IQS9342 Datasheet

Multi-Channel Inductive Sensing Device Aimed at Analog Keyboard Applications with Multi-Level Detection of Numerous Keys

1 Device Overview

The IQS9342 ProxSense® IC is a multi-channel inductive sensing device that supports up to 42 channels per device and up to 16 kHz sampling rate. The IC also supports on-chip environmental compensation.

1.1 Main Features

- Up to 42 channels with single-pin measurement
- Up to 21 channels with dual-pin measurement
- Up to 16 kHz sampling rate
- Environmental tracking
- Configurable power states
- Fully configurable via SPI interface
- 16-bit raw data per channel
- SPI communication interface up to 20 MHz
- Designed for multiplexed device array
- QFN64 (8×8×0.75 mm) – 0.4 mm pitch
- Wide input voltage supply range: 2.4 V to 3.6 V
- Wide operating temperature range: –20 °C to +85 °C

Figure 1.1: IQS9342 QFN64 Package

1.2 Applications

- Analog keyboards for gaming/productivity
- Contactless button applications for industrial/white goods
- Musical equipments
- Forcepads

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2 QFN64 Pinout

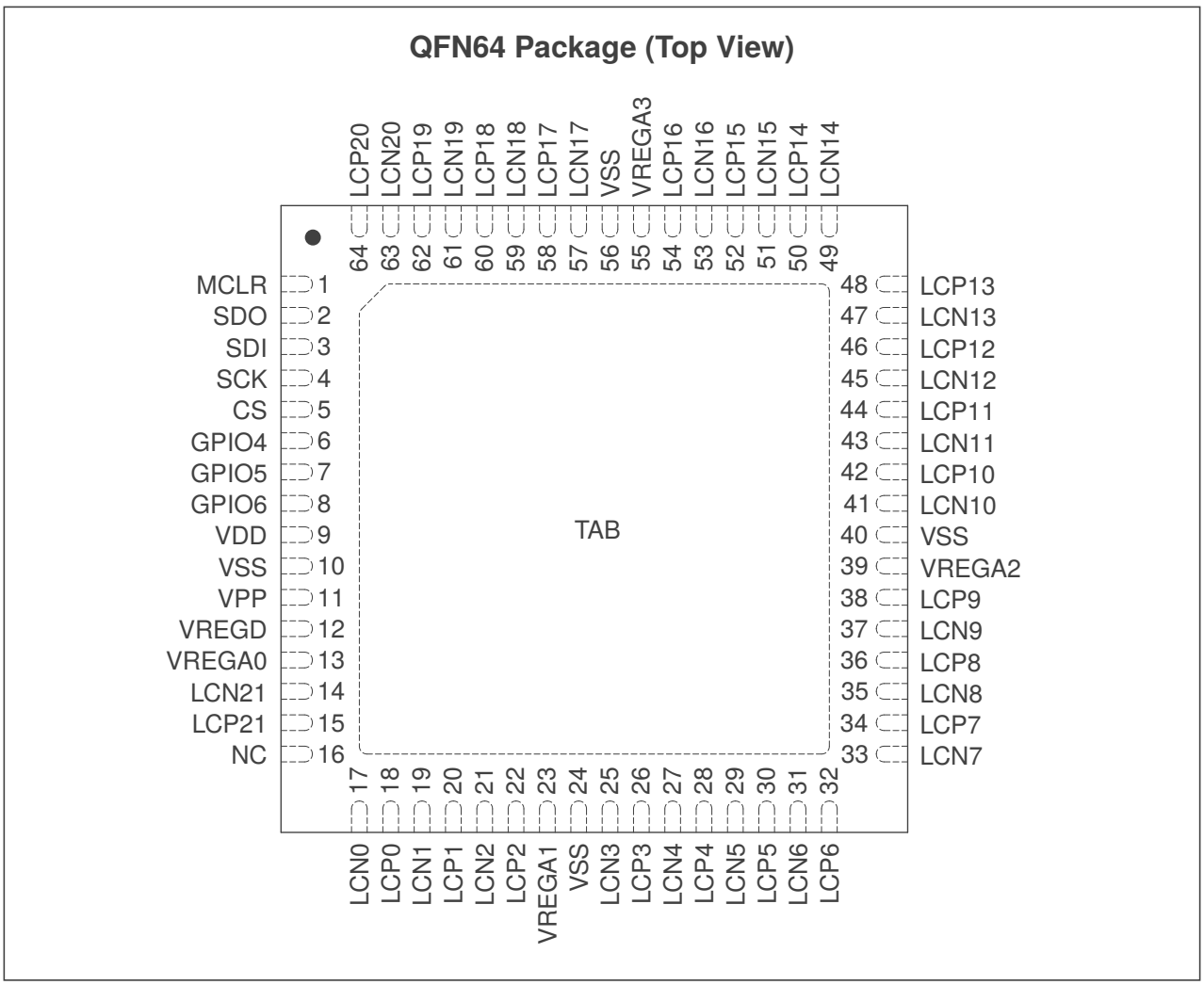

Figure 2.1: QFN64 Pinout

Table 2.1: QFN64 Pin Descriptions

Pin	Name	Type[i]	Function	Description
1	MCLR	I	nReset	Device reset request
2	SDO	O	SPI	SPI serial data out
3	SDI	I	SPI	SPI serial data in
4	SCK	I	SPI	SPI port clock
5	CS	I	SPI	SPI enable / chip-select
6	GPIO4	I/O	GPIO	General purpose pin or external reference clock input
7	GPIO5	I/O	GPIO	General purpose pin
8	GPIO6	I/O	GPIO	General purpose pin
9	VDD	P	Power	Power supply input voltage
10	VSS	P	Power	Analog/digital ground
11	VPP	P	Power	Fuse programming voltage

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Table 2.1: QFN64 Pin Descriptions (Continued)

Pin	Name	Type[i]	Function	Description
12	VREGD	P	Power	Internally-regulated digital supply voltage
13	VREGA0	P	Power	Internally-regulated analog supply voltage
14	LCN21	I/O	Analog	LC oscillator 21 negative terminal
15	LCP21	I/O	Analog	LC oscillator 21 positive terminal
16	NC	-	-	Not Connected
17	LCN0	I/O	Analog	LC oscillator 0 negative terminal
18	LCP0	I/O	Analog	LC oscillator 0 positive terminal
19	LCN1	I/O	Analog	LC oscillator 1 negative terminal
20	LCP1	I/O	Analog	LC oscillator 1 positive terminal
21	LCN2	I/O	Analog	LC oscillator 2 negative terminal
22	LCP2	I/O	Analog	LC oscillator 2 positive terminal
23	VREGA1	P	Power	Internally-regulated analog supply voltage
24	VSS	P	Power	Analog/digital ground
25	LCN3	I/O	Analog	LC oscillator 3 negative terminal
26	LCP3	I/O	Analog	LC oscillator 3 positive terminal
27	LCN4	I/O	Analog	LC oscillator 4 negative terminal
28	LCP4	I/O	Analog	LC oscillator 4 positive terminal
29	LCN5	I/O	Analog	LC oscillator 5 negative terminal
30	LCP5	I/O	Analog	LC oscillator 5 positive terminal
31	LCN6	I/O	Analog	LC oscillator 6 negative terminal
32	LCP6	I/O	Analog	LC oscillator 6 positive terminal
33	LCN7	I/O	Analog	LC oscillator 7 negative terminal
34	LCP7	I/O	Analog	LC oscillator 7 positive terminal
35	LCN8	I/O	Analog	LC oscillator 8 negative terminal
36	LCP8	I/O	Analog	LC oscillator 8 positive terminal
37	LCN9	I/O	Analog	LC oscillator 9 negative terminal
38	LCP9	I/O	Analog	LC oscillator 9 positive terminal
39	VREGA2	P	Power	Internally-regulated analog supply voltage
40	VSS	P	Power	Analog/digital ground
41	LCN10	I/O	Analog	LC oscillator 10 negative terminal
42	LCP10	I/O	Analog	LC oscillator 10 positive terminal
43	LCN11	I/O	Analog	LC oscillator 11 negative terminal
44	LCP11	I/O	Analog	LC oscillator 11 positive terminal
45	LCN12	I/O	Analog	LC oscillator 12 negative terminal
46	LCP12	I/O	Analog	LC oscillator 12 positive terminal
47	LCN13	I/O	Analog	LC oscillator 13 negative terminal
48	LCP13	I/O	Analog	LC oscillator 13 positive terminal
49	LCN14	I/O	Analog	LC oscillator 14 negative terminal
50	LCP14	I/O	Analog	LC oscillator 14 positive terminal
51	LCN15	I/O	Analog	LC oscillator 15 negative terminal
52	LCP15	I/O	Analog	LC oscillator 15 positive terminal
53	LCN16	I/O	Analog	LC oscillator 16 negative terminal

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Table 2.1: QFN64 Pin Descriptions (Continued)

Pin	Name	Type[i]	Function	Description
54	LCP16	I/O	Analog	LC oscillator 16 positive terminal
55	VREGA3	P	Power	Internally-regulated analog supply voltage
56	VSS	P	Power	Analog/digital ground
57	LCN17	I/O	Analog	LC oscillator 17 negative terminal
58	LCP17	I/O	Analog	LC oscillator 17 positive terminal
59	LCN18	I/O	Analog	LC oscillator 18 negative terminal
60	LCP18	I/O	Analog	LC oscillator 18 positive terminal
61	LCN19	I/O	Analog	LC oscillator 19 negative terminal
62	LCP19	I/O	Analog	LC oscillator 19 positive terminal
63	LCN20	I/O	Analog	LC oscillator 20 negative terminal
64	LCP20	I/O	Analog	LC oscillator 20 positive terminal
	TAB	-	-	Thermal pad (floating). It is recommended to connect this to VSS.

[i] Pin Types: I = Input, O = Output, I/O = Input or Output, P = Power

3 Reference Schematic

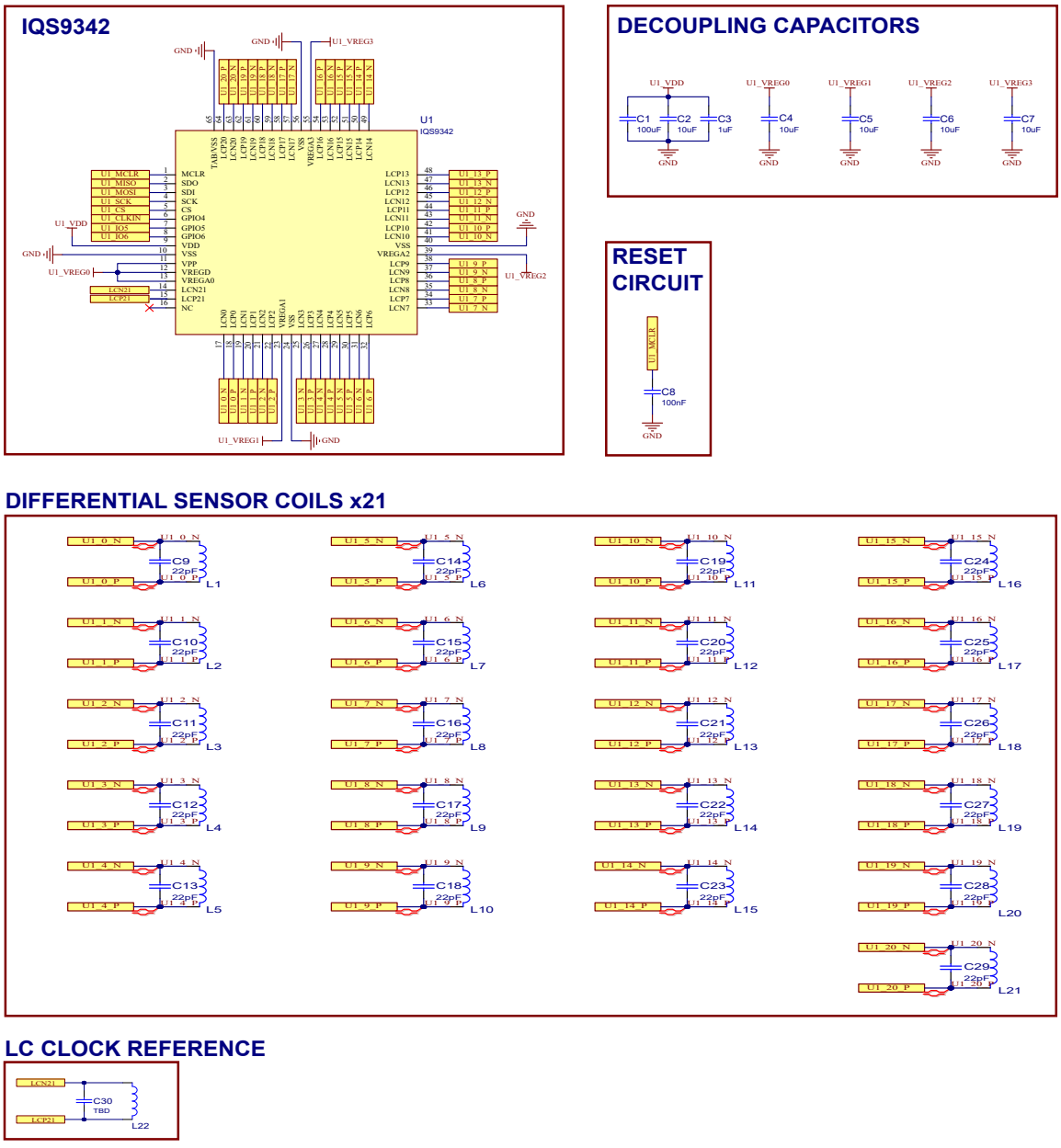


Figure 3.1: Dual-pin Measurement - IQS9342 Single Device Reference Schematic

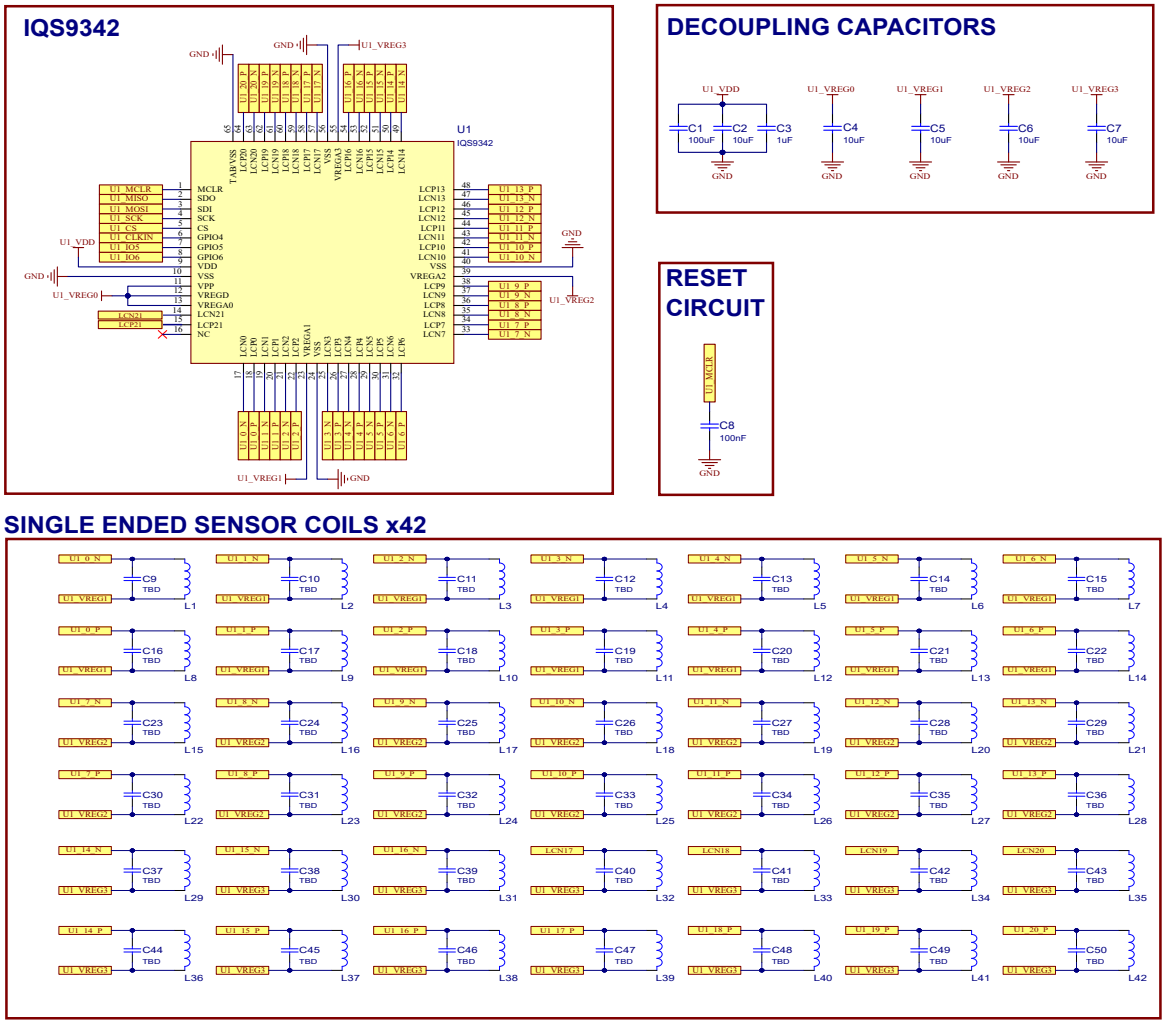


Figure 3.2: Single-pin Measurement - IQS9342 Single Device Reference Schematic

4 Electrical Characteristics

4.1 Absolute Maximum Ratings

Table 4.1: Absolute Maximum Ratings

Symbol	Rating	Min	Max	Unit
V_{DD}	Voltage applied at VDD pin (referenced to VSS)	–0.3	3.6	V
V_{IN}	Voltage applied to any analog, VREG, or VPP pin (referenced to VSS)	–0.3	V_{REG}	V
	Voltage applied to any other pin (referenced to VSS)	–0.3	V_{DD} + 0.3 (3.6 V max)	V
T_{stg}	Storage temperature	–40	85	°C

4.2 General Operating Conditions

Table 4.2: General Operating Conditions

Symbol	Parameter	Typ	Unit
f_{RCO}	RC oscillator frequency	18	MHz
V_{REG}	Internally-regulated supply output	1.8	V

4.3 ESD Rating

Table 4.3: ESD Rating

			Value	Unit
$V_{(ESD)}$	Electrostatic discharge voltage	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001[i]	±2000	V

[i] JEDEC document JEP155 states that 500 V HBM allows safe manufacturing with a standard ESD control process. Pins listed as ±2000 V may actually have higher performance.

4.4 Reset Levels

Table 4.4: Reset Levels

Parameter		Min	Max	Unit
V_{DD}	Power-up (Reset trigger) – slope > 500 V/s		1.9	V
	Power-down (Reset trigger) – slope < –500 V/s	0.8		

4.5 MCLR Pin Levels and Characteristics

Table 4.5: MCLR Pin Characteristics

Parameter		Min	Typ	Max	Unit
V_{IL}	MCLR input low level voltage	V_{SS} – 0.3		0.2 × V_{DD}	V
V_{IH}	MCLR input high level voltage	0.8 × V_{DD}		V_{DD} + 0.3	V
R_{PU}	MCLR pull-up equivalent resistor		150		kΩ
t_{Trig}	MCLR input pulse width – ensure trigger	250			ns

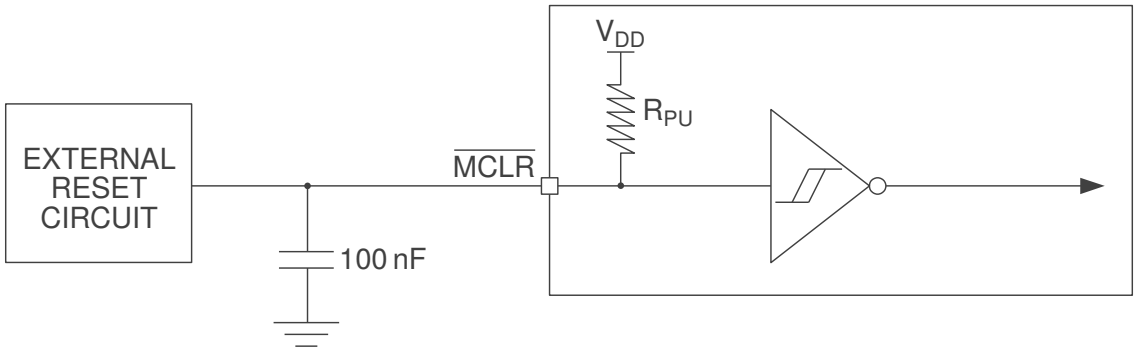


Figure 4.1: MCLR Pin Diagram

4.6 Recommended Operating Conditions

Table 4.6: Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
V_{DD}	Standard operating voltage, applied at VDD pin	2.4		3.6	V
T_A	Operating free-air temperature	–20		85	°C
C_{VDD}	Recommended capacitor at VDD		3 × C_{VREGA}		µF
$C_{VREGA[0..3]}$	Recommended external buffer capacitor at VREG (ESR ≤ 200 mΩ)		10		µF

4.7 Digital I/O Characteristics

Table 4.7: Digital I/O Characteristics

Parameter		Test Conditions[i]	Min	Max	Unit
V_{OL}	Output low voltage of GPIO pins	I_{OL} = 10 mA		0.1 × V_{DD}	V
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

[i] Standard operating conditions:
V_{DD}: 2.5 V to 3.6 V, unless otherwise stated.
Operating temperature: –20 °C to 85 °C.

4.8 SPI Characteristics

Table 4.8: I²C Characteristics

Parameter[i]		Min	Max	Unit
$f_{c(SCK)}$ $1 / t_{c(SCK)}$	SPI clock frequency[ii]		1.33 × f_{sysclk}	MHz
$t_{su(CS)}$	CS setup time	70		ns
$t_{h(CS)}$	CS hold time	70		ns
$t_{idle(CS)}$	CS idle time	3.1 × t_{sysclk}		ns
$t_{su(SI)}$	SDI input setup time	6		ns
$t_{h(SI)}$	SDI input hold time	2		ns
$t_{v(SO)}$	SDO valid output time (slow mode)		85	ns
	SDO valid output time (fast mode)		20	
$t_{h(SO)}$	SDO output hold time	0		ns
$t_{dis(SO)}$	SDO output disable time	1		ns

[i] Unless otherwise stated, the following characteristics are derived from design specifications and not tested in production. These are applicable under the following conditions:
- V_{DD}: 3.3 V
- Capacitive load: 20 pF
- Operating temperature: –20 °C to 85 °C

[ii] $t_{c(SCK)}$ is additionally limited to a maximum of 2 × ($t_{v(SO)}$ + $t_{su(MI)}$), where $t_{su(MI)}$ is the controller's data input setup time.

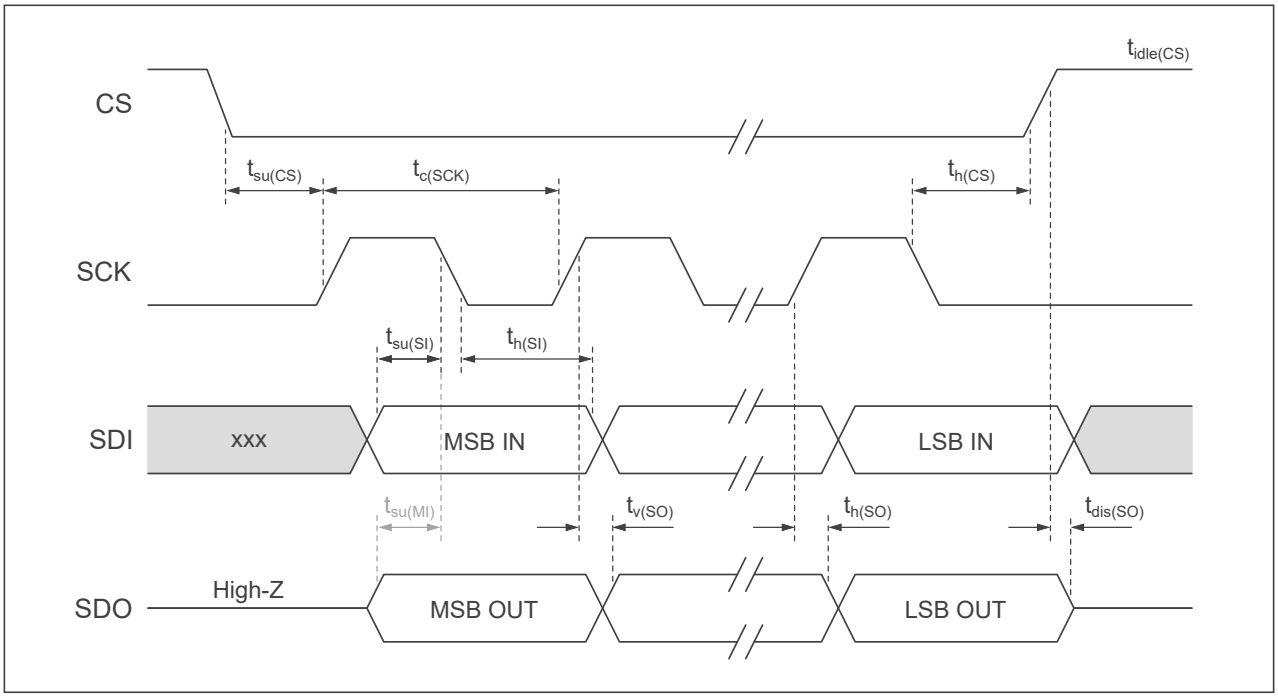


Figure 4.2: SPI Timing Diagram – CPOL = 0, CPHA = 1

4.9 Current Consumption

4.9.1 Device State

The IQS9342 supports several device power states, each of which enables a defined subset of the internal components. For the states in which an external clock source is required, a 4 MHz square wave is applied to the *External Clock Input* pin.

Device states are managed via the SPI interface by enabling or disabling individual internal components. The device starts up in the *Standby* state, in which the internal RC oscillator is enabled and selected as the system clock source, and the left analogue regulator is enabled and used to power the digital domain. The *Idle* state may be entered by enabling additional analogue regulators to power the measurement and oscillation circuits, and configuring the PLL to produce a high-frequency reference clock used for all analogue measurements. The *Active* state may then be entered by enabling the oscillation and measurement circuits to perform analogue measurements. The device may also be placed in the *Off* state, in which none of the regulators are powered and no internal clock is generated.

The device wakes from the *Off* state when the *SPI CS* or *MCLR* pin is pulled *LOW*, and the device enters the *Standby* state. The wake-up time is dominated by the stabilisation time of the left analogue regulator, which is typically less than 2 ms with a 10 µF decoupling capacitor on the VREGD pad.

Table 4.9: Current Consumption for Device States

Description	Current Consumption [µA]	System Clock Source	VREGA 0 (Left)	VREGA 1 (Bottom)	VREGA 2 (Right)	VREGA 3 (Top)	Internal RC Clock	External Clock	PLL	Oscillator	Measurement
Standby	280	RCC	X				X				
Off	<1	RCC									
Standby + 1 ×VREGA	350	RCC	X	X			X				
Standby + 2 ×VREGA	430	RCC	X	X	X		X				
Standby + 3 ×VREGA	500	RCC	X	X	X	X	X				
Standby + PLL (RCC)	1510	PLL(RCC)	X				X		X		
Standby + PLL (EXT)	1550	PLL(EXT)	X				X	X	X		
Idle	1720	PLL(EXT)	X	X	X	X	X	X	X		
Active	>5000	PLL(EXT)	X	X	X	X	X	X	X	X	X

4.9.2 Active Continuous Measurements

The current consumption for both *Dual-Pin* and *Single-Pin* continuous measurements are displayed in Table 4.10 and Figure 4.3. The current measurements results were measured on the 3.3 V supply to the VDD pin with external LC tank circuits consisting of 1.2 uH inductors placed in parallel to 27 pF capacitors to produce a resonant frequency of 28 MHz. The device is configured to produce a 96 MHz PLL output signal, sourced from a 4 MHz signal received from an external clock source. The current consumption of the device increases as the number of channels and the oscillator bias current increases, with parameters such as *Oversample Factor* and *Division* having minimal affect on the current consumption.

Table 4.10: Current Consumption for Active Continuous Measurements

Current Consumption [µA]						
		Bias Current				
		5	10	20	40	60
Number of Channels	1	5900	6010	6230	6650	7070
	3	6810	7130	7770	9040	10290
	5	7720	8260	9340	11450	13560
	7	8620	9380	10890	13860	16820
	9	9600	10570	12510	16340	20140
	11	10485	11680	14050	18730	23380
	13	11390	12800	15600	21150	26650
	15	12350	13980	17210	23600	29940
	17	13240	15090	18750	26000	33190
	19	14140	16200	20300	28410	36440
	21	15040	17300	21850	30820	39700

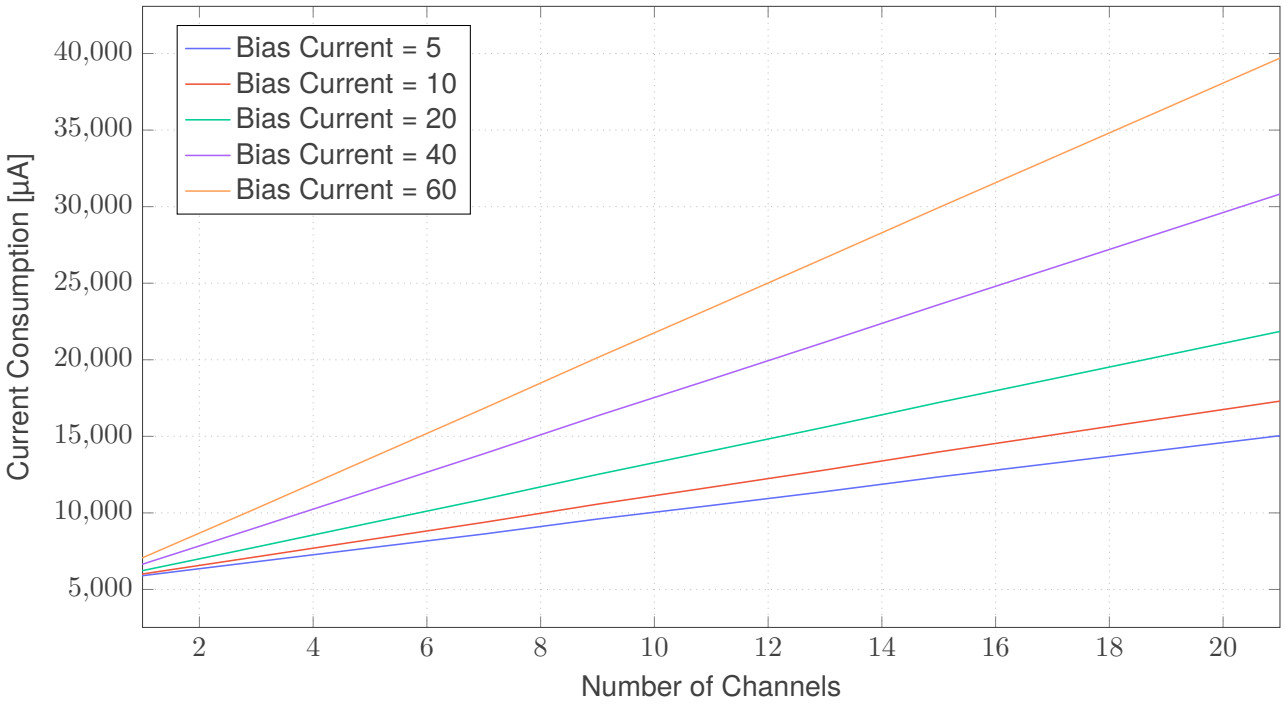


Figure 4.3: Dual-Pin Current Consumption

5 Ordering Information

5.1 Ordering Code

IQS9342 – zzz ppb

Table 5.1: Order Code Description

IC NAME				IQS9342
CONFIGURATION	zzz	=	000	Default Configuration SPI
PACKAGE TYPE	pp	=	QF	QFN-64 Package
BULK PACKAGING	b	=	R	QFN-64 Reel (3000 pcs/reel)

Example : IQS9342-000QFR

5.2 QFN64 Top Markings

Figure 5.1: IQS9342-QFN64 Package Top Marking

6 QFN64 Package Information

6.1 QFN64 Package Outline

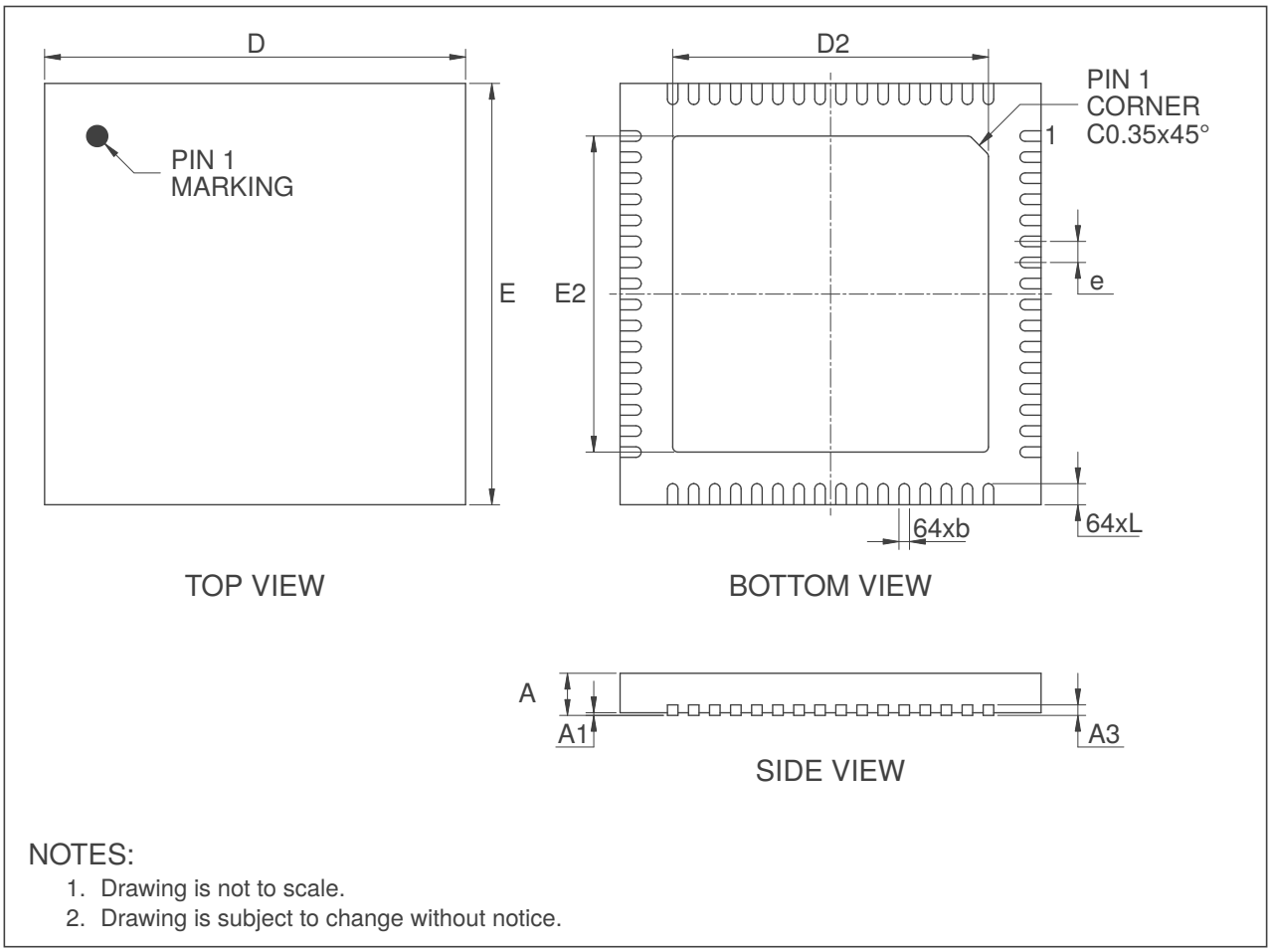
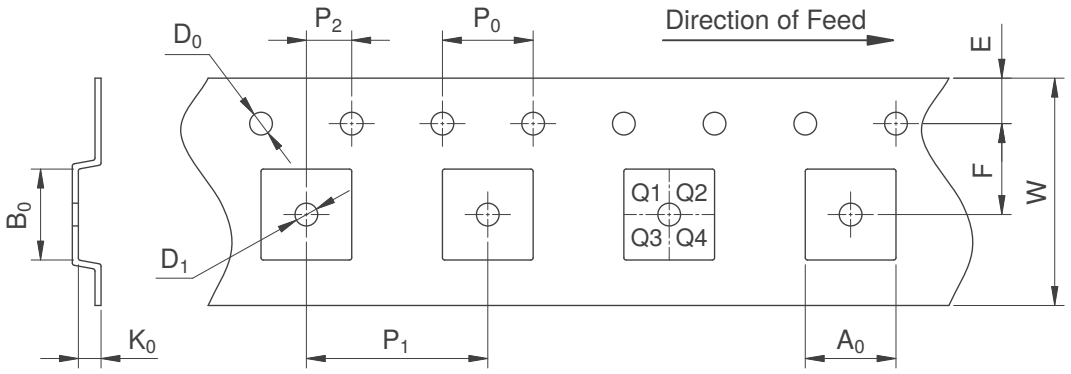


Figure 6.1: QFN64 Package Outline

Table 6.1: QFN64 Package Dimensions [mm]

Dimension	Millimeters		
	Min	Typ	Max
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.20 REF	
b	0.15	0.20	0.25
D		8.00 BSC	
E		8.00 BSC	
D1	5.90	6.00	6.10
E1	5.90	6.00	6.10
e		0.40 BSC	
L	0.30	0.40	0.50

6.2 Tape and Reel Specifications

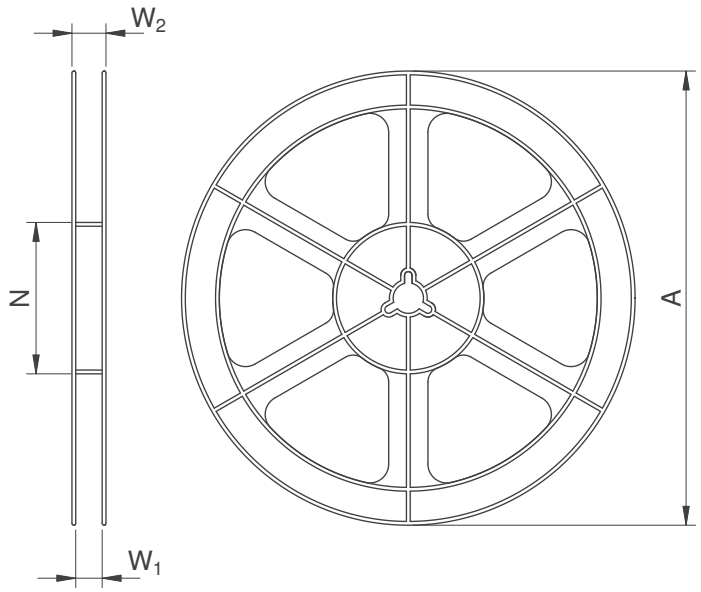


NOTES:
1. Drawing is not to scale.
2. Drawing is subject to change without notice.

Figure 6.2: Carrier Tape Specification

Table 6.2: Carrier Tape Dimensions [mm]

Dimension	Package
	QFN64
A_0	8.30
B_0	8.30
K_0	1.10
D_0	1.50
D_1	1.50
E	1.75
F	7.50
P_0	4.00
P_1	12.00
P_2	2.00
W	16.00
Pin 1 Quadrant	Q2



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

Figure 6.3: Reel Specification

Table 6.3: Reel Dimensions [mm]

Dimension	Package
	QFN64
A	330
N	100
W_1	16.4
W_2 (Max)	22.4

7 Memory Map

7.1 Memory Map

Table 7.1: SPI Memory Map

Address	Length	Description	Default	Notes
Read-Write		**Port 1 Digital Input/Output**		
0x0022	2	SPI Pin Configuration	0	Section 7.2.1
0x0024	2	PIO4 Pin Configuration	0x0004	Section 7.2.2
0x0026	2	PIO5 Pin Configuration	0	Section 7.2.3
0x0028	2	PIO6 Pin Configuration	0	Section 7.2.4
Read-Write		**Fuse Control**		
0x0040	2	Programming Control	0	Section 7.2.5
0x0042	2	Address	0	u16
0x0044	2	Read Data Out	–	u16
Read-Write		**Sequencer**		
0x0050	2	Control and Status	0	Section 7.2.6
0x0054	2	Instruction and Report Address Offsets	0	Section 7.2.7
Read-Write		**System Identification**		
0x0080	2	Device ID	0x0305	u16
0x0082	2	Device Hardware Version	0xF000	u16
Read-Write		**Hardware Configuration**		
0x0090	2	IREF Trim	0	u16
0x0092	2	VREG Trim	0	u16
0x0094	2	RC Oscillator Trim	0	u16
0x0096	2	PLL Loop Filter	0x0003	Section 7.2.8
0x0098	2	PLL Configuration	0x00B1	Section 7.2.9
0x009A	2	Device Configuration	0x0012	Section 7.2.10
0x009C	2	Power Control	0x0001	Section 7.2.11
Read-Write		**Device Status**		
0x00F0	4	Hardware Status	0x0088	Section 7.2.12
0x00F4	2	Regulator Status	–	Section 7.2.13
Read-Write		**Sensor**		
0x0200	44	Configuration 0	0	Section 7.2.14 [22]
0x0240	44	Configuration 1	0	Section 7.2.15 [22]
0x02B0	2	Global Configuration 0	0	Section 7.2.16
0x02B4	4	Oscillator Enable	0	u32
0x02B8	4	Start Measurement	0	u32
0x02BC	4	Continuous Measurement Enable	0	u32
0x02C0	44	Output	0	u16 [22]
0x02F0	2	Control and Status	0	Section 7.2.17
0x02F2	2	Timer Period	0	u16
0x02F4	4	Error Flags	0	u32
0x02F8	4	Amplitude Flags	0	u32

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Table 7.1: SPI Memory Map (Continued)

0x02FC	4	Overflow Flags	0	u32
Read-Write		**Sequencer Memory**		
0x0800	512	Report Memory	0	u16 [256]
0x0A00	512	Instruction Memory	0	u16 [256]

7.2 Register Bit Descriptions

7.2.1 SPI Pin Configuration (0x0022)

Bit	15	14	13	12	11	10	9	8
Description	Reserved							

Bit	7	6	5	4	3	2	1	0
Description	Reserved						Disable CS Filter	Disable IO Filter

- Bit 0: **Disable IO Filter**
  - 0: Spike filter enabled for SCK and SDI
  - 1: Spike filter disabled
- Bit 1: **Disable CS Filter**
  - 0: Spike filter enabled for CS
  - 1: Spike filter disabled

7.2.2 PIO4 Pin Configuration (0x0024)

Bit	15	14	13	12	11	10	9	8
Description	Reserved							

Bit	7	6	5	4	3	2	1	0
Description	Reserved			Disable Spike Filter	Enable Analog Output to Pin	Enable Input Path	Drive State Select	

- Bit 0-1: **Drive State Select**
  - 0: High-impedance input
  - 1: PLL reference clock
  - 2: Drive low
  - 3: Drive high
- Bit 2: **Enable Input Path**
  - 0: Disabled
  - 1: Enabled
- Bit 3: **Enable Analog Output to Pin**
  - 0: Disabled
  - 1: Enabled
- Bit 4: **Disable Spike Filter**
  - 0: Filter enabled
  - 1: Filter disabled

7.2.3 PIO5 Pin Configuration (0x0026)

Bit	15	14	13	12	11	10	9	8
Description	Reserved							

Bit	7	6	5	4	3	2	1	0
Description	Reserved	Disable Spike Filter	Enable Analog Output to Pin	Enable Open-Drain Operation	Drive State Select			

- Bit 0-3: **Drive State Select**
  - 0: High-impedance input
  - 1: PLL reference clock
  - 2: Drive low
  - 3: Drive high
  - 4: PLL lock indicator
  - 5: Indicator for measurement timeout, channel error or not busy
  - 6: Indicate sequencer wait-event state
  - 7: Indicate sequencer halt state
  - 8: LC oscillator ready and sequencer wait-event state
  - 9: LC oscillator not busy indicator
  - 10: PLL feedback clock
  - 11: System clock
  - 12: LC oscillator clock
  - 13: LC oscillator amplitude high indicator
- Bit 4: **Enable Open-Drain Operation**
  - 0: Disabled
  - 1: Enabled
- Bit 5: **Enable Analog Output to Pin**
  - 0: Disabled
  - 1: Enabled
- Bit 6: **Disable Spike Filter**
  - 0: Filter enabled
  - 1: Filter disabled

7.2.4 PIO6 Pin Configuration (0x0028)

Bit	15	14	13	12	11	10	9	8
Description	Reserved							

Bit	7	6	5	4	3	2	1	0
Description	Reserved	Disable Spike Filter	Enable Analog Output to Pin	Enable Open-Drain Operation	Drive State Select			

- Bit 0-3: **Drive State Select**
  - 0: High-impedance input
  - 1: PLL reference clock
  - 2: Drive low
  - 3: Drive high
  - 4: PLL lock indicator
  - 5: Indicator for measurement timeout, channel error or not busy
  - 6: Indicate sequencer wait-event state
  - 7: Indicate sequencer halt state
  - 8: LC oscillator ready and sequencer wait-event state
  - 9: LC oscillator not busy indicator

- 10: PLL feedback clock
- 11: System clock
- 12: LC oscillator clock
- 13: LC oscillator amplitude high indicator

- Bit 4: **Enable Open-Drain Operation**
  - 0: Disabled
  - 1: Enabled
- Bit 5: **Enable Analog Output to Pin**
  - 0: Disabled
  - 1: Enabled
- Bit 6: **Disable Spike Filter**
  - 0: Filter enabled
  - 1: Filter disabled

7.2.5 Programming Control (0x0040)

Bit	15	14	13	12	11	10	9	8
Description	Reserved							

Bit	7	6	5	4	3	2	1	0
Description	Reserved					Enable Fuse Reset Control	Enable Programming Pin	Enable Fuse Module

- Bit 0: **Enable Fuse Module**
  - 0: Disabled
  - 1: Enabled
- Bit 1: **Enable Programming Pin**
  - 0: Disabled
  - 1: Enabled
- Bit 2: **Enable Fuse Reset Control**
  - 0: Disabled
  - 1: Enabled
  - Hold reset control to fuse until low

7.2.6 Sequencer Control and Status (0x0050)

Bit	15	14	13	12	11	10	9	8
Description	Reserved							

Bit	7	6	5	4	3	2	1	0
Description	Reserved				Single Step Go	Single Step	State Select	Run Sequencer

- Bit 0: **Run Sequencer**
  - 0: Disabled
  - 1: Enabled
  - Set bit to start the sequencer
  - Auto-clear on invalid sequencer state
- Bit 1: **State Select**
  - 0: Default State
  - 1: Alternative State
  - Used for sequence instruction execution to select execution branch
- Bit 2: **Single Step**
  - 0: Disabled
  - 1: Enabled

- Set in hardware on invalid instruction or halt condition

› Bit 3: **Single Step Go**
- 0: Disabled
- 1: Enabled
- Start next instruction and auto-clear bit

7.2.7 Instruction and Report Address Offsets (0x0054)

Bit	15	14	13	12	11	10	9	8
Description	Report Address Pointer							

Bit	7	6	5	4	3	2	1	0
Description	Instruction Address Pointer							

› Bit 0-7: **Instruction Address Pointer**
- Range: 0 - 255
- Generally pointing to the next word

› Bit 8-15: **Report Address Pointer**
- Range: 0 - 255
- Points to SRAM destination address

7.2.8 PLL Loop Filter (0x0096)

Bit	15	14	13	12	11	10	9	8
Description	Reserved							

Bit	7	6	5	4	3	2	1	0
Description	Reserved		Disable Loop Filter	Lock Detection	Increase Loop Gain	Loop Filter Gain		

› Bit 0-3: **Loop Filter Gain**
- Range: 0 - 15

› Bit 4: **Increase Loop Gain**
- 0: Disabled
- 1: Enabled
- Set to increase PLL loop filter gain by about 60%

› Bit 5: **Lock Detection**
- 0: Disabled
- 1: Enabled
- Must be set for lock detect when LC oscillator not in use

› Bit 6: **Disable Loop Filter**
- 0: Loop filter not disabled
- 1: Loop filter disabled
- Disable loop filter which disables the phase feedback

7.2.9 PLL M and N Factors (0x0098)

Bit	15	14	13	12	11	10	9	8
Description	Reserved		Enable all Phases	PLL Enable	PLL Reference Source		N Factor	

Bit	7	6	5	4	3	2	1	0
Description	N Factor				M Factor			

› Bit 0-3: **M Factor**

- Range: 0 - 15
- PLL reference clock pre-scaler

- Bit 4-9: **N Factor**
  - Range: 3 - 63
  - VCO output divider
- Bit 10-11: **PLL Reference Source**
  - 0: Internal RC oscillator
  - 1: External clock source
  - 2: External LC oscillator
- Bit 12: **PLL Enable**
  - 0: Disabled
  - 1: Enabled
- Bit 13: **Enable all Phases**
  - 0: Disabled
  - 1: Enabled

7.2.10 Device Configuration (0x009A)

Bit	15	14	13	12	11	10	9	8
Description	Reserved			Select LCO Reference Clock				

Bit	7	6	5	4	3	2	1	0
Description	Measure Phase	Reserved	SRAM Test Select		System Clock Select		PLL Divider Selection	

- Bit 0-1: **PLL Divider Selection**
  - 0: Divide by 2
  - 1: Divide by 3
  - 2: Divide by 4
  - 3: Divide by 5
  - Divide only applies to PLL output for system clock
- Bit 2-3: **System Clock Select**
  - 0: Internal RC oscillator
  - 1: External clock
  - 2: External LC oscillator
  - 3: PLL output
- Bit 4-5: **SRAM Test Select**
  - 0: None - Do not test SRAM on warm-boot
  - 1: Zero - Zero SRAM on warm-boot
  - 2: Partial - Zero and single pass SRAM test on warm-boot
  - 3: Full - Zero and multiple pass SRAM test on warm-boot
- Bit 7: **Measure Phase**
  - 0: Disabled
  - 1: Enabled
  - Generate and measure phases from RC oscillator
- Bit 8-12: **Select LCO Reference Clock**
  - Range: 0 - 22
  - Select LCO engine for clock output to IO5 and IO6

7.2.11 Power Control (0x009C)

Bit	15	14	13	12	11	10	9	8
Description	Reserved			Enable Pad Latch	POR Request	Turn off RC Oscillator	Reserved	Clock Power Control

Bit	7	6	5	4	3	2	1	0
Description	Disable Voltage Regulator Soft-Start	Enable Regulator Status Latch	Disable Voltage Regulators Globally	Enable Trim Latch	Enable Top Voltage Regulator	Enable Right Voltage Regulator	Enable Bottom Voltage Regulator	Enable Left Voltage Regulator

- Bit 0: **Enable Left Voltage Regulator**
  - 0: Disabled
  - 1: Enabled
- Bit 1: **Enable Bottom Voltage Regulator**
  - 0: Disabled
  - 1: Enabled
- Bit 2: **Enable Right Voltage Regulator**
  - 0: Disabled
  - 1: Enabled
- Bit 3: **Enable Top Voltage Regulator**
  - 0: Disabled
  - 1: Enabled
- Bit 4: **Enable Trim Latch**
  - 0: Disabled
  - 1: Enabled
- Bit 5: **Disable Voltage Regulators Globally**
  - 0: Voltage regulators may be enabled individually
  - 1: Voltage regulators disabled
- Bit 6: **Set Regulator Status Latch**
  - 0: No event
  - 1: Set latch in *Regulator Status* register
  - Auto-cleared after latch is set
- Bit 7: **Disable Voltage Regulator Soft-Start**
  - 0: Voltage regulator soft-start enabled
  - 1: Voltage regulator soft-start disabled
- Bit 8: **Clock Power Control**
  - 0: Do not send clock signal to power control logic circuit
  - 1: Send clock signal to power control logic circuit
  - Will automatically clear after state has been updated
- Bit 10: **Disable RC Oscillator**
  - 0: RC Oscillator enabled
  - 1: RC Oscillator disabled
- Bit 11: **Power-on-Reset Request**
  - 0: Do not reset
  - 1: Reset request
- Bit 12: **Enable Pad Latch**
  - 0: Disabled
  - 1: Enabled

7.2.12 Hardware Status (0x00F0)

Bit	15	14	13	12	11	10	9	8
Description	Reserved						LC Oscillator Clock Detect	SRAM Busy

Bit	7	6	5	4	3	2	1	0
Description	Cold Boot Indicator	Reserved	System Clock Source		RC Oscillator Enabled	PLL Locked	PLL Enabled	SRAM Failure

- Bit 0: **SRAM Failure**
  - 0: SRAM test success
  - 1: SRAM test failure
- Bit 1: **PLL Enabled**
  - 0: Disabled
  - 1: Enabled
- Bit 2: **PLL Locked**
  - 0: Not Locked - Not Stable/Enabled
  - 1: Locked - Stable
- Bit 3: **RC Oscillator Enabled**
  - 0: Disabled
  - 1: Enabled
- Bit 4-5: **System Clock Source**
  - 0: Internal RC oscillator
  - 1: External clock
  - 2: External LC oscillator
  - 3: PLL output
- Bit 7: **Cold Boot Indicator**
  - 0: Warm boot
  - 1: Cold boot
  - Cleared when *Clock Power Control* bit is set in *Power Control* register.
- Bit 8: **SRAM Busy**
  - 0: SRAM test active
  - 1: SRAM test inactive
- Bit 9: **LC Oscillator Clock Detect**
  - 0: No LC oscillator clock source detected
  - 1: LC oscillator clock source detected

7.2.13 Regulator Status (0x00F4)

Bit	15	14	13	12	11	10	9	8
Description	Top too High	Top too Low	Top OK Latch	Top OK	Right too High	Right too Low	Right OK Latch	Right OK

Bit	7	6	5	4	3	2	1	0
Description	Bottom too High	Bottom too Low	Bottom OK Latch	Bottom OK	Left too High	Left too Low	Left OK Latch	Left OK

- Bit 0,4,8,12: **OK**
  - 0: Regulator outside band
  - 1: Regulator within band
- Bit 1,5,9,13: **OK Latch**
  - Retain state of OK bit when *Set Regulator Status Latch* bit is set in *Power Control* register.
  - Cleared when OK bit is cleared
  - Indicate when regulator exits band
- Bit 2,6,10,14: **Too Low**
  - 0: Regulator voltage not too low
  - 1: Regulator voltage too low
- Bit 3,7,11,15: **Too High**
  - 0: Regulator voltage not too high
  - 1: Regulator voltage too high

7.2.14 Sensor Configuration 0 (0x0200)

Bit	15	14	13	12	11	10	9	8
Description	Reserved		Disable Startup Delay	Enable Common Mode Voltage	Trimming Capacitor			

Bit	7	6	5	4	3	2	1	0
Description	Pad Control		Bias Current					

- Bit 0-5: **Bias Current**
  - Range: 0 - 63
- Bit 6-7: **Pad Control**
  - 0: Dual-pin
  - 1: Single-pin positive
  - 2: Single-pin negative
  - 3: Alternate
- Bit 8-11: **Trimming Capacitor**
  - Range: 0 - 15
- Bit 12: **Enable Common Mode Voltage**
  - 0: Disabled
  - 1: Enabled
- Bit 13: **Disable Startup Delay**
  - 0: Startup delay enabled
  - 1: Startup delay disabled

7.2.15 Sensor Configuration 1 (0x0240)

Bit	15	14	13	12	11	10	9	8
Description	Enable Additional Right Shift	Reserved	Oversample Factor		Divider			

Bit	7	6	5	4	3	2	1	0
Description	Divider							

- Bit 0-11: **Divider**
  - Range: 1 - 4095
  - LCO clock divider
- Bit 12-13: **Oversample Factor**
  - 0: 1x
  - 1: 4x
  - 2: 32x
  - 3: 64x
- Bit 15: **Enable Additional Right Shift**
  - 0: Shift right by N
  - 1: Shift right by $N+1$

7.2.16 Sensor Global Configuration 0 (0x02B0)

Bit	15	14	13	12	11	10	9	8
Description	Map Timer to Count Address	Enable Stretch Start	Number of Phases		Test Timeout	Startup Delay		

Bit	7	6	5	4	3	2	1	0
Description	Reserved			Enable Amplitude Detection	Amplitude Level			

- Bit 0-3: **Amplitude Level**
  - Range: 0 - 15
  - Threshold selection for amplitude detection circuit
- Bit 4: **Enable Amplitude Detection**
  - 0: Disabled
  - 1: Enabled
- Bit 8-10: **Startup Delay**
  - 0: 16
  - 1: 32
  - 2: 64
  - 3: 96
  - 4: 128
  - 5: 192
  - 6: 256
  - 7: 512
  - Number of system clock pulses before measurement start
  - Timeout starts after writing to *Start Measurement* register
- Bit 11: **Test Timeout**
  - 0: Disabled
  - 1: Enabled
  - Start timer independent of *Start Measurement* register
- Bit 12-13: **Number of Phases**
  - 0: 2 Phases
  - 1: 4 Phases
  - 2: 8 Phases
- Bit 14: **Enable Stretch Start**
  - 0: Disabled
  - 1: Enabled
  - Enables a longer start pulse to LC oscillator
- Bit 15: **Map Timer to Count Address**
  - 0: Disabled
  - 1: Enabled

7.2.17 Sensor Control and Status (0x02F0)

Bit	15	14	13	12	11	10	9	8
Description	Report Buffer							

Bit	7	6	5	4	3	2	1	0
Description	Hard Reset	Global Enable	Sequencer Halt State	Sequencer Wait State	Error	Timeout	Overflow	Busy

- Bit 0: **Busy**
  - 0: No bits set in *Start Measurement* register. No active sample
  - 1: Sensor is busy. Bits are set in *Start Measurement* register without being set in *Enable Continuous Measurement* register.
- Bit 1: **Overflow**
  - 0: Latest measurement output within 16-bit range
  - 1: Latest measurement output exceeds 16-bit range
  - Only the least-significant word is available in the *Sensor Output* register
- Bit 2: **Timeout**
  - 0: Latest measurement did not trigger a timeout event
  - 1: Latest measurement did trigger a timeout event
- Bit 3: **Error**
  - 0: Latest measurement did not trigger an error event
  - 1: Latest measurement did trigger an error event
- Bit 4: **Sequencer Wait State**
  - 0: Sequencer inactive, or executing other operation
  - 1: Sequencer awaiting event
- Bit 5: **Sequencer Halt State**
  - 0: Sequencer inactive, or executing other operation
  - 1: Sequencer operation has halted
- Bit 6: **Global Sensor Enable**
  - 0: All sensors are disabled
  - 1: Sensors may be configured for measurement
- Bit 7: **Reset**
  - 0: Do not modify engine configuration
  - 1: Clear engine configuration
  - Does not auto-clear after engines have been reset
- Bit 8-15: **Report Address Pointer**
  - Range: 0 - 255
  - Same value as in *Instruction and Report Address Offsets* register

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