox and touch thresholds
0x61	Hysteresis UI filter halt threshold	Threshold setting to trigger a filter halt for on channel 1
0x62	Hysteresis UI proximity threshold	Proximity threshold used for hysteresis UI detections on channel 1
0x63	Hysteresis UI touch threshold	Touch threshold used for hysteresis UI detections on channel 1

### 3.4.3 Example code:

Example code for an Arduino Uno can be downloaded at:

[www.azoteq.com/images/stories/software/IQS62x\\_Demo.zip](http://www.azoteq.com/images/stories/software/IQS62x_Demo.zip)





### 3.5 Sensor data output and flags

The following registers can be monitored by the master to detect inductive sensor related events.

- a) **Global events (0x11)** to prompt for inductive sensor activation. Bit3 denoted as **HYSTERESIS UI EVENT** will indicate the detection of a metal object using the inductive sensing.

Global events (0x11)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R	R	R	R	R	R	R
Name	-	POWER MODE EVENT	SYS EVENT	TEMP EVENT	<b>HYSTERESIS UI EVENT</b>	ALS EVENT	HALL EVENT	PROX SENSE EVENT

- b) The **Hysteresis UI flags (0x13)** register provides the classic prox/touch two level activation outputs as well as a **signed output** bit to distinguish between whether the counts have risen or fallen below the LTA (direction of counts).

Hysteresis UI flags (0x13)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	-	-	-	R	R	R
Name	-	-	-	-	-	<b>Signed output</b>	TOUCH	PROX

- c) **Hysteresis UI output (0x14 - 0x15)** registers will provide a combined 16-bit value to acquire the magnitude of the inductive sensed object.

Hysteresis UI output (0x14 - 0x15)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	<b>Hysteresis UI output low byte</b>							
Bit Number	15	14	13	12	11	10	9	8
Data Access	R	R	R	R	R	R	R	R
Name	<b>Hysteresis UI output high byte</b>							



## 4 Ambient light sensing (ALS)

### 4.1 Introduction to ambient light sensing

The IQS621 employs two light sensitive semi-conductor areas on chip to realise an ambient light sensor. The sensor capabilities include:

- Absolute Lux output value
- 4-bit ALS range output (0 – 10)
- Human eye response and IR compensated
- Dual threshold detection for day/night indication with hysteresis
  - 8-bit individual definable light and dark trigger thresholds
  - Dark threshold range: 0 – 1020 Lux in steps of 4 Lux.
  - Light threshold range: 0 – 4080 Lux in steps of 16 Lux.
- CS size, multipliers and charge frequency fully adjustable.
- **Ch3 – ALS channel 1:**
  - Assigned to Wide spectrum ALS.
- **Ch4 – ALS channel 2:**
  - Assigned to narrow spectrum ALS.

### 4.2 Channel specifications

The IQS621 provides 2 dedicated channels to ALS conversions.

**Table 4.1 Ambient light sensing - channel allocation**

Sensor/UI type	CH0	CH1	CH2	CH3	CH4	CH5	CH6
ALS				•	•		

Key:

- - Optional implementation
- - Fixed use for UI

### 4.3 Hardware configuration

No external hardware required. Package placement and lens clearance required.



## 4.4 Software configuration

### 4.4.1 Registers to configure for ALS sensing:

Table 4.2 ALS sensing settings registers

Address	Name	Description	Recommended setting
0x70	ALS Settings 0	ALS conversion settings and filter configuration settings	None
0x71	ALS Settings 1	ALS channel ATI target and multiplier calibration value	None

### 4.4.2 Registers to configure for the ALS UI:

Table 4.3 ALS UI settings registers

Address	Name	Description
0x80	ALS dark threshold	Threshold setting value to detect a dark condition
0x81	ALS light threshold	Threshold setting value to detect a light condition
0x82	ALS to Lux divider	Calibration value used to provide an absolute Lux output from ALS measurements
0x83	ALS IR divider	Calibration value used to compensate for the influence of IR spectrum radiation in ALS measurements

### 4.4.3 Example code:

Example code for an Arduino Uno can be downloaded at:

[www.azoteq.com/images/stories/software/IQS62x\\_Demo.zip](http://www.azoteq.com/images/stories/software/IQS62x_Demo.zip)



## 4.5 Sensor data output and flags

The following registers can be monitored by the master to detect ALS related events.

- a) The **ALS EVENT (bit 2)** in the **Global events (0x11)** register are dedicated to ALS related events. This bit will toggle when any change in ALS flags occurs and is automatically cleared after reading the registers.

Global events (0x11)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R	R	R	R	R	R	R
Name	-	POWER MODE EVENT	SYS EVENT	TEMP EVENT	HYSTERESIS UI EVENT	<b>ALS EVENT</b>	HALL EVENT	PROX SENSE EVENT

- b) The **ALS UI flags (0x16)** register provides a 4-bit ALS Range value to indicate the current ALS reading (**ALS range value bit 0-3**). An additional **LIGHT/DARK bit (bit 7)** is used to indicate the ALS sensor status measured against the two-configurable light/dark threshold values in registers 0x80 and 0x81. The user can thus setup his own triggering thresholds for light and dark perceived readings and incorporate a hysteresis using this UI.

ALS UI flags (0x16)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	-	-	-	R	R	R	R
Name	<b>LIGHT/DARK</b>	Reserved			<b>ALS range value</b>			

- c) The **ALS UI output (0x17 - 0x18)** registers provide a 16-bit value of the ALS amplitude in units of Lux as obtained by the current sensor measurement.

ALS UI output (0x17 - 0x18)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	<b>ALS UI output low byte</b>							
Bit Number	15	14	13	12	11	10	9	8
Data Access	R	R	R	R	R	R	R	R
Name	<b>ALS UI output high byte</b>							



## 5 Hall-effect sensing

### 5.1 Introduction to Hall-effect sensing

The IQS621 has two internal Hall-effect sensing plates (on chip). No external sensing hardware is required for Hall-effect sensing.

The Hall-effect measurement is essentially a current measurement of the induced current through the Hall-effect-sensor plates produced by the magnetic field passing perpendicular through each plate.

Advanced digital signal processing is performed to provide sensible output data.

- Two threshold levels are provided (proximity & touch).
- Hall-effect output is linearized by inverting signals.
- North/South field direction indication provided.
- Differential Hall-effect sensing:
  - Removes common mode disturbances
  - North-South field indication

### 5.2 Channel specifications

Channels 5 and 6 are dedicated to Hall-effect sensing. Channel 5 performs the positive direction measurements and channel 6 will handle all measurements in the negative direction. These two channels are used in conjunction to acquire differential Hall-effect data and will always be used as input data to the Hall-effect UI's.

There is a dedicated Hall-effect user interface:

- a) Hall-effect switch UI

**Table 5.1 Hall-effect sensor – channel allocation**

Sensor/UI type	CH0	CH1	CH2	CH3	CH4	CH5	CH6
Hall-effect switch UI						• Positive	• Negative

Key:

- - Optional implementation
- - Fixed use for UI



### 5.3 Hardware configuration

Rudimentary hardware configurations.

Axially polarized magnet (linear movement or magnet presence detection)	
Hall-effect push switch	
Smart cover	
Bar magnet (linear movement and magnet field detection)	
Slide switch	



## 5.4 Software configuration

### 5.4.1 Registers to configure for Hall-effect sensing:

**Table 5.2 Hall-effect sensing settings registers**

Address	Name	Description	Recommended setting
<b>0x90</b>	Hall-effect settings 0	Charge frequency divider and ATI mode settings	Charge frequency adjusts the conversion rate of the Hall-effect channels. Faster conversions consume less current. Full ATI is recommended for fully automated sensor tuning.
<b>0x91</b>	Hall-effect settings 1	ATI base and target selections	ATI target should be more than ATI base to achieve an ATI
<b>0xA0</b>	Hall-effect switch UI settings	Various settings for the Hall-effect switch UI	None
<b>0xA1</b>	Hall-effect switch UI proximity threshold	Proximity Threshold for UI	Less than touch threshold
<b>0xA2</b>	Hall-effect switch UI touch threshold	Touch Threshold for UI	None

### 5.4.2 Example code:

Example code for an Arduino Uno can be downloaded at:

[www.azoteq.com/images/stories/software/IQS62x\\_Demo.zip](http://www.azoteq.com/images/stories/software/IQS62x_Demo.zip)



## 5.5 Sensor data output and flags

The following registers can be monitored by the master to detect Hall-effect related events.

- d) The **HALL\_EVENT (bit 1)** in the **Global events (0x11)** register are dedicated to Hall-effect related events. This bit will toggle when either one of the three Hall flags is set and is automatically cleared after reading the registers.

Global events (0x11)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R	R	R	R	R	R	R
Name	-	POWER MODE EVENT	SYS EVENT	TEMP EVENT	HYSTEREISIS UI EVENT	ALS EVENT	<b>HALL EVENT</b>	PROX SENSE EVENT

- e) The **Hall UI flags (0x19)** register provides the standard two level activation output (prox and touch) as well as a **HALL\_N/S** bit to indicate the magnet polarity orientation.

Hall-effect UI flags (0x19)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	-	-	-	R	R	R
Name	-	-	-	-	-	<b>HALL TOUT</b>	<b>HALL POUT</b>	<b>HALL N/S</b>

- f) The **Hall UI output (0x1A - 0x1B)** registers provide a 16-bit value of the Hall-effect amplitude detected by the sensor.

Hall-effect UI output (0x1A - 0x1B)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Hall-effect UI output low byte							
Bit Number	15	14	13	12	11	10	9	8
Data Access	R	R	R	R	R	R	R	R
Name	Hall-effect UI output high byte							





## 6 Temperature monitoring

### 6.1 Introduction to temperature monitoring

The IQS621 provides temperature monitoring capabilities which can be used for temperature change detection in order to ensure the integrity of other sensing technology. The use of the temperature sensor is primarily to reseed other sensor channels to account for sudden changes in environmental conditions.

The IQS621 uses a linearly proportional to absolute temperature sensor for temperature data. The temperature output data is given by,

$$T = \frac{a \cdot 2^{19}}{b \cdot CH_2} + c$$

Where  $a$ ,  $b$  and  $c$  are constants that can be determined to provide a required output data as a function of device temperature. Additionally, the channel setup must be calculated during a testing process.

**Table 6.1 Temperature calibration setting registers and ranges**

Parameter		IQS621		
Name	Description	Register	Range	
$a$	<i>Multiplier</i>	0xC2	Higher nibble	1 – 16
$b$	<i>Divider</i>		Lower nibble	1 – 16
$c$	<i>Offset</i>	0xC3		0 – 255

### 6.2 Channel specifications

The IQS621 requires only external passive components to do temperature monitoring (no additional circuitry/components required). The temperature UI will be executed using data from channel 2.

**Table 6.2 Temperature monitoring – channel allocation**

Sensor / UI type	CH0	CH1	CH2	CH3	CH4	CH5	CH6
<b>Temperature trip and output</b>			•				

Key:

- - Optional implementation
- - Fixed use for UI

### 6.3 Hardware configuration

No additional hardware required. Temperature monitoring is realized on-chip.

### 6.4 Software configuration

#### 6.4.1 Registers to configure for temperature sensing:

**Table 6.3 Temperature sensing settings registers**

Address	Name	Description	Recommended setting
<b>0xC0</b>	Temperature UI settings	Channel reseed settings	Reseed enable should be set
<b>0xC1</b>	Multipliers channel 2	Temperature sensor channel multiplier selection	Dependent on calibration step
<b>0xC2</b>	Temperature calibration data 0	4-bit Multiplier ( $a+1$ ) and divider ( $b+1$ ) calibration values	Requires sample calibration
<b>0xC3</b>	Temperature calibration data 1	8-bit Offset ( $c$ ) calibration value	Requires sample calibration



## 6.5 Sensor data output and flags

The following registers can be monitored by the master to detect temperature sensor related events.

- a) **Global events (0x11)** to prompt for temperature sensor activation. Bit4 denoted as **TEMP\_EVENT** will indicate the detection of a temperature threshold trigger using the temperature sensing.

Global events (0x11)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R	R	R	R	R	R	R
Name	-	POWER MODE EVENT	SYS EVENT	<b>TEMP EVENT</b>	HYSTE-RESIS UI EVENT	ALS EVENT	HALL EVENT	PROX SENSE EVENT

- b) The **Temperature UI flags (0x1C)** register provides a single bit for temperature trip indication.

Temperature UI flags (0x1C)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Temp Trip	Reserved						

- c) The **Temperature UI output (0x1D - 0x1E)** registers will provide a combined 16-bit value to acquire the magnitude of the temperature sensed.

Temperature UI Output (0x1D - 0x1E)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Temperature UI output low byte							
Bit Number	15	14	13	12	11	10	9	8
Data Access	R	R	R	R	R	R	R	R
Name	Temperature UI output high byte							



## 7 Device clock, power management and mode operation

### 7.1 Device main oscillator

The IQS621 has a **16MHz** main oscillator (default enabled) to clock all system functionality.

An option exists to reduce the main oscillator to 8MHz. This will result in all system timings, charge transfers and sample rates to be slower by half of the default implementations.

To set this option this:

- As a software setting – Set the System\_settings: bit4 = 1, via an I<sup>2</sup>C command.
- As a permanent setting – Set the OTP option in OTP Bank 0: bit2 = 1, using Azoteq USBProg program.

### 7.2 Device modes

The IQS621 supports the following modes of operation;

- **Normal mode** (Fixed report rate)
- **Low power mode** (Reduced report rate, no UI execution)
- **Ultra-low power mode** (Only channel 0 is sensed for a prox)
- **Halt mode** (Suspended/disabled)

*Note: Auto modes must be disabled to enter or exit halt mode.*

The device will automatically switch between the different operating modes by default. However, this Auto mode feature may be disabled by setting the DSBL\_AUTO\_MODE bit (Power\_mode\_settings 0xD2: bit5) to confine device operation to a specific power mode. The POWER\_MODE bits (Power\_mode\_settings 0xD2: bit4-3) can then be used to specify the desired mode of operation.

#### 7.2.1 Normal mode

Normal mode is the fully active sensing mode to function at a fixed report rate specified in the Normal mode report rate (0xD3) register. This 8-bit value is adjustable from 0ms – 255ms in intervals of 1ms.

*Note: The device's low power oscillator has an accuracy as specified in section 9.*

#### 7.2.2 Low power mode

Low power mode is a reduced sensing mode where all channels are sensed but at a reduced oscillator speed. The sample rate can be specified in the Low Power mode report rate (0xD4) register. The 8-bit value is adjustable from 0ms – 255ms in intervals of 1ms. Reduced report rates also reduce the current consumed by the sensor.

*Note: The device's low power oscillator has an accuracy as specified in section 9.*

#### 7.2.3 Ultra-low power mode

Ultra-low power mode is a reduced sensing mode where only channel 0 is sensed and no other channels or UI code are executed. Set the EN\_ULP\_MDE bit (Power\_mode\_settings: bit6) to enable use of the ultra-low power mode. The sample rate can be specified in the Low Power mode report rate (0xD5) register. The 8-bit value is adjustable from 0ms – 4sec in intervals of 16ms.

Wake up will occur on prox detection on channel 0.

#### 7.2.4 Halt mode

Halt mode will suspend all sensing and will place the device in a dormant or sleep state. The device requires an I<sup>2</sup>C command from a master to explicitly change the power mode out of the halt state before any sensor functionality can continue.

#### 7.2.5 Mode time

The mode time is specified in the Auto mode timer (0xD6) register. The 8-bit value is adjustable from 0ms – 2 min in intervals of 500ms.



---

### 7.3 System reset

The IQS621 device monitor's system resets and events.

- a) Every device power-on and reset event will set the Show Reset bit (System flags 0x10: bit7) and the master should explicitly clear this bit by writing it active to acknowledge a valid reset.
- b) The system events will also be indicated with the Global events register's SYS\_EVENT bit (Global events 0x11: bit4) if any system event occur such as a reset. This event will continuously trigger until the reset has been acknowledged.



## 8 Communication

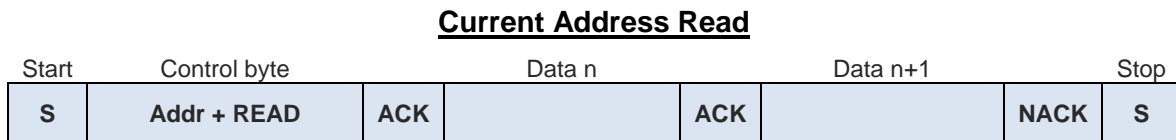
### 8.1 I<sup>2</sup>C module specification

The device supports a standard two wire I<sup>2</sup>C interface with the addition of an RDY (ready interrupt) line. The communications interface of the IQS621 supports the following:

- *Fast-mode (Fm)* standard I<sup>2</sup>C up to 400kHz.
- Streaming data as well as event mode.
- The master may address the device at any time. If the IQS621 is not in a communication window, the device will return an ACK after which clock stretching may be induced until a communication window is entered. Additional communication checks are included in the main loop in order to reduce the average clock stretching time.
- The provided interrupt line (RDY) is an open-drain active low implementation and indicates a communication window.

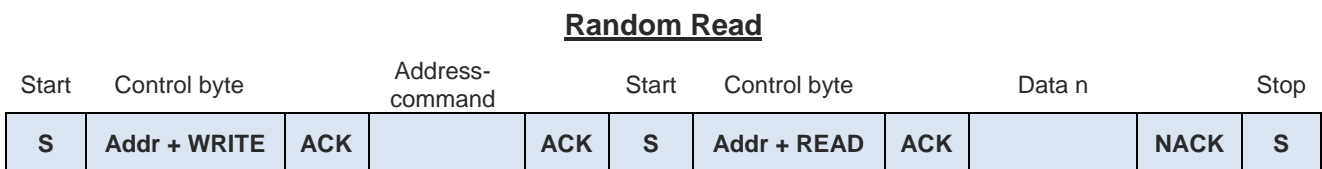
### 8.2 I<sup>2</sup>C Read

To read from the device a *current address read* can be performed. This assumes that the address-command is already setup as desired.



**Figure 8.1 Current Address Read**

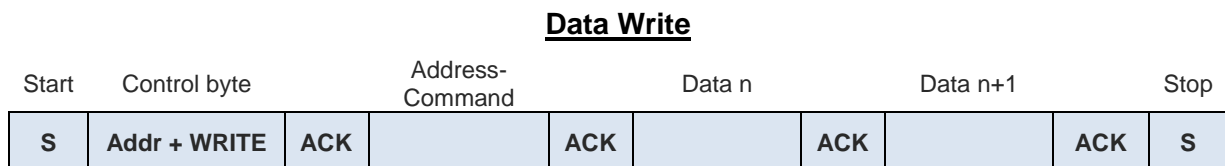
If the address-command must first be specified, then a *random read* must be performed. In this case, a WRITE is initially performed to setup the address-command, and then a repeated start is used to initiate the READ section.



**Figure 8.2 Random Read**

### 8.3 I<sup>2</sup>C Write

To write settings to the device a *Data Write* is performed. Here the Address-Command is always required, followed by the relevant data bytes to write to the device.



**Figure 8.3 I<sup>2</sup>C Data Write**



## 8.4 Stop-bit disable option

The IQS621 offer:

- an additional [I<sup>2</sup>C settings](#) register (0xD9) specifically added for stop-bit disable functionality,
- as well as a [RDY timeout period](#) register (0xD8) in order to set the required timeout period for termination of any communication windows (RDY = Low) if no I<sup>2</sup>C activity is present on SDA and SCL pins.

Customers using a MCU with a binary serial-encoder peripheral which is not fully I<sup>2</sup>C compatible (but provide some crude serial communication functions) can use this option to configure the IQS621 so that any auto generated stop command from the serial peripheral can be ignored by the IQS621 I<sup>2</sup>C hardware. This will restrict the IQS621 from immediately exiting a communication window during event mode (reduced communication only for events) until all required communication has been completed and a stop command can correctly be transmitted. Please refer to the figures below for serial data transmission examples.

Please note:

1. Stop-bit disable and enable must be performed at the beginning and end of a communication window. The first and last I<sup>2</sup>C register to be written to ensure no unwanted communication window termination.
2. Leaving the Stop-bit disabled will result in successful reading of registers but will not execute any commands written over I<sup>2</sup>C in a communication window being terminated after a RDY timeout and with no IQS recognised stop command.
3. The default RDY timeout period for IQS621 is purposefully long (10.24ms) for slow responding MCU hardware architectures. Please set this register according to your requirements/preference.

### Stop-bit Disable

Communication window open	Start	Control byte	Address-Command	Disable stop-bit	Ignored stop	Continue with reads / writes			
RDY = ↓LOW	S	Addr + WRITE	ACK	0xD9	ACK	0x81	ACK	S	...

Figure 8.4 I<sup>2</sup>C Stop-bit Disable

### Stop-bit Enable

Reads / Writes Finished	Start	Control byte	Address-Command	Enable stop-bit	Stop	Communication window closed			
...	S	Addr + WRITE	ACK	0xD9	ACK	0x01	ACK	S	RDY = ↑HIGH

Figure 8.5 I<sup>2</sup>C Stop-bit Enable



## 8.5 Device address and sub-addresses

The default device address is **0x44 = DEFAULT\_ADDR**.

Alternative sub-address options are definable in the following one-time programmable bits:

**OTP Bank0 (bit3; 0; bit1; bit0) = SUB\_ADDR\_0 to SUB\_ADDR\_7**

- a) Default address:       **0x44 = DEFAULT\_ADDR (0x44)   OR   SUB\_ADDR\_0 (0000b)**
- b) Sub-address:         **0x45 = DEFAULT\_ADDR (0x44)   OR   SUB\_ADDR\_1 (0001b)**
- c) Sub-address:         **0x46 = DEFAULT\_ADDR (0x44)   OR   SUB\_ADDR\_2 (0010b)**
- d) Sub-address:         **0x47 = DEFAULT\_ADDR (0x44)   OR   SUB\_ADDR\_3 (0011b)**
- e) Sub-address:         **0x4C = DEFAULT\_ADDR (0x44)   OR   SUB\_ADDR\_4 (1000b)**
- f) Sub-address:         **0x4D = DEFAULT\_ADDR (0x44)   OR   SUB\_ADDR\_5 (1001b)**
- g) Sub-address:         **0x4E = DEFAULT\_ADDR (0x44)   OR   SUB\_ADDR\_6 (1010b)**
- h) Sub-address:         **0x4F = DEFAULT\_ADDR (0x44)   OR   SUB\_ADDR\_7 (1011b)**

## 8.6 Additional OTP options

All one-time-programmable device options are located in OTP bank 0.

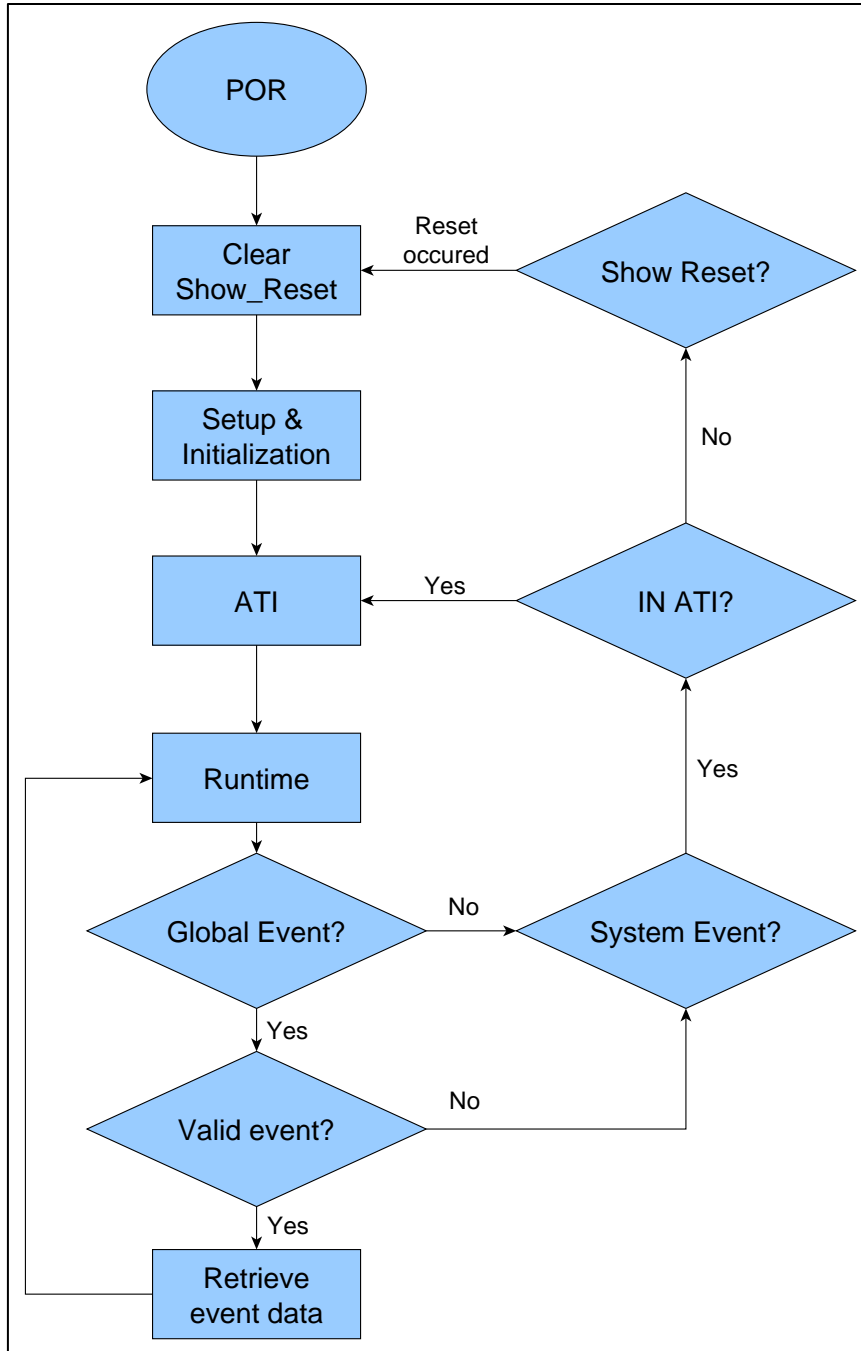
OTP Bank0								
Bit Number	7	6	5	4	3	2	1	0
Name	-	COMMS ATI	Internal use		SUB ADR 2	8MHz	SUB ADR 0_1	

Bit definitions:

- Bit 6: Communication during ATI
  - 0: No streaming events are generated during ATI
  - 1: Communication continues as setup regardless of ATI state.
- Bit4-5: Internal use
  - Do not configure
- Bit 2: Main Clock frequency selection
  - 0: Run FOSC at 16MHz
  - 1: Run FOSC at 8MHz
- Bit 3,1,0: I2C sub-address
  - I2C address = 0x44 OR SUB\_ADDR

## 8.7 Recommended communication and runtime flow diagram

The following is a basic master program flow diagram to communicate and handle the device. It addresses possible device events such as output events, ATI and system events (resets).



**Figure 8.6 Master command structure and runtime event handling flow diagram**

It is recommended that the master verifies the status of the System\_Flags0 bits to identify events and resets. Detecting either one of these should prompt the master to the next steps of handling the IQS621.

Streaming mode communication is used for detail sensor evaluation during prototyping and/or development phases.

Event mode communication is recommended for runtime use of the IQS621. This reduce the communication on the I<sup>2</sup>C bus and report only triggered events.





## 9 Memory map

The full memory map is summarized below. Register groups are explained in the latter subsections.

**Table 9.1 IQS621 Memory map index**

Full Address	Group Name	Item Name	Data Access
0x00	<a href="#">Device information data</a>	<a href="#">Product number</a>	Read-Only
0x01		<a href="#">Software number</a>	Read-Only
0x02		<a href="#">Hardware number</a>	Read-Only
0x10	<a href="#">Flags and user interface data</a>	<a href="#">System flags</a>	Read-Only
0x11		<a href="#">Global events</a>	Read-Only
0x12		<a href="#">ProxFusion UI flags</a>	Read-Only
0x13		<a href="#">Hysteresis UI flags</a>	Read-Only
0x14		<a href="#">Hysteresis UI output 0</a>	Read-Only
0x15		<a href="#">Hysteresis UI output 1</a>	Read-Only
0x16		<a href="#">ALS flags</a>	Read-Only
0x17		<a href="#">ALS output low</a>	Read-Only
0x18		<a href="#">ALS output high</a>	Read-Only
0x19		<a href="#">Hall-effect UI flags</a>	Read-Only
0x1A		<a href="#">Hall-effect UI output 0</a>	Read-Only
0x1B		<a href="#">Hall-effect UI output 1</a>	Read-Only
0x1C		<a href="#">Temperature UI flags</a>	Read-Only
0x1D		<a href="#">Temperature output low</a>	Read-Only
0x1E		<a href="#">Temperature output high</a>	Read-Only
0x20	<a href="#">Channel counts (raw data)</a>	<a href="#">Channel 0 counts low</a>	Read-Only
0x21		<a href="#">Channel 0 counts high</a>	Read-Only
0x22		<a href="#">Channel 1 counts low</a>	Read-Only
0x23		<a href="#">Channel 1 counts high</a>	Read-Only
0x24		<a href="#">Channel 2 counts low</a>	Read-Only
0x25		<a href="#">Channel 2 counts high</a>	Read-Only
0x26		<a href="#">Channel 3 counts low</a>	Read-Only
0x27		<a href="#">Channel 3 counts high</a>	Read-Only
0x28		<a href="#">Channel 4 counts low</a>	Read-Only
0x29		<a href="#">Channel 4 counts high</a>	Read-Only
0x2A		<a href="#">Channel 5 counts low</a>	Read-Only
0x2B		<a href="#">Channel 5 counts high</a>	Read-Only
0x2C	<a href="#">Channel 6 counts low</a>	Read-Only	
0x2D	<a href="#">Channel 6 counts high</a>	Read-Only	
0x30	<a href="#">LTA values (filtered data)</a>	<a href="#">Channel 0 LTA low</a>	Read-Only
0x31		<a href="#">Channel 0 LTA high</a>	Read-Only
0x32		<a href="#">Channel 1 LTA low</a>	Read-Only
0x33		<a href="#">Channel 1 LTA high</a>	Read-Only
0x40	<a href="#">ProxFusion sensor settings</a>	<a href="#">ProxFusion settings 0_0</a>	Read-Write
0x41		<a href="#">ProxFusion settings 0_1</a>	Read-Write
0x42		<a href="#">ProxFusion settings 1_0</a>	Read-Write
0x43		<a href="#">ProxFusion settings 1_1</a>	Read-Write
0x44		<a href="#">ProxFusion settings 2_0</a>	Read-Write
0x45		<a href="#">ProxFusion settings 2_1</a>	Read-Write
0x46		<a href="#">ProxFusion settings 3_0</a>	Read-Write
0x47		<a href="#">ProxFusion settings 3_1</a>	Read-Write
0x48		<a href="#">ProxFusion settings 4</a>	Read-Write
0x49		<a href="#">ProxFusion settings 5</a>	Read-Write
0x4A		<a href="#">Compensation Ch0</a>	Read-Write
0x4B		<a href="#">Compensation Ch1</a>	Read-Write
0x4C		<a href="#">Multipliers Ch0</a>	Read-Write
0x4D		<a href="#">Multipliers Ch1</a>	Read-Write



0x50	<a href="#">ProxFusion UI settings</a>	<a href="#">Prox threshold Ch0</a>	Read-Write
0x51		<a href="#">Touch threshold Ch0</a>	Read-Write
0x52		<a href="#">Prox threshold Ch1</a>	Read-Write
0x53		<a href="#">Touch threshold Ch1</a>	Read-Write
0x54		<a href="#">ProxFusion UI halt time</a>	Read-Write
0x60	<a href="#">Hysteresis UI settings</a>	<a href="#">Hysteresis UI settings</a>	Read-Write
0x61		<a href="#">Hysteresis UI filter halt threshold</a>	Read-Write
0x62		<a href="#">Hysteresis UI prox threshold</a>	Read-Write
0x63		<a href="#">Hysteresis UI touch threshold</a>	Read-Write
0x70	<a href="#">ALS sensor settings</a>	<a href="#">ALS settings 0</a>	Read-Write
0x71		<a href="#">ALS settings 1</a>	Read-Write
0x72		<a href="#">ALS filter speed</a>	Read-Write
0x73		<a href="#">Multipliers Ch3 Ch4</a>	Read-Write
0x80	<a href="#">ALS UI settings</a>	<a href="#">ALS dark threshold</a>	Read-Write
0x81		<a href="#">ALS light threshold</a>	Read-Write
0x82		<a href="#">ALS to Lux divider</a>	Read-Write
0x83		<a href="#">ALS IR divider</a>	Read-Write
0x90	<a href="#">Hall sensor settings</a>	<a href="#">Hall-effect settings 0</a>	Read-Write
0x91		<a href="#">Hall-effect settings 1</a>	Read-Write
0x92		<a href="#">Compensation Ch4 and Ch5</a>	Read-Write
0x93		<a href="#">Multipliers Ch4 and Ch5</a>	Read-Write
0xA0	<a href="#">Hall switch UI settings</a>	<a href="#">Hall-effect switch UI settings</a>	Read-Write
0xA1		<a href="#">Hall-effect switch UI prox threshold</a>	Read-Write
0xA2		<a href="#">Hall-effect switch UI touch threshold</a>	Read-Write
0xC0	<a href="#">Temperature UI settings</a>	<a href="#">Temperature UI settings</a>	Read-Write
0xC1		<a href="#">Multipliers Ch2</a>	Read-Write
0xC2		<a href="#">Temperature calibration 0</a>	Read-Write
0xC3		<a href="#">Temperature calibration 1</a>	Read-Write
0xD0	<a href="#">Device and power mode settings</a>	<a href="#">System settings</a>	Read-Write
0xD1		<a href="#">Active channels</a>	Read-Write
0xD2		<a href="#">Power mode settings</a>	Read-Write
0xD3		<a href="#">Normal power mode report rate</a>	Read-Write
0xD4		<a href="#">Low power mode report rate</a>	Read-Write
0xD5		<a href="#">Ultra-low power mode report rate</a>	Read-Write
0xD6		<a href="#">Auto mode time</a>	Read-Write
0xD7		<a href="#">Global event mask</a>	Read-Write
0xD8		<a href="#">RDY timeout period</a>	Read-Write
0xD9		<a href="#">I<sup>2</sup>C settings</a>	Read-Write



## 9.2 Device Information Data

### 9.2.1 Product number

Product number (0x00)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Device product number							

Bit definitions:

- Bit 7-0: Device product number
  - 0x46 = D'70': IQS621 product number

### 9.2.2 Software number

Software number (0x01)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Device software number							

Bit definitions:

- Bit 7-0: Device software number
  - 0x09 = D'09': IQS621 production software number

### 9.2.3 Hardware number

Hardware number (0x02)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Device hardware number							

Bit definitions:

- Bit 7-0: Device hardware number
  - 0x82 = D'130': IQS621 hardware number



## 9.3 Flags and user interface data

### 9.3.1 System flags

System flags (0x10)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	-	-	R	R	R	R	R
Name	SHOW RESET	-	-	POWER MODE		IN ATI	EVENT	NP SEG ACTIVE

Bit definitions:

- Bit 7: Reset indicator
  - 0: No reset event
  - 1: A device reset has occurred and needs to be acknowledged.
- Bit 4-3: Current power-mode indicator
  - 00: Normal mode
  - 01: Low power mode
  - 10: Ultra-low power mode
  - 11: Halt Mode
- Bit 2: ATI busy indicator
  - 0: No channels are in ATI
  - 1: One or more channels are in ATI
- Bit 1: Global event indicator
  - 0: No new event to service
  - 1: An event has occurred and should be serviced
- Bit 0: Normal power segment indicator
  - 0: Not performing a normal power update
  - 1: Busy performing a normal power update

### 9.3.2 Global events

Global events (0x11)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R	R	R	R	R	R	R
Name	-	POWER MODE EVENT	SYS EVENT	TEMP EVENT	HYSTE-RESIS UI EVENT	ALS EVENT	HALL EVENT	PROX SENSE EVENT

Bit definitions:

- Bit 6: Power mode event flag
  - 0: No event to report
  - 1: A power mode event has occurred and should be handled
- Bit 5: System event flag
  - 0: No event to report
  - 1: A System event has occurred and should be handled
- Bit 4: Temperature event flag
  - 0: No event to report
  - 1: A Temperature event has occurred and should be handled
- Bit 3: Hysteresis UI event flag
  - 0: No event to report
  - 1: A Hysteresis event has occurred and should be handled
- Bit 2: ALS event flag



- 0: No event to report
- 1: An ALS event has occurred and should be handled
- Bit 1: Hall-effect event flag
  - 0: No event to report
  - 1: A Hall-effect event has occurred and should be handled
- Bit 0: ProxSense event flag
  - 0: No event to report
  - 1: A capacitive key event has occurred and should be handled

### 9.3.3 ProxFusion UI flags

ProxFusion UI flags (0x12)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	R	R	-	-	R	R
Name	-	-	CH1_T	CH0_T	-	-	CH1_P	CH0_P

Bit definitions:

- Bit 5: Ch1 touch indicator
  - 0: Delta below touch threshold
  - 1: Delta above touch threshold
- Bit 4: Ch0 touch indicator
  - 0: Delta below touch threshold
  - 1: Delta above touch threshold
- Bit 1: Ch1 proximity indicator
  - 0: Delta below proximity threshold
  - 1: Delta above proximity threshold
- Bit 0: Ch0 proximity indicator
  - 0: Delta below proximity threshold
  - 1: Delta above proximity threshold.

### 9.3.4 Hysteresis UI flags

Hysteresis UI flags (0x13)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	-	-	-	R	R	R
Name	-	-	-	-	-	Signed output	TOUCH	PROX

Bit definitions:

- Bit 2: Delta direction signed output
  - 0: Counts rise above the LTA
  - 1: Counts fall below the LTA
- Bit 1: Hysteresis UI touch indicator
  - 0: Delta below touch threshold
  - 1: Delta above touch threshold
- Bit 0: Hysteresis proximity indicator
  - 0: Delta below prox threshold
  - 1: Delta above prox threshold



### 9.3.5 Hysteresis UI output

Hysteresis UI output (0x14/0x15)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	Hysteresis UI output low byte							
<b>Bit Number</b>	15	14	13	12	11	10	9	8
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	Hysteresis UI output high byte							

Bit definitions:

- Bit 15-0: Hysteresis UI output
  - 0-65 535: Hysteresis UI output value

### 9.3.6 ALS UI flags

ALS UI flags (0x16)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R	-	-	-	R	R	R	R
<b>Name</b>	LIGHT / DARK	Reserved			ALS Range Value			

Bit definitions:

- Bit 7: Light/Dark
  - 0: Light indication
  - 1: Dark indication
- Bit 3-0: ALS Range value
  - 0-10 range value of ALS measurement

### 9.3.7 ALS UI output

ALS UI output (0x17/0x18)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	ALS UI Output Low Byte							
<b>Bit Number</b>	15	14	13	12	11	10	9	8
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	ALS UI Output High Byte							

Bit definitions:

- Bit 15-0: ALS UI output
  - 0-65 535: ALS UI output value in Lux



### 9.3.8 Hall-effect UI flags

Hall-effect UI flags (0x19)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	-	-	-	-	-	R	R	R
<b>Name</b>	-	-	-	-	-	TOUCH	PROX	HALL N/S

Bit definitions:

- Bit 2: Hall-effect touch indicator
  - 0: Field strength below touch level
  - 1: Field strength above touch level
- Bit 1: Hall-effect proximity indicator
  - 0: Field strength below proximity level
  - 1: Field strength above proximity level
- Bit 0: Hall-effect North South Field indication
  - 0: North field present
  - 1: South field present

### 9.3.9 Hall-effect UI output

Hall-effect UI output (0x1A/0x1B)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	Hall-effect UI output low byte							
<b>Bit Number</b>	15	14	13	12	11	10	9	8
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	Hall-effect UI output high byte							

Bit definitions:

- Bit 15-0: Hall-effect UI output
  - 0-65 535: Hall-effect UI output value



### 9.3.10 Temperature UI flags

Temperature UI flags (0x1C)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	-	-	-	-	-	-	-
Name	TEMP TRIP	-	-	-	-	-	-	-

Bit definitions:

- Bit 7: Temperature trip indicator
  - 0: Temperature below trip level
  - 1: Temperature above trip level

### 9.3.11 Temperature output

Temperature output (0x1D/0x1E)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Temperature output low byte							
Bit Number	15	14	13	12	11	10	9	8
Data Access	R	R	R	R	R	R	R	R
Name	Temperature output high byte							

Bit definitions:

- Bit 15-0: Temperature output
  - 0-65 535: Temperature output value





## 9.4 Channel counts (raw data)

Channel counts Ch0/1/2/3/4/5/6 (0x20/0x21-0x2C/0x2D)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	Channel data low byte							
<b>Bit Number</b>	15	14	13	12	11	10	9	8
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	Channel data high byte							

Bit definitions:

- Bit 15-0: AC filter or raw count value

## 9.5 LTA values (filtered data)

LTA Ch0/1 (0x30/0x31-0x32/0x33)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	LTA low byte							
<b>Bit Number</b>	15	14	13	12	11	10	9	8
<b>Data Access</b>	R	R	R	R	R	R	R	R
<b>Name</b>	LTA high byte							

Bit definitions:

- Bit 15-0: LTA filter value



## 9.6 ProxFusion sensor settings block 1

### 9.6.1 ProxFusion settings 0

#### 9.6.1.1 Capacitive sensing

ProxFusion settings 0_0/1 (0x40-0x41)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	-	-	R/W	R/W	R/W	R/W
Name	Capacitive sensor mode		Internal use	Internal use	TX SELECT		RX SELECT	
Fixed value	0	0	0	0	0	0	0	1

Bit definitions:

- Bit 6-7: Sensor mode
  - 00: Capacitive sensing mode
- Bit 3-2: TX Select
  - 00: TX 0 and TX 1 is disabled
- Bit 0-1: RX select
  - 00: RX 0 and RX 1 is disabled
  - 01: RX 0 is enabled
  - 10: RX 1 is enabled
  - 11: RX 0 and RX 1 is enabled

#### 9.6.1.2 Inductive sensing

ProxFusion settings 0_1 (0x41)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	-	R/W	R/W	R/W	R/W	R/W
Name	Inductive sensor mode		Internal use	Multiplier range	TX SELECT		RX SELECT	
Fixed value	1	0	0		0	0	1	1

Bit definitions:

- Bit 7-6: Sensor mode
  - 10: Inductive sensor mode
- Bit 4: Multiplier range
  - 0: Large
  - 1: Small
- Bit 3-2: TX Select
  - 00: TX 0 and TX 1 is disabled
- Bit 1-0: RX Select
  - 11: RX 0 and RX 1 is enabled



## 9.6.2 ProxFusion settings 1

### 9.6.2.1 Capacitive sensing

ProxFusion settings 1_0/1 (0x42-0x43)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	-	R/W	R/W	R/W	-	-	R/W	R/W
<b>Name</b>	-	CSz	CHARGE FREQ		Internal use		AUTO ATI MODE	
<b>Default</b>	0x67							
	0	1	1	0	0	1	1	1

Bit definitions:

- Bit 6: CS size
  - 0: Prox storage capacitor size is 15 pF
  - 1: Prox storage capacitor size is 60 pF
- Bit 5-4: Charge frequency divider
  - 00: 1/2
  - 01: 1/4
  - 10: 1/8
  - 11: 1/16
- Bit 1-0: Auto ATI Mode
  - 00: ATI disabled
  - 01: Partial ATI (all multipliers are fixed)
  - 10: Semi-partial ATI (coarse multipliers are fixed)
  - 11: Full-ATI

### 9.6.2.2 Inductive sensing

ProxFusion settings 1_1 (0x43)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	-	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	-	CSz	CHARGE FREQ		PROJ BIAS		AUTO ATI MODE	
<b>Fixed use</b>	0x4F							
	0	1	0	0	1	1	1	1

Bit definitions:

- Bit 6: CS size
  - 0: Prox storage capacitor size is 15pF
  - 1: Prox storage capacitor size is 60pF
- Bit 5-4: Charge frequency divider
  - 00: 1/2
  - 01: 1/4
  - 10: 1/8
  - 11: 1/16
- Bit 3-2: Projected bias / Internal resistor (all modes except prox)
  - 00: 2.5µA / 88kΩ
  - 01: 5µA / 66kΩ
  - 10: 10µA / 44kΩ
  - 11: 20µA / 22kΩ
- Bit 1-0: Auto ATI Mode
  - 00: ATI disabled
  - 01: Partial ATI (all multipliers are fixed)
  - 10: Semi-Partial ATI (coarse multipliers are fixed)
  - 11: Full-ATI



### 9.6.3 ProxFusion settings 2

#### 9.6.3.1 Capacitive sensing

ProxFusion settings 2_0/1 (0x44 - 0x45)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	ATI BASE		ATI TARGET (x32)					
<b>Default</b>	0xD0							
	1	1	0	1	0	0	0	0

Bit definitions:

- Bit 7-6: Auto ATI base value
  - 00: 75
  - 01: 100
  - 10: 150
  - 11: 200
- Bit 5-0: Auto ATI Target
  - ATI Target is 6-bit value x 32

#### 9.6.3.2 Inductive sensing

ProxFusion settings 2_1 (0x45)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	ATI BASE		ATI TARGET (x32)					
<b>Default</b>	0xD0							
	1	1	0	1	0	0	0	0

Bit definitions:

- Bit 7-6: Auto ATI base value
  - 00: 75
  - 01: 100
  - 10: 150
  - 11: 200
- Bit 5-0: Auto ATI Target
  - ATI Target is 6-bit value x 32



## 9.6.4 ProxFusion settings 3

### 9.6.4.1 Capacitive sensing

ProxFusion settings 3_0/1 (0x46-0x47)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	-	R/W	R/W	R/W	-
Name	UP LENGTH SELECT		CS DIV	Internal use	UP LENGTH EN	PASS LENGTH		-
Default	0x06							
	0	0	0	0	0	1	1	0

Bit definitions:

- Bit 7-6: Up Length Select (requires **UP\_LENGTH\_EN = 1** for use)
  - 00: Up length = 0010
  - 01: Up length = 0110
  - 10: Up length = 1010
  - 11: Up length = 1110
- Bit 5: CS divider
  - 0: Normal CS cap size
  - 1: CS cap size 5 times smaller
- Bit 3: Up length select enable
  - 0: Up length select is disabled
  - 1: Up length select is enabled (value in bit 7-6 is used)
- Bit 2-1: Pass length select
  - 00: Pass length = 001
  - 01: Pass length = 011
  - 10: Pass length = 101
  - 11: Pass length = 111

### 9.6.4.2 Inductive sensing

ProxFusion settings 3_1 (0x47)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	-	R/W	R/W	R/W	-
Name	UP LENGTH SELECT		CS DIV	Internal use	UP LENGTH EN	PASS LENGTH		-
Fixed use	0x36							
	0	0	1	1	0	1	1	0

Bit definitions:

- Bit 7-6: Up length select (requires **UP\_LENGTH\_EN = 1** for use)
  - 00: Up length = 0010
  - 01: Up length = 0110
  - 10: Up length = 1010
  - 11: Up length = 1110
- Bit 5: CS divider
  - 0: Normal CS cap size
  - 1: CS cap size 5 times smaller
- Bit 3: Up length select enable
  - 0: Up length select is disabled
  - 1: Up length select is enabled (value in bit 7-6 is used)
- Bit 2-1: Pass length select
  - 00: Pass length = 001
  - 01: Pass length = 011
  - 10: Pass length = 101
  - 11: Pass length = 111



## 9.6.5 ProxFusion settings 4

### 9.6.5.1 Capacitive sensing

ProxFusion settings 4 (0x48)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	R/W	R/W	R/W	R/W	R/W	R/W
Name	-	Internal use	TWO SIDED EN	ACF DISABLE	LTA BETA		ACF BETA	
Default	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 5: Two-sided detection
  - 0: Bidirectional detection disabled
  - 1: Bidirectional detection enabled
- Bit 4: Disable AC Filter
  - 0: AC filter enabled
  - 1: AC filter disabled
- Bit 3-2: Long term average beta value
  - 00: 7
  - 01: 8
  - 10: 9
  - 11: 10
- Bit 1-0: AC filter beta value
  - 00: 1
  - 01: 2
  - 10: 3
  - 11: 4

### 9.6.5.2 Inductive sensing

ProxFusion settings 4 (0x48)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	-	HYSTERESIS UI EN	TWO SIDED EN	ACF DISABLE	LTA BETA		ACF BETA	
Default	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 6: Hysteresis UI enable
  - 0: Hysteresis UI is disabled
  - 1: Hysteresis UI is enabled
- Bit 5: Two-sided detection
  - 0: Bidirectional detection disabled
  - 1: Bidirectional detection enabled
- Bit 4: Disable AC filter
  - 0: AC filter enabled
  - 1: AC filter disabled
- Bit 3-2: Long term average beta value
  - 00: 7
  - 01: 8
  - 10: 9
  - 11: 10
- Bit 1-0: AC filter beta value
  - 00: 1
  - 01: 2
  - 10: 3
  - 11: 4



### 9.6.6 ProxFusion settings 5

ProxFusion settings 5 (0x49)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	-	-	-	-	-	-	-	-
<b>Name</b>	Internal use							
<b>Default</b>	0x01							
	0	0	0	0	0	0	0	1

Bit definitions:

- Bit 7-0: Internal use

### 9.6.7 Compensation

Compensation Ch0/1/2/3 (0x4A - 0x4B)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	Compensation (0-7)							

Bit definitions:

- Bit 7-0: Compensation (7-0)
  - 0-255: Lower 8-bits of the Compensation value.

### 9.6.8 Multipliers

Multipliers Ch0/1/2/3 (0x4C-0x4D)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	Compensation (8-9)		Multiplier coarse		Multiplier fine			

Bit definitions:

- Bit 7-6: Compensation (8-9)
  - 0-3: Upper 2-bits of the Compensation value.
- Bit 5-4: Multiplier coarse
  - 0-3: Coarse multiplier selection
- Bit 3-0: Multiplier fine
  - 0-15: Fine multiplier selection



## 9.7 ProxFusion UI settings

### 9.7.1 Prox threshold Ch0/1

Prox Threshold Ch0/1 (0x50/0x52)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	Prox threshold value							
<b>Default</b>	0x16 = D'22							
	0	0	0	1	0	1	1	0

Bit definitions:

- Bit 7-0: Prox threshold = Prox threshold value

### 9.7.2 Touch threshold Ch0/1

Touch Threshold Ch0/1 (0x51/0x53)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	Touch threshold value							
<b>Default</b>	0x20 = D'32							
	0	0	1	0	0	0	0	0

Bit definitions:

- Bit 7-0: Touch threshold = Touch threshold value \* LTA/256

### 9.7.3 ProxFusion discrete UI halt time

ProxFusion discrete UI halt time (0x54)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	Halt time							
<b>Default</b>	0x28 = D'40 * 500ms = 20sec							
	0	0	1	0	0	0	0	0

Bit definitions:

- Bit 7-0: Halt time in 500ms increments (decimal value x 500ms)
  - 0 – 127sec: ProxFusion discrete UI halt time
  - 0xFF = 255: Always halt filters





## 9.8 Hysteresis UI settings

### 9.8.1 Hysteresis UI settings

Hysteresis UI settings (0x60)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	R/W	R/W	-	-	R/W	R/W
Name	-	-	Hysteresis_T		-	-	Hysteresis_P	
Default	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 5-4: Touch hysteresis
  - 00: Disabled
  - 01: 1/4 of threshold
  - 10: 1/8 of threshold
  - 11: 1/16 of threshold
- Bit 1-0: Proximity hysteresis
  - 00: Disabled
  - 01: 1/4 of threshold
  - 10: 1/8 of threshold
  - 11: 1/16 of threshold

### 9.8.2 Hysteresis UI filter halt threshold

Hysteresis UI filter halt threshold (0x61)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Hysteresis UI filter halt threshold value							
Default	0x01 = D'01							
	0	0	0	0	0	0	0	1

Bit definitions:

- Bit 7-0: Hysteresis UI filter halt threshold
  - 0-255: Hysteresis UI filter halt threshold value

### 9.8.3 Hysteresis UI proximity threshold

Hysteresis UI proximity threshold (0x62)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Proximity threshold value							
Default	0x16 = D'22							
	0	0	0	1	0	1	1	0

Bit definitions:

- Bit 7-0: Proximity threshold
  - 0-255: Proximity threshold value



#### 9.8.4 Hysteresis UI touch threshold

Hysteresis UI touch threshold (0x63)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Touch threshold value							
Default	0x20 = D'32 * 4 = 128							
	0	0	1	0	0	0	0	0

Bit definitions:

- Bit 7-0: Touch threshold
  - 0-1020: Touch threshold value \* 4



## 9.9 ALS sensor settings

### 9.9.1 ALS settings 0

ALS settings 0 (0x70)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	R/W	R/W	R/W	R/W	-	-
Name	-	Internal use	CHARGE FREQ		INC DELAY	CSz	-	-
Default	0x04							
	0	0	0	0	0	1	0	0

Bit definitions:

- Bit 5-4: Charge frequency divider
  - 00: 1/2
  - 01: 1/4
  - 10: 1/8
  - 11: 1/16
- Bit 3: Inc Delay
  - 0: Pre-charge delay is at default
  - 1: Increase pre-charge delay to improve low light performance
- Bit 2: CS divider size
  - 0: CS capacitor size 15pF
  - 1: CS capacitor size 60pF

### 9.9.2 ALS settings 1

ALS settings 1 (0x71)									
Bit Number	7	6	5	4	3	2	1	0	
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Name	ATI Target (x32)						MULTIPLIER CALIBRATION		
Default	0x80								
	1	0	0	0	0	0	0	0	

Bit definitions:

- Bit 7-2: ATI target for ALS Ch4
  - 0-2016: ATI target Ch4 = ATI target value value x 32
- Bit 1-0: Multiplier calibration
  - 0-3: Multiplier calibration size for ALS sensor calibration

### 9.9.3 ALS settings filter speed

ALS settings filter speed (0x72)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	ALS settings filter speed							
Default	0x07 = D'7							
	0	0	0	0	0	1	1	1

Bit definitions:

- Bit 7-0: ALS settings filter speed
  - 0: Both filter stages are disabled
  - 1: Only the IIR filter is enabled



- 2-255: Windowed minima filter (with window length of 2-255) and the IIR is enabled

#### 9.9.4 Multipliers Ch3/4

Multipliers Ch3/4 (0x73)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	-		MULTIPLIER COARSE		MULTIPLIER FINE			

Bit definitions:

- Bit 5-4: Multiplier coarse
  - 0-3: Coarse multiplier selection
- Bit 3-0: Multiplier fine
  - 0-15: Fine multiplier selection



## 9.10 ALS UI settings

### 9.10.1 ALS dark threshold

ALS dark threshold (0x80)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	ALS dark threshold x4 (Lux)							
<b>Default</b>	0x0A = D'10 * 4 = 40 Lux							
	0	0	0	0	1	0	1	0

Bit definitions:

- Bit 7-0: Dark threshold = Dark threshold value x4

### 9.10.2 ALS light threshold

ALS light threshold (0x81)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	ALS Light Threshold x16 (Lux)							
<b>Default</b>	0x0A = D'10 * 16 = 160 Lux							
	0	0	0	0	1	0	1	0

Bit definitions:

- Bit 7-0: Light Threshold = Light Threshold value x16

### 9.10.3 ALS raw to Lux divider

ALS raw to Lux divider (0x82)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	ALS raw to Lux divider							

Bit definitions:

- Bit 7-0: ALS raw to Lux divider = ALS raw to Lux divider value (*The default value is loaded from OTP Bank 2, 0 disables divider*)

### 9.10.4 ALS IR compensation

ALS IR compensation (0x83)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	ALS IR compensation divider							

Bit definitions:

- Bit 0-7: ALS IR compensation divider = ALS IR compensation divider value.
- The default value is loaded from OTP:
  - For IQS621: a 6-bit value stored in OTP Bank 0 (bit 5 & 4) & OTP Bank 3 (bit 3 – 0)
  - A value equal to 0 disables the divider.



## 9.11 Hall-effect sensor settings

### 9.11.1 Hall-effect settings 0

Hall-effect settings 0 (0x90)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	R/W	R/W	-	-	R/W	R/W
Name	-	-	CHARGE_FREQ		reserved		AUTO ATI MODE	
Default	0x03							
	0	0	0	0	0	0	1	1

Bit definitions:

- Bit 0-1: Auto ATI Mode
  - 00: ATI disabled
  - 01: Partial ATI (all multipliers are fixed)
  - 10: Semi-Partial ATI (only coarse multipliers are fixed)
  - 11: Full-ATI
- Bit 4-5: Charge frequency divider
  - 00: 1/2
  - 01: 1/4
  - 10: 1/8
  - 11: 1/16

### 9.11.2 Hall-effect settings 1

Hall-effect settings 1 (0x91)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	ATI_BASE		ATI_TARGET (x32)					
Default	0x50							
	0	1	0	1	0	0	0	0

Bit definitions:

- Bit 0-5: Auto ATI Target
  - 0-2016: ATI Target = ATI target 6-bit value x 32
- Bit 6-7: Auto ATI base value
  - 00: 75
  - 01: 100
  - 10: 150
  - 11: 200

### 9.11.3 Compensation Ch4/5

Compensation Ch5/6 (0x92)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Compensation (7-0)							

Bit definitions:

- Bit 7-0: Compensation (7-0)
  - 7-0: Lower 8-bits of the Compensation value.



### 9.11.4 Multipliers Ch4/5

Multipliers Ch5/6 (0x93)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Compensation (9-8)		Multipliers coarse		Multipliers fine			

Bit definitions:

- Bit 7-6: Compensation (9-8)
  - 0-3: Upper 2-bits of the Compensation value.
- Bit 5-4: Multipliers coarse
  - 0-3: Coarse multiplier selection
- Bit 3-0: Multipliers fine
  - 0-15: Fine multiplier selection



## 9.12 Hall-effect switch UI settings

### 9.12.1 Hall-effect UI settings

Hall-effect UI settings (0xA0)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R/W	R/W	R/W	-	R/W	R/W	R/W
Name		Lin Mode	Hysteresis T		-	Swap Direction	Hysteresis P	
Default	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 6: Linearize output
  - 0: Disabled
  - 1: Enabled
- Bit 4-5: Touch hysteresis
  - 00: Disabled
  - 01: 1/4 of threshold
  - 10: 1/8 of threshold
  - 11: 1/16 of threshold
- Bit 2: Swap field direction indication
  - 0: Disabled
  - 1: Enabled
- Bit 0-1: Proximity hysteresis
  - 00: Disabled
  - 01: 1/4 of threshold
  - 10: 1/8 of threshold
  - 11: 1/16 of threshold

### 9.12.2 Hall-effect UI proximity threshold

Hall-effect UI proximity threshold (0xA1)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Proximity threshold value							
Default	0x19 = D'25							
	0	0	0	1	1	0	0	1

Bit definitions:

- Bit 0-7: Hall-effect UI proximity threshold
  - 0-255: Hall-effect UI Proximity Threshold = Proximity threshold value

### 9.12.3 Hall-effect UI touch threshold

Hall-effect UI touch threshold (0xA2)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Touch threshold value							
Default	0x19 = D'25 * 4 = 100							
	0	0	0	1	1	0	0	1

Bit definitions:

- Bit 0-7: Hall-effect UI touch threshold
  - 0-1020: Hall-effect touch threshold = Touch threshold value \* 4





## 9.13 Temperature monitoring UI settings

### 9.13.1 Temperature UI settings

Temperature UI settings (0xC0)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	reserved	RESEED IN PROX	RESEED EN	RESEED THRESHOLD				
Default	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 6: Allow temperature channel to reseed channel 0 and 1 while in proximity
  - 0: Reseed in prox disabled
  - 1: Reseed in prox enabled
- Bit 5: Temperature reseed of channel 0 and 1 enable
  - 0: Reseed is disabled
  - 1: Reseed is enabled
- Bit 4-0: Temperature reseed threshold = Temperature reseed threshold value

### 9.13.2 Multiplier channel 2

Multiplier Ch2 (0xC1)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	-	-	Multiplier coarse		Multiplier fine			
Default	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 5-4: Multiplier coarse
  - 0-3: Coarse multiplier selection
- Bit 3-0: Multiplier fine
  - 0-15: Fine multiplier selection



### 9.13.3 Temperature calibration 0

Temperature calibration 0 (0xC2)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	Temperature multiplier				Temperature divider			
<b>Default</b>	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 7-4: Temperature multiplier = Temperature multiplier value +1
  - 1-16: Temperature multiplier
- Bit 3-0: Temperature divider = Temperature divider value +1
  - 1-16: Temperature divider

### 9.13.4 Temperature calibration 1

Temperature calibration 1 (0xC3)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	Temperature offset							
<b>Default</b>	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 7-0: Temperature offset = Temperature offset value
  - 0-255: Temperature offset



## 9.14 Device and power mode settings

### 9.14.1 System settings

System settings (0xD0)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	W=1	W=1	R/W	R/W	R/W	R/W	W=1	W=1
Name	SOFT RESET	ACK RESET	EVENT MODE	8MHz	COMMS ATI	ATI BAND	REDO ATI	RESEED
Default	0x08							
	0	0	0	0	1	0	0	0

Bit definitions:

- Bit 7: Software Reset (**Set only, will clear when done**)
  - 1: Causes the device to perform a WDT reset
- Bit 6: ACK Reset (**Set only, will clear when done**)
  - 1: Acknowledge that a reset has occurred. This event will trigger until acknowledged.
- Bit 5: Event mode enable
  - 0: Event mode disabled. Default streaming mode communication.
  - 1: Event mode communication enabled.
- Bit 4: Main Clock frequency selection
  - 0: Run FOSC at 16MHz
  - 1: Run FOSC at 8MHz
- Bit 3: Communications during ATI
  - 0: No communications are generated during ATI
  - 1: Communication continue as setup regardless of ATI state.
- Bit 2: Re-ATI Band selection
  - 0: Re-ATI when outside 1/8 of ATI target
  - 1: Re-ATI when outside 1/16 of ATI target
- Bit 1: Redo ATI on all channels (**Set only, will clear when done**)
  - 1: Redo the ATI on all channels
- Bit 0: Reseed all Long-term filters (**Set only, will clear when done**)
  - 1: Reseed all channels

### 9.14.2 Active channels

Active channels (0xD1)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	-	Ch6	Ch5	Ch4	Ch3	Ch2	Ch1	Ch0
Default	0x7F							
	0	1	1	1	1	1	1	1

Bit definitions:

- Bit 6: Ch6 (**note: Ch5 and Ch6 must both be enabled for Hall-effect switch UI to be functional**)
  - 0: Channel is disabled
  - 1: Channel is enabled



- Bit 5: Ch5 (**note: Ch5 and Ch6 must both be enabled for Hall-effect switch UI to be functional**)
  - 0: Channel is disabled
  - 1: Channel is enabled
- Bit 4: Ch4 (**note: Ch3 and Ch4 must both be enabled for ALS UI to be functional**)
  - 0: Channel is disabled
  - 1: Channel is enabled
- Bit 3: Ch3 (**note: Ch3 and Ch4 must both be enabled for ALS UI to be functional**)
  - 0: Channel is disabled
  - 1: Channel is enabled
- Bit 2: Ch2 (**note: Ch2 must be enabled for temperature UI to be functional**)
  - 0: Channel is disabled
  - 1: Channel is enabled
- Bit 1: Ch1
  - 0: Channel is disabled
  - 1: Channel is enabled
- Bit 0: Ch0
  - 0: Channel is disabled
  - 1: Channel is enabled

### 9.14.3 Power mode settings

Power mode settings (0xD2)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	NP SEG ALL	EN ULP MODE	DSBL AUTO MODE	POWER MODE		NP SEG RATE		
Default	0x03							
	0	0	0	0	0	0	1	1

Bit definitions:

- Bit 7: Normal Power Segment bounds check
  - 0: NP-segment check on PRX channels only
  - 1: NP-segment check on all channels
- Bit 6: Allow auto ultra-low power mode switching
  - 0: ULP is disabled during auto-mode switching
  - 1: ULP is enabled during auto-mode switching
- Bit 5: Disable auto mode switching
  - 0: Auto mode switching is enabled
  - 1: Auto mode switching is disabled
- Bit 4-3: Manually select power mode (**note: bit 5 must be set**)
  - 00: Normal Power mode. The device runs at the normal power rate, all enabled channels and UIs will execute.
  - 01: Low Power mode. The device runs at the low power rate, all enabled channels and UIs will execute.
  - 10: Ultra-Low Power mode. The device runs at the ultra-low power rate, Ch0 is run as wake-up channel. The other channels execute at the NP-segment rate.
  - 11: Halt Mode. No conversions are performed; the device must be removed from this mode using an I2C command.
- Bit 2-0: Normal power segment update rate
  - 000: ½ ULP rate
  - 001: ¼ ULP rate
  - 010: 1/8 ULP rate
  - 011: 1/16 ULP rate
  - 100: 1/32 ULP rate
  - 101: 1/64 ULP rate
  - 110: 1/128 ULP rate
  - 111: 1/256 ULP rate



#### 9.14.4 Normal power mode report rate

Normal power mode report rate (0xD3)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Normal power mode report rate in ms							
Default	0x0C = D'12 = 12ms							
	0	0	0	0	1	1	0	0

Bit definitions:

- Bit 7-0: Normal mode report rate in ms (**note: LPOSC timer has ± 4ms accuracy**)
  - 0 – 255ms: Normal mode report rate

*Please note: Report rates faster than 4ms can be delayed due to channel setup and comm speed.*

#### 9.14.5 Low power mode report rate

Low power mode report rate (0xD4)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Low power mode report rate in ms							
Default	0x30 = D'48 = 48ms							
	0	0	1	1	0	0	0	0

Bit definitions:

- Bit 7-0: Low-power mode report rate in ms (**note: LPOSC timer has ± 4ms accuracy**)
  - 0 – 255ms: Low-power mode report rate

#### 9.14.6 Ultra-low power mode report rate

Ultra-low power mode report rate (0xD5)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Ultra-low power mode report rate in 16ms increments							
Default	0x08 = D'8 * 16 = 128ms							
	0	0	0	0	1	0	0	0

Bit definitions:

- Bit 7-0: Ultra-low power mode report rate in 16ms increments (decimal value x 16ms)
  - 0 – 4080ms: Ultra-low power mode report rate

#### 9.14.7 Auto mode timer

Auto mode timer (0xD6)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	Auto mode timer in 500ms increments							
Default	0x14 = D'20 * 500 = 10sec							
	0	0	0	1	0	1	0	0

Bit definitions:

- Bit 7-0: Auto modes switching time in 500ms increments (decimal value x 500ms)
  - 0 – 127.5s: Auto mode switching time



### 9.14.8 Global event mask

Global event mask (0xD7)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Name	-	POWER MODE EVENT	SYS EVENT	TEMP EVENT	HYSTERESIS UI EVENT	ALS EVENT	HALL EVENT	PROX SENSE EVENT
Default	0x00							
	0	0	0	0	0	0	0	0

Bit definitions:

- Bit 6: Power mode event mask
  - 0: Event is allowed
  - 1: Event is masked
- Bit 5: System event mask
  - 0: Event is allowed
  - 1: Event is masked
- Bit 4: Temperature event mask
  - 0: Event is allowed
  - 1: Event is masked
- Bit 3: Hysteresis UI event mask
  - 0: Event is allowed
  - 1: Event is masked
- Bit 2: ALS UI event mask
  - 0: Event is allowed
  - 1: Event is masked
- Bit 1: Hall-effect UI event mask
  - 0: Event is allowed
  - 1: Event is masked
- Bit 0: ProxSense event mask
  - 0: Event is allowed
  - 1: Event is masked



### 9.14.9 RDY timeout period

RDY timeout period (0xD8)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
<b>Name</b>	RDY timeout period value							
<b>Default</b>	0x20 = D'32 * 0.32 = 10.24ms							
	0	0	1	0	0	0	0	0

Bit definitions:

- Bit 7-0: RDY timeout period = RDY timeout period value \* 0.32ms
  - 0 – 81.6ms: RDY timeout period

### 9.14.10 I<sup>2</sup>C settings

I <sup>2</sup> C settings (0xD9)								
<b>Bit Number</b>	7	6	5	4	3	2	1	0
<b>Data Access</b>	R/W	-	-	-	-	-	-	R/W
<b>Name</b>	STOP DISABLE	Reserved						Reserve
<b>Default</b>	0x01							
	0	0	0	0	0	0	0	1

Bit definitions:

- Bit 7: Stop disable
  - 0: Stop enabled: Stop bit will exit the communication window.
  - 1: Stop disabled: Stop bit will not exit the communication window. No start within the RDY timeout period (0xD8) will exit the communication window.
- Bit 6 – 1: Reserved
  - Do not configure, leave cleared.
- Bit 0: Reserved
  - Must always be set (bit 0 = 1).



## 10 Electrical characteristics

### 10.1 Absolute Maximum Specifications

The following absolute maximum parameters are specified for the device:

*Exceeding these maximum specifications may cause damage to the device.*

**Table 10.1 Absolute maximum specification**

Parameter	Absolute maximum
Operating temperature	-20°C to +85°C
Supply Voltage (VDDHI – GND)	3.6V
Maximum pin voltage	VDDHI + 0.5V (may not exceed VDDHI max)
Maximum continuous current (for specific pins)	10mA
Minimum pin voltage	GND - 0.5V
Minimum power-on slope	100V/s
ESD protection	±4kV (Human body model)

### 10.2 Voltage regulation specifications

**Table 10.2 Internal voltage regulator operating conditions**

DESCRIPTION	SYMBOL	MIN	TYPICAL	MAX	UNIT
Supply voltage	VDDHI	1.8	-	3.3	V
Internal voltage regulator	VREG	1.63	1.66	1.69	V

### 10.3 Reset conditions

**Table 10.3 Device reset specifications**

DESCRIPTION	Explanation	SYMBOL	MIN	MAX	UNIT
Reset - V <sub>DDHI</sub> rising level	V <sub>DDHI</sub> rising level to ensure active state startup	RESET <sub>VDDHI</sub> ↑	-	1.55	V
Reset - V <sub>DDHI</sub> falling level	V <sub>DDHI</sub> falling level to ensure reset	RESET <sub>VDDHI</sub> ↓	0.70	-	
Reset - V <sub>REG</sub> falling level	V <sub>REG</sub> falling level for reset during LP & ULP modes	RESET <sub>VREG</sub> ↓	0.65	1.41	





## 10.4 I<sup>2</sup>C module output logic fall time limits

Table 10.4 I<sup>2</sup>C module output logic fall time specifications

DESCRIPTION	VDDHI (V)	Temp (°C)	Pull-up resistor (Ω)	C <sub>LOAD</sub> (pF)	SYMBOL	MIN	MAX	UNIT
SDA & SCL minimum fall times	1.8	-20	7000	50	T <sub>F_min</sub>	11.80		ns
			885	400		28.70		
		+25	7000	50		11.80		
			885	400		30.70		
		+85	7000	50		11.80		
			885	400		33.80		
	3.3	-20	7000	50		7.90		
			885	400		18.60		
		+25	7000	50		11.80		
			885	400		30.70		
		+85	7000	50		11.80		
			885	400		33.80		
SDA & SCL maximum fall times	1.8	-20	420	50	T <sub>F_max</sub>		42.50	ns
			420	400			65.10	
		+25	420	50			43.40	
			420	400			69.70	
		+85	420	50			45.30	
			420	400			77.30	
	3.3	-20	770	50			20.20	
			770	400			32.80	
		+25	770	50			19.90	
			885	400			34.30	
		+85	770	50			20.00	
			770	400			36.80	



## 10.5 I<sup>2</sup>C module slew rates

**Table 10.5 I<sup>2</sup>C module fastest falling slew rates and matching rising slew rates**

DESCRIPTION	VDDHI (V)	Conditions	Fall time (ns)	Rise time (ns)	SYMBOL	SR	UNIT
SDA & SCL slew rates for the minimum allowed bus capacitance	1.8	C <sub>BUS</sub> = 50pF R <sub>PU</sub> = 7kΩ T <sub>A</sub> = -20°C	11.80		SR <sub>FALL</sub>	61.02	V/μs
				296.55	SR <sub>RISE</sub>	2.43	
	3.3	C <sub>BUS</sub> = 50pF R <sub>PU</sub> = 7kΩ T <sub>A</sub> = -20°C	7.90		SR <sub>FALL</sub>	167.09	
				296.55	SR <sub>RISE</sub>	4.45	
SDA & SCL slew rates for the maximum allowed bus capacitance	1.8	C <sub>BUS</sub> = 400pF R <sub>PU</sub> = 885Ω T <sub>A</sub> = -20°C	28.70		SR <sub>FALL</sub>	25.09	
				299.94	SR <sub>RISE</sub>	2.40	
	3.3	C <sub>BUS</sub> = 400pF R <sub>PU</sub> = 885Ω T <sub>A</sub> = -20°C	18.60		SR <sub>FALL</sub>	70.97	
				299.94	SR <sub>RISE</sub>	4.40	

**Table 10.6 I<sup>2</sup>C module slowest falling slew rates and matching rising slew rates**

DESCRIPTION	VDDHI (V)	Conditions	Fall time (ns)	Rise time (ns)	SYMBOL	SR	UNIT
SDA & SCL slew rates for the minimum allowed bus capacitance	1.8	C <sub>BUS</sub> = 50pF R <sub>PU</sub> = 420Ω T <sub>A</sub> = +85°C	45.30		SR <sub>FALL</sub>	15.89	V/μs
				17.79	SR <sub>RISE</sub>	40.47	
	3.3	C <sub>BUS</sub> = 50pF R <sub>PU</sub> = 770Ω T <sub>A</sub> = -20°C	20.20		SR <sub>FALL</sub>	65.35	
				32.62	SR <sub>RISE</sub>	40.47	
SDA & SCL slew rates for the maximum allowed bus capacitance	1.8	C <sub>BUS</sub> = 400pF R <sub>PU</sub> = 420Ω T <sub>A</sub> = +85°C	77.30		SR <sub>FALL</sub>	9.31	
				142.34	SR <sub>RISE</sub>	5.06	
	3.3	C <sub>BUS</sub> = 400pF R <sub>PU</sub> = 770Ω T <sub>A</sub> = +85°C	36.80		SR <sub>FALL</sub>	35.87	
				260.96	SR <sub>RISE</sub>	5.06	



## 10.6 I2C pins (SCL & SDA) input/output logic levels

Table 10.7 I<sup>2</sup>C pins (SCL & SDA) input and output logic level boundaries

DESCRIPTION	Conditions	SYMBOL	Temperature	MIN	TYP	MAX	UNIT	
Input low level voltage	400kHz I <sup>2</sup> C clock frequency	$V_{in\_LOW}$	-20°C	32.12			% of VDDHI	
			+25°C		34.84			
			+85°C			39.39		
Input high level voltage		$V_{in\_HIGH}$	-20°C			71.51		
			+25°C		68.18			
			+85°C	66.06				
Output low level voltage			$V_{out\_LOW}$	-20°C – +85°C		0		
Output high level voltage			$V_{out\_HIGH}$	-20°C – +85°C		100		

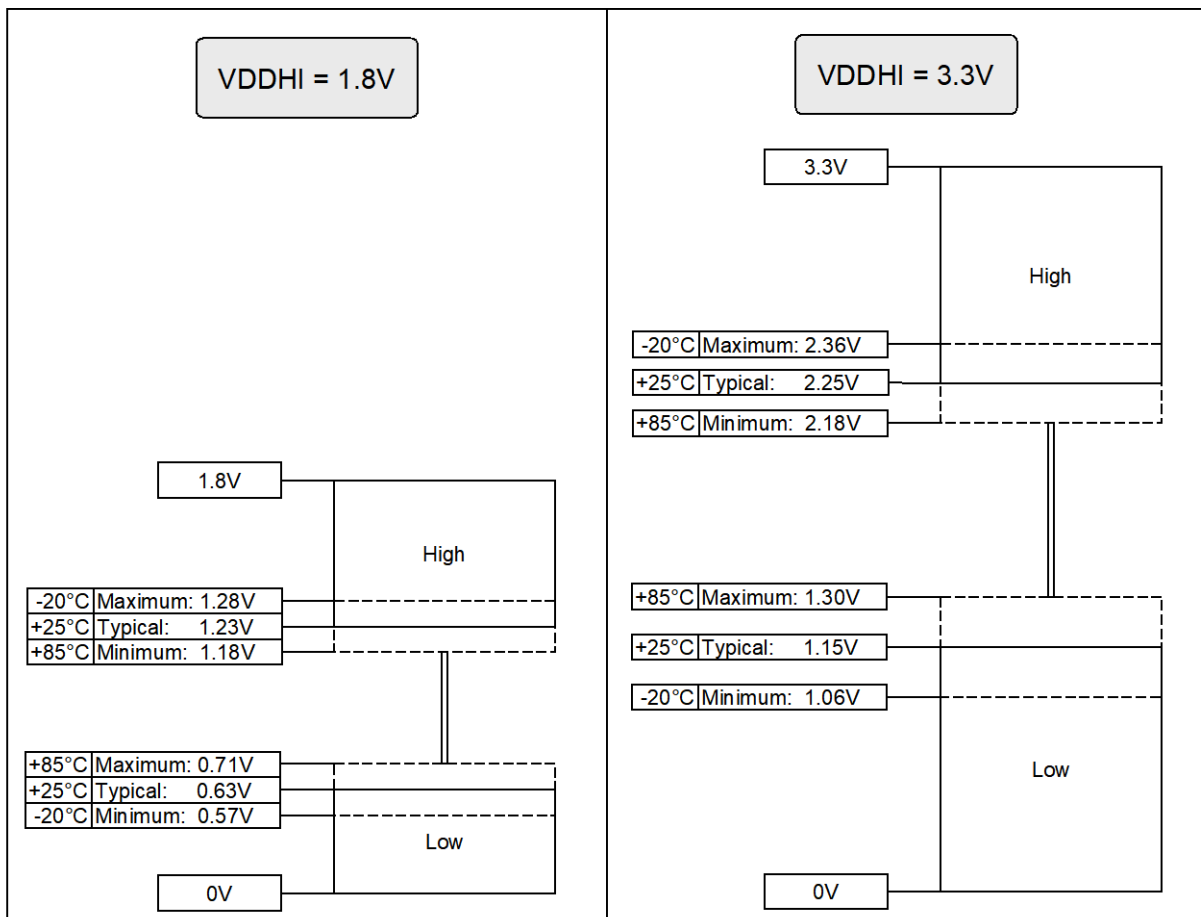


Figure 10.1 Calculated input buffer trigger levels for I<sup>2</sup>C pins at 400kHz clock frequency for 1.8V and 3.3V VDDHI power supplies

## 10.7 General purpose digital output pins (GPIO0 & GPIO3) logic levels

DESCRIPTION	SYMBOL	Temperature	MIN	TYP	MAX	UNIT
Output low level voltage	$V_{out\_LOW}$	-20°C – +85°C		0		% of VDDHI
Output high level voltage	$V_{out\_HIGH}$	-20°C – +85°C		100		



## 10.8 Current consumptions

### 10.8.1 IC subsystems

**Table 10.8 IC subsystem current consumption**

Description	TYPICAL	MAX	UNIT
Core active	339	377	μA
Core sleep	0.63	1	μA

**Table 10.9 IC subsystem typical timing**

Power mode	Core active	Core sleep	TOTAL	UNIT
NP mode	5	5	10	ms
LP mode	5	43	48	ms
ULP mode	1.75	128	129.75	ms

### 10.8.2 Capacitive sensing alone

**Table 10.10 Capacitive sensing current consumption**

Power mode	Conditions	Report rate	MIN	TYPICAL	MAX	UNIT
NP mode	VDD = 1.8V	10ms	72.54	73.40	74.08	μA
	VDD = 3.3V		73.09	73.53	73.97	μA
LP mode	VDD = 1.8V	48ms	20.94	21.38	21.79	μA
	VDD = 3.3V		19.96	20.71	21.20	μA
ULP mode	VDD = 1.8V	128ms	4.95	5.54	6.01	μA
	VDD = 3.3V		4.34	4.88	5.24	μA

-These measurements were done on the default setup of the IC

**Table 10.11 Single capacitive wake-up channel current consumption**

Power mode	Supply voltage	Charging frequency	ATI target	Report rate	TYPICAL	UNIT
ULP mode	VDD = 1.8V	2MHz	192	256ms	2.51	μA
	VDD = 3.3V	2MHz	192	256ms	2.76	

-These measurements were done with enhanced settings for minimum current consumption for a single touch channel

### 10.8.3 Inductive sensing alone

**Table 10.12 Inductive sensing current consumption**

Power mode	Conditions	Report rate	MIN	TYPICAL	MAX	UNIT
NP mode	VDD = 1.8V	10ms	75.31	75.85	76.48	μA
	VDD = 3.3V		76.45	76.88	77.53	μA
LP mode	VDD = 1.8V	48ms	21.14	21.83	30.91	μA
	VDD = 3.3V		21.68	22.36	23.46	μA
ULP mode	VDD = 1.8V	128ms	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	μA
	VDD = 3.3V		N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	μA

-These measurements were done on the default setup of the IC

(1) It is not advised to use the IQS621 in ULP without capacitive sensing. This is due to the inductive sensor being disabled in ULP.



### 10.8.4 ALS sensing alone

**Table 10.13 Ambient light sensing current consumption**

Power mode	Conditions	Report rate	MIN	TYPICAL	MAX	UNIT
NP mode	VDD = 1.8V	10ms	60.89	61.56	62.01	μA
	VDD = 3.3V		55.62	57.79	58.47	μA
LP mode	VDD = 1.8V	48ms	17.52	18.03	18.45	μA
	VDD = 3.3V		15.42	16.52	17.13	μA
ULP mode	VDD = 1.8V	128ms	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	μA
	VDD = 3.3V		N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	μA

-These measurements were done on the default setup of the IC and in 300 Lux ambient light

(2) It is not advised to use the IQS621 in ULP without capacitive sensing due to the ALS sensor disabled in ULP.

### 10.8.5 Hall-effect sensing alone

**Table 10.14 Hall-effect current consumption**

Power mode	Conditions	Report rate	MIN	TYPICAL	MAX	UNIT
NP mode	VDD = 1.8V	10ms	93.49	93.73	93.96	μA
	VDD = 3.3V		92.63	92.97	93.79	μA
LP mode	VDD = 1.8V	48ms	26.03	26.71	27.28	μA
	VDD = 3.3V		25.11	25.88	26.45	μA
ULP mode	VDD = 1.8V	128ms	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	μA
	VDD = 3.3V		N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	μA

-These measurements were done on the default setup of the IC

(1) It is not advised to use the IQS621 in ULP without capacitive sensing due to the Hall-effect sensor disabled in ULP.

### 10.8.6 Temperature monitoring alone

**Table 10.15 Temperature monitoring current consumption**

Power mode	Conditions	Report rate	MIN	TYPICAL	MAX	UNIT
NP mode	VDD = 1.8V	10ms	41.54	42.02	42.37	μA
	VDD = 3.3V		41.20	41.62	41.98	μA
LP mode	VDD = 1.8V	48ms	11.98	12.25	12.68	μA
	VDD = 3.3V		11.18	11.55	11.94	μA
ULP mode	VDD = 1.8V	128ms	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	μA
	VDD = 3.3V		N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	N/A <sup>(1)</sup>	μA

-These measurements were done on the default setup of the IC

(1) It is not advised to use the IQS621 in ULP without capacitive sensing due to the temperature sensor disabled in ULP.

### 10.8.7 Halt mode

**Table 10.16 Halt mode current consumption**

Power mode	Conditions	TYPICAL	UNIT
Halt mode	VDD = 1.8V	1.6	μA
Halt mode	VDD = 3.3V	1.9	μA



## 10.9 Start-up timing specifications

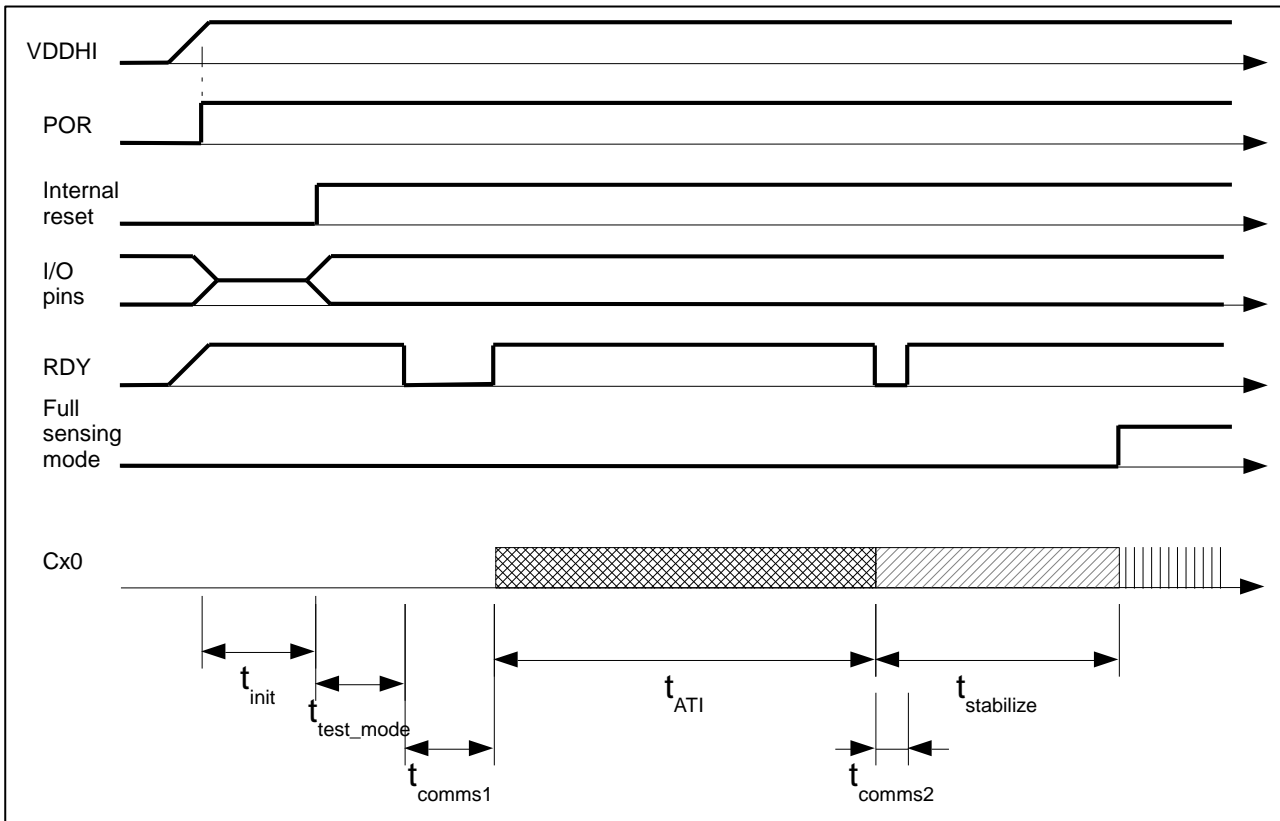


Figure 10.2 IQS621 start-up timing diagram

Table 10.17 Timing values for IQS621 start-up timing diagram

Timing	Min	Typical	Max
$t_{init}$		6ms	
$t_{test\_mode}$		5ms	
$t_{comms1}$ (16MHz)	until I <sup>2</sup> C stop bit		10ms (time-out)
$t_{comms1}$ (8MHz)	until I <sup>2</sup> C stop bit		20ms (time-out)
$t_{ATI}$ (16MHz)		110ms (default settings)	
$t_{ATI}$ (8MHz)		220ms (default settings)	
$t_{comms2}$ (event mode enabled – system event)	until I <sup>2</sup> C stop bit		Time-out value defined in register 0xD8 (x2 for 8MHz mode)
$t_{stabilize}$ (16MHz)	40ms	70ms (default settings)	
$t_{stabilize}$ (8MHz)	80ms	140ms (default settings)	
$t_{full\_sensing\_mode}$ (16MHz)		201ms (from POR)	
$t_{full\_sensing\_mode}$ (8MHz)		402ms (from POR)	



## 10.10 ALS specifications

### 10.10.1 Human eye response Lux calculation

The spectral response of the human eye does not match that of typical silicone based light sensors. The human eye perceives a peak response in the “green” colour band centred at around 550nm. However, silicone based sensors has a maximum response to ambient light typically in the infrared band. To translate the sensor measurement to correlate with the human eye’s natural perceived ambient light sensitivity a dynamic mathematical function is applied.

The follow parameter values are defined for explanatory purposes:

- ***a* → ALS multiplier:**
  - A dynamic multiplier value calculated as in the table below for the specific ALS setup and current ALS value output.
- ***b* → ALS (raw) to Lux divider:**
  - 8-bit value loaded from OTP Bank 2 into register 0x82. This calibration value is determined during IC calibration.
- ***c* → ALS IR compensation divider:**
  - For IQS621 a 6-bit value is loaded from OTP Bank 0 (bit 5 & 4) and OTP Bank 3 (bit3 - 0) into register 0x83.
  - This calibration value is determined during IC calibration and can be increased to an 8-bit value if calibration requires a higher value.

The IQS621’s ALS multiplier (parameter *a*) is calculated as specified in the following table.

**Table 10.18 ALS multiplier calculation**

Inputs					Output
ALS value (0x16: bit3-0)	Coarse multiplier (0x75: bit5-4)	Fine multiplier (0x75: bit3-0)	Charge frequency divider (0x70: bit5-4)	CS size (0x70: bit2)	ALS multiplier <i>a</i>
0	0	MULTIPLIER_CALIBRATION	3	0	1
1	0	MULTIPLIER_CALIBRATION	2	0	2
2	0	MULTIPLIER_CALIBRATION	1	0	4
3	0	MULTIPLIER_CALIBRATION	0	0	8
4	0	MULTIPLIER_CALIBRATION	1	1	16
5	0	MULTIPLIER_CALIBRATION	0	1	32
6	0	(MULTIPLIER_CALIBRATION+1)*2-1	0	1	64
7	0	(MULTIPLIER_CALIBRATION+1)*4-1	0	1	128
8	1	(MULTIPLIER_CALIBRATION+1)*4-1	0	1	384
9	2	(MULTIPLIER_CALIBRATION+1)*4-1	0	1	1152
10	3	(MULTIPLIER_CALIBRATION+1)*4-1	0	1	3456

All the calculations performed on chip are simplified for fixed-point arithmetic. The ALS Lux output is calculated by the following equation:

$$ALS \cong \frac{a}{b} \left( \frac{2^{21}}{c.H_4} - \frac{2^{21}}{c.H_3} \right)$$

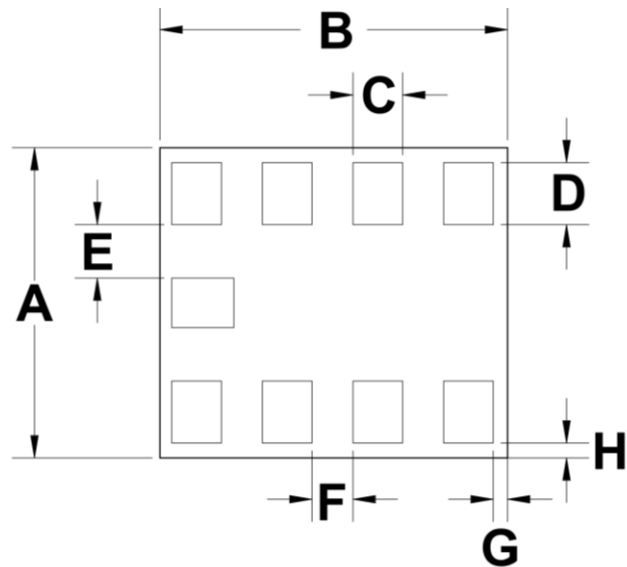
ALS in units of Lux (as perceived by a human eye) is calculated using the measurement of channels 3 (IR-component) & 4 (ALS-component) as well as the three compensation parameters *a*, *b* & *c* as defined above. The output of this function is a 16-bit integer available in the **ALS UI output** register (0x17-0x18).

## 11 Package information

### 11.1 UOLG-2.8 x 2.5 x 0.6 – 9-pin package and footprint specifications

**Table 11.1 UOLG-2.8 x 2.5 x 0.6 – 9-pin package dimensions (bottom)**

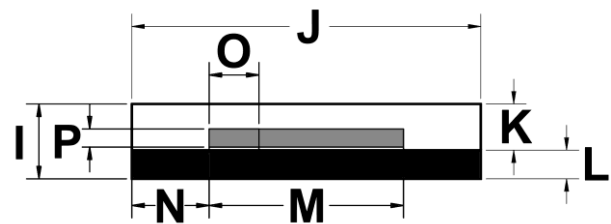
Dimension	Min. [mm]	Nom. [mm]	Max. [mm]
A	2.40	2.50	2.60
B	2.70	2.80	2.90
C	0.35	0.40	0.45
D	0.45	0.50	0.55
E	-	0.43	-
F	-	0.33	-
G	0.05	0.10	0.15
H	0.05	0.10	0.15



**Figure 11.1 UOLG-2.8 x 2.5 x 0.6-9N Package dimensions (bottom view).**

**Table 11.2 UOLG-2.8 x 2.5 x 0.6 – 9-pin package dimensions (side)**

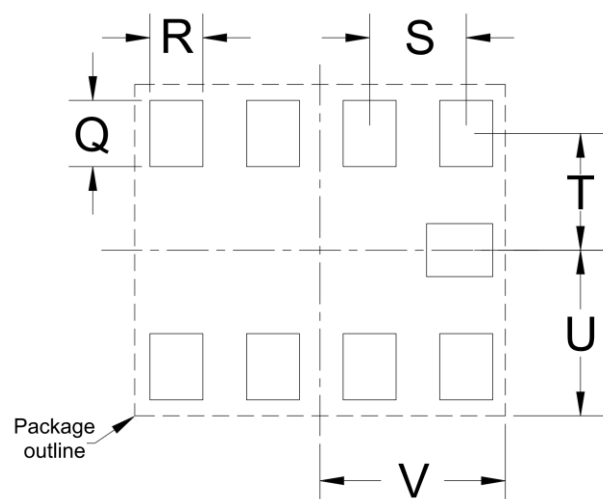
Dimension	Min. [mm]	Nom. [mm]	Max. [mm]
I	0.55	0.60	0.65
J	2.70	2.80	2.90
K	-	0.37	-
L	-	0.23	-
M	-	1.56	-
N	-	0.62	-
O	-	0.40	-
P	-	0.145	-



**Figure 11.2 UOLG-2.8 x 2.5 x 0.6-9N Package dimensions (side view)**

**Table 11.3 UOLG-2.8 x 2.5 x 0.6 – 9-pin landing pad dimensions**

Dimension	Min. [mm]	Nom. [mm]	Max. [mm]
Q	0.45	0.50	0.55
R	0.35	0.40	0.45
S	0.69	0.74	0.79
T	0.83	0.88	0.93
U	1.20	1.25	1.30
V	1.35	1.40	1.45



**Figure 11.3 UOLG-2.8 x 2.5 x 0.6-9N Landing pad dimensions (top view)**





## 11.2 Device marking and ordering information

### 11.2.1 Device marking:

No device marking due to clear package.

Pin 1 indication:

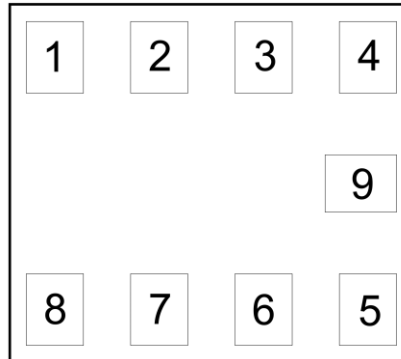


Figure 11.4 UOLG-2.8 x 2.5 x 0.6-9N pin numbers as viewed from top

### 11.2.2 Ordering Information:

#### IQS621zppb

- z – Configuration
  - 0: 44H sub-address
  - 1: 45H sub-address
- pp – Package type
  - U9: UOLG-2.8 x 2.5 x 0.6-9N
- b – Bulk packaging
  - R: Reel (3k per reel, MOQ=1 Reel)

#### Example:

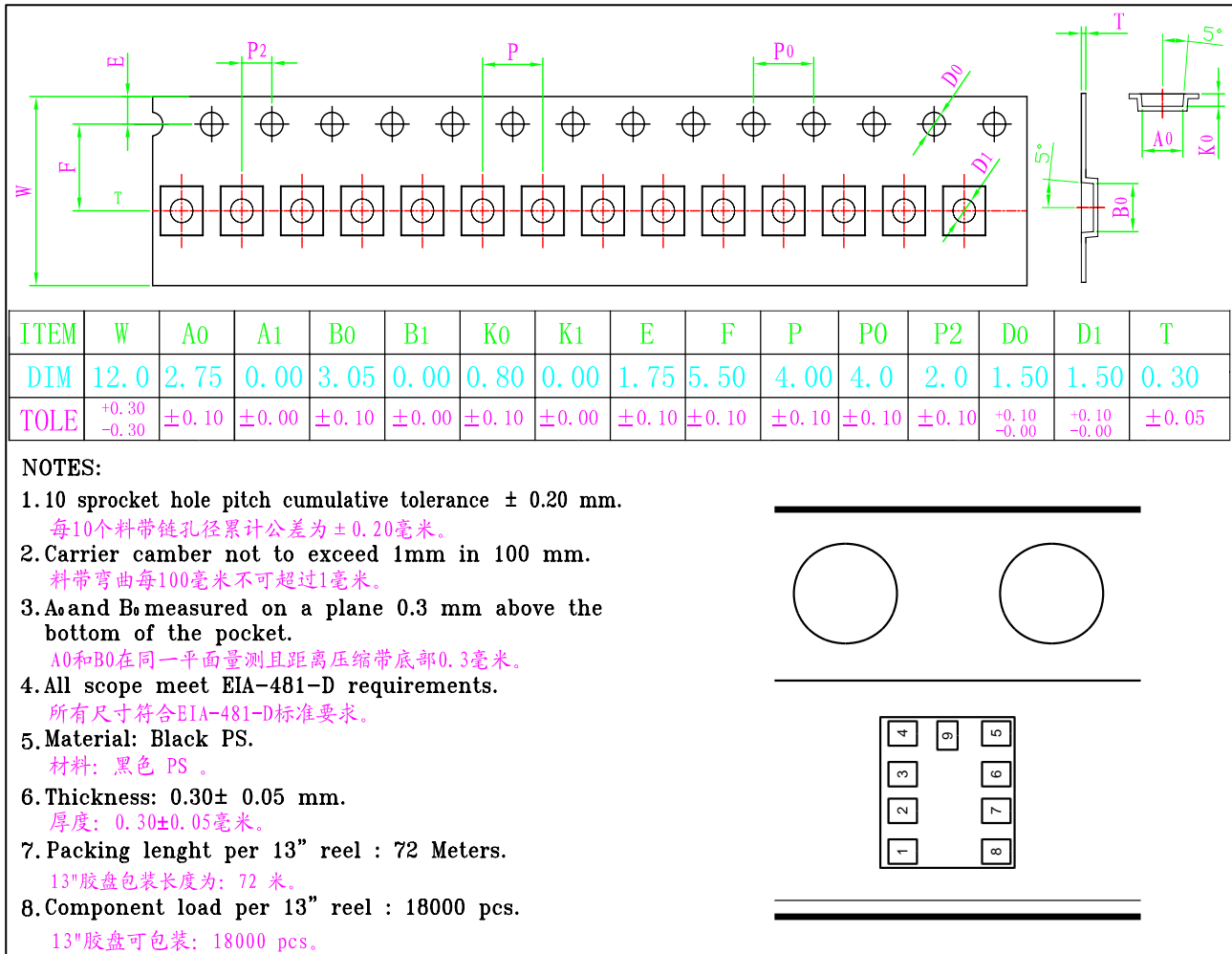
IQS6210U9R

- 0 - configuration is default (44H sub-address)
- U9 - UOLG-2.8 x 2.5 x 0.6-9N package
- R - packaged in reels of 3k (must be ordered in multiples of 3k)

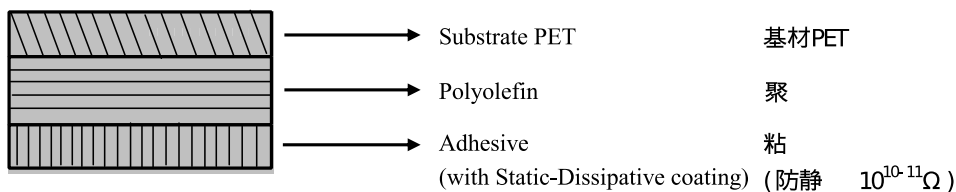


## 11.3 Bulk packaging specification

### 11.3.1 Tape specification



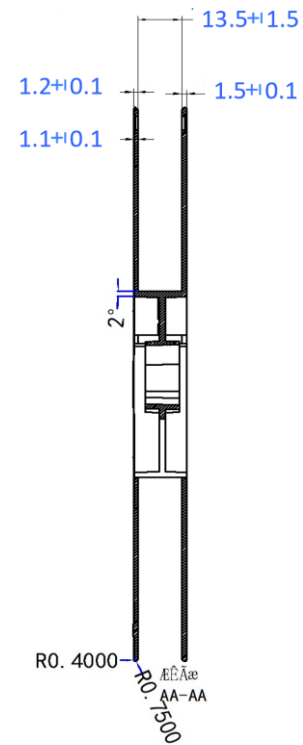
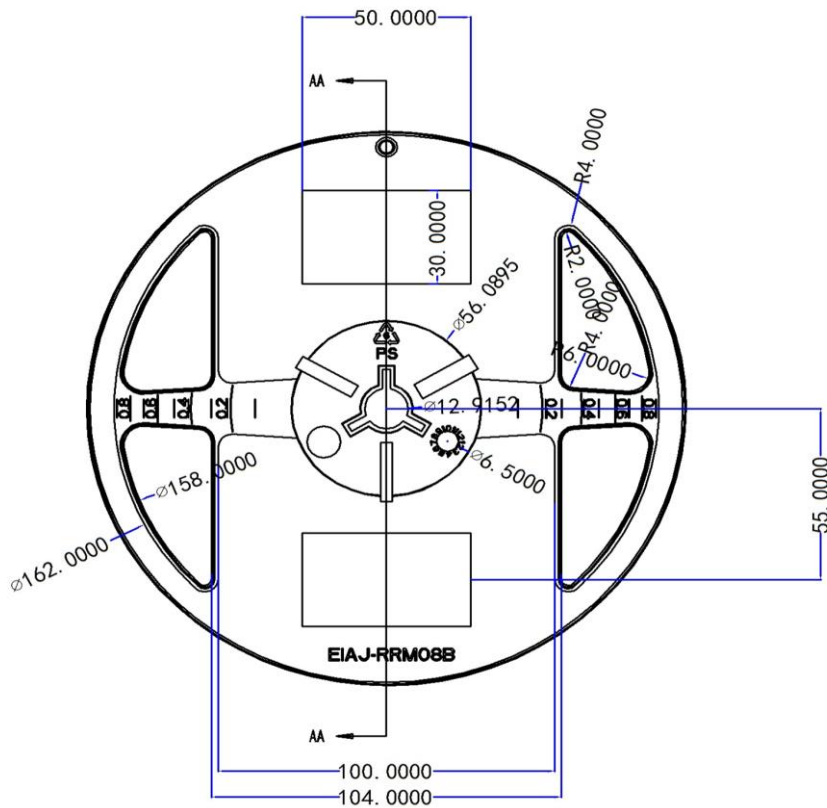
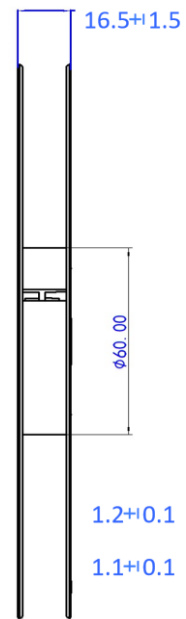
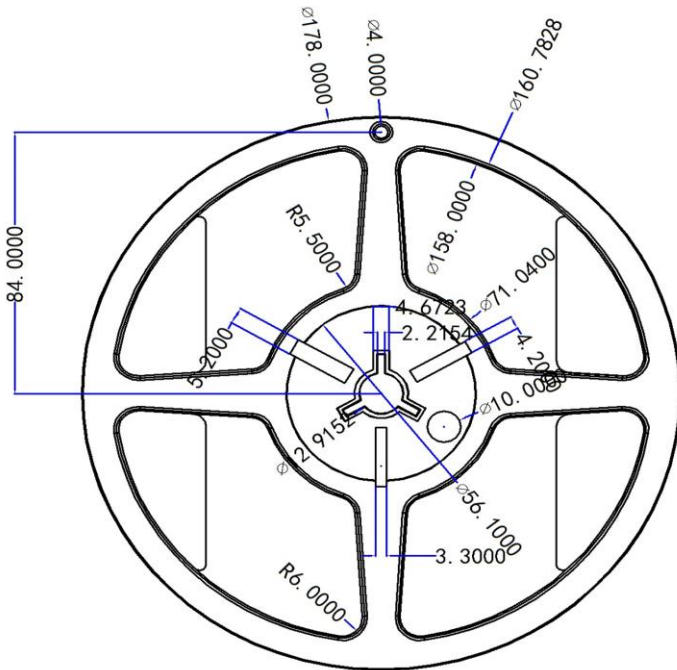
## COVER TAPE SPECIFICATION



度 Width of Carrier	8	12	16	24	32	44	56	72	88
盖 度 Width of Cover Tape	5.3	9.3	13.3	21.3	25.5	37.5	49.5	65.5	81.5
包装(卷/箱) Packing (Roll/box)	38	20	15	9	7	5	4	3	2
公差(mm) Tolerance(mm):	+/-0.1								
厚度 Thickness(mm)	0.06+/-0.005								
度 Length(m)	300m+10/-0								
心 Core	3 inch (76.2mm)								



### 11.3.2 Reel specification





## 11.4 MSL Level

**Moisture Sensitivity Level (MSL)** relates to the packaging and handling precautions for some semiconductors. The MSL is an electronic standard for the period in which a moisture sensitive device can be exposed to ambient room conditions (approximately 30°C / 60% RH see J-STD033C for more info) before reflow occur.

Package	Level (duration)
UOLG-2.8 x 2.5 x 0.6-9N	MSL 4 (72 hours at ≤ 30°C / 60% RH) Reflow profile peak temperature < 260°C for < 30 seconds



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## 12 Datasheet revisions

### 12.1 Revision history

v1.00: – First release version

v1.10: – Datasheet update

- Table 6.1 added for temperature calibration value descriptions.
- Default register values added (hex and binary representation) for all memory map registers.
- Register 0xC2 and 0xC3 ranges corrected (offset of 1; hex value of 0 = 1 used in equations).

v1.11: – Datasheet update

- I<sup>2</sup>C stop-bit disable functionality explained. Section 8.4 added.

v1.12: – Datasheet update

- Voltage regulation specifications added (10.2).

v1.13: – Datasheet update

- Low power mode description corrected.
- ProxFusion® updated to a registered trademark.

v1.14: – Datasheet update

- Hall-effect sensing operational range confirmed and updated to 10mT – 200mT.
- Section 1.5 ProxFusion® Sensitivity added for ATI algorithm explanation.
- Section 10.4 & 10.5 added: I<sup>2</sup>C module fall times and slew rates.
- Section 10.6 updated and illustrated in additional Figure 10.1.
- Appendix B. Hall ATI added.

v1.15: – Datasheet update

- Section 10.9 added: Start-up timing specifications.
- Section 10.3 Reset conditions updated.
- Appendix A. Contact information updated.

### 12.2 Errata




## Appendix A. Contact information

	USA	Asia	South Africa
<b>Physical Address</b>	6507 Jester Blvd Bldg 5, suite 510G Austin TX 78750 USA	Rm1227, Glittery City Shennan Rd Futian District Shenzhen, 518033 China	109 Main Street Paarl 7646 South Africa
<b>Postal Address</b>	6507 Jester Blvd Bldg 5, suite 510G Austin TX 78750 USA	Rm1227, Glittery City Shennan Rd Futian District Shenzhen, 518033 China	PO Box 3534 Paarl 7620 South Africa
<b>Tel</b>	+1 512 538 1995	+86 755 8303 5294 ext 808	+27 21 863 0033
<b>Fax</b>	+1 512 672 8442		+27 21 863 1512
<b>Email</b>	<a href="mailto:info@azoteq.com">info@azoteq.com</a>	<a href="mailto:info@azoteq.com">info@azoteq.com</a>	<a href="mailto:info@azoteq.com">info@azoteq.com</a>

Please visit [www.azoteq.com](http://www.azoteq.com) for a list of distributors and worldwide representation.

The following patents relate to the device or usage of the device: US 6,249,089; US 6,952,084; US 6,984,900; US 8,395,395; US 8,531,120; US 8,659,306; US 9,209,803; US 9,360,510; US 9,496,793; US 9,709,614; US 9,948,297; EP 2,351,220; EP 2,559,164; EP 2,748,927; EP 2,846,465; HK 1,157,080; SA 2001/2151; SA 2006/05363; SA 2014/01541; SA 2017/02224;

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## Appendix B: Hall ATI

Azoteq’s ProxFusion® Hall technology has ATI Functionality; which ensures stable sensor sensitivity. The ATI functionality is similar to the ATI functionality found in ProxSense® technology. The difference is that the Hall ATI requires two channels for a single plate.

Using two channels ensures that the ATI can still be used in the presence of the magnet. The two channels are the inverse of each other, this means that the one channel will sense North and the other South. The two channels being inverted allows the capability of calculating a reference value which will always be the same regardless of the presence of a magnet.

### 13.1.1 Hall reference value:

The equation used to calculate the reference value, per plate:

$$Ref_n = \frac{1}{2 \cdot \left( \frac{1}{P_n} + \frac{1}{P'_n} \right)}$$

### 13.1.2 ATI parameters:

**Channel 5/6**

<p><b>Multipliers</b></p> <p>Coarse : <input type="text" value="1"/> Fine : <input type="text" value="10"/></p>	<p><b>Compensation</b></p> <p><input type="text" value="100"/></p>	<p><b>ATI Target x32</b></p> <p><input type="text" value="16"/> <input type="text" value="512"/></p>
---	--	--

---

**Auto ATI Mode**

ATI disabled  
 Partial ATI (all multipliers are fixed)  
 Semi-Partial ATI (only coarse multipliers are fixed)  
 Full-ATI

---

**Auto ATI Base Value**

75  
 100  
 150  
 200

The ATI process adjusts three values (Coarse multiplier, Fine multiplier, Compensation) using two parameters per plate (ATI base and ATI target). The ATI process is used to ensure that the sensor’s sensitivity is not severely affected by external influences (Temperature, voltage supply change, etc.).

### 13.1.3 Coarse and Fine multipliers:

In the ATI process the compensation is set to 0 and the coarse and fine multipliers are adjusted such that the counts of the reference value (*Ref*) are roughly the same as the ATI Base value. This means that if the base value is increased, the coarse and fine multipliers should also increase and vice versa.

### 13.1.4 ATI-Compensation:

After the coarse and fine multipliers are adjusted, the compensation is adjusted till the reference value (*Ref*) reaches the ATI target. A higher target means more compensation and therefore more sensitivity on the sensor.

The ATI process ensures that long term temperature changes, or bulk magnetic interference (e.g. the accidental placement of another magnet too close to the setup), do not affect the sensor’s ability to detect the intended magnetic change.

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## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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