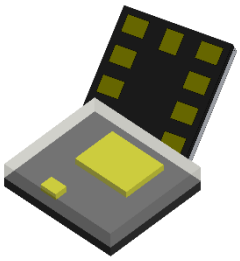
IQS621 Datasheet

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 I²C 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 – 100mT
- **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
- **A**utomatic **T**uning **I**mplementation (**ATI**) – performance enhancement (10bit)
- Minimal external components
- Standard **I²C** 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**



UOLG 2.8 x 2.5 x 0.6
9-pin
Representations only

Applications

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

Available Packages	
T_A	UOLG-2.8 x 2.5 x 0.6–9N
-20°C to 85°C	IQS621

[1] The part is not automotive qualified.

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List of abbreviations

AC – Alternating Current
ACK – I²C 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
I²C – 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 – I²C 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 – I²C Clock
SDA – I²C Data
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.

1.2 Packaging and Pin-Out

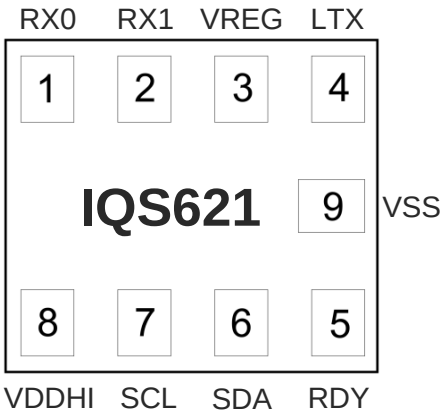


Figure 1.1 IQS621 pin-out (UOLG-2.8x2.5x0.6–9-pin package; device appearance may differ)

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	**RDY** (I^2C Ready interrupt signal)
6	SDA	Digital Input / Output	**SDA** (I^2C Data signal)
7	SCL	Digital Input / Output	**SCL** (I^2C Clock signal)
8	VDDHI	Supply Input	Supply: 1.8V – 3.3V
9	VSS	Signal GND	Common ground reference

1.3 Reference schematic

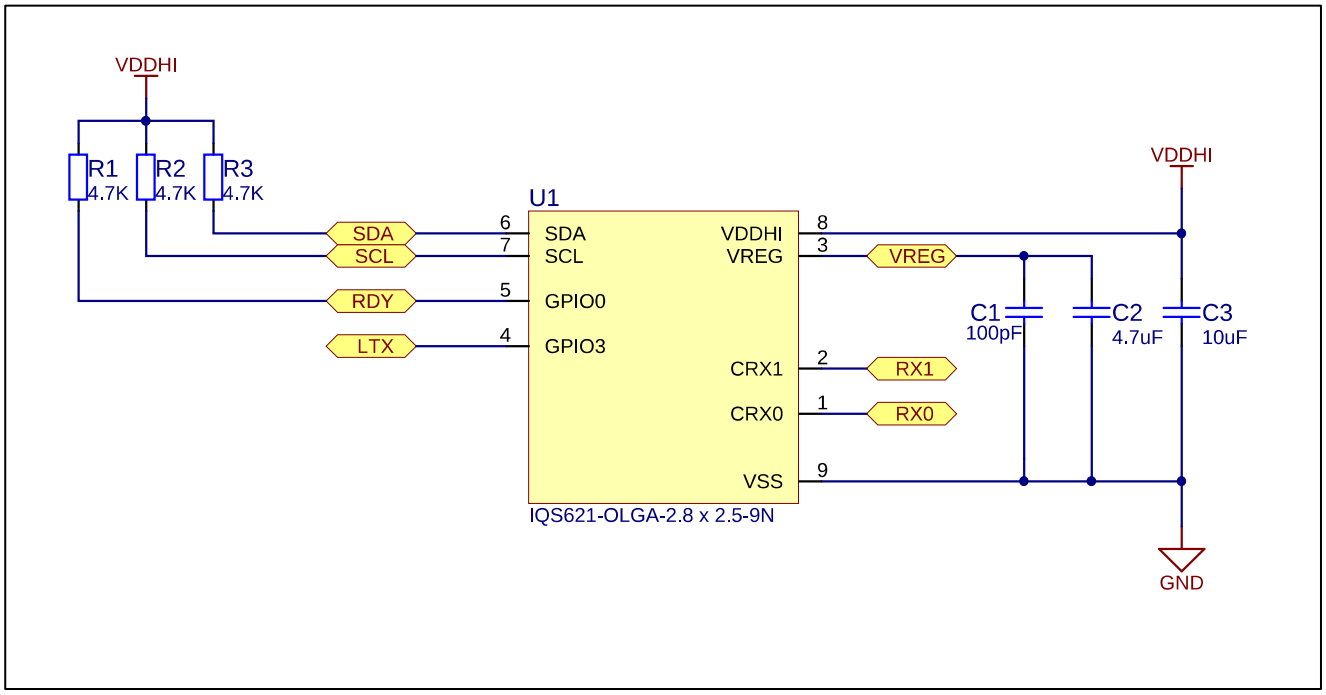


Figure 1.2 IQS621 reference schematic

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

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		•					

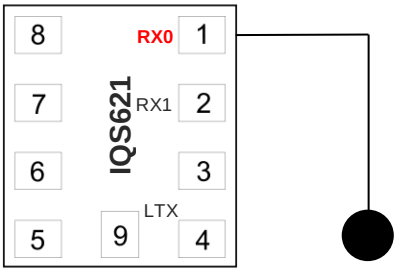
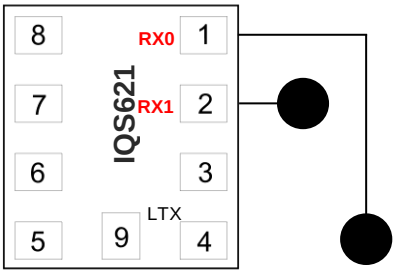
Key:

○ - 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
1 button	
2 buttons	

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
0x40 0x41	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
0x42 0x43	ProxFusion Settings 1	Channel settings for the ProxSense sensors	Full ATI is recommended for fully automated sensor tuning.
0x44 0x45	ProxFusion Settings 2	ATI settings for ProxSense sensors	ATI target should be more than ATI base to achieve an ATI
0x46 0x47	ProxFusion Settings 3	Additional Global settings for ProxSense sensors	None
0x48	ProxFusion Settings 4	Filter settings	Keep AC filter enabled
0x49	ProxFusion Settings 5	Advance sensor settings	None
0x50 0x52	Proximity threshold	Proximity Thresholds for all capacitive channels (except for SAR active on channel 0)	Preferably more than touch threshold
0x51 0x53	Touch threshold	Touch Thresholds for all capacitive channels	None
0x54	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
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

2.4.3 Example code:

Example code for an Arduino Uno can be downloaded at:

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	**HYSTE-RESIS 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

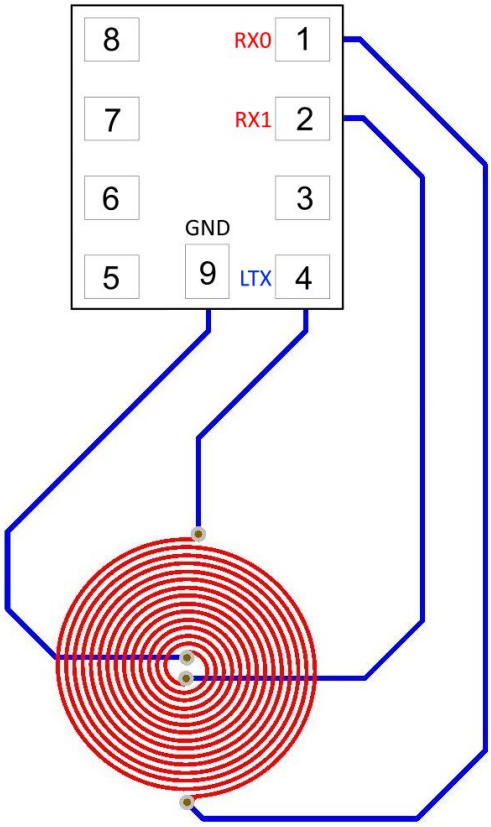
Mode	CH0	CH1	CH2	CH3	CH4	CH5	CH6
Mutual inductive	○	○					
Hysteresis UI		•					

Key:

○ - Optional implementation
• - Fixed use for UI

3.3 Hardware configuration

Table 3.2 Mutual inductive hardware description

Mutual inductive


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
0x41	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
0x43	ProxFusion Settings 1	Channel 1 settings for the inductive sensor	Full ATI is recommended for fully automated sensor tuning.
0x45	ProxFusion Settings 2	ATI settings for the inductive sensor	ATI target should be more than ATI base to achieve an ATI
0x47	ProxFusion Settings 3	Additional settings for the inductive sensor	None
0x48	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

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	**HYSTE-RESIS UI EVENT**	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	-	-	-	-	-	**Signed output**	**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	**Hysteresis 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	**Hysteresis UI output high byte**							

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

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	HYSTE-RESIS UI EVENT	**ALS EVENT**	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	**LIGHT/ DARK**	Reserved			**ALS range value**			

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	**ALS 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	**ALS UI output high byte**							

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

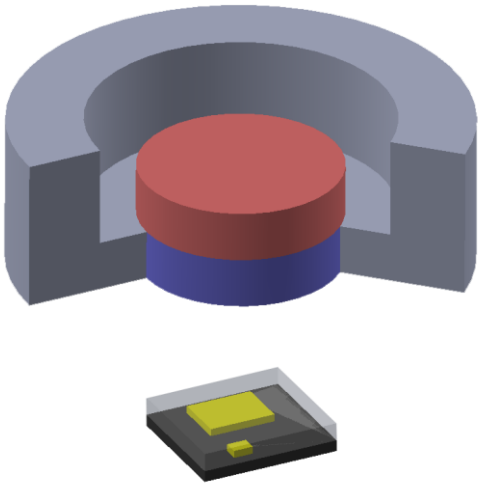
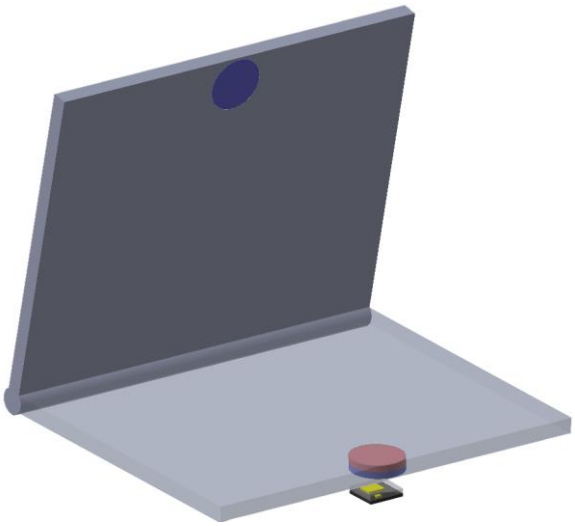
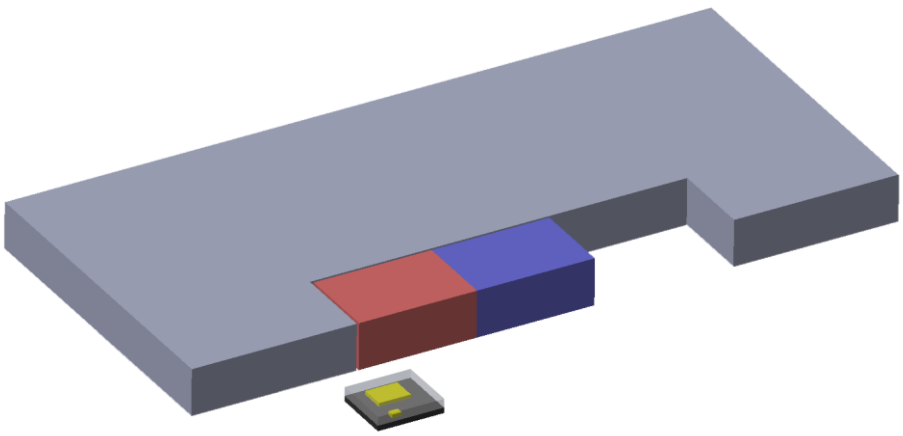
Sensor/UI type	CH0	CH1	CH2	CH3	CH4	CH5	CH6
Hall-effect switch UI						• Positive	• Negative

Key:

o - 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
0x90	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.
0x91	Hall-effect settings 1	ATI base and target selections	ATI target should be more than ATI base to achieve an ATI
0xA0	Hall-effect switch UI settings	Various settings for the Hall-effect switch UI	None
0xA1	Hall-effect switch UI proximity threshold	Proximity Threshold for UI	Less than touch threshold
0xA2	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

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	HYSTE-REISIS UI EVENT	ALS EVENT	**HALL EVENT**	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	-	-	-	-	-	**HALL TOUT**	**HALL POUT**	**HALL N/S**

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,

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

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	$Multiplier$	0xC2	Higher nibble	1 – 16
b	$Divider$		Lower nibble	1 – 16
c	$Offset$	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
Temperature trip and output			•				

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
0xC0	Temperature UI settings	Channel reseed settings	Reseed enable should be set
0xC1	Multipliers channel 2	Temperature sensor channel multiplier selection	Dependent on calibration step
0xC2	Temperature calibration data 0	4-bit Multiplier (a+1) and 4-bit divider (b+1) calibration values	Requires sample calibration
0xC3	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	**TEMP EVENT**	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^2C command.
- As a permanent setting – Set the OTP option in FG 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 no UI code are executed. 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^2C 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 I²C module specification

The device supports a standard two wire I²C interface with the addition of an RDY (ready interrupt) line. The communications interface of the IQS621 supports the following:

- 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 I²C Read

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

Current Address Read

Start	Control byte		Data n		Data n+1		Stop
S	Addr + READ	ACK		ACK		NACK	S

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.

Random Read

Start	Control byte		Address-command		Start	Control byte		Data n		Stop
S	Addr + WRITE	ACK		ACK	S	Addr + READ	ACK		NACK	S

Figure 8.2 Random Read

8.3 I²C 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.

Data Write

Start	Control byte		Address-Command		Data n		Data n+1		Stop
S	Addr + WRITE	ACK		ACK		ACK		ACK	S

Figure 8.3 I²C Data Write

8.4 Stop-bit disable option

The IQS621 offer:

- an additional I²C 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 I²C activity is present on SDA and SCL pins.

Customers using a MCU with a binary serial-encoder peripheral which is not fully I²C 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 I²C 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 I²C 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 I2C 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 I²C 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 I²C 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).

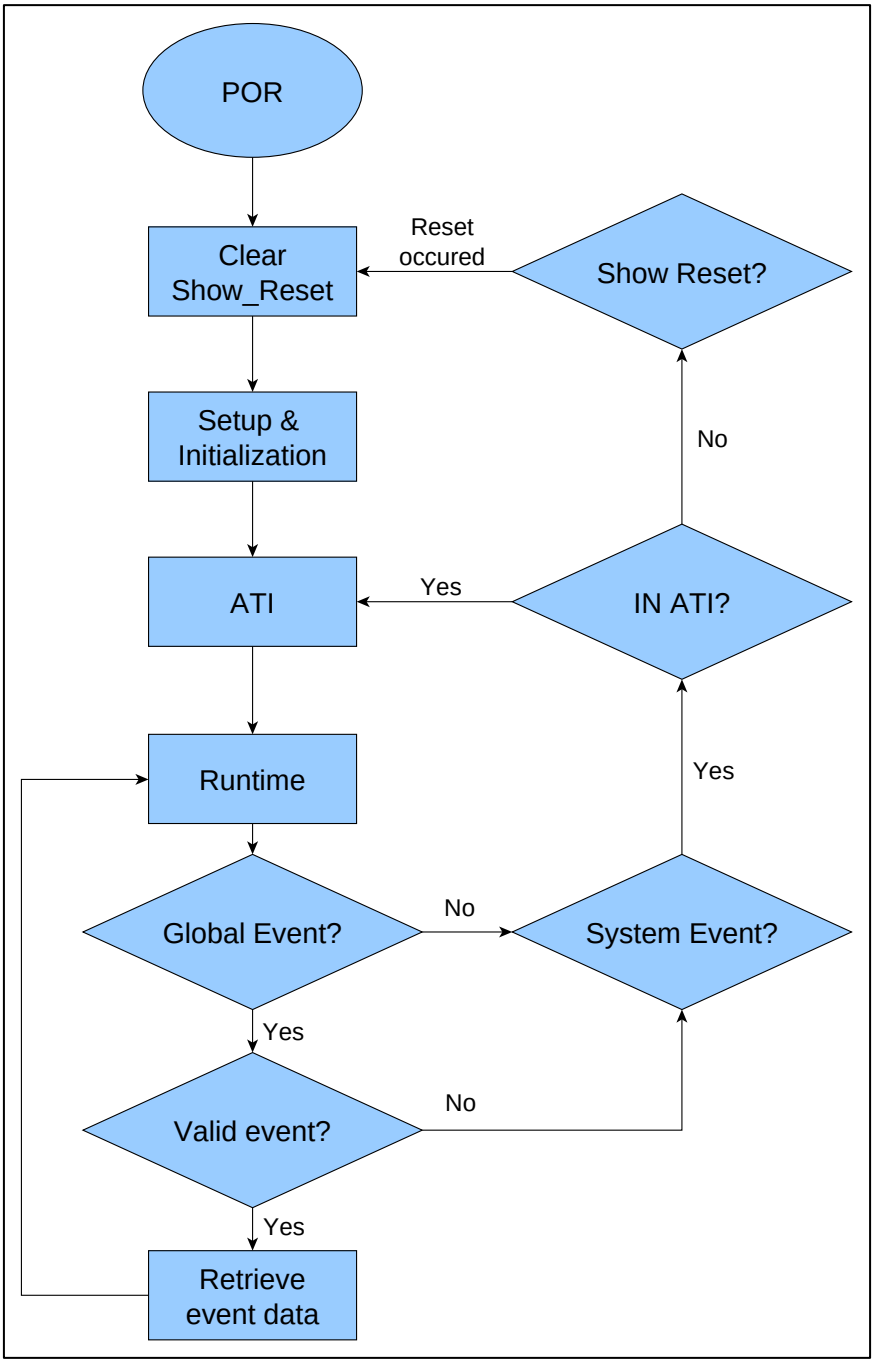


Figure 8.6 Master command structure and runtime event handling flow diagram

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

0x50	ProxFusion UI settings	Prox threshold Ch0	Read-Write
0x51		Touch threshold Ch0	Read-Write
0x52		Prox threshold Ch1	Read-Write
0x53		Touch threshold Ch1	Read-Write
0x54		ProxFusion UI halt time	Read-Write
0x60	Hysteresis UI settings	Hysteresis UI settings	Read-Write
0x61		Hysteresis UI filter halt threshold	Read-Write
0x62		Hysteresis UI prox threshold	Read-Write
0x63		Hysteresis UI touch threshold	Read-Write
0x70	ALS sensor settings	ALS settings 0	Read-Write
0x71		ALS settings 1	Read-Write
0x72		ALS filter speed	Read-Write
0x73		Multipliers Ch3 Ch4	Read-Write
0x80	ALS UI settings	ALS dark threshold	Read-Write
0x81		ALS light threshold	Read-Write
0x82		ALS to Lux divider	Read-Write
0x83		ALS IR divider	Read-Write
0x90	Hall sensor settings	Hall-effect settings 0	Read-Write
0x91		Hall-effect settings 1	Read-Write
0x92		Compensation Ch4 and Ch5	Read-Write
0x93		Multipliers Ch4 and Ch5	Read-Write
0xA0	Hall switch UI settings	Hall-effect switch UI settings	Read-Write
0xA1		Hall-effect switch UI prox threshold	Read-Write
0xA2		Hall-effect switch UI touch threshold	Read-Write
0xC0	Temperature UI settings	Temperature UI settings	Read-Write
0xC1		Multipliers Ch2	Read-Write
0xC2		Temperature calibration 0	Read-Write
0xC3		Temperature calibration 1	Read-Write
0xD0	Device and power mode settings	System settings	Read-Write
0xD1		Active channels	Read-Write
0xD2		Power mode settings	Read-Write
0xD3		Normal power mode report rate	Read-Write
0xD4		Low power mode report rate	Read-Write
0xD5		Ultra-low power mode report rate	Read-Write
0xD6		Auto mode time	Read-Write
0xD7		Global event mask	Read-Write
0xD8		RDY timeout period	Read-Write
0xD9		I²C settings	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)								
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	15	14	13	12	11	10	9	8
Data Access	R	R	R	R	R	R	R	R
Name	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)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	-	-	-	R	R	R	R
Name	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)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	ALS 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	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)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	-	-	-	R	R	R
Name	-	-	-	-	-	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)								
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							

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)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	Channel data low byte							
Bit Number	15	14	13	12	11	10	9	8
Data Access	R	R	R	R	R	R	R	R
Name	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)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R	R	R	R	R	R	R	R
Name	LTA low byte							
Bit Number	15	14	13	12	11	10	9	8
Data Access	R	R	R	R	R	R	R	R
Name	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)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	R/W	R/W	R/W	-	-	R/W	R/W
Name	-	CSz	CHARGE FREQ		Internal use		AUTO ATI MODE	
Default	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)								
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	-	CSz	CHARGE FREQ		PROJ BIAS		AUTO ATI MODE	
Fixed use	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)								
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	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)								
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	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	-	HYSTE-RESIS 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)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	-	-	-	-	-	-	-	-
Name	Internal use							
Default	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)								
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 (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)								
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 (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)								
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	Prox threshold value							
Default	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)								
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							
	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)								
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	Halt time							
Default	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		MULIPLIER 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)								
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 dark threshold x4 (Lux)							
Default	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)								
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 Light Threshold x16 (Lux)							
Default	0x0A = D'10 * 16 = 160 Lux							
	0	0	0	0	1	0	1	0

Bit definitions:

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

9.10.3 ALS raw to Lux divider

ALS raw to Lux divider (0x82)								
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 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 FGB2, 0 disables divider)*

9.10.4 ALS IR compensation

ALS IR compensation (0x83)								
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 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 7-0: Multiplier channel 2

9.13.3 Temperature calibration 0

Temperature calibration 0 (0xC2)								
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	Temperature multiplier				Temperature divider			
Default	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)								
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	Temperature offset							
Default	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: U LP 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***)

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***)

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)

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)

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	HYSTE-RESIS 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)								
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	RDY timeout period value							
Default	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 I²C settings

I²C settings (0xD9)								
Bit Number	7	6	5	4	3	2	1	0
Data Access	R/W	-	-	-	-	-	-	R/W
Name	STOP DISABLE	Reserved						Reserve
Default	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	PARAMETER	MIN	TYPICAL	MAX	UNIT
Supply voltage	V_{DDHI}	1.8	-	3.3	V
Internal voltage regulator	V_{REG}	1.63	1.66	1.69	V

10.3 Power On-reset/Brown out

Table 10.3 Power on-reset and brown out detection specifications

DESCRIPTION	Conditions	PARAMETER	MIN	MAX	UNIT
Power On Reset	V_{DDHI} Slope ≥ 100V/s @25°C	POR	1.15	1.6	V
Brown Out Detect	V_{DDHI} Slope ≥ 100V/s @25°C	BOD	1.2	1.6	V

10.4 Digital input/output trigger levels

Table 10.4 Digital input/output trigger level specifications

DESCRIPTION	Conditions	PARAMETER	MIN	TYPICAL	MAX	UNIT
All digital inputs	VDD = 1.8V	Input low level voltage	0.54	0.60	0.76	V
All digital inputs	VDD = 1.8V	Input high level voltage	0.90	1.00	1.20	V
All digital inputs	VDD = 3.3V	Input low level voltage	1.19	1.30	1.30	V
All digital inputs	VDD = 3.3V	Input high level voltage	1.90	2.10	2.20	V

10.5 Current consumptions

10.5.1 IC subsystems

Table 10.5 IC subsystem current consumption

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

Table 10.6 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

10.5.2 Capacitive sensing alone

Table 10.7 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 where done on the default setup of the IC

Table 10.8 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 where done with enhanced settings for minimum current consumption for a single touch channel

10.5.3 Inductive sensing alone

Table 10.9 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 (1)	N/A (1)	N/A (1)	µA
	VDD = 3.3V		N/A (1)	N/A (1)	N/A (1)	µA

-These measurements where 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.

10.5.4 ALS sensing alone

Table 10.10 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 (1)	N/A (1)	N/A (1)	µA
	VDD = 3.3V		N/A (1)	N/A (1)	N/A (1)	µA

-These measurements where 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. This is due to the ALS sensor being disabled in ULP.

10.5.5 Hall-effect sensing alone

Table 10.11 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 (1)	N/A (1)	N/A (1)	µA
	VDD = 3.3V		N/A (1)	N/A (1)	N/A (1)	µA

-These measurements where 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 Hall-effect sensor being disabled in ULP.

10.5.6 Temperature monitoring alone

Table 10.12 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 (1)	N/A (1)	N/A (1)	µA
	VDD = 3.3V		N/A (1)	N/A (1)	N/A (1)	µA

-These measurements where 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 temperature sensor being disabled in ULP.

10.5.7 Halt mode

Table 10.13 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

10.6 ALS specifications

10.6.1 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:

- $\boldsymbol{a \rightarrow ALS\ multiplier}$:
  - A dynamic multiplier value calculated as in the table below for the specific ALS setup and current ALS value output.
- $\boldsymbol{b \rightarrow ALS\ (raw)\ to\ Lux\ divider}$:
  - 8-bit value loaded from OTP Bank 2 into register 0x82. This calibration value is determined during IC calibration.
- $\boldsymbol{c \rightarrow ALS\ IR\ compensation\ divider}$:
  - 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 $\boldsymbol{a}$) is calculated as specified in the following table.

Table 10.14 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 $\boldsymbol{a}$
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:

$$ALS \cong \frac{\boldsymbol{a}}{\boldsymbol{b}}\left(\frac{2^{21}}{CH_4} - \frac{2^{21}}{\boldsymbol{c}.CH_3}\right)$$

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 $\boldsymbol{a}, \boldsymbol{b}$ & $\boldsymbol{c}$ 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

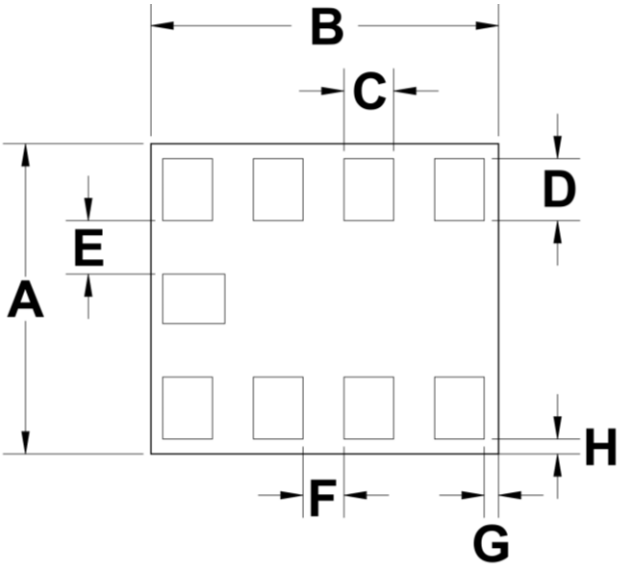


Figure 11.1 UOLG-2.8 x 2.5 x 0.6-9N Package dimensions (bottom view).

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	-

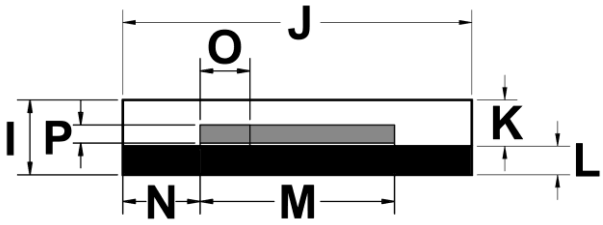


Figure 11.2 UOLG-2.8 x 2.5 x 0.6-9N Package dimensions (side view)

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

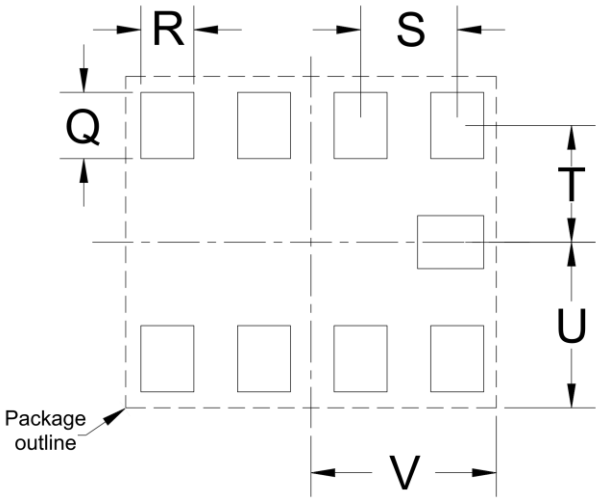


Figure 11.3 UOLG-2.8 x 2.5 x 0.6-9N Landing pad dimensions (viewed from top)

11.2 Device marking and ordering information

11.2.1 Device marking:

No device marking due to clear package.

Pin 1 indication:

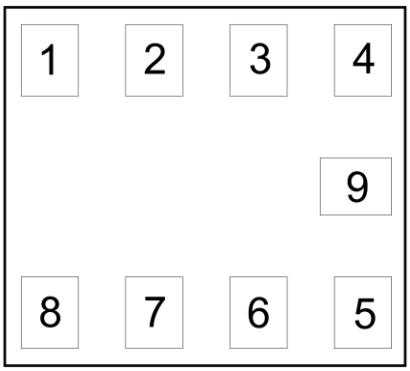


Figure 11.4 UOLG-2.8 x 2.5 x 0.6-9N pin numbers as viewed from top

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

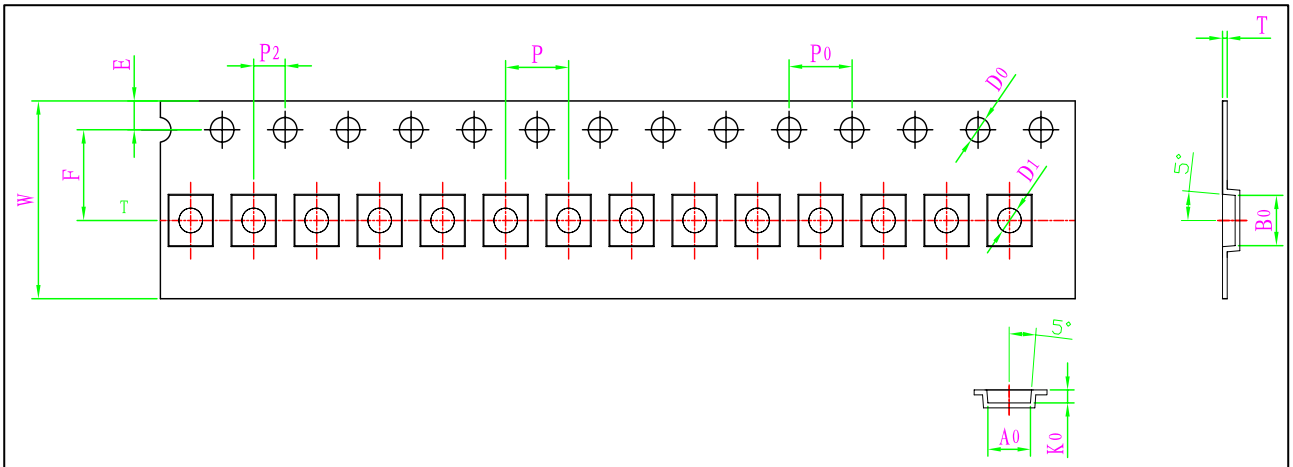
b – Bulk packaging
- R: Reel (3k per reel, MOQ=1 Reel)

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

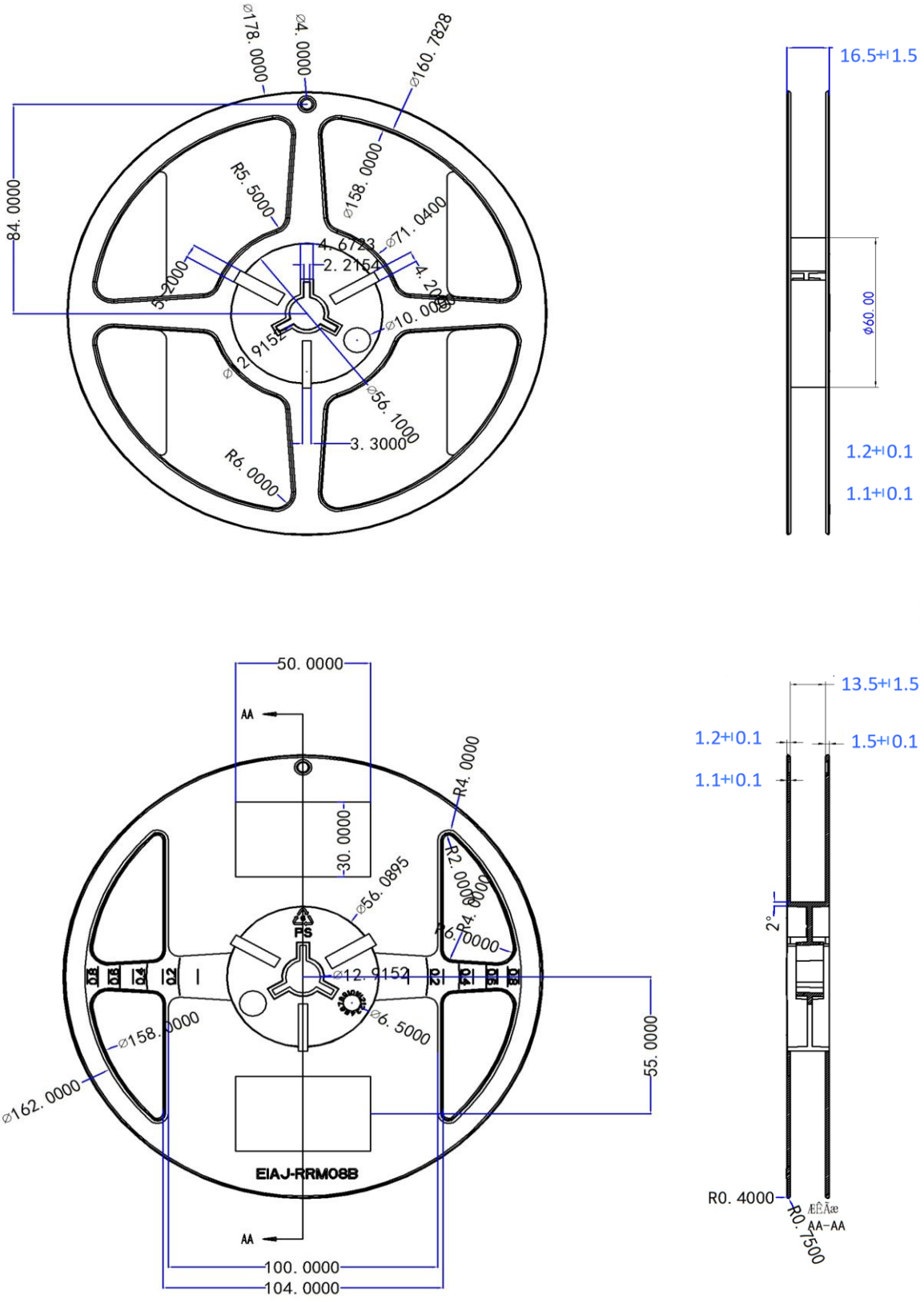


ITEM	W	A0	A1	B0	B1	K0	K1	E	F	P	P0	P2	D0	D1	T
DIM	12.0	2.75	0.00	3.05	0.00	0.80	0.00	1.75	5.50	4.00	4.0	2.0	1.50	1.50	0.30
TOLE	+0.30 −0.30	±0.10	±0.00	±0.10	±0.00	±0.10	±0.00	±0.10	±0.10	±0.10	±0.10	±0.10	+0.10 −0.00	+0.10 −0.00	±0.05

NOTES:

1. 10 sprocket hole pitch cumulative tolerance ± 0.20 mm.
   每10个料带链孔径累计公差为±0.20毫米。
2. Carrier camber not to exceed 1mm in 100 mm.
   料带弯曲每100毫米不可超过1毫米。
3. A_0 and B_0 measured on a plane 0.3 mm above the bottom of the pocket.
   A0和B0在同一平面量测且距离压缩带底部0.3毫米。
4. All scope meet EIA-481-D requirements.
   所有尺寸符合EIA-481-D标准要求。
5. Material: Black PS.
   材料: 黑色 PS 。
6. Thickness: 0.30± 0.05 mm.
   厚度: 0.30±0.05毫米。
7. Packing lenght per 13" reel : 72 Meters.
   13"胶盘包装长度为: 72 米。
8. Component load per 13" reel : 18000 pcs.
   13"胶盘可包装: 18000 pcs。

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

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^2C stop-bit disable functionality explained. Section 8.4 added.

v1.12: – Datasheet update
- Voltage regulation specifications added (Table 10.2).

12.2 Errata

Appendix A. Contact information

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