IQS253 Memory Map

IQ Switch® - ProxSense® Series

Multi-channel Integrated Proximity Sensor with Micro-Processor Core

This design guide provides a description of the communication interface between the master and the IQS253 controller. The Memory Map of the IQS253 is provided in this document, followed by a description of each register and instruction. The IQS253 communicates via I^2C. The last section of this document is dedicated to an example implementation and provides example code.

Contents

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1 I²C Details

1.1.1 Control byte and Device Address

The Control byte indicates the 7-bit device address and the Read/Write indicator bit. The structure of the control byte is shown in Figure 1.1.

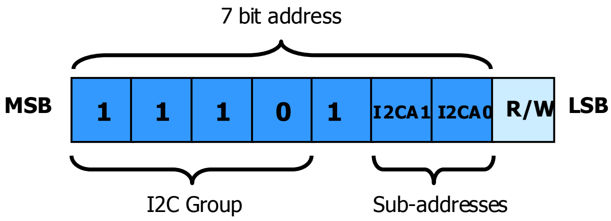

Figure 1.1 I²C control byte

The I²C device has a 7 bit Slave Address in the control byte as shown in Figure 1.1. To confirm the address, the software compares the received address with the device address. Please contact your local Azoteq distributor for devices with preconfigured I²C addresses. The two sub-addresses allow 4 IQS253 slave devices to be used on the same I²C bus, as well as to prevent address conflict.

1.1.2 I²C read

With the R/W bit SET in the control byte, a read is initiated. Data will be read from the address specified by the internal address pointer (Figure 1.2). This pointer will be automatically incremented to read through the memory map data blocks. If a random address is to be read, a *Random Read* must be performed. The process for a Random Read is as follows: write to the pointer (*Word Address* in Figure 1.3), initiate a repeated-Start, read from the address.

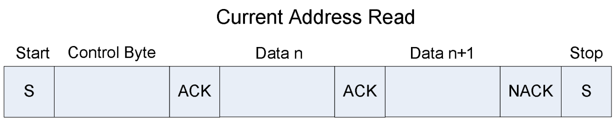

Figure 1.2 I²C Current Address Read

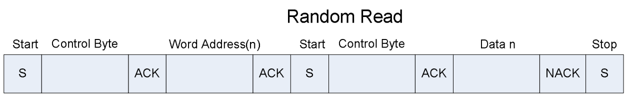

Figure 1.3 I²C Random Read

1.1.3 I²C write

With the R/W bit cleared in the control byte, a write is initiated. An I²C write is performed by sending the address, followed by the data. The Address is only sent once, followed by data bytes. A block of data can be written by sending the address followed by multiple blocks of data. The internal address pointer is incremented automatically for each consecutive write, if the pointer increments to an address which doesn't exist in the memory map, no write will take place.

Note that the pointer doesn't automatically jump from the end of the LT average block to the settings block.

An example of the write process is given in Figure 1.4.

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DATA WRITE

Start	Control Byte		Word Address(n)		Data n		Data n+1		Stop
S		ACK		ACK		ACK		ACK	S

Figure 1.4 I²C write

1.1.4 I²C Communications Window Terminate Command

To terminate the communication window in I²C, a STOP is given. When sending numerous Read and Write commands in one communication cycle, a Repeated Start command must be used to stack them together (since a STOP will jump out of the communication window, which is not desired).

2 Memory Map

The general ProxSense® Memory Map is shown below.

Table 2.1 **IQS253 Memory Mapping**

Address	Access	Size(Bytes)	
00H-0FH	R	16	**Device Information**
10H-30H	R	32	**Device Specific Data**
31H-34H	R	4	**Proximity Status Bytes**
35H-38H	R	4	**Touch Status Bytes**
39H-3CH	R	4	**Halt Bytes**
3DH-41H	R	4	**Active Bytes (indicate cycle)**
42H-82H	R	64	**Counts**
83H-C3H	R/W	64	**LTAs**
C4h-FDh	R/W	64	**Device Settings**

* Note 'FE' and 'FF' are reserved for other functions in communication.

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2.2 IQS253 Memory Map

2.2.1 Device Information

00H

Access
R

	Product Number (PROD_NR)							
Bit	7	6	5	4	3	2	1	0
Value	31 (Decimal)							

01H

Access
R

	Software Number (SW_NR)							
Bit	7	6	5	4	3	2	1	0
Value	SW_NR							

2.2.2 Device Specific Data

10H

Access
R

	System Flags (SYSFLAGS)							
Bit	7	6	5	4	3	2	1	0
Name	SYSTEM _USE	SYSTEM_ USE	SHOW_ RESET	PROJ_ MODE	LP	ATI_ BUSY	NOISE	ZOOM

2.2.3 Proximity Status Bytes

The proximity status of all the channels on the device are shown here. These bits should not be monitored if the IC is in DYCAL mode.

31H

Access
R

	Proximity Status (PROX)							
Bit	7	6	5	4	3	2	1	0
Name	~	~	~	~	~	CH2	CH1	CH0

2.2.4 Touch Status Bytes

The touch status of all the channels on the device are shown here. These bits should not be monitored if the IC is in DYCAL mode.

35H

Access
R

	Touch Status (TOUCH)							
Bit	7	6	5	4	3	2	1	0
Name	Boolean_Output	~	~	~	~	CH2	CH1	CH0

2.2.5 DYCAL Touch Mode indication

36H

Access
R

	DYCAL TM Indication (DYCAL_TM)							
Bit	7	6	5	4	3	2	1	0
Name	~	~	~	~	~	CH2	CH1	CH0
Note	Indicates if Channel is in TM							

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2.2.6 DYCAL Output indication

37H		DYCAL Output Indication (DYCAL_OUT)							
	Bit	7	6	5	4	3	2	1	0
Access	Name	~	~	~	~	~	CH2	CH1	CH0
R		Indicates a DYCAL detection on a channel							

2.2.7 Halt Bytes

The LTA filter halt status of all the channels are shown here.

39H		LTA Halt Status (HALT)							
	Bit	7	6	5	4	3	2	1	0
Access	Name	~	~	~	~	~	CH2	CH1	CH0
R									

2.2.8 Channel Number

3DH		Channel Number							
	Bit	7	6	5	4	3	2	1	0
Access	Value	Variable (0-2)							
R	Note	Indicates which channels' data is currently available							

2.2.9 Counts

The Counts of the current channel is available here.

42H		Counts (CS_H)							
	Bit	7	6	5	4	3	2	1	0
Access	Value	Variable (HIGH byte)							
R	Note	Counts of active channel (see Channel Number)							

43H		Counts (CS_H)							
	Bit	7	6	5	4	3	2	1	0
Access	Value	Variable (LOW byte)							
R	Note	Counts of active channel (see Channel Number)							

2.2.10 Long-Term Averages

The Long-Term average of the current channel is available here to read.

83H		Long-Term Average (LTA_H)							
	Bit	7	6	5	4	3	2	1	0
Access	Value	Variable (HIGH byte)							
R	Note	LTA of active channel (see Channel Number)							

84H		Long-Term Average (LTA_L)							
	Bit	7	6	5	4	3	2	1	0
Access	Value	Variable (LOW byte)							
R	Note	LTA of active channel (see Channel Number)							

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2.2.11 Device Settings

It is attempted that the commonly used settings are situated closer to the top of the memory block. Settings that are regarded as more 'once-off' are placed further down.

C4H — Access: **R/W**

ATI Target Value (ATI_TARGET)								
Bit	7	6	5	4	3	2	1	0
Value	ATI Target value (x8 to get real target)							
Default	1	0	0	0	0	0	0	0
Note	128 Decimal (x8 gives Target value = 1024)							

C5H — Access: **R/W**

CH0 Compensation (COMP0)								
Bit	7	6	5	4	3	2	1	0
Value	Automatically adjusted when ATI enabled							
Default	00							

C6H — Access: **R/W**

CH1 Compensation (COMP1)								
Bit	7	6	5	4	3	2	1	0
Value	Automatically adjusted when ATI enabled							
Default	00							

C7H — Access: **R/W**

CH2 Compensation (COMP2)								
Bit	7	6	5	4	3	2	1	0
Value	Automatically adjusted when ATI enabled							
Default	00							

C8H — Access: **R/W**

CH0 ATI BASE and Multipliers (CH0_ATI_BASE)								
Bit	7	6	5	4	3	2	1	0
	CH0_ BASE1	CH0_ BASE0	MULT_ COMP1	MULT_ COMP0	MULT_ SENSE3	MULT_ SENSE2	MULT_ SENSE1	MULT_ SENSE0
			gain		scale			

C9H — Access: **R/W**

CH1 ATI BASE and Multipliers (CH1_ATI_BASE)								
Bit	7	6	5	4	3	2	1	0
	CH1_ BASE1	CH1_ BASE0	MULT_ COMP1	MULT_ COMP0	MULT_ SENSE3	MULT_ SENSE2	MULT_ SENSE1	MULT_ SENSE0

CAH — Access: **R/W**

CH2 ATI BASE and Multipliers (CH2_ATI_BASE)								
Bit	7	6	5	4	3	2	1	0
	CH2_ BASE1	CH2_ BASE0	MULT_ COMP1	MULT_ COMP0	MULT_ SENSE3	MULT_ SENSE2	MULT_ SENSE1	MULT_ SENSE0

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CBH

Access
R/W

Proximity Sensitivity Threshold (PROX_TH_CH0)								
Bit	7	6	5	4	3	2	1	0
Name	PT_7	PT_6	PT_5	PT_4	PT_3	PT_2	PT_1	PT_0
Default	0	0	0	0	0	1	0	0

CCH

Access
R/W

Proximity Sensitivity Threshold (PROX_TH_CH1)								
Bit	7	6	5	4	3	2	1	0
Name	PT_7	PT_6	PT_5	PT_4	PT_3	PT_2	PT_1	PT_0
Default			0	0	0	1	0	0

CDH

Access
R/W

Proximity Sensitivity Threshold (PROX_TH_CH2)								
Bit	7	6	5	4	3	2	1	0
Name	PT_7	PT_6	PT_5	PT_4	PT_3	PT_2	PT_1	PT_0
Default			0	0	0	1	0	0

CEH

Access
R/W

Touch Sensitivity Threshold (TOUCH_TH_CH0)								
Bit	7	6	5	4	3	2	1	0
Name	TT_5	TT_5	TT_5	TT_4	TT_3	TT_2	TT_1	TT_0
Default	0	0	1	0	0	0	0	0
Note	Touch THR = (value / 256 * LTA)							

CFH

Access
R/W

Touch Sensitivity Threshold (TOUCH_TH_CH1)								
Bit	7	6	5	4	3	2	1	0
Name	TT_5	TT_5	TT_5	TT_4	TT_3	TT_2	TT_1	TT_0
Default	0	0	1	0	0	0	0	0
Note	Touch THR = (value / 256 * LTA)							

D0H

Access
R/W

Touch Sensitivity Threshold (TOUCH_TH_CH2)								
Bit	7	6	5	4	3	2	1	0
Name	TT_5	TT_5	TT_5	TT_4	TT_3	TT_2	TT_1	TT_0
Default	0	0	1	0	0	0	0	0
Note	Touch THR = (value / 256 * LTA)							

D1H

Access
R/W

ProxSense Module Settings 0 (PROX_SETTINGS0)								
Bit	7	6	5	4	3	2	1	0
Value	ATI_ OFF	ATI_ PARTIAL	10s_ATI_ BLOCK	REDO_ ATI	RESEED	CS_ SIZE	PROJ_ BIAS1	PROJ_ BIAS0
Default	0	0	1	0	0	1	1	1

D2H

Access

ProxSense Module Settings 1 (PROX_SETTINGS1)								
Bit	7	6	5	4	3	2	1	0
Value	PROJ	ALT_ BASE	DYCAL_ TURBO	HC	ND	ND_ TRIM0	ND_ TRIM0	ND_ TRIM0

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R/W	Default	0	0	0	0	0	0	0	0

D3H

Access R/W	ProxSense Module Settings 2 (PROX_SETTINGS2)								
	Bit	7	6	5	4	3	2	1	0
	Value	ACK_ RESET	COMMS_ WDT_ DISABLE	FORCE_ HALT	ACF_ DISABLE	TIME_ OUT_ DISABLE	EVENT_ MODE _ DISABLE	HALT1	HALT0
	Default	0 (W)	0	0	0	0	0	0	0

D4H

Access R/W	ProxSense Module Settings 3 (PROX_SETTINGS3)								
	Bit	7	6	5	4	3	2	1	0
	Value	~	~	LTA_ ADAPT1	LTA_ ADAPT0	~	PROX_ DEBOUNCE	XFER_ FREQ1	XFER_ FREQ0
	Default	~	~	~	~	~	~	0	1

D5H

Access R/W	Active Channels (ACTIVE_CHAN)								
	Bit	7	6	5	4	3	2	1	0
	Value	~	~	~	~	~	CH2	CH1	CH0
	Default	~	~	~	~	~	1	1	1

D6H

Access R/W	Low Power Settings (LOW_POWER)								
	Bit	7	6	5	4	3	2	1	0
	Value	LP7	LP6	LP5	LP4	LP3	LP2	LP1	LP0
	Default	Normal Power default (00H). See Note below.							
	Note	Custom value between 1 and 256 – value x 16ms = LP time							

NOTE: While in any power mode the device will zoom to Boost Power (BP) mode whenever the counts (CS) indicate a possible proximity or touch event. This improves the response time. The device will remain in BP for t_{ZOOM} seconds and then return to the selected power mode. The zoom function allows reliable detection of events with counts being produced at the BP rate.

D7H

Access R/W	DYCAL Specific Settings (DYCAL_SETTINGS)								
	Bit	7	6	5	4	3	2	1	0
	Value	250ms_ DELAY_ TM	ALWAYS_ HALT_ DYCAL	BETA_ TM_ OUT1	BETA_ TM_ OUT0	BETA_ TM_IN	OUTPUT_ ON_ TOUCH	REL_ THR1	REL_ THR0
	Default	0	0	0	0	0	0	0	0

D8H

Access R/W	DYCAL Channels Enable (DYCAL_CHANS)								
	Bit	7	6	5	4	3	2	1	0
	Name	~	~	~	~	BLOCK_ON_CH1_ENABLE	CH2	CH1	CH0
	Default	~	~	~	~	0	1	1	1

D9H

	EVENT MODE MASK (EVENT_MASK)								
	Bit	7	6	5	4	3	2	1	0

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Access	Name	~	~	ATI	DYCAL	BOOLEAN	NOISE	TOUCH	PROX
R/W	Default	~	~	1	1	1	1	1	1

DAH

		Boolean Settings (BOOLEAN_SETTINGS)							
	Bit	7	6	5	4	3	2	1	0
Access	Value	~	~	~	~	BOOL_ AND_OR	MASK_ CH2	MASK_ CH1	MASK_ CH0
R/W	Default	~	~	~	~	0	0	0	0

DBH

		Boolean NOT Mask (BOOLEAN_NOT)							
	Bit	7	6	5	4	3	2	1	0
Access	Name	~	~	~	~	~	NOT_ CH2	NOT_ CH1	NOT_ CH0
R/W	Default	~	~	~	~	~	0	0	0

DDH

		DEFAULT_COMMS_POINTER							
	Bit	7	6	5	4	3	2	1	0
Access **R/W**	Default	10H (Beginning of Device Specific Data)							

2.3 Memory Map Description

2.3.1 Device Information

[00H] PROD_NR

The product number for the IQS253 is 31 (decimal).

[01H] SW_NR

The software version number of the device ROM can be read in this byte. The Engineering version numbers are shown below.

IQS253 sw nr	Description
13 (decimal)	IQS253 - 3 Channel Self Capacitive Sensor version 1
14 (decimal)	IQS253 - 3 Channel Projected Sensor version 1

2.3.2 Device Specific Data

[10H] SYSFLAGS

Bit 7: ***SYSTEM_USE***

0 = No reset has occurred since last cleared

1 = Reset has occurred

Bit 6: ***SYSTEM_USE***

Bit 5: ***SHOW_RESET:*** This bit can be read to determine whether a reset occurred on the device since the ***ACK_RESET*** bit has been set. The value of ***SHOW_RESET*** can be set to '0' by writing a '1' in the ***ACK_RESET*** bit in the **PROX_SETTINGS_2** byte.

Bit 4: ***PROJ_MODE:*** Capacitive Sensing Technology used

0 = Self Capacitive sensing

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1 = Projected Capacitive sensing

Bit 3: ***LP:*** If a LP mode is enabled, this bit indicates that charging is currently occurring in a LP rate.

0 = Full-speed charging

1 = Charging currently occur at a lower rate

Bit 2: ***ATI_BUSY:*** Status of automated ATI routine

0 = Auto ATI is not busy

1 = Auto ATI in progress

Bit 1: ***NOISE:*** This bit indicates the presence of noise interference.

0 = IC has not detected the presence of noise

1 = IC has detected the presence of noise

Bit 0: ***ZOOM:*** Zoom will indicate full-speed charging once an undebounced proximity is detected. In NP mode, this will not change the charging frequency.

0 = IC not zoomed in

1 = IC detected undebounced proximity and IC is charging at full-speed

2.3.3 Proximity Status Bytes

[31H] PROX

The proximity status of the channels is indicated in this byte. The PROX bit of a channel should not be used if a channel is set as a DYCAL channel.

Bit 7-3: ***Unused***

Bit 2: ***CH2:*** Indicate that a proximity event has been detected on CH2

0 = No proximity event detected

1 = Proximity event detected

Bit 1: ***CH1:*** Indicate that a proximity event has been detected on CH1

0 = No proximity event detected

1 = Proximity event detected

Bit 0: ***CH0:*** Indicate that a proximity event has been detected on CH0

0 = No proximity event detected

1 = Proximity event detected

2.3.4 Touch Status Bytes

[35H] TOUCH

The touch status of the channels is indicated in this byte. The TOUCH bit of a channel should not be used if a channel is set as a DYCAL channel.

Bit 7: ***BOOLEAN_OUTPUT:*** A Boolean combination can be outputted to this bit. The Boolean combination can be configured through bytes BOOLEAN_SETTINGS and BOOLEAN_NOT. This bit will correspond with the output status of the B_OUT pin of the IQS253 Self capacitive IC.

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0 = Boolean Output not active

1 = Boolean Output active

Bit 6-3: ***Unused***

Bit 2: ***CH2:*** Indicate that a touch event has been detected on CH2

0 = No touch event detected

1 = Touch event detected

Bit 1: ***CH1:*** Indicate that a touch event has been detected on CH1

0 = No touch event detected

1 = Touch event detected

Bit 0: ***CH0:*** Indicate that a touch event has been detected on CH0

0 = No touch event detected

1 = Touch event detected

2.3.5 DYCAL Touch Mode Indication

[36H] DYCAL_TM

If a channel is configured as a DYCAL channel, these bits will indicate whether TM has been entered. TM is entered once the touch threshold of a channel has been exceeded.

Bit 7-3: ***Unused***

Bit 2: ***CH2:*** CH2 TM indication

0 = Channel not in TM

1 = Channel in TM

Bit 1: ***CH1:*** CH1 TM indication

0 = Channel not in TM

1 = Channel in TM

Bit 0: ***CH0:*** CH0 TM indication

0 = Channel not in TM

1 = Channel in TM

2.3.6 DYCAL Output Indication

[37H] DYCAL_OUT

If a channel is configured as a DYCAL channel, these bits will indicate whether the DYCAL output is set. It will default be set with the detection of a proximity, but can be set by a touch by configuring bit **DYCAL_SETTINGS:OUTPUT_ON_TOUCH**.

Bit 7-3: ***Unused***

Bit 2: ***CH2:*** CH2 DYCAL output

0 = DYCAL not detected

1 = DYCAL detected

Bit 1: ***CH1:*** CH1 DYCAL output

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0 = DYCAL not detected

1 = DYCAL detected

Bit 0: ***CH0:*** CH0 DYCAL output

0 = DYCAL not detected

1 = DYCAL detected

2.3.7 Halt Bytes

[39H] **HALT**

Indicate the halting state of each channels Long Term Average (LTA). If in non-TM, the halt bit of a channel will be set once proximity is detected. Once a touch is detected, the IC will enter TM and the halt bit will be cleared. The halting bit will now only be set again if the CS exceeds the LTA by 16 in Self or if the CS is less than the LTA by more than 16 in Projected mode.

Bit 7-3: ***Unused***

Bit 2: ***CH2:*** CH2 LTA halting state

0 = Channels LTA adapts to the environment

1 = Channels LTA halted

Bit 1: ***CH1:*** CH1 halting state

0 = Channels LTA adapts to the environment

1 = Channels LTA halted

Bit 0: ***CH0:*** CH0 halting state

0 = Channels LTA adapts to the environment

1 = Channels LTA halted

2.3.8 Current Channel

[3DH] **CHAN_NUM**

The channel number that can be read in this byte indicates which channels' data is currently available.

2.3.9 Counts (CS)

[42H & 43H] **CS_H & CS_L**

The counts for the current channel can be read in this byte. The HIGH byte and LOW byte are found in consecutive addresses.

2.3.10 Long-Term Average

[83H & 84H] LTA_H & LTA_L

The LTA value for the current channel can be read in this byte. The HIGH byte and LOW byte are found in consecutive addresses.

2.3.11 Device Settings

The settings contained in this section can be configured by the user.

[C4H] ATI_TARGET

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The automated ATI target can be set in this byte. The value written to this byte multiplied by 8 will be the target value of all 3 channels.

If a new target value is required, the required target (divided by 8) should be written to this byte, where-after a re-ATI event should be sent. All 3 channels will now be at the target value once the SYSFLAGS_ATI_BUSY flag is cleared.

ATI Multiplier and Compensation

The ATI Multiplier and ATI Compensation bits allow the controller to be compatible with a large range of sensors, and in many applications with different environments. ATI allows the user to maintain a specific sample value on all channels. The ATI Multiplier parameters would produce the largest changes in sample values and can be thought of as the high bits of ATI. The ATI Compensation bits are used to influence the sample values on a smaller scale to provide precision when balancing all channels as close as possible to the target. The ATI Multiplier parameters are further grouped into two parameters namely ATI Multiplier-Compensation and ATI Multiplier-Sensitivity. ATI multiplier-Compensation consists of 2 bits and has the biggest effect on the sample value and can be considered as the highest bit of the ATI parameters.

The ATI Multiplier-Sensitivity can be adjusted with 4 bits for each channel. The value of '1111' would provide the highest CS value and the value of '0000' would provide the lowest.

[C5H, C6H, C7H] Compensation settings (CH0_COMP, CH1_COMP, CH2_COMP)

The compensation settings for each channel are contained in these bytes. The values in these bytes are automatically determined if the Auto ATI function was used. If PROX_SETTINGS0:ATI_OFF is set, the Automatic ATI setting is disabled and this byte can be altered to achieve a custom target value.

The ATI Compensation parameter can be configured for each channel in a range between 0-255 (decimal). The ATI compensation bits can be used to make small adjustments of the sample values of the individual channels.

[C5H, C6H, C7H] Base values and Multiplier settings (CH0_BASE, CH1_BASE, CH2_BASE)

The base value or Multiplier settings of each channel can be set in these bytes.

Bit 7-6: ***CHx_BASE1:CHx_BASE0:*** Channel base values

(ALT_BASE = 0)	*(ALT_BASE = 1)*
00 = 200	00 = 150
01 = 50	01 = 350
10 = 100	10 = 500
11 = 250	11 = 700

Bit 5-4: ***MULT_COMP1:MULT_COMP0:*** Multiplier Compensation setting.

00 = 1:1 (smallest)

01 = 3:1

10 = 1:3

11 = 1:9

Bit 3-0: ***MULT_SENSE3:MULT_SENSE0:*** Multiplier Sensitivity setting

0000 = 1 (smallest)

0001 = 2

0010 = 3

0011 = 4

0100 = 5

0101 = 6

0110 = 7

0111 = 8

1000 = 9

1001 = 10

1010 = 11

1011 = 12

1100 = 14

1101 = 14

1110 = 16

1111 = 18

[CBH, CCH, CDH] Proximity Sensitivity Settings (PROX_TH_CHx)

Proximity sensitivity thresholds can be anything from 1 to 64.

[CEH, CFH, D0H]Touch Sensitivity Settings (TOUCH_TH_CHx)

Touch sensitivity thresholds are calculated as a fraction of the LTA:

Touch THR = (TOUCH_THR_CHx / 256 * LTA).

There are 256 possible touch threshold values.

[D1H] PROX_SETTINGS0

Bit 7: ***AUTO_ATI:*** Enable the automated ATI routine. By enabling this bit, the device will perform an automated ATI routine on all channels if the channels target values are outside their boundaries[1].

0 = No action

1 = Auto ATI routine active

Bit 6: ***ATI_PARTIAL:*** Enable Partial ATI.

0 = If ATI occur, it will use the base values as reference

1 = If ATI occur, it will use the MULTIPLIER_COMPx and MULTIPLIER_SENSx as reference

Bit 5: ***ATI_BLOCK:*** Enable the 10 second block of ATI after an actuation.

---

[1] The boundaries for the AUTO_ATI routine = Target value / 8.

0 = Channels will always redo ATI if LTA is outside boundaries if no actuation is detected

1 = ATI will be blocked for 10 seconds after an actuation has occurred.

Bit 4: ***REDO_AUTO_ATI:*** Force the ATI routine to perform. The last written ATI_TARGET value will be used as target.

0 = No action

1 = Force ATI routine to perform.

Bit 3: ***RESEED:*** Reseed the LTA filter. This can be used to adapt to an abrupt environment change, where the filter is too slow to track this change. Note that with the Short and Long Halt selections, an automatic Reseed will be performed when the halt time has expired, thus automatically adjusting to the new surroundings.

0 : Do not reseed

1 : Reseed (this is a global reseed)

Bit 2: ***CS:*** Set the size of the internal sampling capacitor. A larger CS capacitor requires more transfers (higher counts) to be charged.

0 = 29.9pF

1 = 59.8pF

Bit 1-0: ***PROJ_BIAS1:PROJ_BIAS0:*** Projected Bias Current[2]

00 = 1.25uA (smallest)

01 = 2.5uA

10 = 5uA

11 = 10uA

[D2] PROX_SETTINGS1

Bit 7: ***PROJ:*** Use the IQS253 in projected mode. This setting can only be enabled in the SETUP communications window.

0 : IQS253 in Self Capacitive sensing mode

1 : IQS253 in Projected Capacitive sensing mode

Bit 6: ***ALT_BASE:*** Set this bit to choose the alternative base values

0 : Normal base values

1 : Alternative base values

Bit 5: ***DYCAL_TURBO*****:** Enable the DYCAL Turbo functionality. By enabling this bit, the device will drastically decrease the time to detect users' proximity and touch events.

0 = Normal DYCAL

1 = Enable DYCAL Turbo

---

[2] Only applicable if IC is in projected mode. See datasheet for explanation.

Bit 4: ***HC*****:** Halt charges. The device will not perform capacitive sensing charge transfers and thus not be able to detect any user events.

0 = Charge transfers occur normally

1 = No charge transfers occur

Bit 3: ***ND*****:** Noise Detection Enable. This setting is used to enable the on-chip noise detection circuitry. With noise detected, the noise affected samples will be ignored, and have no effect on the Prox, touch or LTA calculations. The ***NOISE*** bit will appropriately be set as indication of the noise status.

0 = Disable noise detection

1 = Enable noise detection

Bit 2-0: ***ND_TRIM2:ND_TRIM0:*** ND Trim values

000 = 19.1mV

001 = 9.65mV

010 = 0mV

011 = -10mV

100 = -19.1mV

101 = -29.8mV

110 = -40.9mV

111 = -57.4mV

[D3H] PROX_SETTINGS2

Bit 7: ***ACK_RESET*****:** Acknowledge 'SHOW_RESET'.

0 = Nothing

1 = Clear the **SHOW_RESET** flag (send only once)

Bit 6: ***WDT_DISABLE*****:** Device watchdog timer (WDT) disable.

0 = Enabled

1 = Disabled

Bit 5: ***FORCE_HALT:*** The LTA is halted by setting this bit. It will only be allowed to adapt to the environment once it is cleared.

0 : LTA adapts to environment until actuation detected.

1 : Halt LTA.

Bit 4: ***ACF_DISABLE*****:** Disable the AC Filter employed on the Counts (CS).

0 = Enable AC filter.

1 = Disable AC filter.

Bit 3: ***TIME_OUT_DISABLE*****:** Enable I^2C communication timeout. This bit will enable the IC to resume charge transfers if communication does not commence within 20ms of the RDY indicating that data is ready.

0 = Disable time-out.

1 = Enable time-out.

Bit 2: ***EVENT_MODE_DISABLE*****:** Enable the IC to stream data continuously.

0 = I^2C Communication will only occur if an event occur (events defined in EVENT_MODE_MASK byte)

1 = Continuous streaming mode

Bit 1-0: ***HALT1:HALT0:*** LTA halt timings.

00 = 20s

01 = 40s

10 = Never

11 = Always

[D4H] PROX_SETTINGS3

Bit 7-6: ***Unused***

Bit 5-4: ***LTA_ADAPT*****:** Rate at which LTA adapts to CS when no actuation is detected (non-TM mode).

00 = 3.13% (fastest)

01 = 1.56%

10 = 0.78%

11 = 0.39% (slowest)

Bit 3: ***Unused***

Bit 2: ***PROX_DEBOUNCE*****:** Number of consecutive CS samples required exceeding proximity threshold to detect a proximity event.

0 = 6

1 = 4

Bit 1-0: ***XFER_FREQ1:XFER_FREQ0*****:** Charge transfer frequency.

00 = 1MHz

01 = 500kHz

10 = 250kHz

11 = 125kHz

The charge transfer frequency is a very important parameter. Dependant on the design application, the device frequency must be optimised. For example, if keys are to be used in an environment where steam or water droplets could form on the keys, a higher transfer frequency improves immunity. Also, if a sensor electrode is a very large object/size, then a slower frequency must be selected since the capacitance of the sensor is large, and a slower frequency is required to allow effective capacitive sensing on the sensor.

[D5H] ACTIVE_CHAN

Each channel can be individually disabled in this register.

Bit 7-3: ***Unused***

Bit 2: ***CH2*****:** Setting this bit will disable the channel

0 = Active / Charging

1 = Inactive / Not charging

Bit 1: ***CH1*****:** Setting this bit will disable the channel

0 = Active / Charging

1 = Inactive / Not charging

Bit 0: ***CH0*****:** Setting this bit will disable the channel

0 = Active / Charging

1 = Inactive / Not charging

[D6H] LP_PERIOD

Byte indicates the sleep time between a burst of conversions. Default (00H), a channel is charged every 27ms. The LP time can be set to any custom value between 1 and 256. The time between the conversions will then be the 'value' x 16ms. (NOTE: CX2 does a dummy conversion before the burst of the active channels are executed.)

[D7H] DYCAL_SETTINGS

Byte indicates which channels are actively charged.

Bit 7: ***250ms_DELAY_TM:*** A 250ms delay is applied on the LTA when a touch is detected, before the LTA is reseeded to the LTA-TOUCH_THR

0 = Enabled

1 = Disabled

Bit 6: ***ALWAYS_HALT_DYCAL*****:** Always halt LTA in TM if CS exceeds LTA by 16 (Self) or if CS is lower than LTA by 16 (projected)

0 = Halting of LTA in TM according to HALT1:HALT0 settings

1 = Always halt LTA if above condition is met

Bit 5-4: ***LTA_ADAPT_IN*****:** Rate at which LTA adapts after reseed when heading towards the CS in TM

00 = 1.56%

01 = 6.25% (fastest)

10 = 3.13%

11 = 0.78% (slowest)

Bit 3: ***LTA_ADAPT_OUT*****:** Rate at which LTA adapts after it's reached CS, when CS is heading out of TM.

0 = 0.10% (fastest)

1 = 0.01% (slowest)

Bit 2: ***OUTPUT_ON_TOUCH*****:** Setting this bit will enable the DYCAL output to change with touch actuation.

0 = DYCAL on Proximity

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1 = DYCAL on Touch

Bit 1-0: ***RELEASE_THR1:RELEASE_THR0*****:** Release threshold with which CS should exceed LTA for LTA to reseed back to non-TM.

00 = 75%

01 = 50%

10 = 87.5%

11 = 100%

[D8H] DYCAL enable and Block channel enable (DYCAL_CHANS)

Channels are default configured as DYCAL channels. Clearing a channel bit, will make it a direct output channel.

Bit 7-4: ***Unused***

Bit 3: ***CH1_BLOCK*****:** Setting this bit will make channel 1 a block channel

0 = Normal output

1 = CH1 will block the output of the other channels if actuated

Bit 2: ***CH2*****:** Clearing this bit, will make the channel a direct output channel

0 = Direct Output channel

1 = DYCAL channel

Bit 1: ***CH1*****:** Clearing this bit, will make the channel a direct output channel

0 = Direct Output channel

1 = DYCAL channel

Bit 0: ***CH0*****:** Clearing this bit, will make the channel a direct output channel

0 = Direct Output channel

1 = DYCAL channel

[D9H] Event Mode mask (EVENT_MASK)

Bit 7-6: ***Unused***

Bit 5: ***ATI*****:** A communication event will occur if an ATI or re-ATI occurs.

0 = Communication event will not occur

1 = Communication event will occur

Bit 4: ***DYCAL*****:** A communication event will occur if a DYCAL state change occurs.

0 = Communication event will not occur

1 = Communication event will occur

Bit 3: ***BOOLEAN*****:** A communication event will occur if a Boolean state change occurs.

0 = Communication event will not occur

1 = Communication event will occur

Bit 2: ***NOISE*****:** A communication event will occur if noise is detected.

0 = Communication event will not occur

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1 = Communication event will occur

Bit 1: ***TOUCH*****:** A communication event will occur if a proximity state change occurs. Should only be used if a channel is in direct mode.

0 = Communication event will not occur

1 = Communication event will occur

Bit 0: ***PROXIMITY*****:** A communication event will occur if a proximity state change occurs. Should only be used if a channel is in direct mode.

0 = Communication event will not occur

1 = Communication event will occur

[DAH] BOOLEAN_SETTINGS

Bit 7-4: ***Unused***

Bit 3: ***BOOLEAN_AND_OR*****:** Boolean AND operation on the channels chosen to perform this action on

0 = Boolean AND operation

1 = Boolean OR operation

Bit 2: ***CH2*****:** Use this channel in the Boolean operation

0 = No

1 = Yes

Bit 1: ***CH1*** Use this channel in the Boolean operation

0 = No

1 = Yes

Bit 0: ***CH0*** Use this channel in the Boolean operation

0 = No

1 = Yes

[DBH] BOOLEAN_NOT

Bit 7-3: ***Unused***

Bit 2: ***CH2*****:** Invert this channels polarity (NOT operation)

0 = No action

1 = NOT Channel (Invert channel polarity)

Bit 1: ***CH1*****:** Invert this channels polarity (NOT operation)

0 = No action

1 = NOT Channel (Invert channel polarity)

Bit 0: ***CH0*****:** Invert this channels polarity (NOT operation)

0 = No action

1 = NOT Channel (Invert channel polarity)

[DDH] Default Comms Pointer

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The value stored in this register will be loaded into the Comms Pointer at the start of a communication window. For example, if the design only requires the Proximity Status information each cycle, then the *Default Comms Pointer* can be set to ADDRESS ‘31H’. This would mean that at the start of each communication window, the comms pointer would already be set to the Proximity Status register, simply allowing a READ to retrieve the data, without the need of setting up the address.

3 General Implementation hints

When implementing the communication interface with the IQS253, please refer to the IQS253 datasheet for a detailed description of the I^2C communication. This section contains some general guidelines and hints regarding the communication interface.

3.1 I^2C Communication window

When communicating via I^2C, the communication window will automatically close when a STOP bit is received by the IQS253. The IQS253 will then proceed to start with a new conversion and the READY line will be pulled low until the new conversion is complete.

Note that there is no command via I^2C to initiate a new conversion. To perform multiple read and write commands, the repeated start function of the I^2C must be used to stack the commands together.

3.2 Startup Procedure

After sending initial settings to the IQS253, it is important to execute a reseed. It is suggested to execute an estimated 24 conversions after initial settings before calling for a reseed, to allow the system to stabilize.

3.3 General I^2C Hints

3.3.1 I^2C Pull-up resistors

When implementing I^2C it is important to remember the pull-up resistors on the data and clock lines. 4.7kΩ is recommended, but for lower clock speeds bigger pull-ups will reduce power consumption.

3.3.2 Reset Device while using I^2C

When a reset occurs, some care needs to be taken to ensure that the IQS253 restarts correctly. The reset pin needs to be LOW before the IQS253 can be initialised, else the master will read a ready signal prematurely. To accomplish this without any delays, define the ready pin on the master as an output and pull it LOW. Then, redefine it as an input line just before initializing the IQS253.

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