# IQS7211G DATASHEET

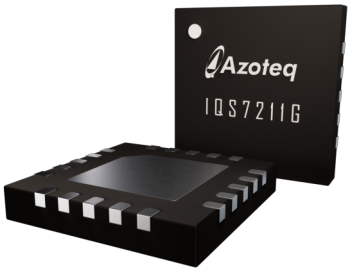
Versatile trackpad touchscreen controller with proximity, touch, snap and trackpad outputs.

## 1 Device Overview

The IQS7211G ProxSense® IC is a capacitive touch, snap and proximity trackpad/touchscreen controller implementation. The IQS7211G features best in class sensitivity, signal-to-noise ratio and automatic tuning of electrodes. Low power proximity detection allows extreme low power operation.

### 1.1 Main Features

- Highly flexible ProxSense® device
- 13 (QFN20) / 11 (WLCSP18) external sensor pad connections
- Self-/Mutual-capacitive sensors configuration for display wake-up
- ULP wake-up on touch:
  - Dedicated Ultra Low Power wake-up touch sensor or
  - Wake-up on screen/trackpad
- Sensor flexibility:
  - Automatic sensor tuning for optimum sensitivity
  - Internal voltage regulator
  - Reference capacitor
  - On-chip noise filtering
  - Detection debounce and hysteresis
  - Wide range of capacitance detection
- Trackpad/Touchscreen:
  - Up to 2 fingers tracking
  - High resolution coordinate outputs
  - Fast response: Coordinate report rate up to 100 Hz
  - Individual sensor touch
  - Integrated touch size output (area and strength) for touch integrity
  - Snap dome detection
  - Electrode mapping for optimal PCB layout
  - Configurable coordinate resolution and orientation
  - Compatible with wide range of overlay materials and thicknesses
  - Compatible with multiple 1-and 2-layer sensor patterns
  - Adjustable sensing frequency offset for limiting potential display interference
  - No calibration required - systems automatically compensated for mechanical and temperature changes
  - Water immunity features
- Design and manufacturing support:
  - Touch pattern layout drawing
  - Full FPC layout package (example & customised)
  - Test guide for touch pattern
  - RFI immunity design support
- Design simplicity:
  - PC Software for debugging and obtaining optimal performance
  - One-time settings programming (during MP) or pre-programmed devices
  - Auto-run from programmed settings for simplified integration
  - No production line calibration required




*QFN20*




*WLCSP18*

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- Display cover lens thickness:
  - Minimum thickness: 0.5 mm
  - Maximum thickness: 2-4 mm depending on design parameters
- Minimise display noise:
  - Advanced DSP for touch performance
  - Display and charger interference avoidance
  - Auto adjusting digital filters
- Supports different display touch panel types:
  - On-cell
  - Add-on touch panel
- Supporting up to 2.5" panels
- Screen resolutione:
  - 256 per channel
  - Example: 2048x768 (9x4 channels), 1536x1280 (7x6 channels)
- Automated system power modes for optimal response vs consumption
- $I^2C$ communication interface with IRQ/RDY(up to fast plus -1 MHz)
- Event and streaming modes
- Customisable user interface due to programmable memory
- Supply voltage:
  - 1.8 V(-5%) to 3.5 V @ 14 MHz
  - Minimum 2.2 V @ 18 MHz
- Small packages:
  - WLCSP18 (1.62 x 1.62 x0.5 mm) - interleaved 0.4 mm x 0.6 mm ball pitch
  - QFN20 (3 x 3 x 0.5 mm) - 0.4 mm pitch

## 1.2 Applications

- Fitness bands
- True Wireless Stereo (TWS) earbuds
- Game controller touch pads
- Headphones

## 1.3 Block Diagram

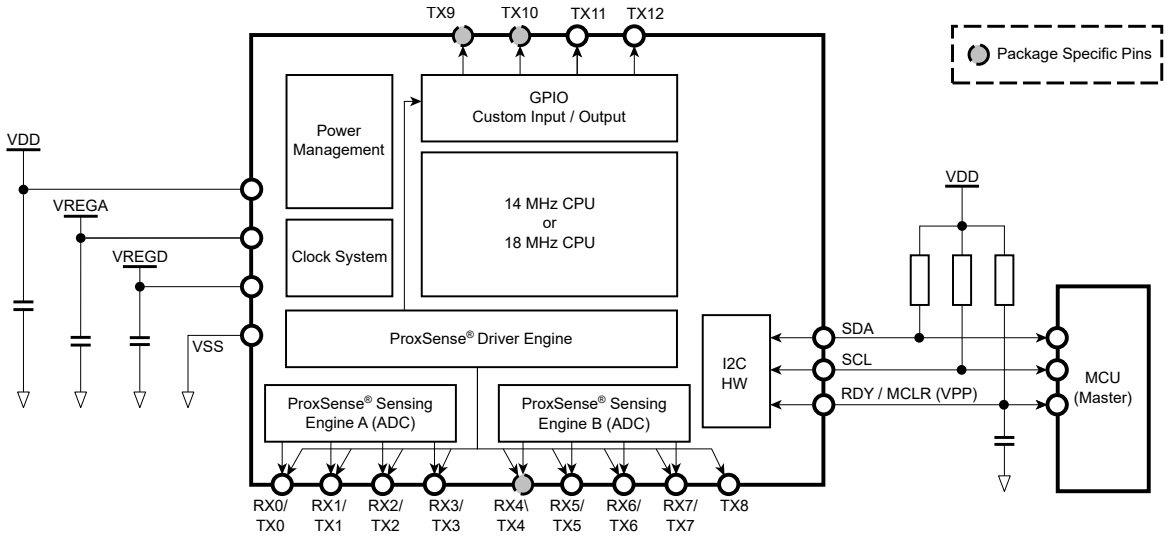



*Figure 1.3: Functional Block Diagram*[i]

[i] WLCSP18 packages do not have a RX4/TX4 and combines TX9 and TX10

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## 1.4 Option Summary

*Table 1.1: Maximum Sensor Configurations - QFN20*

|  | Trackpad square | Trackpad rectangle |
|---|---|---|
| Trackpad option | 6x6 | 8x5 |

*Table 1.2: Maximum Sensor Combinations - WLCSP18*

|  | Trackpad square | Trackpad rectangle |
|---|---|---|
| Trackpad option | 5x5 | 7x4 |

*Table 1.3: Trackpad Configurations with Different Sensor Combinations*[ii]

| Total Sensors | Total Rxs | Total Txs | Channels (max 42) | Timeslots (max 21) | Possible? |
|---|---|---|---|---|---|
| 13 | 1 | 12 | 12 | 12 | ✓ |
| | 2 | 11 | 22 | 11 | ✓ |
| | 3 | 10 | 30 | 20 | ✓ |
| | 4 | 9 | 36 | 18 | ✓ |
| | 5 | 8 | 40 | 24 | ✗ |
| | 6 | 7 | 42 | 21 | ✓ |
| | 7 | 6 | 42 | 24 | ✗ |
| | 8 | 5 | 40 | 20 | ✓ |
| 12 | 1 | 11 | 11 | 11 | ✓ |
| | 2 | 10 | 20 | 10 | ✓ |
| | 3 | 9 | 27 | 18 | ✓ |
| | 4 | 8 | 32 | 16 | ✓ |
| | 5 | 7 | 35 | 21 | ✓ |
| | 6 | 6 | 36 | 18 | ✓ |
| | 7 | 5 | 35 | 20 | ✓ |
| | 8 | 4 | 32 | 16 | ✓ |
| 11 | 1 | 10 | 10 | 10 | ✓ |
| | 2 | 9 | 18 | 9 | ✓ |
| | 3 | 8 | 24 | 16 | ✓ |
| | 4 | 7 | 28 | 14 | ✓ |
| | 5 | 6 | 30 | 18 | ✓ |
| | 6 | 5 | 30 | 15 | ✓ |
| | 7 | 4 | 28 | 16 | ✓ |
| | 8 | 3 | 24 | 12 | ✓ |

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| Total Sensors | Total Rxs | Total Txs | Channels | Timeslots | Possible? |
|---|---|---|---|---|---|
| 10 | 1 | 9 | 9 | 9 | ✓ |
| | 2 | 8 | 16 | 8 | ✓ |
| | 3 | 7 | 21 | 14 | ✓ |
| | 4 | 6 | 24 | 12 | ✓ |
| | 5 | 5 | 25 | 15 | ✓ |
| | 6 | 4 | 24 | 12 | ✓ |
| | 7 | 3 | 21 | 12 | ✓ |
| | 8 | 2 | 16 | 8 | ✓ |

[ii] Sensor combinations with less sensors are possible. WLCSP18 package has a maximum of 11 sensors.

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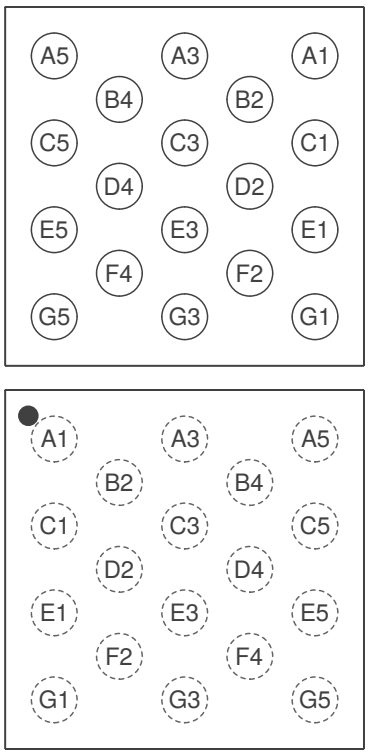
**B Revision History** **61**

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# 2 Hardware Connection

## 2.1 WLCSP18 Pin Diagrams

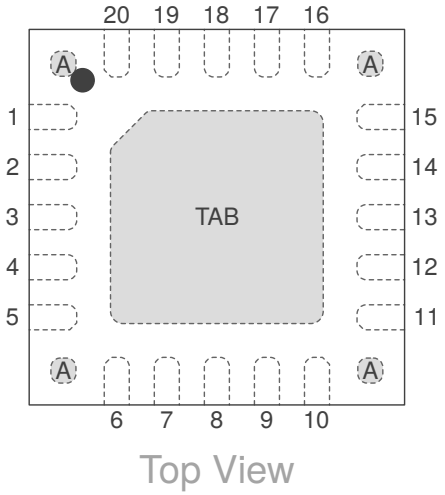
*Table 2.1: 18-pin WLCSP18 Package*




| Pin no. | Signal |
|---|---|
| A1 | TX9/TX10[i] |
| A3 | SCL |
| A5 | RDY/MCLR (VPP) |
| B2 | TX11 |
| B4 | SDA |
| C1 | TX8 |
| C3 | TX12 |
| C5 | VDD |
| D2 | RX2/TX2 |
| D4 | VSS |
| E1 | RX6/TX6 |
| E3 | RX1/TX1 |
| E5 | VREGD |
| F2 | RX5/TX5 |
| F4 | RX0/TX0 |
| G1 | RX7/TX7 |
| G3 | RX3/TX3 |
| G5 | VREGA |

## 2.2 QFN20 Pin Diagram

*Table 2.2: 20-pin QFN Package (Top View)*




| Pin no. | Signal name | Pin no. | Signal name |
|---|---|---|---|
| 1 | VDD | 11 | RX6/TX6 |
| 2 | VREGD | 12 | RX7/TX7 |
| 3 | VSS | 13 | TX8 |
| 4 | VREGA | 14 | TX9 |
| 5 | RX0/TX0 | 15 | TX10 |
| 6 | RX1/TX1 | 16 | TX11 |
| 7 | RX2/TX2 | 17 | TX12 |
| 8 | RX3/TX3 | 18 | SCL |
| 9 | RX4/TX4 | 19 | SDA |
| 10 | RX5/TX5 | 20 | RDY/MCLR (VPP) |

| Area name | Signal name |
|---|---|
| TAB[ii] | Thermal pad (floating) |
| A[iii] | Thermal pad (floating) |

[i] Please note that TX9 and TX10 are connected together in the WLCSP18 package.
[ii] It is recommended to connect the thermal pad (TAB) to VSS.

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## 2.3 Pin Attributes

*Table 2.3: Pin Attributes*

| Pin no. | | Signal name | Signal type | Buffer type | Power source |
|---|---|---|---|---|---|
| WLCSP18 | QFN20 | | | | |
| C5 | 1 | VDD | Power | Power | N/A |
| E5 | 2 | VREGD | Power | Power | N/A |
| D4 | 3 | VSS | Power | Power | N/A |
| G5 | 4 | VREGA | Power | Power | N/A |
| F4 | 5 | RX0/TX0 | Analog | | VREGA |
| E3 | 6 | RX1/TX1 | Analog | | VREGA |
| D2 | 7 | RX2/TX2 | Analog | | VREGA |
| G3 | 8 | RX3/TX3 | Analog | | VREGA |
| - | 9 | RX4/TX4 | Analog | | VREGA |
| F2 | 10 | RX5/TX5 | Analog | | VREGA |
| E1 | 11 | RX6/TX6 | Analog | | VREGA |
| G1 | 12 | RX7/TX7 | Analog | | VREGA |
| C1 | 13 | TX8 | Analog | | VREGA |
| A1 | 14 | TX9 | Prox/Digital | | VREGA/VDD |
| B4 | 19 | SDA | Digital | | VDD |
| A3 | 18 | SCL | Digital | | VDD |
| A1 | 15 | TX10 | Prox/Digital | | VREGA/VDD |
| B2 | 16 | TX11 | Prox/Digital | | VREGA/VDD |
| C3 | 17 | TX12 | Prox/Digital | | VREGA/VDD |
| A5 | 20 | RDY/MCLR (VPP) | Digital | | VDD |

[iii] Electrically connected to TAB. These exposed pads are only present on *–QNR* order codes.

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## 2.4 Signal Descriptions

*Table 2.4: Signal Descriptions*

| Function | Signal name | Pin no. | | Pin type[iv] | Description |
|---|---|---|---|---|---|
| | | WLCSP18 | QFN20 | | |
| ProxFusion® | RX0/TX0 | F4 | 5 | IO | ProxFusion® channel |
| | RX1/TX1 | E3 | 6 | IO | |
| | RX2/TX2 | D2 | 7 | IO | |
| | RX3/TX3 | G3 | 8 | IO | |
| | RX4/TX4 | - | 9 | IO | |
| | RX5/TX5 | F2 | 10 | IO | |
| | RX6/TX6 | E1 | 11 | IO | |
| | RX7/TX7 | G1 | 12 | IO | |
| | TX8 | C1 | 13 | O | TX8 pad |
| | TX9 | A1 | 14 | IO | TX9 pad |
| | TX10 | A1 | 15 | IO | TX10 pad |
| | TX11 | B2 | 16 | IO | TX11 pad |
| | TX12 | C3 | 17 | IO | TX12 pad |
| GPIO | RDY/MCLR (VPP) | A5 | 20 | IO | RDY pad<br>VPP input for OTP |
| $I^2C$ | SDA | B4 | 19 | IO | $I^2C$ data |
| | SCL | A3 | 18 | IO | $I^2C$ clock |
| Power | VDD | C5 | 1 | P | Power supply input voltage |
| | VREGD | E5 | 2 | P | Internal regulated supply output for digital domain |
| | VSS | D4 | 3 | P | Analog/digital ground |
| | VREGA | G5 | 4 | P | Internal regulated supply output for analog domain |

[iv] Pin Types: I = Input, O = Output, IO = Input or Output, P = Power.

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## 2.5 Reference Schematic

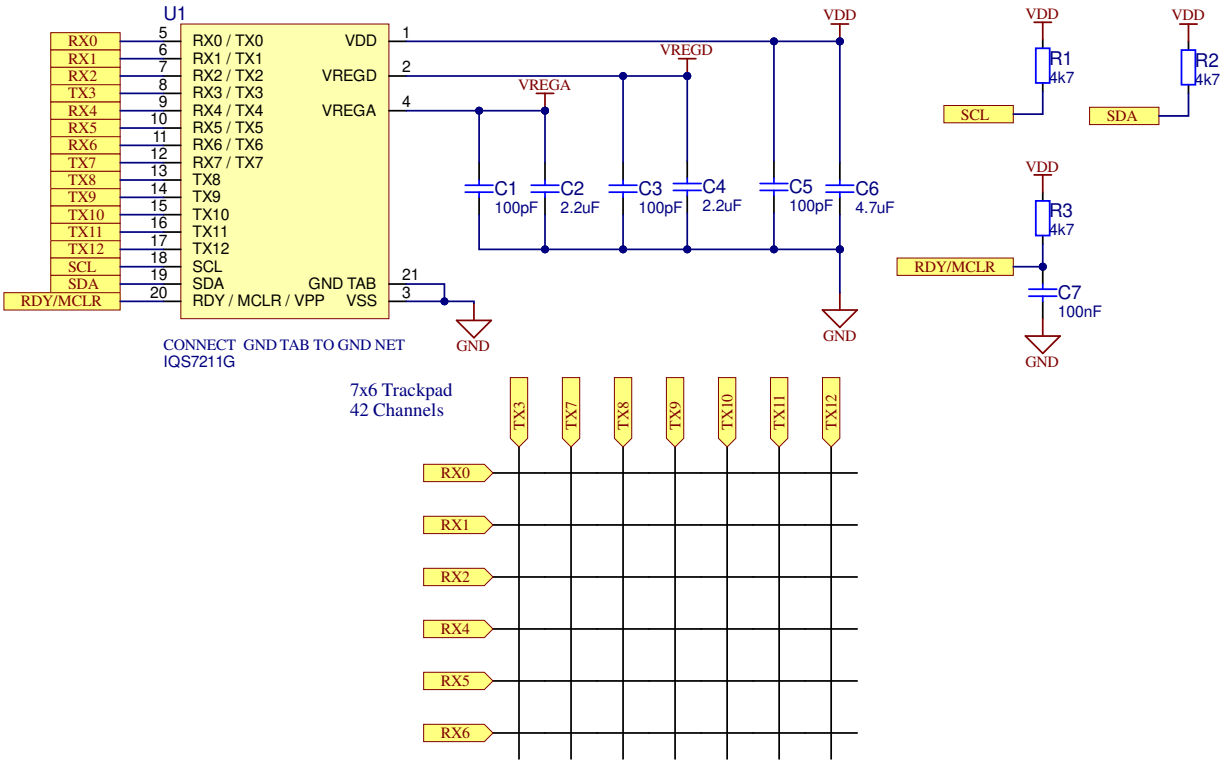



*Figure 2.1: Reference Trackpad Schematic: 7x6 Pattern*

# 3 Electrical Characteristics

## 3.1 Absolute Maximum Ratings

*Table 3.1: Absolute Maximum Ratings*

| | Min | Max | Unit |
|---|---|---|---|
| Voltage applied at VDD pin to VSS | 1.71 | 3.6 | V |
| Voltage applied to any ProxFusion® pin (referenced to VSS) | –0.3 | VREGA | V |
| Voltage applied to any other pin (referenced to VSS) | –0.3 | VDD + 0.3 (3.6 V max) | V |
| Storage temperature, $T_{stg}$ | –40 | 85 | °C |

## 3.2 Recommended Operating Conditions

*Table 3.2: Recommended Operating Conditions*

| | | Min | Nom | Max | Unit |
|---|---|---|---|---|---|
| VDD | Supply voltage applied at VDD pin:<br>$f_{OSC}$ = 14 MHz<br>$f_{OSC}$ = 18 MHz | <br>1.71<br>2.2 | | <br>3.6<br>3.6 | V |
| VREGA | Internal regulated supply output for analog domain:<br>$f_{OSC}$ = 14 MHz<br>$f_{OSC}$ = 18 MHz | <br>1.49<br>1.7 | <br>1.53<br>1.75 | <br>1.57<br>1.79 | V |
| VREGD | Internal regulated supply output for digital domain:<br>$f_{OSC}$ = 14 MHz<br>$f_{OSC}$ = 18 MHz | <br>1.56<br>1.75 | <br>1.59<br>1.8 | <br>1.64<br>1.85 | V |
| VSS | Supply voltage applied at VSS pin | | 0 | | V |
| $T_A$ | Operating free-air temperature | –40 | 25 | 85 | °C |
| $C_{VDD}$ | Recommended capacitor at VDD | $2\times C_{VREGA}$ | $3\times C_{VREGA}$ | | µF |
| $C_{VREGA}$ | Recommended external buffer capacitor at VREGA, ESR $\leq$ 200 mΩ | 2[i] | 4.7 | 10 | µF |
| $C_{VREGD}$ | Recommended external buffer capacitor at VREGD, ESR $\leq$ 200 mΩ | 2[i] | 4.7 | 10 | µF |
| $Cx_{SELF–VSS}$ | Maximum capacitance between ground and all external electrodes on all ProxFusion® blocks (self-capacitance mode) | 1 | | 400[ii] | pF |
| $Cm_{CTx–CRx}$ | Capacitance between receiving and transmitting electrodes on all ProxFusion® blocks (mutual-capacitance mode) | 0.2 | | 9[ii] | pF |
| $Cp_{CRx–VSS}$ | Maximum capacitance between ground and all external electrodes on all ProxFusion® blocks (mutual-capacitance mode at $f_{xfer}$ = 1 MHz) | | | 100[ii] | pF |
| $\frac{Cp_{CRx–VSS}}{Cm_{CTx–CRx}}$ | Capacitance ratio for optimal SNR in mutual-capacitance mode[iii] | 10 | | 20 | n/a |
| $RCx_{CRx/CTx}$ | Series (in-line) resistance of all mutual-capacitance pins (Tx & Rx pins) in mutual-capacitance mode | 0[iv] | 0.47 | 10[v] | kΩ |
| $RCx_{SELF}$ | Series (in-line) resistance of all self-capacitance pins in self-capacitance mode | 0[iv] | 0.47 | 10[v] | kΩ |

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## 3.3 ESD Rating

*Table 3.3: ESD Rating*

| | | Value | Unit |
|---|---|---|---|
| $V_{(ESD)}$ Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001[vi] | ±4000 | V |

[i] Absolute minimum allowed capacitance value is 1 µF, after taking derating, temperature, and worst-case tolerance into account. Please refer to AZD004 for more information regarding capacitor derating.
[ii] RCx = 0 Ω.
[iii] Please note that the maximum values for Cp and Cm are subject to this ratio.
[iv] Nominal series resistance of 470 Ω is recommended to prevent received and emitted EMI effects. Typical resistance also adds additional ESD protection.
[v] Series resistance limit is a function of $f_{xfer}$ and the circuit time constant, $RC$. $R_{max} \times C_{max} = \frac{1}{(6 \times f_{xfer})}$ where $C$ is the pin capacitance to VSS.
[vi] JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Pins listed as ±4000 V may actually have higher performance.

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## 3.4 Current Consumption

The current consumption of the IQS7211G is highly dependent on the specific parameters configured during initialisation. Therefore, the table provided below serves as an illustration of the expected power consumption for similar configurations[vii]. All measurements are taken without I²C communication, since the amount of data read via I²C will impact the current consumption and sampling period of the device. The device configurations outlined in the table represent practical setups commonly encountered in various applications. The main oscillator frequency was set to *14 MHz* for all measurements.

*Table 3.4: Current Consumption*

| Power mode | Active channels | Report rate [ms] | Auto-prox cycles | Setup | Current [µA] |
|---|---|---|---|---|---|
| Active Mode | Trackpad (42 Channel) | 10 | N/A | Configured as a 7x6 trackpad<br>ATI Target of 200 counts<br>1.4 MHz conversion frequency<br>1 finger touch (8 mm diameter) active<br>No I²C comms | 1500 |
| Active Mode | Trackpad (42 Channel) | 16 | N/A | Configured as a 7x6 trackpad<br>ATI Target of 200 counts<br>1.4 MHz conversion frequency<br>1 finger touch (8 mm diameter) active<br>No I²C comms | 985 |
| Idle Mode | Trackpad (42 Channel) | 50 | N/A | Same as above but no touch, and no I²C | 309 |
| Low Power 1 | Wake-up on Trackpad | 100 | None | ALP configured with ATI Target of 200 counts<br>6 Rxs and 4 Txs active<br>1.4 MHz conversion frequency<br>No user interaction / No comms (event mode) | 11 |
| Low Power 1 | Wake-up on Trackpad | 100 | 32 | ALP configured with ATI Target of 200 counts<br>6 Rxs and 4 Txs active<br>1.4 MHz conversion frequency<br>No user interaction / No comms (event mode) | 9 |
| Low Power 2 | Wake-up on Trackpad | 200 | None | ALP configured with ATI Target of 200 counts<br>6 Rxs and 4 Txs active<br>1.4 MHz conversion frequency<br>No user interaction / No comms (event mode) | 7 |
| Low Power 2 | Wake-up on Trackpad | 200 | 32 | ALP configured with ATI Target of 200 counts<br>6 Rxs and 4 Txs active<br>1.4 MHz conversion frequency<br>No user interaction / No comms (event mode) | 5 |

[vii] These measurements are based on bench testing and have not been characterised over large volumes.

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# 4 Timing and Switching Characteristics

## 4.1 Reset Levels

*Table 4.1: Reset Levels*

| Parameter | | Min | Max | Unit |
|---|---|---|---|---|
| $V_{VDD}$ | Power-up (Reset trigger) – slope > 100 V/s | | 1.65 | V |
| | Power-down (Reset trigger) – slope < –100 V/s | 0.9 | | |

## 4.2 MCLR Pin Levels and Characteristics

*Table 4.2: MCLR Pin Characteristics*

| Parameter | | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{IL(MCLR)}$ | MCLR Input low level voltage | VDD = 3.3 V | VSS – 0.3 | - | 1.05 | V |
| | | VDD = 1.7 V | | | 0.75 | |
| $V_{IH(MCLR)}$ | MCLR Input high level voltage | VDD = 3.3 V | 2.25 | - | VDD + 0.3 | V |
| | | VDD = 1.7 V | 1.05 | | | |
| $R_{PU(MCLR)}$ | MCLR pull-up equivalent resistor | | 180 | 210 | 240 | kΩ |
| $t_{PULSE(MCLR)}$ | MCLR input pulse width – no trigger | VDD = 3.3 V | - | - | 15 | ns |
| | | VDD = 1.7 V | | | 10 | |
| $t_{TRIG(MCLR)}$ | MCLR input pulse width – ensure trigger | | 250 | - | - | ns |

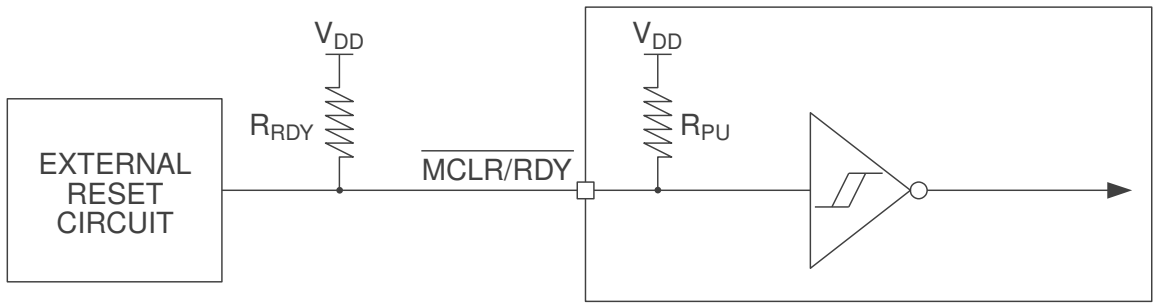



*Figure 4.1: MCLR Pin Diagram*

## 4.3 Miscellaneous Timings

*Table 4.3: Miscellaneous Timings*

| Parameter | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $f_{OSC}$ | Master CLK frequency tolerance 14 MHz | 13.23 | 14 | 14.77 | MHz |
| $f_{OSC}$ | Master CLK frequency tolerance 18 MHz | 17.1 | 18 | 19.54 | MHz |
| $f_{xfer}$ | Charge transfer frequency (derived from $f_{OSC}$) | 70 | 500 – 1500 | 9000 | kHz |

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## 4.4 Digital I/O Characteristics

*Table 4.4: Digital I/O Characteristics*

| Parameter | | Test Conditions[i] | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{OL}$ | Output low voltage of SDA and SCL pins | $I_{OL}$ = 20 mA<br>$V_{DD} > 2$ V | | 0.4 | V |
| | | $I_{OL}$ = 20 mA<br>$V_{DD} \leq 2$ V | | 0.2 $V_{DD}$ | |
| | Output low voltage of SDA and SCL pins in GPIO output mode | $I_{OL}$ = 10 mA | | 0.1 $V_{DD}$ | |
| | Output low voltage of RDY/MCLR (VPP) | $I_{OL}$ = 5 mA | | | |
| | Output low voltage of any other GPIO pin | $I_{OL}$ = 10 mA | | | |
| $V_{OH}$ | Output high voltage | $I_{OH}$ = −5 mA | 0.9 $V_{DD}$ | | V |
| $V_{IL}$ | Input low voltage | | $V_{SS}$ − 0.3 | 0.3 $V_{DD}$ | V |
| $V_{IH}$ | Input high voltage | | 0.7 $V_{DD}$ | $V_{DD}$ + 0.3 | V |
| $C_b$ | SDA and SCL bus capacitance | | | 550 | pF |

[i] Standard operating conditions:
$V_{DD}$: 1.8 V to 3.6 V, unless otherwise stated.
Operating temperature: −20 °C to 80 °C.

## 4.5 I²C Characteristics

*Table 4.5: I²C Characteristics*

| Parameter | | Min | Max | Unit |
|---|---|---|---|---|
| $f_{SCL}$ | SCL clock frequency | | 1000 | kHz |
| $t_{HD,STA}$ | Hold time (repeated) START condition | 0.26 | | µs |
| $t_{LOW}$ | LOW period of the SCL clock | 0.5 | | µs |
| $t_{HIGH}$ | HIGH period of the SCL clock | 0.26 | | µs |
| $t_{SU,STA}$ | Setup time for a repeated START | 0.26 | | µs |
| $t_{HD,DAT}$ | Data hold time | 0 | | ns |
| $t_{SU,DAT}$ | Data setup time | 50 | | ns |
| $t_{SU,STO}$ | Setup time for STOP | 0.26 | | µs |
| $t_{BUF}$ | Bus free time between a STOP and START condition | 0.5 | | µs |
| $t_{SP}$ | Pulse duration of spikes suppressed by input filter | 0 | 50 | ns |

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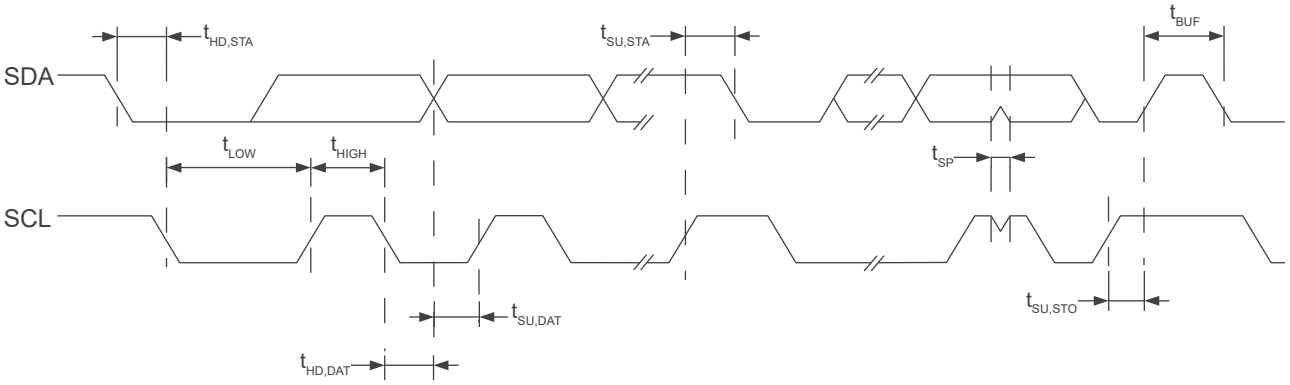



*Figure 4.2: $I^2C$ Mode Timing Diagram*

# 5 ProxSense® Module

The IQS7211G contains a ProxSense® module that uses patented technology to measure and process the capacitive sensor data. The channel touch output and snap is the primary output from the sensors. These are processed further to provide secondary trackpad outputs that include finger position and finger size.

## 5.1 Trackpad Channels

On a trackpad sensor (typically a diamond shape pattern), each intersection of an Rx and Tx row/column forms a mutual-capacitive sensing element which is referred to as a *channel*. Each channel has an associated count value, reference value, touch status and snap status (if enabled).

### 5.1.1 Channel Numbers

Trackpad channels are numbered from 0 to (*TotalRxs* ∗ *TotalTxs*) - 1. They are assigned from the top-left corner, first along the Rxs before stepping to the next Tx. The channel number must be known for some settings such as allocating channels into *sensing cycles* (timeslots), and configuring snap channels. Here is an example of a 4x3 trackpads' channel numbers:

*Table 5.1: Channel Number Assignment*

| | Rx0 (Column 0) | Rx4 (Column 1) | Rx1 (Column 2) | Rx5 (Column 3) |
|---|---|---|---|---|
| **Tx8 (Row 0)** | 0 | 1 | 2 | 3 |
| **Tx10 (Row 1)** | 4 | 5 | 6 | 7 |
| **Tx2 (Row 2)** | 8 | 9 | 10 | 11 |

## 5.2 Alternate Low-Power Channel (ALP)

To provide lower power consumption, the trackpad can be configured as a single sensor in LP1 and LP2, instead of sensing the individual trackpad channels. This channel has a lot of setup flexibility:

- *Sensing method:* mutual capacitive or self-capacitive (*Sensing Method*).
- *Multiple electrode selection:* which Rxs (*Rx EN*) / Txs (*TX EN*) are active during conversions.
- *Auto-prox:* autonomous sensing cycles while core is asleep (*LPX Auto-Prox Cycles*) giving further power saving, but similar wake-up capability.
- *Count value filtering (Count Filter):* gives reliable proximity detection in noisy environments.
- *Single channel:* since the alternate channel is processed as only a single channel, much less processing is done, allowing for lower overall power consumption.

## 5.3 Count Value

The capacitive sensing measurement returns a *count value* for each channel. Count values are inversely proportional to capacitance, and all outputs are derived from this.

### 5.3.1 Trackpad Count Values

The individual trackpad channel count values (*Count Values*) are unfiltered.

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### 5.3.2 ALP Count Values

If Rxs from both prox engine A and B are enabled, there will be two count measurements (*ALP Count A/B*). To reduce processing time (and thus decrease current consumption) the measurements are added together (*ALP channel count*) and processed as a single channel. A count value filter is implemented on this channel to give stable proximity output for system wake-up from low-power mode. It is recommended to leave this count filter enabled (*Count Filter*) The amount of filtering can be modified (*ALP count filter beta*) if required. This beta is used as follows to determine the damping factor of the filter:

$$\text{Count damping factor} = (8 * \text{Beta} - 7) / 2048$$

If the beta is small, the filtering is stronger (filtered count follows raw count slower), and if the beta is larger, the filtering is weaker (filtered count follows raw count faster).

### 5.3.3 Max Count

Each channel is limited to having a count value smaller than the configurable limit (*Max Count*). If the ATI setting or hardware causes measured count values higher than this, the conversion will be stopped, and the max value will be read for that relevant count value.

### 5.3.4 Trackpad Delta Value

The signed delta values (*Trackpad delta values*) are simply:

$$\text{Delta} = \text{Count} - \text{Reference}$$

## 5.4 Reference Value/Long-Term Average (LTA)

User interaction is detected by comparing the measured count values to some reference value. The reference value/LTA of a sensor is slowly updated to track changes in the environment and is not updated during user interaction.

### 5.4.1 Trackpad References

The trackpad *reference values* are a snapshot (identical to a reseed) of the count value, stored during a time of no user activity, and thus is a non-affected reference. The trackpad reference values are only updated from LP1 and LP2 mode when modes are managed automatically, where no user interaction is assumed. Thus, if the system is controlled manually, the reference must also be managed and updated manually by the host.

The reference value is updated or refreshed according to a configurable interval (*Reference update time*), in seconds. The Reference update time has a maximum setting of *60 seconds*.

### 5.4.2 ALP Long-Term Average

The ALP channel does not have a snapshot reference value as used on the trackpad but utilises a filtered long-term average value (*ALP channel LTA*). The LTA tracks the environment closely for accurate comparisons to the measured count value, to allow for small proximity deviations to be sensed. The speed of LTA tracking can be adjusted with the *ALP LTA beta*. There is a beta for LP1 and LP2. This is to allow different settings for different report rates, so that the speed of LTA tracking can remain the same. These beta settings are used in the same way as for the counts, see Section 5.3.2.

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### 5.4.3 Reseed

Since the *Reference* (or *LTA* for ALP channel) is critical for the device to operate correctly, there could be known events or situations which would call for a manual reseed. A reseed takes the latest measured counts, and seeds the *reference/LTA* with this value, therefore updating the value to the latest environment. A reseed command can be given by setting the corresponding bit (*TP Reseed* or *ALP Reseed*.

## 5.5 Channel Outputs

### 5.5.1 Trackpad Touch Output

The trackpad touch output (*Touch status*) is set when a channel's count value increases by more than the selected threshold.

The touch threshold for a specific channel is calculated as follows:

$$\text{Threshold} = \text{Reference} \times (1 + \textit{Multiplier} / \mathbf{128})$$

where *Multiplier* is an 8-bit unsigned value for both the 'set' and 'clear' threshold, allowing a hysteresis to provide improved touch detection. A smaller fraction will thus be a more sensitive threshold.

A trackpad will have optimal XY data if all the channels in the trackpad exhibit similar deltas under similar user inputs. In such a case all the channels will have identical thresholds. In practice, sensor design and hardware restrictions could cause deltas that are not constant over the entire trackpad. It could then be required to select individual multiplier values. These *Individual Touch Threshold Adjustments* are signed 8-bit values and indicate how much the unsigned 8-bit global value *Touch Set/Clear Threshold Multiplier* must be adjusted. The threshold used for a specific channel (set and clear) is as follows:

$$\text{Adjusted Multiplier} = \text{Set/Clear Threshold Multiplier} + \text{Individual Threshold Adjustment}$$

**Note:** If individual touch thresholds are updated via $I^2C$ by the master, a trackpad reseed command must be issued for the changes to take immediate effect.

### 5.5.2 Trackpad Snap Output

When adding a metal snap-dome overlay to the trackpad pattern, an additional snap output is available in the *Snap Status* registers. The device is able to distinguish between a normal 'touch' on the overlay and an actual button 'snap', which depresses the metal dome onto the Rx/Tx pattern. The design must be configured so that a snap on the metal dome will result in a channels count value falling well below the reference for that channel. If required, the function must be enabled in the *Trackpad Snap Channel Enable* registers for each channel on which snap is designed. Only channels with snap must be marked as such, since channels are handled differently if they are snap channels compared to non-snap channels.

When a snap is performed, a sensor saturation effect causes the deviation to be negative. Because it is only necessary to read the individual snap registers if a state change has occurred, a status bit (*Snap Toggle*) is added to the *Info Flags* register to indicate this. This is only set when there is a change of status of any snap channel. A reseed is executed if a snap is sensed for longer than the *Snap Timeout* (in seconds). A setting of '0' will never reseed. The timeout is reset if any snap is set or cleared.

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The trackpad snap output *Snap Status* is set when a channel's snap count value decreases by more than the selected threshold.

The threshold for a snap channel is determined as follows:

$$\text{Threshold} = \text{Reference} - \text{Snap Threshold}$$

This output is set when a channel's count value decreases below the selected threshold – thus a delta setting. *Snap Set Threshold* is an 8-bit unsigned value for the 'set' threshold. *Snap Clear Threshold* is an 8-bit unsigned value for the 'clear' threshold, allowing a hysteresis to provide improved snap detection.

### 5.5.3 ALP Output

This output (*ALP Output*) is set when a channel's count value deviates from the LTA value by more than the selected threshold - thus a delta setting (*ALP threshold*). This can be used to implement a proximity or touch detection, depending on the threshold used.

### 5.5.4 Output Debounce

There is no debounce on the trackpad touch or snap detection (or release). This is because debouncing adds too much delay, and fast movements on the touch panel cannot be debounced fast enough to provide reliable XY output data.

Debounce on the ALP output is however done, to allow for stable proximity detection if needed. An 8-bit unsigned value is used for the set and clear debounce parameter (*ALP set/clear debounce*).

## 5.6 Automatic Tuning Implementation (ATI)

The ATI is a sophisticated technology implemented in the new ProxSense® devices to allow optimal performance of the devices for a wide range of sensing electrode capacitances, without modification to external components. The ATI settings allow tuning of various parameters.

The main advantage of the ATI is to balance out small variations between trackpad hardware and IQS7211G variation, to give similar performance across devices and temperature.

For a detailed description of ATI, please contact Azoteq.

### 5.6.1 ATI Coarse Divider/ Multiplier

The *ATI coarse divider / multiplier* can be used to configure the base value for the trackpad and ALP channels. There is one global setting parameter for all the active trackpad channels for the course divider and one for the course multiplier. The divider is a 5-bit setting (0-31) and the multiplier a 4-bit setting (0-15).

### 5.6.2 ATI Fine Divider

The *ATI fine divider* is also used to configure the trackpad and ALP base value. There is one global setting parameter for all the active trackpad channels for the fine divider. The divider is a 5-bit setting (0-31).

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### 5.6.3 ATI Compensation (and ATI Target)

The ATI Compensation value for each channel (*ATI compensation*) and (*ALP ATI compensation*) is set by the ATI procedure, and are chosen so that each count value is close to the selected target value (*TP ATI target* / *ALP ATI target*). The algorithm is queued using *TP / ALP Re-ATI*.

The *TP / ALP Re-ATI* bits clear automatically on chip when the algorithm has completed.

The queued re-ATI routine will execute as soon as the corresponding channels are sensed. For example, the trackpad re-ATI when the system is in Active, Idle-Touch or Idle mode, and the ALP re-ATI when the system is in LP1 or LP2.

The ALP channel has individual compensation values (*ALP ATI compensation*) for both proximity engines A (Rx0-3) and B (Rx4-7).

The ALP ATI target value applies to each of the individual count values configured for the ALP channel. The combined channel will thus have a count near the sum of the ATI target.

This routine will only execute after the communication window is terminated, and the $I^2C$ communication will only resume once the ATI routine has completed.

ATI compensation is 10-bit value, thus 0 to 1023.

### 5.6.4 ATI Divider

The ATI compensation can be scaled using the *Trackpad ATI Compensation Divider* / *ALP ATI Compensation Divider*.

Since the compensation step size is scaled by the divider, a smaller divider value results in larger compensation steps. Conversely, a larger divider value provides finer compensation resolution, but reduces the overall compensation range.

Unlike the IQS7211E, the IQS7211G automatically selects an appropriate compensation divider as part of the ATI algorithm, instead of a single global divider setting.

### 5.6.5 Compensation Seed Value

The *Trackpad Compensation Seed Value* / *ALP Compensation Seed Value* specifies the initial preload value used by the ATI algorithm during compensation divider selection. It is recommended to keep this register at its default value. Do not modify this setting without guidance from Azoteq.

## 5.7 Automatic Re-ATI

### 5.7.1 Description

When enabled (*TP Re-ATI EN*) or (*ALP Re-ATI EN*) a re-ATI will be triggered if certain conditions are met. One of the most important features of the re-ATI is that it allows easy and fast recovery from an incorrect ATI, such as when performing ATI during user interaction with the sensor. This could cause the wrong ATI Compensation to be configured, since the user affects the capacitance of the sensor. A re-ATI would correct this. It is recommended to always have this enabled. When a re-ATI is performed on the IQS7211G, a status bit will set momentarily to indicate that this has occurred (*TP / ALP ReATI Occurred*).

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### 5.7.2 Conditions for Re-ATI to activate

**1. Reference drift**

A re-ATI is performed when the reference of a channel drifts outside of the acceptable range around the ATI Target. The boundaries where re-ATI occurs for the trackpad channels and for the ALP channels are independently set via the drift threshold value (*Reference drift limit* / *ALP LTA drift limit*). The re-ATI boundaries are calculated from the delta value as follows:

$$\text{Re-ATI Boundary} = \text{ATI target} \pm \text{Drift limit}$$

For example, assume that the ATI target is configured to 800 and that the reference drift value is set to 50. If re-ATI is enabled, the ATI algorithm will be repeated under the following conditions:

$$\text{Reference} > 850 \text{ or Reference} < 750$$

The ATI algorithm executes in a short time, so goes unnoticed by the user.

**2. Decreased Count Value**

A considerable decrease in the count value of a trackpad channel is abnormal since user interaction increases the count value. Therefore, if a decrease larger than the configurable threshold (*Trackpad minimum count re-ATI value*) is seen on such a trackpad channel, it is closely monitored. If this is continuously seen for 15 cycles, it will trigger a re-ATI. This condition does NOT apply to channels with snap enabled, as these channels are expected to show a decrease in touch signal when the snap dome is pressed. Therefore, ONLY channels with physical snap domes should be configured as snap channels.

**3. Trackpad Positive Delta Re-ATI**

Enabling snap sensors presents an issue where, during an ATI, if a metal dome press occurs, an abnormally large positive delta is detected upon release – much larger than what would be expected from a regular user touch. To address this, if a positive delta exceeding the *Trackpad Positive Delta Re-ATI Value* is identified on a trackpad channel with snap enabled, it triggers a re-ATI after 15 consecutive cycles for recovery.

### 5.7.3 ATI Error

After the ATI algorithm is performed, a check is done to see if there was any error with the algorithm. An ATI error is reported if one of the following is true for any channel after the ATI has completed:

- ATI Compensation = 0 (min value)
- ATI Compensation = 1023 (max value)
- Count is already outside the re-ATI range upon completion of the ATI algorithm

If any of these conditions are met, the corresponding error flag will be set (*ATI Error / ALP ATI Error*). The flag status is only updated again when a new ATI algorithm is performed.

**Re-ATI will not be repeated immediately if an ATI Error occurs.** A configurable time (*Re-ATI retry time*) will pass where the re-ATI is momentarily suppressed. This is to prevent the re-ATI repeating indefinitely. An ATI error should however not occur under normal circumstances. The Re-ATI retry time has a maximum setting of *60 seconds*.

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# 6 Sensing Modes

The IQS7211G automatically switches between different charging modes dependent on user interaction and other aspects. This is to allow for fast response, and low power consumption when applicable. The current mode can be read from the device (*Charging Mode*).

The modes are best illustrated by means of the following state diagram.

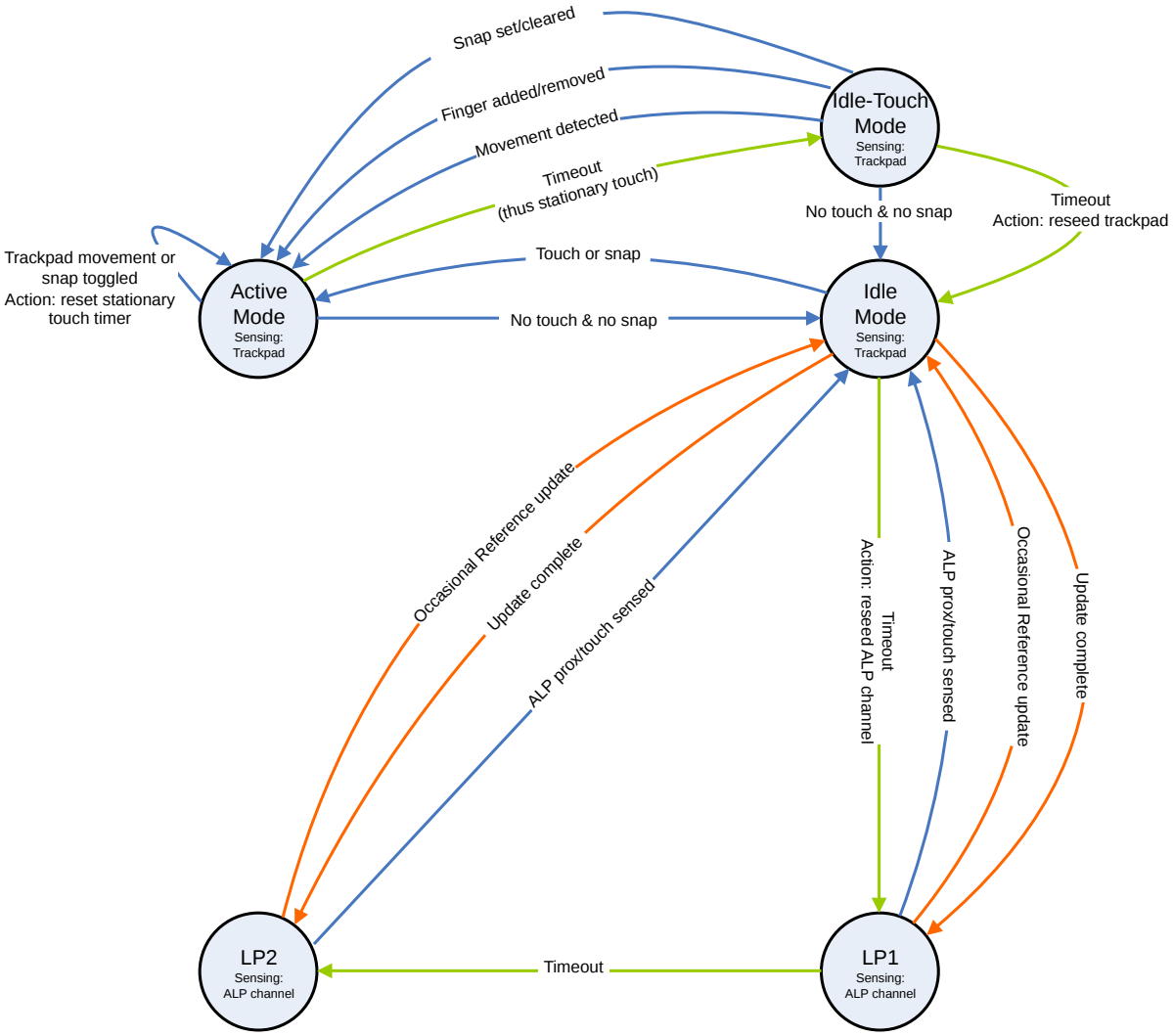



*Figure 6.1: System Mode State Diagram*

## 6.1 Report Rate

The report rate for each mode can be adjusted as required by the design. A faster report rate will have a higher current consumption but will give faster response to user interaction. *Active mode* typically has the fastest report rate, and the other modes are configured according to the power budget of the design, and the expected response time.

The report rate is configured by selecting the cycle time (in milliseconds) for each mode:

- *Report rate Active mode*

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- *Report rate Idle touch mode*
- *Report rate Idle mode*
- *Report rate LP1 mode*
- *Report rate LP2 mode*

## 6.2 Mode Timeout

The timeout values can be configured, and once these times have elapsed, the system will change to the next state according to the state diagram. These times are adjusted by selecting a desired value (in seconds), for the specific timeout:

- *Timeout - Active mode*
- *Timeout - Idle touch mode*
- *Timeout - Idle mode*
- *Timeout - LP1 mode*

A timeout value of 0 will result in a ‘never’ timeout condition.

## 6.3 Manual Control

The default method (manual control disabled) allows the IQS7211G to automatically switch between modes and update *reference values* as shown in Figure 6.1. This requires no interaction from the master to manage the device, and is the recommended option.

The master can manage various states and implement custom power modes when *Manual Control* is enabled. The master needs to control the mode (*Mode Select*), and also manage the reference values by reseeding (*TP Reseed*).

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# 7 Trackpad

## 7.1 Configuration

### 7.1.1 Size Selection

The total number of Rx and Tx channels used for trackpad purposes must be configured (*Total Rxs* / *Total Txs*). This gives a rectangular area of channels, formed by rows and columns of Rx and Tx sensors.

### 7.1.2 Cycle Setup

The trackpad channels need to be packed into cycles. The Azoteq PC GUI can be used to assist with this setup. Each cycle can simultaneously sense one channel from Prox block A (Rx0-3) and one from Prox block B (Rx4-7). They must be for the same Tx, and the channel numbers are packed into the cycle numbers (*Cycle allocation registers*) accordingly. A value of 255 for the channel number indicates no channel is allocated.

It is best to select the Rxs as the even numbered sensors, so that optimal cycles/timeslot usage occurs. Similarly, a balanced number of sensors from A and B are optimal.

### 7.1.3 Trackpad Channel and Cycle Limitations

This product is limited to 42 channels, and 21 cycles. Any trackpad size and configuration that fits into these limits are possible to implement. Refer to Table 1.3 for more information.

### 7.1.4 Individual Channel Disabling

If the sensor is not a complete rectangle (this could be due to mechanical cut-outs or trackpad shape), there will be some channels that fall within the (*Total Rxs* / *Total Txs*) rectangle but do not exist. They must simply not be allocated to a sensing cycle, see Section 7.1.2. The channel numbers are however still allocated for the complete rectangle, see Section 5.1.1.

Please note that the count and reference value of a disabled (unused) channel will not read as 0 as on the IQS7210A and IQS7211A devices, but will reflect the ATI Target value.

### 7.1.5 Rx/Tx Mapping

The Rxs and Txs of the trackpad can be assigned to the trackpad in any order to simplify PCB layout and design. The *Rx/Tx mapping* configures which actual Rx and Tx electrodes are used for the trackpad. The Rxs are specified first, up until the number of Rxs as defined by the *Total Rxs*, then the Txs follow immediately.

Following the example in Table 5.1, the *Rx/Tx mapping* settings will be as follows:

RxTxMapping[0] = 0
RxTxMapping[1] = 4
RxTxMapping[2] = 1
RxTxMapping[3] = 5
RxTxMapping[4] = 8
RxTxMapping[5] = 10
RxTxMapping[6] = 2
RxTxMapping[7..12] = n/a

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## 7.2 Trackpad Outputs

The channel count variation (deltas) and touch status outputs are used to calculate finger location data.

### 7.2.1 Number of Fingers

This gives an indication of the number of active finger inputs on the trackpad (*No of fingers*).

### 7.2.2 Relative XY

If there is only one finger active, a *Relative X* and *Relative Y* value is available. This is a signed 2's complement 16-bit value. It is a delta of the change in X and Y, in the scale of the selected output resolution.

### 7.2.3 Absolute XY

For all the multi-touch inputs, the absolute finger position (*Absolute X/Y*), in the selected resolution (*Resolution X/Y*) of the trackpad, is available.

### 7.2.4 Touch Strength

This value (*Touch strength*) indicates the strength of the touch by giving a sum of all the deltas associated with the finger, and therefore varies according to the sensitivity setup of the sensors.

### 7.2.5 Area

The number of channels associated with a finger is provided here. This area is usually equal to or smaller than the number of touch channels under the finger (*Finger 1 area*) / (*Finger 2 area*).

### 7.2.6 Tracking Identification

The fingers are tracked from one cycle to the next, and the same finger will be in the same position in the memory map. The memory location thus identifies the finger.

## 7.3 Maximum Number of Multi-touches

The maximum number of allowed multi-touches is configurable (*Max multi-touches*) up to 2 points. If more than the selected value is sensed, a flag is set (*Too Many Fingers*) and the XY data is cleared.

## 7.4 XY Resolution

The output resolution for the X and Y coordinates are configurable (*X/Y Resolution*). The on-chip algorithms use 256 points between each row and column. The resolution is defined as the total X and total Y output range across the complete trackpad.

## 7.5 Stationary Touch

A stationary touch is defined as a point that does not move outside of a certain boundary within a specific time. This movement boundary or threshold can be configured (*Stationary touch movement threshold*) and is defined as a movement in either X or Y in the configured resolution.

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The device will switch to *Idle-Touch* mode when a stationary point is detected for the active mode timeout period, where a lower duty cycle can be implemented to save power in applications where long touches are expected.

If movement is detected, a status flag (*TP Movement*) is set.

## 7.6 Multi-touch Finger Split

The position algorithm looks at areas (polygons) of touches and calculates positional data from this. Two fingers near each other could have areas touching, which would merge them incorrectly into a single point. A finger split algorithm is implemented to separate these merged polygons into multiple fingers. There is a *Finger split factor* which can be adjusted to determine how aggressive this finger splitting must be implemented. A value of '0' will not split polygons, and thus merge any fingers with touch channels adjacent (diagonally also) to each other.

## 7.7 XY Output Flip & Switch

By default, X positions are calculated from the first column to the last column. Y positions are by default calculated from the first row to the last row. The X and/or Y output can be flipped (*Flip X / Flip Y*), to allow the [0, 0] co-ordinate to be defined as desired. The X and Y axes can also be switched (*Switch XY Axis*) allowing X to be the Txs, and Y to be along the Rxs. *Note: The channel numbers are still assigned the same way, first along the Rxs, then to the next Tx, it is not affected by this setting.*

## 7.8 XY Position Filtering

Stable XY position data is available due to two on-chip filters, namely the Moving Average (MAV) filter, and the Infinite Impulse Response (IIR) filter. The filters are applied to the raw positional data. It is recommended to keep both filters enabled for optimal XY data.

### 7.8.1 MAV Filter

If enabled (*MAV Filter*), raw XY points from the last two cycles are averaged to give the filter output.

### 7.8.2 IIR Filter

The IIR filter, if enabled (*IIR Filter*), can be configured to select between a dynamic and a static filter (*IIR Static*).

$$\text{Damping factor} = \text{Beta} / 256$$

#### Dynamic Filter

Relative to the speed of movement of a co-ordinate, the filter dynamically adjusts the amount of filtering (damping factor) performed. When fast movement is detected, and quick response is required, less filtering is done. Similarly, when a co-ordinate is stationary or moving at a slower speed, more filtering can be applied.

The damping factor is adjusted depending on the speed of movement. Three of these parameters are adjustable to fine-tune the dynamic filter if required:

- *XY dynamic filter - bottom speed*
- *XY dynamic filter - top speed*

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- *Dynamic filter bottom beta*

The speed is defined as the distance (in the selected resolution) travelled in one cycle (pixels/cycle).

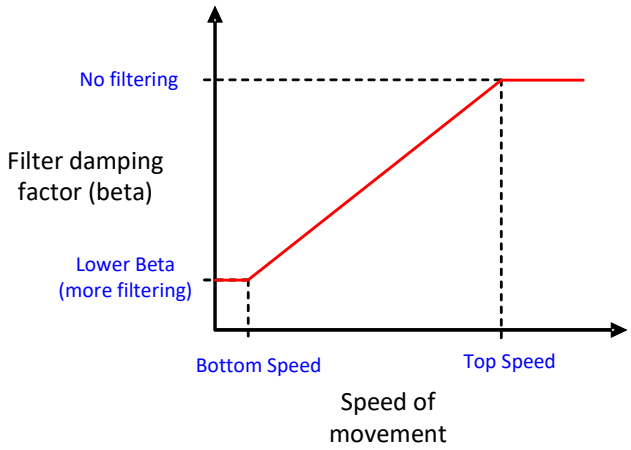



*Figure 7.1: Dynamic Filter Parameters*

### Static Filter

Co-ordinates filtered with a fixed but configurable damping factor (*XY static beta*) are obtained when using the static filter (*IIR Static*). It is recommended that the dynamic filter is used due to the advantages of a dynamically changing damping value.

## 7.9 X & Y Trim

Due to boundary conditions at the edges of the trackpad, it is unlikely that the X and Y extreme values will be achievable (0 and X/Y Resolution). To be able to achieve this, the edges can be trimmed with configurable amount (*X Trim / Y Trim*) on-chip. For example, say *X Trim* is set to 0, and a finger on the left of the trackpad gives a minimum X output of 48, and a maximum of 960 for a finger to the far right (for X resolution set to 1000). Then an X Trim = 50 could be used to trim away the 'dead' area, and the full 0 to 1000 range will be achievable.

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# 8 Hardware Settings

Settings specific to hardware and the ProxSense® Module charge transfer characteristics can be changed.

*Below some are described, the other hardware parameters are not discussed as they should only be adjusted under guidance of Azoteq support engineers.*

## 8.1 Main Oscillator

The main oscillator frequency can be configured to 14 MHz or 18 MHz (*14 MHz/18 MHz*). When 18 MHz is selected the minimum VDD allowed increases, please see Section 3.2 for details.

Smaller adjustments to incrementally decrease the main oscillator can be made *Main Osc Adj*.

## 8.2 Charge Transfer Frequency

The charge transfer frequency ($f_{xfer}$) for both the trackpad and ALP channels can be configured independently. This is done by selecting appropriate *Frequency Fraction* and *Conversion Period* values to achieve the desired frequency.

For high resistance sensors (such as ITO), it might be needed to decrease $f_{xfer}$.

### Integer Division-Based Conversion Frequency

When using integer division from the system clock ($f_{OSC}$), only specific values of the *Frequency Fraction* setting are valid. These values must satisfy the following condition:

$$\text{Number of clocks} = \frac{256}{\text{Frequency Fraction}}$$

where the result must be an integer with no remainder. This constraint limits the available *Fraction* and *Period* values to a fixed set, independent of the main oscillator frequency. Furthermore, the *Frequency Fraction* must be a power of 2. The supported values are listed in Table 8.1.

*Table 8.1: Supported Integer Division-Based Conversion Frequency Parameters*

| | | Conversion Frequency $f_{xfer}$ | |
|---|---|---|---|
| **FRACTION** | **PERIOD** | **14 MHz $f_{OSC}$** | **18 MHz $f_{OSC}$** |
| 32 | 2 | 1.75 MHz | 2.25 MHz |
| 16 | 6 | 875 kHz | 1.12 MHz |
| 8 | 14 | 438 kHz | 562 kHz |
| 4 | 30 | 219 kHz | 281 kHz |
| 2 | 62 | 109 kHz | 141 kHz |
| 1 | 126 | 55 kHz | 70 kHz |

* The maximum recommended conversion frequency for self-capacitive sensing is 1 MHz. The maximum recommended conversion frequency for mutual-capacitive sensing is 2 MHz.

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### Non-integer Division-Based Conversion Frequency

To get a wider range of conversion frequencies, the *Frequency Fraction* can be fixed to 127, and the *Conversion Period* can be adjusted to achieve the desired frequency. This approach enables finer resolution in frequency selection, allowing values not limited to binary-related steps as seen with integer division.

Unlike the integer division approach, where the resulting frequencies are constrained to binary-related ratios, non-integer division allows more flexibility. This is useful in systems that require tuning away from specific harmonic frequencies or interference bands.

However, because the conversion frequency is no longer derived from a clean integer divide of the system clock, harmonic relationships between channels are less predictable. As a result, this mode may be more susceptible to certain types of noise or jitter.

*Table 8.2: Supported Non-integer Division-Based Conversion Frequency Parameters*

| FRACTION | PERIOD | Conversion Frequency $f_{xfer}$ | |
|---|---|---|---|
| | | 14 MHz $f_{OSC}$ | 18 MHz $f_{OSC}$ |
| 127 | 2 | 1.75 MHz | 2.25 MHz |
| | 3 | 1.40 MHz | 1.80 MHz |
| | 5 | 1.00 MHz | 1.29 MHz |
| | 7 | 778 kHz | 1.00 MHz |
| | 12 | 500 kHz | 643 kHz |
| | 16 | 389 kHz | 500 kHz |
| | 23 | 280 kHz | 360 kHz |

* The maximum recommended conversion frequency for self-capacitive sensing is 1 MHz. The maximum recommended conversion frequency for mutual-capacitive sensing is 2 MHz.

## 8.3 Reset

### 8.3.1 Reset Indication

After a reset, the *Show Reset* bit will be set by the system to indicate the reset event occurred. This bit will clear when the master sets the *Ack Reset*, if it becomes set again, the master will know a reset has occurred, and can react appropriately.

Note that *Event Mode* will not work until the Ack Reset has been used to clear the Show Reset bit. This allows $I^2C$ to always become active again if an unexpected reset has occurred, allowing the master to react accordingly to the Show Reset flag, such as writing the start-up settings if needed.

### 8.3.2 Software Reset

The IQS7211G can be reset by means of an $I^2C$ command (*SW Reset*). This reset will take effect shortly after the SW Reset bit has been set and the $I^2C$ communication window terminated.

### 8.3.3 Hardware Reset

The MCLR/RDY pin (active LOW) can be used to reset the device when outside an $I^2C$ communication window. For more details see Section 4.2.

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# 9 Additional Features

## 9.1 GUI for Parameter Setup

The Azoteq product GUI can be utilised to configure the optimal settings required for the specific hardware. The device performance can be easily monitored and evaluated in the graphical environment until the optimal configuration is obtained. Once these parameters have been finalised, there are two options for production, namely to program the IC with the firmware integrated with the specific settings/parameters, or to use a default configured IC and then perform the device setup over $I^2C$ after power-up.

### 9.1.1 Automated Start-up

If the IC is programmed with the application firmware bundled with settings specifically configured for the current hardware, then an automated start-up is achieved. These parameters are used as the default values without requiring any setup from the master. After power-up the device will automatically use the settings and perform the configuration/setup accordingly.

For large volume orders Azoteq can provide pre-programmed devices with customer specific firmware.

Two bytes (*Settings version number*) are available so that the designer can label and identify the user selected default start-up settings. This allows the master to verify if the device firmware has the intended configuration as required.

### 9.1.2 Manual Start-up

If the device is not programmed with customer specific settings, then they need to be configured by the master via $I^2C$. The parameters can still be obtained using the GUI, but then these need to be configured in the memory map accordingly.

The device will thus be programmed with defaults not necessarily applicable to the current application. It is recommended that the whole memory map is overwritten to be sure all settings are as intended. Once this has been done set the re-ATI bits for the trackpad and ALP channel, so that the ATI can be executed on the intended settings.

## 9.2 Suspend

The IQS7211G can be placed into a suspended state, where no processing is performed, minimal power is consumed (<1.5 µA), and the device retains existing data. This state is entered after the communication session that sets the *Suspend* bit.

The device can be woken from suspend by forcing $I^2C$ communication (see Section 10.9.2) and clearing the suspend bit in that communication session. An automatic reseed of the trackpad is triggered after the device is woken from suspend, since it cannot be guaranteed that the reference values are still relevant.

## 9.3 Watchdog Timer (WDT)

A software watchdog timer is implemented to improve system reliability.

The working of this timer is as follows:

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- A software timer $t_{WDT}$ is linked to the LFTMR (Low frequency timer) running on the “always on" Low Frequency Oscillator (10 kHz).
- This timer is reset at a strategic point in the main loop.
- Failing to reset this timer will cause the appropriate ISR (interrupt service routine) to run.
- This ISR performs a software triggered POR (Power on Reset).
- The device will reset, performing a full cold boot.

## 9.4 RF Immunity

The IQS7211G has immunity to high power RF noise. To improve the RF immunity, extra decoupling capacitors are suggested on $V_{REGA}$, $V_{REGD}$ and $V_{DD}$.

Place a 100 pF in parallel with the 2.2 µF ceramic on $V_{REGA}$, $V_{REGD}$ and $V_{DD}$. All decoupling capacitors should be placed as close as possible to the $V_{DD}$ and $V_{REG}$ pads.

If needed, series resistors can be added to Rx electrodes to reduce RF coupling into the sensing pads. Normally these are in the range of 470 Ω-1 kΩ. PCB ground planes also improve noise immunity.

## 9.5 Additional Non-Trackpad Channels

Unused mutual capacitive channels can be used to design additional buttons or sliders. Note that the channels will still provide XY data output, which can be ignored (or utilised) by the master. Please note that the additional sensors will have to use the same global ATI and sensitivity parameters, so careful sensor design is needed to ensure that these parameters are applicable. We suggest the button sensor design is identical to the trackpad sensor, with the same overlay material and thickness. Please contact Azoteq if you consider this option.

## 9.6 Version Information

See *Table A.1*.

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# 10 I²C Interface

## 10.1 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 IQS7211G supports the following:

- *Fast-mode-plus* standard I²C up to 1 MHz.
- Streaming data as well as event mode.
- The master may address the device at any time according to the comms request setting, see Section 10.9.2. However for optimal usage, such as power consumption, the RDY is strongly recommended.
- The provided interrupt line (RDY) is an open-drain active low implementation and indicates a communication window.

The IQS7211G implements 8-bit addressing with 2 bytes at each address. Two consecutive read/writes are required in this memory map structure. The two bytes at each address will be referred to as “byte 0" and “byte 1".

## 10.2 I²C Address

The IQS7211G has a fixed I²C address of 0x56.
Other address options exist on special request. Please contact Azoteq.

## 10.3 I³C Compatibility

This device is not compatible with an I³C bus due to clock stretching allowed for data retrieval.

## 10.4 Memory Map Addressing

### 10.4.1 8-bit Address

Most of the memory map implements an 8-bit addressing scheme for the required user data. For all application requirements this should be adequate.

### 10.4.2 Extended 16-bit Address

For development purposes larger blocks of data (such as the trackpad 16-bit channel count values) are found in an extended 16-bit memory addressable location. It is possible to only address each Block as an 8-bit address, and then continue to clock into the next address locations. For example, address 0xE000 is where the trackpad count values are located. If you thus do the following, you will read the count values from address 0xE000 to 0xE003:

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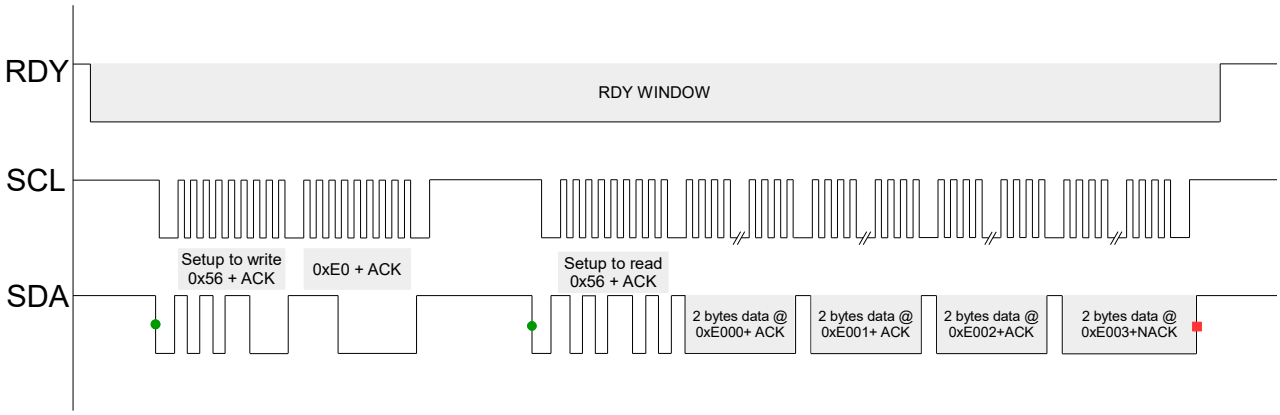



*Figure 10.1: Extended Addressing Comms Diagram*

However, if you need to address a specific byte in that extended memory map space, then you will need to address using the full 16-bit address (note the 16-bit address is high byte first, unlike the data which is low byte first):

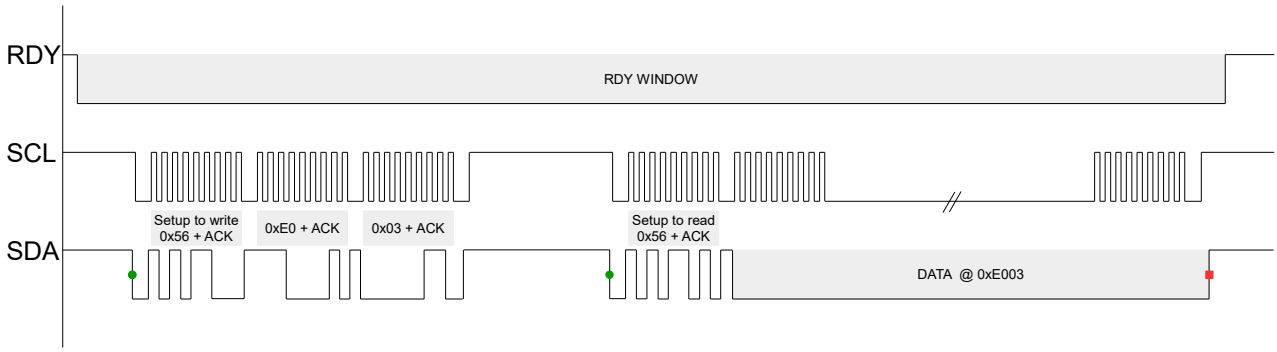



*Figure 10.2: Extended Addressing Comms Diagram (Specific Channel)*

## 10.5 Data

The data is 16-bit words, meaning that each address obtains 2 bytes of data. For example, address 0x10 will provide two bytes, then the next two bytes read will be from address 0x11. The 16-bit data is sent in little endian byte order (least significant byte first).

## 10.6 I²C Timeout

If the communication window is not serviced within the *I²C timeout period* (in milliseconds), the session is ended (RDY goes HIGH), and processing continues as normal. This allows the system to continue and keep reference values up to date even if the master is not responsive, however the corresponding data was missed/lost, and this should be avoided.

## 10.7 Terminate Communication

With the comms end setting cleared (*Comms End Cmd*), a standard I²C STOP ends the current communication window. If multiple I²C transactions need to be done, then they should be strung together using repeated-start conditions instead of giving a STOP. This will allow the communication to occur in the same session.

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The alternative option with comms end setting set, is that an I²C command is needed to terminate the communication window. This can be done by writing 0x00 to address 0xFF, followed by a STOP as follows:

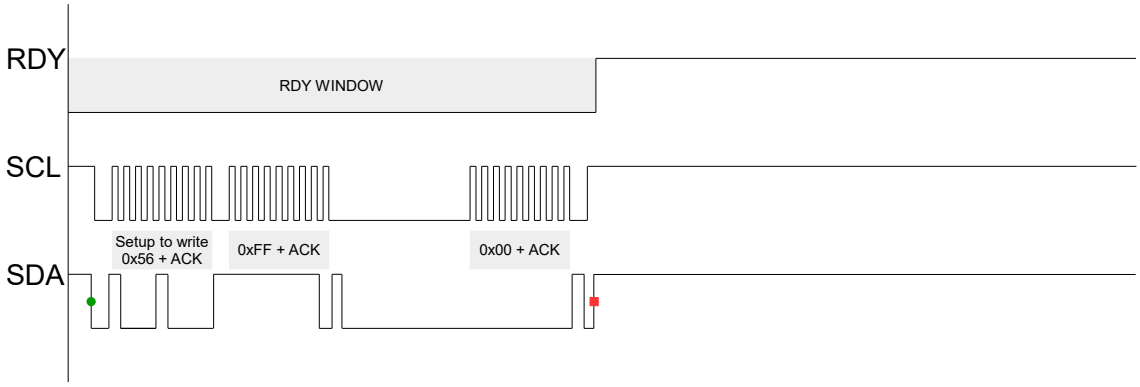



*Figure 10.3: Terminate Comms Diagram*

## 10.8 RDY/IRQ

The communication has an open-drain active-LOW RDY signal to inform the master that updated data is available. It is optimal for the master to use this as an interrupt input and obtain the data accordingly. It is also useful to allow the master MCU to enter low-power/sleep allowing wake-up from the touch device when user presence is detected.

## 10.9 Event Mode Communication

The device can be set up to bypass the communication window when no activity is sensed (*Event Mode*). This is usually enabled since the master does not want to be interrupted unnecessarily during every cycle if no activity occurred. The communication will resume (RDY will indicate available data) if an enabled event occurs. It is recommended that the RDY be placed on an interrupt-on-pin-change input on the master.

Note that Event Mode will only implement if *Show Reset* has been cleared, see Section 8.3.1.

### 10.9.1 Events

Numerous events can be individually enabled to trigger communication, they are:

- Trackpad events (*TP Event*): event triggered if there is a change in X/Y value, or if a finger is added or removed from the trackpad.
- Touch events (*TP Touch Event*): event only triggers if a channel has a change in a touch state. This is mostly aimed at channels that are used for traditional buttons, where you want to know only when a status is changed.
- Re-ATI (*Re-ATI Event*): one communication cycle is given to indicate the re-ATI occurred (*TP / ALP Re-ATI Occurred*).
- Proximity/Touch on ALP (*ALP Event*): event given on state change.
- Snap events (*Snap Event*): Triggers if a snap channel has a change in state.

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### 10.9.2 Force Communication/Polling

The master can initiate communication even while RDY is HIGH (inactive). The default method (*comms request en* set to 0) is that the IQS7211G will clock stretch until an appropriate time to complete the I²C transaction. The master firmware will not be affected (if clock stretching is correctly handled).

If the associated clock stretching cannot be allowed, then an alternative comms request method can be enabled (*Comms Request EN*). To achieve this, the master will do communication when RDY is not active (thus forcing comms), and it will write a comms request to the device. This comms request is as follows:

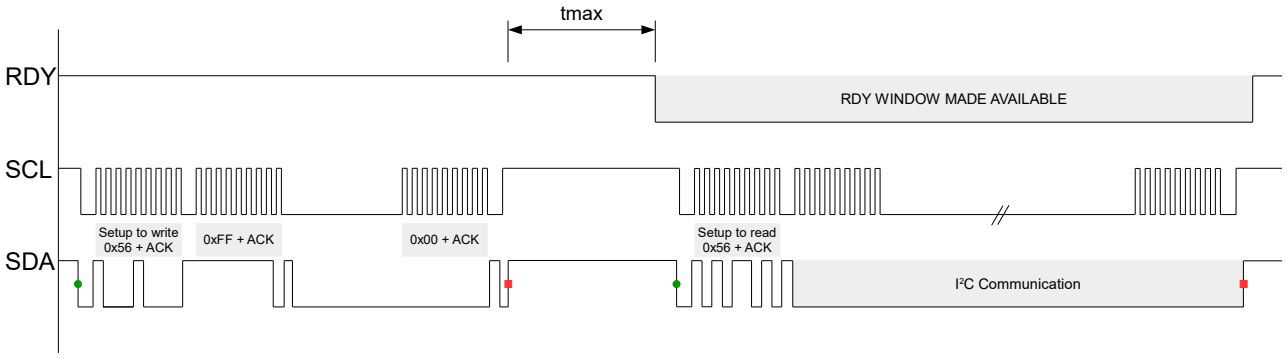



*Figure 10.4: Force Comms Diagram*

After this request for communication has been sent, then the next available communication window will become available as normal (thus RDY going LOW).

For optimal program flow, it is suggested that RDY is used to sync on new data. The forced/polling method is only recommended if the master must perform I²C and Event Mode is active.

## 10.10 Invalid Communications Return

The device will give an invalid communication response (0xEE) under the following conditions:

- The host is trying to read from a memory map register that does not exist.
- The host is trying to read from the device outside of a communication window (i.e. while RDY = high)

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## 11 I²C Memory Map - Register Descriptions

For a more detailed description please see *Appendix A*.

| Address | Data (16bit) | | Notes |
|---|---|---|---|
| 0x00 - 0x09 | Version details | | See Table A.1 |
| | | | |
| 0x0A | Relative X | | See Section 7.2.2 |
| 0x0B | Relative Y | | |
| 0x0C | Snap status <0> | | See Table A.2 |
| 0x0D | Snap status <1> | | |
| 0x0E | Snap status <2> | | |
| 0x0F | Info flags | | See Table A.3 |
| 0x10 | Finger 1 X-coordinate | | See Section 7.2.3 |
| 0x11 | Finger 1 Y-coordinate | | |
| 0x12 | Finger 1 touch strength | | See Section 7.2.4 |
| 0x13 | Finger 1 area | | See Section 7.2.5 |
| 0x14 | Finger 2 X-coordinate | | See Section 7.2.3 |
| 0x15 | Finger 2 Y-coordinate | | |
| 0x16 | Finger 2 touch strength | | See Section 7.2.4 |
| 0x17 | Finger 2 area | | See Section 7.2.5 |
| | | | |
| 0x18 | Touch status <0> | | See Table A.4 |
| 0x19 | Touch status <1> | | |
| 0x1A | Touch status <2> | | |
| 0x1B | ALP channel count | | See Section 5.3.2 |
| 0x1C | ALP channel LTA | | See Section 5.4.2 |
| 0x1D | ALP count A | | See Section 5.3.2 |
| 0x1E | ALP count B | | |
| | *End of Read Only Section* | | |
| | (HIGH byte) | (LOW byte) | |
| | *Start of Read/Write Section* | | |
| 0x1F | ALP ATI compensation & divider A | | See Section 5.6.3, 5.6.4 and Table A.16 |
| 0x20 | ALP ATI compensation & divider B | | |
| 0x21 | Trackpad ATI multiplier/dividers (Global) | | See Table A.5 |
| 0x22 | Trackpad reference drift limit | Reserved | See Section 5.7.2 |
| 0x23 | Trackpad ATI target | | See Section 5.6.3 |
| 0x24 | Trackpad minimum count re-ATI value | | See Section 5.7.2 |
| 0x25 | ALP ATI multiplier/dividers | | See Table A.5 |
| 0x26 | ALP LTA drift limit | Reserved | See Section 5.7.2 |
| 0x27 | ALP ATI target | | See Section 5.6.3 |
| | (HIGH byte) | (LOW byte) | |
| 0x28 | Active mode report rate (ms) | | See Section 6.1 |
| 0x29 | Idle-Touch mode report rate (ms) | | |
| 0x2A | Idle mode report rate (ms) | | |
| 0x2B | LP1 mode report rate (ms) | | |
| 0x2C | LP2 mode report rate (ms) | | |

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| | | | |
|---|---|---|---|
| 0x2D | Active mode timeout (s) | | See Section 6.2 |
| 0x2E | Idle-Touch mode timeout (s) | | |
| 0x2F | Idle mode timeout (s) | | |
| 0x30 | LP1 mode timeout (s) | | |
| 0x31 | Reference update time (s) | Re-ATI retry time (s) | See Section 5.4.1 and 5.7.3 |
| 0x32 | $I^2C$ timeout (ms) | | See Section 10.6 |
| | (HIGH byte) | (LOW byte) | |
| 0x33 | System control | | See Table A.6 |
| 0x34 | Config settings | | See Table A.7 |
| 0x35 | Other settings | | See Table A.8 |
| 0x36 | ALP setup | | See Table A.9 |
| 0x37 | ALP Tx enable | | See Table A.10 |
| | (HIGH byte) | (LOW byte) | |
| 0x38 | Touch clear multiplier | Touch set multiplier | See Section 5.5.1 |
| 0x39 | ALP threshold | | See Section 5.5.3 |
| 0x3A | ALP clear debounce | ALP set debounce | See Section 5.5.4 |
| 0x3B | ALP LTA filter beta - LP1 mode | ALP count filter beta - LP1 mode | See Section 5.3.2 and 5.4.2 |
| 0x3C | ALP LTA filter beta - LP2 mode | ALP count filter beta - LP2 mode | |
| | | | |
| 0x3D | Trackpad conversion frequency | | See Table A.11 |
| 0x3E | ALP conversion frequency | | |
| 0x3F | Trackpad hardware settings | | See Table A.12 |
| 0x40 | ALP hardware settings | | |
| | (HIGH byte) | (LOW byte) | |
| 0x41 | Total Rxs | Trackpad settings | See Table A.13 and Section 7.1.1 |
| 0x42 | Max multi-touches | Total Txs | See Section 7.1.1 and 7.3 |
| 0x43 | X resolution | | See Section 7.4 |
| 0x44 | Y resolution | | |
| 0x45 | XY dynamic filter - bottom speed | | See Section 7.8.2 |
| 0x46 | XY dynamic filter - top speed | | |
| 0x47 | Static filter beta value | Dynamic filter bottom beta | |
| 0x48 | Finger split factor | Stationary touch movement threshold | See Section 7.6 and 7.5 |
| 0x49 | Y trim value | X trim value | See Section 7.9 |
| | (HIGH byte) | (LOW byte) | |
| 0x4A | Settings major version | Settings minor version | See Section 9.1.1 |
| | | | |
| 0x4B | Snap Enable <0> | | See Table A.14 |
| 0x4C | Snap Enable <1> | | |
| 0x4D | Snap Enable <2> | | |
| 0x4E | Snap Clear Threshold (Delta) | Snap Set Threshold (Delta) | See Section 5.5.2 |
| 0x4F | Snap Timeout (s) | | |
| 0x50 | Trackpad Positive Delta Re-ATI Value | | See Section 5.7.2 |
| 0x51 | Trackpad Compensation Seed Value | | See Section 5.6.5 |
| | | | |
| 0x52 | RxTx mapping <1..0> | | See Section 7.1.5 |
| 0x53 | RxTx mapping <3..2> | | |

| | | | |
|---|---|---|---|
| 0x54 | RxTx mapping <5..4> | | |
| 0x55 | RxTx mapping <7..6> | | |
| 0x56 | RxTx mapping <9..8> | | |
| 0x57 | RxTx mapping <11..10> | | |
| 0x58 | *do not use* | RxTx mapping <12> | |
| | (HIGH byte) | (LOW byte) | |
| 0x59 | ProxA channel for cycle-0 | 0x05 | See Section 7.1.2 |
| 0x5A | 0x05 | ProxB channel for cycle-0 | |
| 0x5B | ProxB channel for cycle-1 | ProxA channel for cycle-1 | |
| 0x5C | ProxA channel for cycle-2 | 0x05 | |
| 0x5D | 0x05 | ProxB channel for cycle-2 | |
| 0x5E | ProxB channel for cycle-3 | ProxA channel for cycle-3 | |
| 0x5F | ProxA channel for cycle-4 | 0x05 | |
| 0x60 | 0x05 | ProxB channel for cycle-4 | |
| 0x61 | ProxB channel for cycle-5 | ProxA channel for cycle-5 | |
| 0x62 | ProxA channel for cycle-6 | 0x05 | |
| 0x63 | 0x05 | ProxB channel for cycle-6 | |
| 0x64 | ProxB channel for cycle-7 | ProxA channel for cycle-7 | |
| 0x65 | ProxA channel for cycle-8 | 0x05 | |
| 0x66 | 0x05 | ProxB channel for cycle-8 | |
| 0x67 | ProxB channel for cycle-9 | ProxA channel for cycle-9 | |
| | (HIGH byte) | (LOW byte) | |
| 0x68 | ProxA channel for cycle-10 | 0x05 | See Section 7.1.2 |
| 0x69 | 0x05 | ProxB channel for cycle-10 | |
| 0x6A | ProxB channel for cycle-11 | ProxA channel for cycle-11 | |
| 0x6B | ProxA channel for cycle-12 | 0x05 | |
| 0x6C | 0x05 | ProxB channel for cycle-12 | |
| 0x6D | ProxB channel for cycle-13 | ProxA channel for cycle-13 | |
| 0x6E | ProxA channel for cycle-14 | 0x05 | |
| 0x6F | 0x05 | ProxB channel for cycle-14 | |
| 0x70 | ProxB channel for cycle-15 | ProxA channel for cycle-15 | |
| 0x71 | ProxA channel for cycle-16 | 0x05 | |
| 0x72 | 0x05 | ProxB channel for cycle-16 | |
| 0x73 | ProxB channel for cycle-17 | ProxA channel for cycle-17 | |
| 0x74 | ProxA channel for cycle-18 | 0x05 | |
| 0x75 | 0x05 | ProxB channel for cycle-18 | |
| 0x76 | ProxB channel for cycle-19 | ProxA channel for cycle-19 | |
| 0x77 | ProxA channel for cycle-20 | 0x05 | |
| 0x78 | 0x01 *(NOTE not 0x05)* | ProxB channel for cycle-20 | |
| 0x79 | Reserved (0x00) | | |
| | (HIGH byte) | (LOW byte) | |
| 0x7A | Individual Touch Threshold Adjustment CH1 | Individual Touch Threshold Adjustment CH0 | See Section 5.5.1 |
| 0x7B | Individual Touch Threshold Adjustment CH3 | Individual Touch Threshold Adjustment CH2 | |
| 0x7C | Individual Touch Threshold Adjustment CH5 | Individual Touch Threshold Adjustment CH4 | |
| 0x7D | Individual Touch Threshold Adjustment CH7 | Individual Touch Threshold Adjustment CH6 | |
| 0x7E | Individual Touch Threshold Adjustment CH9 | Individual Touch Threshold Adjustment CH8 | |
| 0x7F | Individual Touch Threshold Adjustment CH11 | Individual Touch Threshold Adjustment CH10 | |

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| | | | |
|---|---|---|---|
| 0x80 | Individual Touch Threshold Adjustment CH13 | Individual Touch Threshold Adjustment CH12 | |
| 0x81 | Individual Touch Threshold Adjustment CH15 | Individual Touch Threshold Adjustment CH14 | |
| 0x82 | Individual Touch Threshold Adjustment CH17 | Individual Touch Threshold Adjustment CH16 | |
| 0x83 | Individual Touch Threshold Adjustment CH19 | Individual Touch Threshold Adjustment CH18 | |
| 0x84 | Individual Touch Threshold Adjustment CH21 | Individual Touch Threshold Adjustment CH20 | |
| 0x85 | Individual Touch Threshold Adjustment CH23 | Individual Touch Threshold Adjustment CH22 | |
| 0x86 | Individual Touch Threshold Adjustment CH25 | Individual Touch Threshold Adjustment CH24 | |
| 0x87 | Individual Touch Threshold Adjustment CH27 | Individual Touch Threshold Adjustment CH26 | |
| 0x88 | Individual Touch Threshold Adjustment CH29 | Individual Touch Threshold Adjustment CH28 | |
| 0x89 | Individual Touch Threshold Adjustment CH31 | Individual Touch Threshold Adjustment CH30 | |
| 0x8A | Individual Touch Threshold Adjustment CH33 | Individual Touch Threshold Adjustment CH32 | |
| 0x8B | Individual Touch Threshold Adjustment CH35 | Individual Touch Threshold Adjustment CH34 | |
| 0x8C | Individual Touch Threshold Adjustment CH37 | Individual Touch Threshold Adjustment CH36 | |
| 0x8D | Individual Touch Threshold Adjustment CH39 | Individual Touch Threshold Adjustment CH38 | |
| 0x8E | Individual Touch Threshold Adjustment CH41 | Individual Touch Threshold Adjustment CH40 | |
| 0x8F | ALP Compensation Seed Value | | See Section 5.6.5 |
| | *End of Read/Write Section* | | |
| | | | |
| | *Begin of Read Only Section* | | |
| 0xE0[i] ... | Trackpad count values | | See Section 5.3.1 |
| 0xE1[i] ... | Trackpad reference values | | See Section 5.4.1 |
| 0xE2[i] ... | Trackpad delta values | | See Section 5.3.4 |
| 0xE3[i] ... | Trackpad ATI compensation & divider values | | See Section 5.6.3 and Table A.15 |
| | *End of Read Only Section* | | |

[i] extended memory map

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# 12 Implementation and Layout

## 12.1 Layout Fundamentals

**Note:** Information in the following Applications section is not part of the Azoteq component specification, and Azoteq does not warrant its accuracy or completeness. Azoteq's customers are responsible for determining the suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 12.1.1 Power Supply Decoupling

Azoteq recommends connecting a combination of a 4.7 µF plus a 100 pF low-ESR ceramic decoupling capacitor between the VDD and VSS pins. Higher-value capacitors may be used but can impact supply rail ramp-up time. Decoupling capacitors must be placed as close as possible to the pins that they decouple (within a few millimetres).

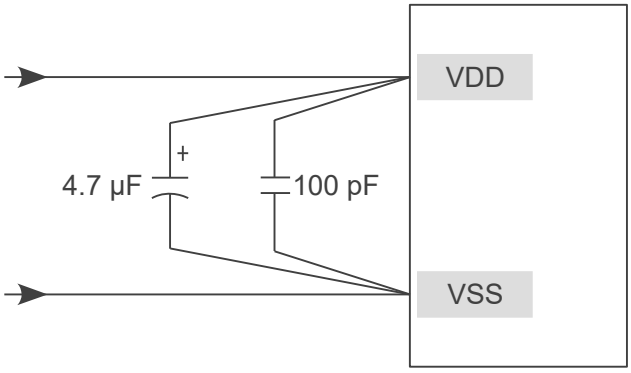



*Figure 12.1: Recommended Power Supply Decoupling*

### 12.1.2 VREG Capacitors

Each VREG pin requires a 2.2 µF capacitor to regulate the LDO internal to the device. This capacitor must be placed as close as possible to the IC. Figure 12.2 below shows an example placement of the VREG capacitors.

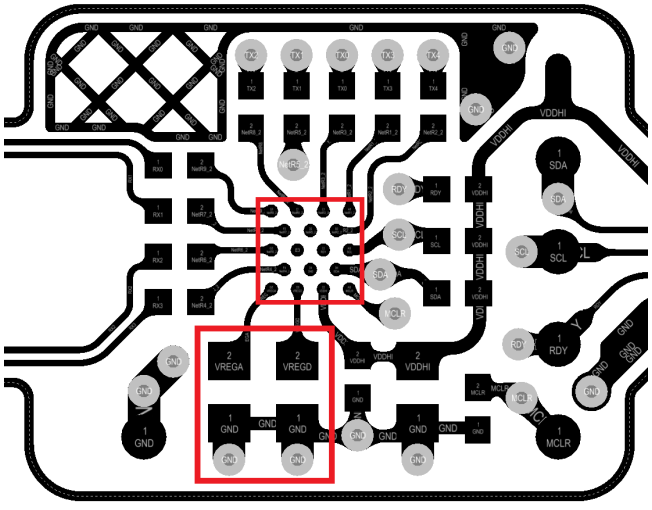



*Figure 12.2: VREG Capacitor Placement Close to IC*

### 12.1.3 WLCSP Light Sensitivity

The CSP package is sensitive to infrared light. When the silicon IC is subject to the photo-electric effect, an increase in leakage current is experienced. Due to the low power consumption of the IC this causes a change in signal and is common in the semiconductor industry with CSP devices.

If the IC could be exposed to IR in the product, then a dark glob-top epoxy material should cover the complete package to block infrared light. It is important to use sufficient material to completely cover the corners of the package. The glob-top also provides further advantages such as mechanical strength and shock absorption.

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# 13 Ordering Information

## 13.1 Ordering Code

IQS7211G zzz ppb

*Table 13.1: Order Code Description*

| | | | | |
|---|---|---|---|---|
| **IC NAME** | | | | IQS7211G |
| **POWER-ON CONFIGURATION** | zzz | = | 001 | Default settings. Setup via $I^2C$. |
| **PACKAGE TYPE** | pp | = | CS<br>QF<br>QN | WLCSP-18 package<br>QFN-20 package<br>QFN-20 package (On special order only[i]) |
| **BULK PACKAGING** | b | = | R | WLCSP-18 Reel (3000 pcs/reel)<br>QFN-20 Reel (2000 pcs/reel) |

Example : IQS7211G001QFR

## 13.2 Top Marking

### 13.2.1 WLCSP18 Package




Product Name
ppp = product code
xx = batchcode

### 13.2.2 QFN20 Package Marking Option 1




Product Name
ppp = product code
xx = batchcode

### 13.2.3 QFN20 Package Marking Option 2




Product Name
ppp = product code
xx = batchcode

[i] Special order codes are subject to larger minimum order quantities, longer lead times and are non-cancelable, non-returnable.

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# 14 Package Specification

## 14.1 Package Outline Description – QFN20 (QFR)

This package outline is specific to order codes ending in *QFR*.

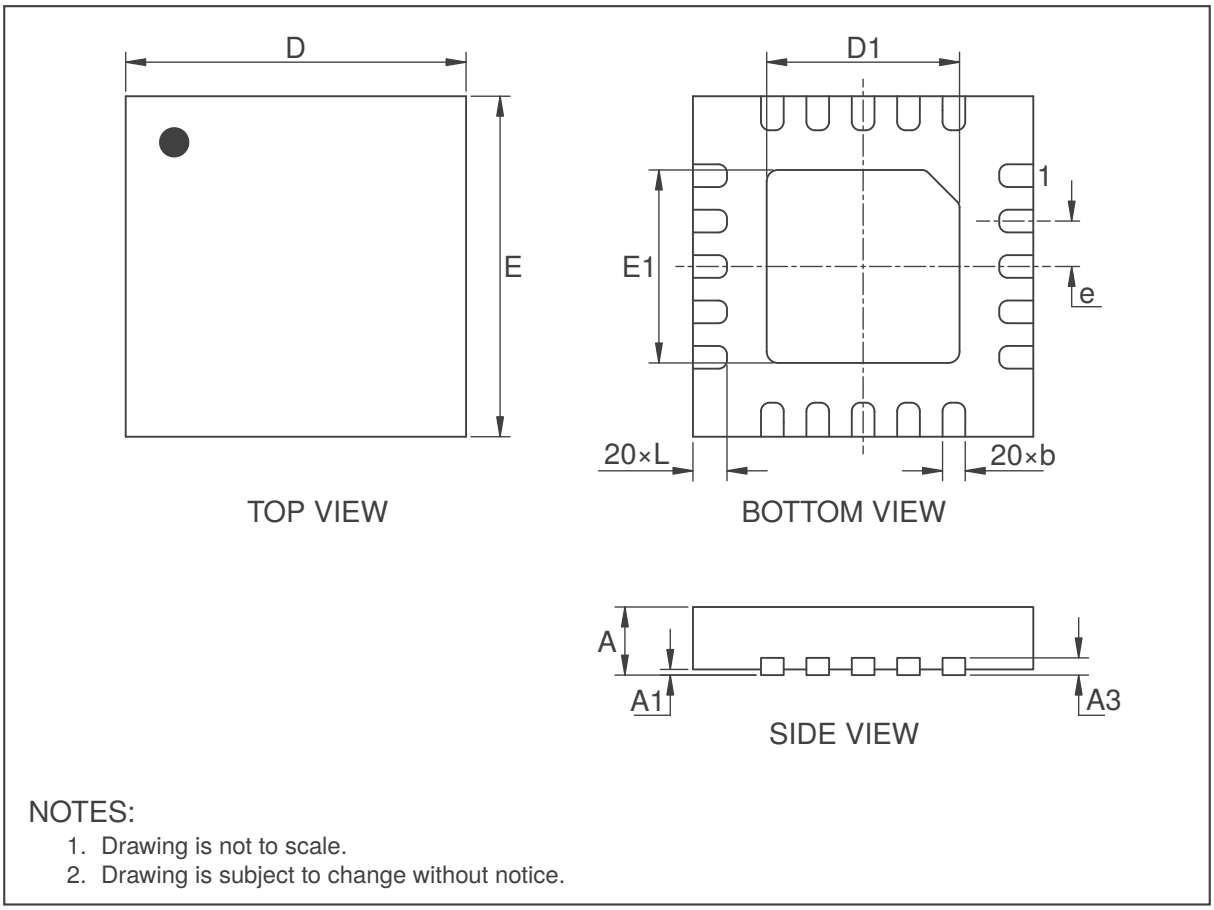


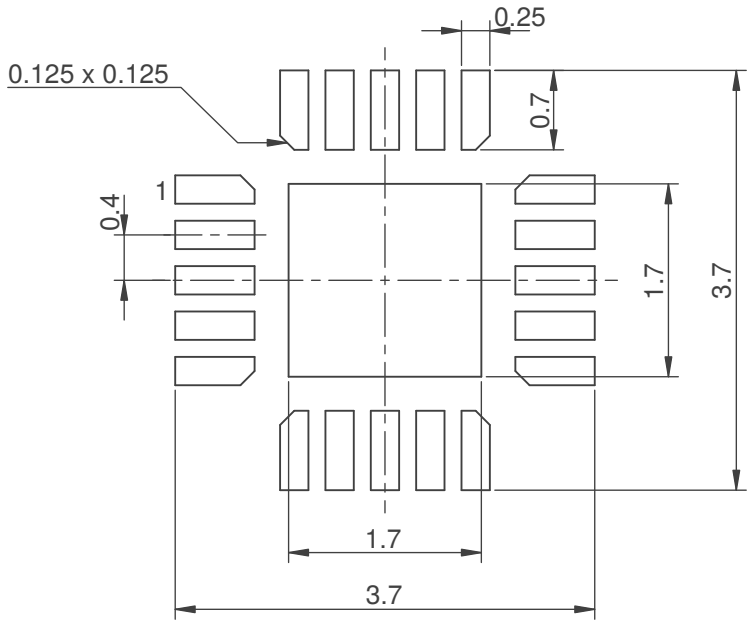

*Figure 14.1: QFN (3x3)-20 (QFR) Package Outline Visual Description*

*Table 14.1: QFR (3x3)-20 Package Outline Dimensions [mm]*

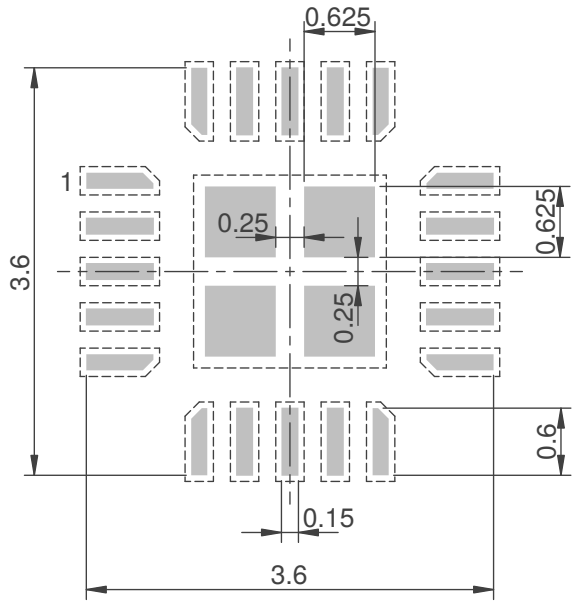
| Dimension | Min | Nom | Max |
|---|---|---|---|
| A | 0.50 | 0.55 | 0.60 |
| A1 | 0 | 0.02 | 0.05 |
| A3 | | 0.152 REF | |
| b | 0.15 | 0.20 | 0.25 |
| D | 2.95 | 3.00 | 3.05 |
| E | 2.95 | 3.00 | 3.05 |
| D1 | 1.60 | 1.70 | 1.80 |
| E1 | 1.60 | 1.70 | 1.80 |
| e | | 0.40 BSC | |
| L | 0.25 | 0.30 | 0.35 |

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## 14.2 Recommended PCB Footprint – QFN20 (QFR)




RECOMMENDED FOOTPRINT




RECOMMENDED SOLDER PASTE APPLICATION

NOTES:

1. Dimensions are expressed in millimeters.
2. Drawing is not to scale.
3. Drawing is subject to change without notice.
4. Final dimensions may vary due to manufacturing tolerance considerations.
5. Customers should consult their board assembly site for solder paste stencil design recommendations.

*Figure 14.2: QFN (3x3)-20 (QFR) Recommended Footprint*

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## 14.3 Package Outline Description – QFN20 (QNR)

This package outline is specific to order codes ending in *QNR*.

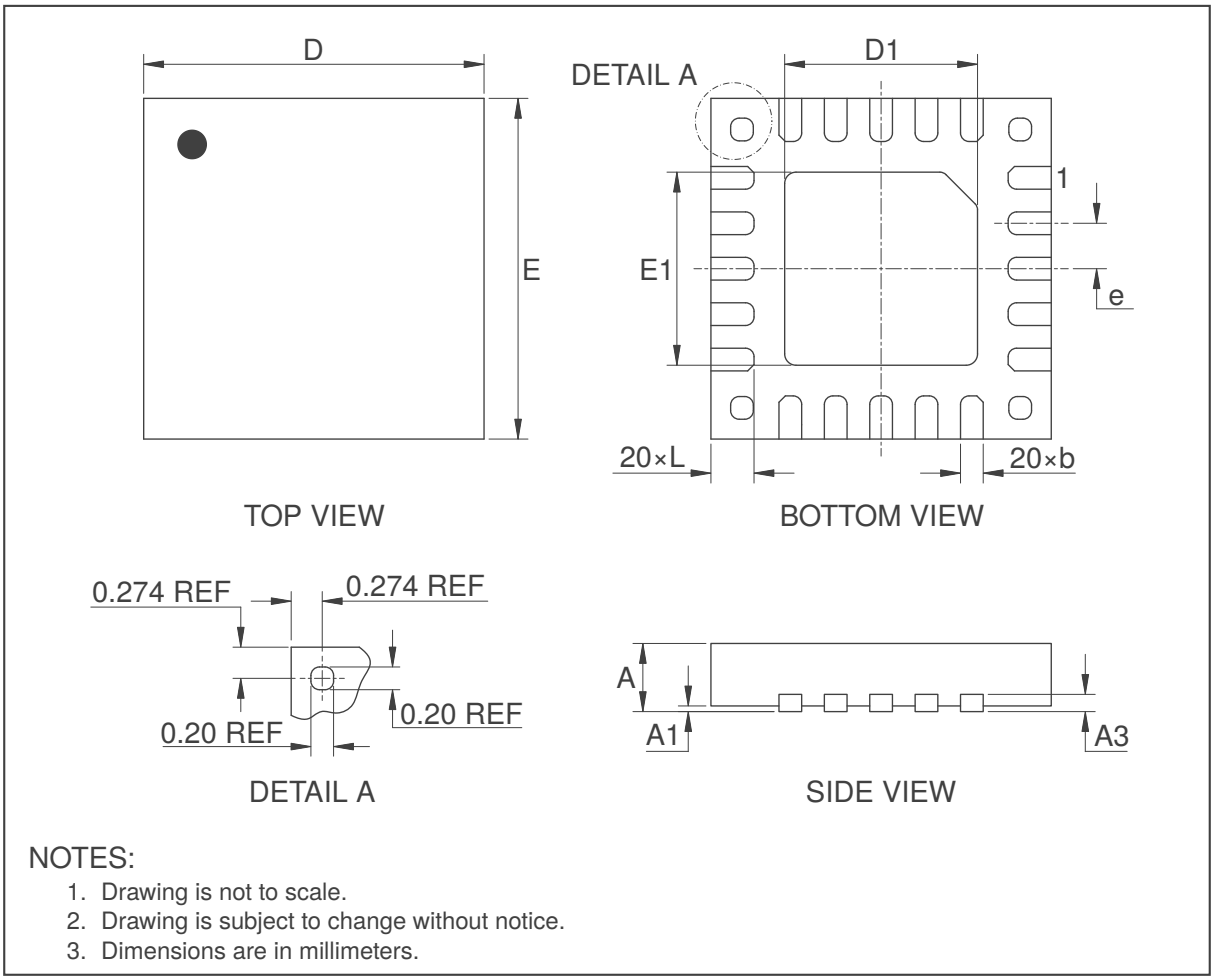


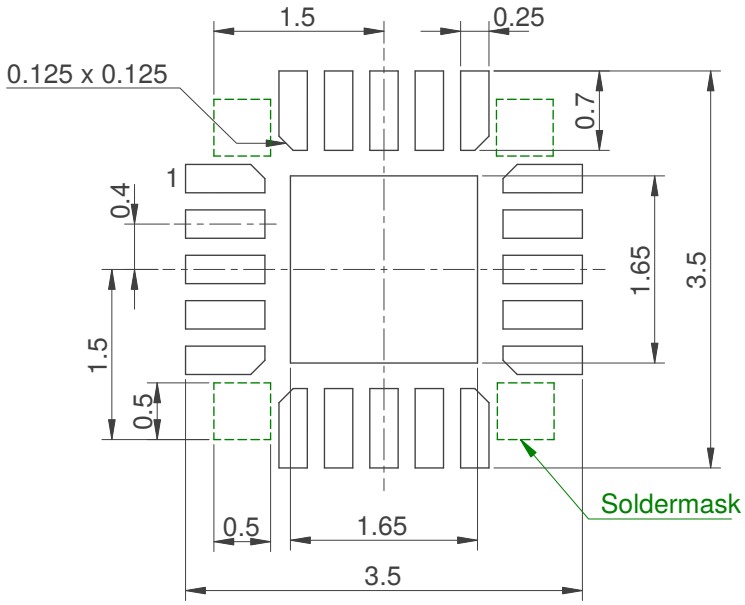

*Figure 14.3: QFN (3x3)-20 (QNR) Package Outline Visual Description*

*Table 14.2: QNR (3x3)-20 Package Outline Dimensions [mm]*

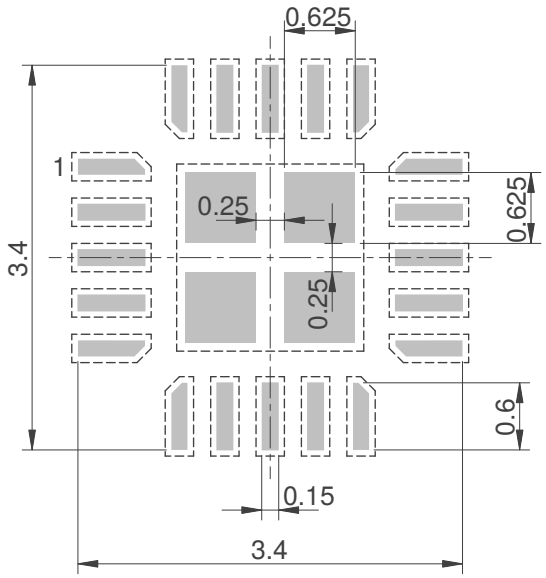
| Dimension | Min | Nom | Max |
|---|---|---|---|
| A | 0.50 | 0.55 | 0.60 |
| A1 | 0 | | 0.05 |
| A3 | | 0.152 REF | |
| b | 0.15 | 0.20 | 0.25 |
| D | 2.95 | 3.00 | 3.05 |
| E | 2.95 | 3.00 | 3.05 |
| D1 | 1.65 | 1.70 | 1.75 |
| E1 | 1.65 | 1.70 | 1.75 |
| e | | 0.40 BSC | |
| L | 0.33 | 0.38 | 0.43 |

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## 14.4 Recommended PCB Footprint – QFN20 (QNR)




RECOMMENDED FOOTPRINT




RECOMMENDED SOLDER PASTE APPLICATION

NOTES:

1. Dimensions are expressed in millimeters.
2. Drawing is not to scale.
3. Drawing is subject to change without notice.
4. Final dimensions may vary due to manufacturing tolerance considerations.
5. Customers should consult their board assembly site for solder paste stencil design recommendations.
6. Solder mask (or exposed copper keep-out) areas necessary to avoid any traces shorting to exposed corner pads.

*Figure 14.4: QFN (3x3)-20 (QNR) Recommended Footprint*

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## 14.5 Package Outline Description – WLCSP18

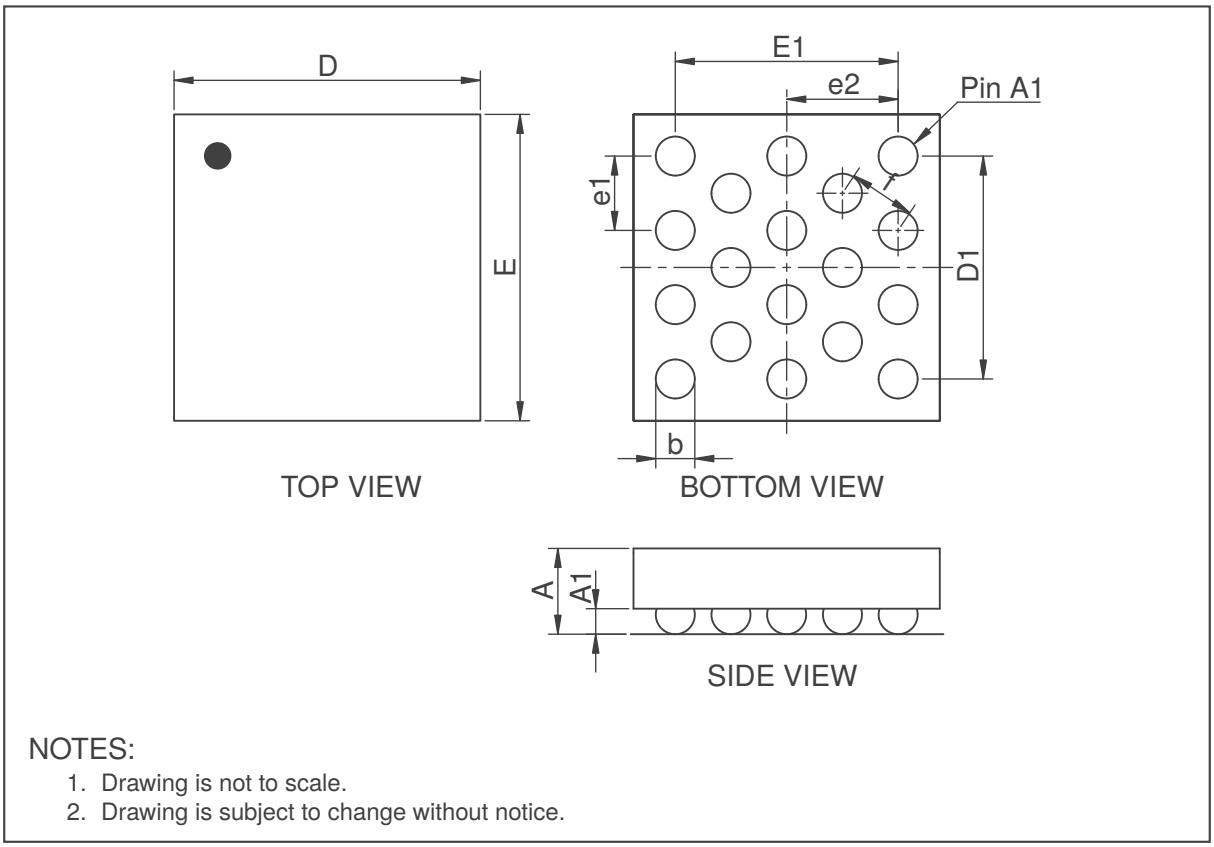


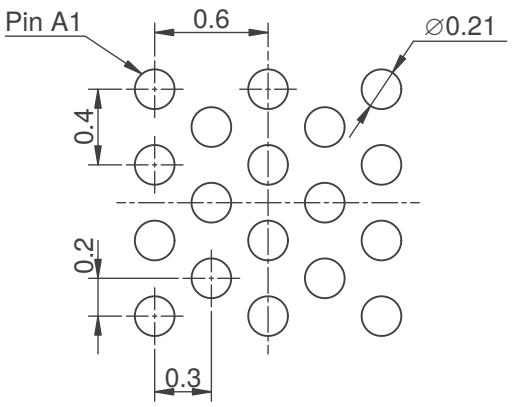

*Figure 14.5: WLCSP (1.62x1.62)-18 Package Outline Visual Description*

*Table 14.3: WLCSP (1.62x1.62)-18 Package Dimensions [mm]*

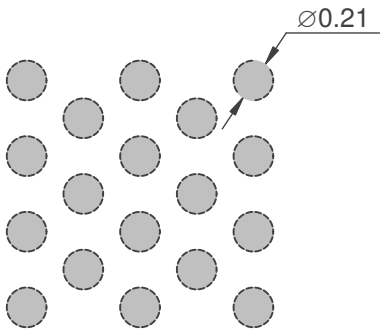
| Dimension | Min | Nom | Max |
|---|---|---|---|
| A | 0.477 | 0.525 | 0.573 |
| A1 | 0.180 | 0.200 | 0.220 |
| b | 0.221 | 0.260 | 0.299 |
| D | 1.605 | 1.620 | 1.635 |
| E | 1.605 | 1.620 | 1.635 |
| D1 | 1.200 BSC | | |
| E1 | 1.200 BSC | | |
| e1 | 0.400 BSC | | |
| e2 | 0.600 BSC | | |
| f | 0.360 REF | | |

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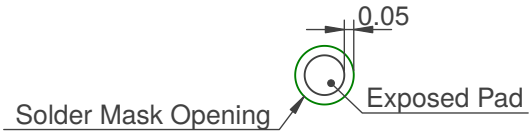
## 14.6 Recommended PCB Footprint – WLCSP18




RECOMMENDED FOOTPRINT




RECOMMENDED SOLDER PASTE APPLICATION




SOLDER MASK BACK-OFF

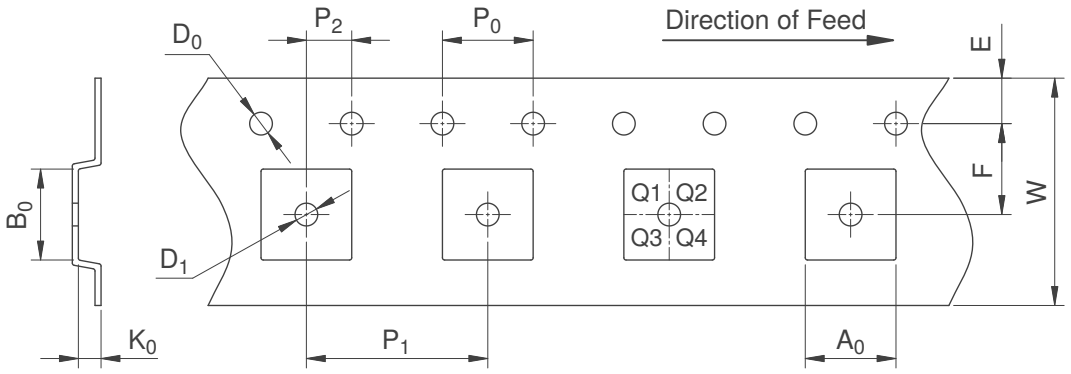
NOTES:

1. Dimensions are expressed in millimeters.
2. Drawing is not to scale.
3. Drawing is subject to change without notice.
4. Final dimensions may vary due to manufacturing tolerance considerations.
5. Customers should consult their board manufacturer for solder mask tolerances.
6. Customers should consult their board assembly site for solder paste stencil design recommendations.

*Figure 14.6: WLCSP18 Recommended Footprint*

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## 14.7 Tape and Reel Specifications



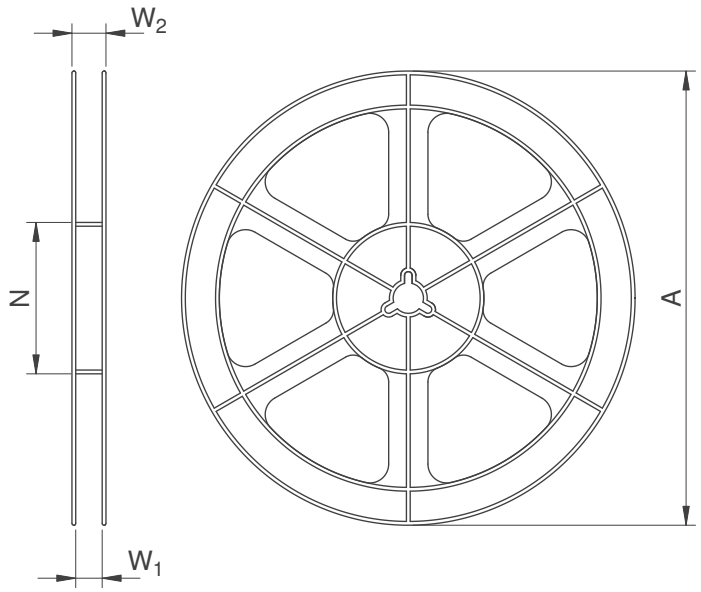

NOTES:
1. Drawing is not to scale.
2. Drawing is subject to change without notice.

*Figure 14.7: Carrier Tape Specification*

*Table 14.4: Carrier Tape Dimensions [mm]*

| Dimension | Package | | |
|---|---|---|---|
| | WLCSP18 | QFN20 (QFR) | QFN20 (QNR) |
| $A_0$ | 1.78 | 3.30 | 3.30 |
| $B_0$ | 1.78 | 3.30 | 3.30 |
| $K_0$ | 0.69 | 0.75 | 0.80 |
| $D_0$ | 1.50 | 1.50 | 1.55 |
| $D_1$ | 0.50 | 1.55 | 1.50 |
| E | 1.75 | 1.75 | 1.75 |
| F | 3.50 | 5.50 | 5.50 |
| $P_0$ | 4.00 | 4.00 | 4.00 |
| $P_1$ | 4.00 | 8.00 | 8.00 |
| $P_2$ | 2.00 | 2.00 | 2.00 |
| W | 8.00 | 12.00 | 12.00 |
| Pin 1 Quadrant | Q1 | Q2 | Q2 |

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NOTES:
1. Drawing is not to scale.
2. Drawing is subject to change without notice.

*Figure 14.8: Reel Specification*

*Table 14.5: Reel Dimensions [mm]*

| Dimension | Package | | |
|---|---|---|---|
| | WLCSP18 | QFN20 (QFR) | QFN20 (QNR) |
| A | 179 | 178 | 180 |
| N | 55 | 60 | 60 |
| $W_1$ | 8.4 | 12.4 | 12.4 |
| $W_2$ (Max) | 14.4 | 18.4 | 18.4 |

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## 14.8 Moisture Sensitivity Levels

*Table 14.6: Moisture Sensitivity Levels*

| Package | MSL |
|---|---|
| QFN20 | 1 |
| WLCSP18 | 1 |

## 14.9 Reflow Specifications

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# A Memory Map Descriptions

*Table A.1: Version Information*

| Register: | 0x00 - 0x09 | | |
|---|---|---|---|
| **Address** | **Category** | **Name** | **Value** |
| 0x00 | Application Version Info | Product Number | 3884 |
| 0x01 | | Major Version | 0 |
| 0x02 | | Minor Version | 1 |
| 0x03 | | Patch Number (Commit hash) | 0x255f5a97 |
| 0x04 | | | |
| 0x05 | ROM Library Version Info | Library Number | 206 |
| 0x06 | | Major Version | 4 |
| 0x07 | | Minor Version | 15 |
| 0x08 | | Patch Number (Commit hash) | 0x16688405 |
| 0x09 | | | |

*Table A.2: Snap Status <Z> (0x0C-0x0E)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Snap Status <0>** | | | | | | | | | | | | | | | |
| CH15 | CH14 | CH13 | CH12 | CH11 | CH10 | CH9 | CH8 | CH7 | CH6 | CH5 | CH4 | CH3 | CH2 | CH1 | CH0 |
| **Snap Status <1>** | | | | | | | | | | | | | | | |
| CH31 | CH30 | CH29 | CH28 | CH27 | CH26 | CH25 | CH24 | CH23 | CH22 | CH21 | CH20 | CH19 | CH18 | CH17 | CH16 |
| **Snap Status <2>** | | | | | | | | | | | | | | | |
| ~ | ~ | ~ | ~ | ~ | ~ | CH41 | CH40 | CH39 | CH38 | CH37 | CH36 | CH35 | CH34 | CH33 | CH32 |

- Snap Flags for CH0 - CH41
  - 0: No snap detected
  - 1: Snap detected

*Table A.3: Info Flags (0x0F)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Snap Toggled | ALP Output | Snap Detected | Too Many Fingers | Reserved | TP Movement | No of Fingers | | Show Reset | ALP ReATI Occurred | ALP ATI Error | ReATI Occurred | ATI Error | Charging Mode | | |

- Bit 15: **Snap Toggled**- Snap detection status of a snap channel toggled
  - 0: Snap output did not toggle
  - 1: Snap output toggled
- Bit 14: **ALP Output**- Prox/Touch detection status of ALP channel
  - 0: No output detected
  - 1: Output detected
- Bit 13: **Snap Detected**- Global snap detection status of any snap channel
  - 0: No output detected
  - 1: Output detected
- Bit 12: **Too Many Fingers**- Indicates more than allowed fingers detected
  - 0: Number of fingers within maximum selected value
  - 1: Number of fingers exceeds maximum selected value
- Bit 11: Unused
- Bit 10: **TP Movement**- Trackpad finger movement detected
  - 0: No touches, or all touches stationary (see Section Section 7.5)
  - 1: Movement of finger(s) detected on trackpad
- Bit 9-8: **No of Fingers**- Number of fingers detected on trackpad
  - 00: No fingers on trackpad
  - 01: 1 finger active
  - 10: 2 fingers active

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- Bit 7: **Show Reset**- Indicates a reset
  - 0: Reset indication has been cleared by host, writing to *Ack Reset*
  - 1: Reset has occurred and indication has not been cleared by host
- Bit 6: **ALP Re-ATI Occurred**- Alternate Low Power channel Re-ATI Status
  - 0: No re-ATI
  - 1: Re-ATI has just completed on alternate LP channel
- Bit 5: **ALP ATI Error**- Alternate Low Power ATI error status
  - 0: Most recent ATI process was successful
  - 1: Most recent ATI process was unsuccessful
- Bit 4: **Re-ATI Occurred**- Trackpad re-ATI status
  - 0: No re-ATI
  - 1: Re-ATI has just completed on the trackpad
- Bit 3: **ATI Error**- Error condition seen on latest trackpad ATI procedure
  - 0: Most recent ATI process was successful
  - 1: Most recent ATI process was unsuccessful
- Bit 2-0: **Charging Mode**: Indicates current mode
  - 000: Active mode
  - 001: Idle-touch mode
  - 010: Idle mode
  - 011: LP1 mode
  - 100: LP2 mode

*Table A.4: Touch Status <Z> (0x18-0x1A)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Touch Status <0>** | | | | | | | | | | | | | | | |
| CH15 | CH14 | CH13 | CH12 | CH11 | CH10 | CH9 | CH8 | CH7 | CH6 | CH5 | CH4 | CH3 | CH2 | CH1 | CH0 |
| **Touch Status <1>** | | | | | | | | | | | | | | | |
| CH31 | CH30 | CH29 | CH28 | CH27 | CH26 | CH25 | CH24 | CH23 | CH22 | CH21 | CH20 | CH19 | CH18 | CH17 | CH16 |
| **Touch Status <2>** | | | | | | | | | | | | | | | |
| ~ | ~ | ~ | ~ | ~ | ~ | CH41 | CH40 | CH39 | CH38 | CH37 | CH36 | CH35 | CH34 | CH33 | CH32 |

- Touch Flags for CH0 - CH41
  - 0: No touch detected
  - 1: Touch detected

*Table A.5: Trackpad and ALP Multipliers/Divider (0x21 / 0x25)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | Fine Divider | | | | | Coarse Multiplier | | | | Coarse Divider | | | | |

- Bit 15-14: Unused
- Bit 13-9: **Fine Fractional Divider**
  - 5-bit value between 1 and 31
- Bit 8-5: **Coarse Multiplier**
  - 4 bit value between 1 and 15
- Bit 4-0: **Coarse Fractional Divider**
  - 5 bit value between 1 and 31

*Table A.6: System Control (0x33)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tx test | Reserved | | | Sus-pend | Res-erved | SW Reset | Res-erved | Ack Reset | ALP ReATI | TP ReATI | ALP Re-seed | TP Re-seed | Mode Select | | |

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- Bit 15: **Tx test**- Tx short test
  - 0: Normal operation
  - 1: Enable Tx short test configuration
- Bit 14-12: Unused
- Bit 11: **Suspend**- Suspend IQS7211G
  - 0: No action
  - 1: Place IQS7211G into suspend after the communication window terminates
- Bit 10: Unused
- Bit 9: **SW Reset**- Reset the device
  - 0: No action
  - 1: Reset device after communication window terminates
- Bit 8: Unused
- Bit 7: **Ack Reset**- Acknowledge a reset
  - 0: No action
  - 1: Acknowledge the reset by clearing *Show Reset* flag
- Bit 6: **ALP Re-ATI**- Queue a re-ATI on ALP channel
  - 0: No action
  - 1: Perform re-ATI when ALP channel is sensed again
- Bit 5: **TP Re-ATI**- Queue a re-ATI on trackpad channels
  - 0: No action
  - 1: Perform re-ATI when trackpad channels are sensed again
- Bit 4: **ALP Reseed**- Reseed alternate low power channel
  - 0: No action
  - 1: Reseed the LTA of the alternate LP channel
- Bit 3: **TP Reseed**- Reseed trackpad channels
  - 0: No action
  - 1: Reseed reference values of trackpad
- Bit 2-0: **Mode Select**- Select mode (only applicable in *Manual Mode*)
  - 000: Active mode
  - 001: Idle-Touch mode
  - 010: Idle mode
  - 011: LP1 mode
  - 100: LP2 mode

*Table A.7: Config Settings (0x34)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Snap Event | TP Touch Event | ALP Event | Res-erved | ReATI Event | TP Event | Res-erved | Event Mode | Manual Con-trol | Comms End Cmd | WDT | Comms Re-quest EN | ALP ReATI EN | TP ReATI EN | Res-erved | Res-erved |

- Bit 15: **Snap Event**- Enable snap triggering event
  - 0: Toggle of snap status does not trigger an event
  - 1: Toggle of snap status triggers an event
- Bit 14: **TP Touch Event**- Enable trackpad touch triggering event
  - 0: Toggle of trackpad touch status does not trigger an event
  - 1: Toggle of trackpad touch status triggers an event
- Bit 13: **ALP Event**- Enable alternate LP channel detection triggering event
  - 0: Toggle of alternate channel prox/touch status does not trigger an event
  - 1: Toggle of alternate channel prox/touch status triggers an event
- Bit 12: Unused

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- Bit 11: **Re-ATI Event**- Enable Re-ATI generating an event
  - 0: Re-ATI occurring does not trigger an event
  - 1: Re-ATI occurring triggers an event
- Bit 10: **TP Event**- Enable trackpad events
  - 0: Trackpad finger movement or finger up/down will not trigger event
  - 1: Trackpad finger movement or finger up/down will trigger event
- Bit 9: Unused
- Bit 8: **Event Mode**- Enable event mode communication
  - 0: $I^2C$ is presented each cycle (except auto-prox cycles)
  - 1: $I^2C$ is only initiated when an enabled event occurs
- Bit 7: **Manual Control**- Override automatic mode switching
  - 0: Modes are automatically controlled by firmware
  - 1: Manual control of modes are handled by host
- Bit 6: **Comms End Cmd**- Alternative method to terminate comms (see Section Section 10.7)
  - 0: $I^2C$ stop ends comms
  - 1: Write one or two bytes (any data) to the address 0xFF followed by a STOP to end comms
- Bit 5: **WDT**- Watchdog timer
  - 0: Watchdog is disabled
  - 1: Watchdog is enabled
- Bit 4: **Comms Request EN**- Alternative polling method (while RDY not LOW)
  - 0: Forcing comms will clock stretch until a comms window
  - 1: A comms window must be requested with a command (no stretching)
- Bit 3: **ALP Re-ATI EN**- Automatic Re-ATI on alternate LP channel
  - 0: Re-ATI is disabled for alternate LP channel
  - 1: Re-ATI is enabled for alternate LP channel
- Bit 2: **TP Re-ATI EN**- Automatic Re-ATI on trackpad
  - 0: Re-ATI is disabled for trackpad channels
  - 1: Re-ATI is enabled for trackpad channels
- Bit 1-0: Unused

*Table A.8: Other Settings (0x35)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | 14MHz / 18MHz | Main Osc Adj | | | |

- Bit 15-5: Unused
- Bit 4: **14MHz/18MHz**- Main oscillator selection
  - 0: Main oscillator is 14MHz
  - 1: Main oscillator is 18MHz
- Bit 3-0: **Main Osc Adj**- Small main oscillator adjustment setting
  - 4-bit value
  - 0-15: 0 = No adjustment .. 15 = Maximum adjustment

*Table A.9: ALP Setup (0x36)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | ALP Count Filter | ALP Sens-ing Method | Rx7_ EN | Rx6_ EN | Rx5_ EN | Rx4_ EN | Rx3_ EN | Rx2_ EN | Rx1_ EN | Rx0_ EN |

- Bit 15-10: Unused

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- Bit 9: **Count Filter**- ALP count filter
  - 0: ALP channel count is unfiltered
  - 1: ALP count filter enabled
- Bit 8: **Sensing Method**- ALP sensing method
  - 0: ALP is setup for self-capacitive sensing
  - 1: ALP is setup for mutual-capacitive sensing
- Bit 7-0: **RX_EN**- ALP Rx electrodes
  - 0: Rx disabled (not used for ALP)
  - 1: Rx enabled (forms part of ALP sensor)

*Table A.10: ALP Tx Enable (0x37)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | Tx12_EN | Tx11_EN | Tx10_EN | Tx9_EN | Tx8_EN | Tx7_EN | Tx6_EN | Tx5_EN | Tx4_EN | Tx3_EN | Tx2_EN | Tx1_EN | Tx0_EN |

- Bit 15-13: Unused
- Bit 12-0: **TX_EN**- ALP Tx electrodes
  - 0: Tx disabled (not used for ALP)
  - 1: Tx enabled (forms part of ALP sensor)

*Table A.11: Conversion Frequency (0x3D / 0x3E)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conversion Frequency Fraction | | | | | | | | Conversion Frequency Period | | | | | | | |

- Bit 15-8: **Frequency Fraction**
  - Range: 0 - 127
- Bit 7-0: **Conversion Period**
  - Range: 0 - 127
- **Note:** The default settings use a *Frequency Fraction* of 26 and a *Conversion Period* of 2. This results in a conversion frequency of 1.42 MHz when the main oscillator is set to 14 MHz, and 1.83 MHz when set to 18 MHz. Refer to Section 8.2 for appropriate settings and recommended values.

*Table A.12: Trackpad and ALP Hardware Settings (0x3F / 0x40)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NM In Static | CS_0v5 Discharge | RF Filter | CS Cap Select | Opamp Bias | | Max Count | | LP2 Auto-Prox Cycles (only in ALP register) | | | LP1 Auto-Prox Cycles (only in ALP register) | | | Init Delay | |

- Bit 15: **NM In Static**- NM In Static
  - 0: Disabled (recommended)
  - 1: Enabled
- Bit 14: **CS 0v5 Discharge**- Select internal Cs discharge voltage
  - 0: Discharge to 0V (recommended for most cases)
  - 1: Discharge to 0.5V
- Bit 13: **RF Filter**- Internal RF filters
  - 0: RF filters disabled
  - 1: RF filters enabled
- Bit 12: **CS Cap Select**- Internal pool capacitor size
  - 0: Internal capacitor is 40pF
  - 1: Internal capacitor is 80pF (recommended)
- Bit 11-10: **Opamp Bias**- Mutual opamp bias

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- 00: 2$\mu$A
- 01: 5$\mu$A
- 10: 7$\mu$A
- 11: 10$\mu$A

- Bit 9-8: **Max Count**- Count upper limit (count value stops conversion after reaching this)
  - 00: 1023
  - 01: 2047
  - 10: 4095
  - 11: 16384
- Bit 7-5: **LP2 Auto-Prox Cycles**- Number of LP2 auto-prox cycles
  - 000: 4
  - 001: 8
  - 010: 16
  - 011: 32
  - 1xx: Auto-prox disabled
- Bit 4-2: **LP1 Auto-Prox Cycles**- Number of LP1 auto-prox cycles
  - 000: 4
  - 001: 8
  - 010: 16
  - 011: 32
  - 1xx: Auto-prox disabled
- Bit 1-0: **Init Delay**- Initial cycles delay
  - 00: 4
  - 01: 16
  - 10: 32
  - 11: 64

*Table A.13: Trackpad Settings (0x41)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Rxs | | | | | | | | Reserved | | MAV Filter | IIR Static | IIR Filter | Switch XY Axis | Flip Y | Flip X |

- Bit 15-8: **Total Rxs**- used for trackpad
- Bit 7-6: Unused
- Bit 5: **MAV Filter**- Moving averaging filter
  - 0: XY MAV filter on touch position disabled
  - 1: XY MAV filter on touch position enabled (recommended)
- Bit 4: **IIR Static**- IIR filtering method for the XY data points
  - 0: Damping factor for IIR filter is dynamically adjusted relative to XY movement (recommended)
  - 1: Damping factor for IIR filter is fixed
- Bit 3: **IIR Filter**- IIR filter
  - 0: XY IIR filter disabled
  - 1: XY IIR filter enabled (recommended)
- Bit 2: **Switch XY Axis**- Switch X and Y axes
  - 0: Rxs are arranged in trackpad columns (X), and Txs in rows (Y)
  - 1: Txs are arranged in trackpad columns (X), and Rxs in rows (Y)
- Bit 1: **Flip Y**- Flip Y output values
  - 0: Keep default Y values
  - 1: Invert Y output values

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- Bit 0: **Flip X**- Flip X output values
  - 0: Keep default X values
  - 1: Invert X output values

*Table A.14: Snap Enable (0x4B-0x4D)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Snap Enable 0** | | | | | | | | | | | | | | | |
| CH15 | CH14 | CH13 | CH12 | CH11 | CH10 | CH9 | CH8 | CH7 | CH6 | CH5 | CH4 | CH3 | CH2 | CH1 | CH0 |
| **Snap Enable 1** | | | | | | | | | | | | | | | |
| CH31 | CH30 | CH29 | CH28 | CH27 | CH26 | CH25 | CH24 | CH23 | CH22 | CH21 | CH20 | CH19 | CH18 | CH17 | CH16 |
| **Snap Enable 2** | | | | | | | | | | | | | | | |
| ~ | ~ | ~ | ~ | ~ | ~ | CH41 | CH40 | CH39 | CH38 | CH37 | CH36 | CH35 | CH34 | CH33 | CH32 |

- Snap Enable bits for CH0 - CH41
  - 0: Snap feature disabled on channel
  - 1: Snap feature enabled on channel

*Table A.15: Trackpad ATI Compensation Values (0xE300 - 0xE329)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trackpad Compensation Divider CHx | | | | | Res-erved | Trackpad Compensation CHx | | | | | | | | | |

- Bit 15-11: **Trackpad Compensation Divider CHx**
  - 5-bit value between 1 and 31
- Bit 10: Unused
- Bit 9-0: **Trackpad Compensation CHx**
  - 10 bit value between 0 and 1023

*Table A.16: ALP ATI Compensation Values (0x1F - 0x20)*

| Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALP Compensation Divider | | | | | Res-erved | ALP Compensation | | | | | | | | | |

- Bit 15-11: **ALP Compensation Divider**
  - 5-bit value between 1 and 31
- Bit 10: Unused
- Bit 9-0: **ALP Compensation**
  - 10 bit value between 0 and 1023

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## B Revision History

| Release | Date | Changes |
|---|---|---|
| v1.0 | August 2026 | Initial document released<br>Document and firmware forked from IQS7211E product<br>Removed gesture recognition, added snap dome detection<br>Added third automatic re-ATI conditon, see Section 5.7.2<br>Added new Section to describe snap output, see Section 5.5.2<br>Minor update to Figure 6.1<br>Updated Memory Map Section, see registers *0x0C – 0x0E* and *0x4B – 0x55*<br>Updated Appendix A, see Table A.2, Table A.3 and Table A.14<br>Added individual touch threshold adjustment settings, see registers *0x7A – 0x8E*<br>Added an improved ATI algorithm with automatic per-channel Compensation Divider selection, replacing the previous global Compensation Divider setting, see Section 5.6.4<br>Added the Compensation Seed Value register, register *0x51*<br>Rearranged the memory map to accommodate the new settings. Register addresses from *0x51 to 0x7A* have shifted accordingly.<br>Updated the Touch Threshold section to describe the individual touch threshold adjustment feature, see Section 5.5.1<br>Added a section describing the Compensation Seed Value, see Section 5.6.5<br>Updated Appendix A with a description of the Compensation registers, see Table A.15<br>Removed the global Trackpad Compensation Divider register from the memory map. The lower byte of register 0x22 is now marked as reserved. |

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| | | |
|---|---|---|
| v1.1 | November 2026 | Updated IC images in Device Overview, see Section 1<br>Updated Reference Schematic, see Section 2.5<br>Added a note at the end of Trackpad Touch Output, see Section 5.5.1<br>Updated reference link and removed invalid information in ATI Divider, see Section 5.6.4<br>Added another reference link in Compensation Seed Value, see Section 5.6.5<br>Added information in Decreased Count Value, see Section 5.7.2<br>Updated information in Trackpad Positive Delta Re-ATI, see Section 5.7.2<br>Removed Force Communication Clock Stretching Issue section<br>Updated $I^2C$ Memory Map - Register Descriptions, see Section 11<br>Updated information in Ordering Information, see Table 13.1<br>Updated information in Version Information, see Table A.1<br>Added ALP ATI Compensation Values (0x1F - 0x20) table in Memory Map Descriptions, see Table A.16 |

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