ISD ARM® Cortex®-M0 SoC

ISD9100 Series

DataSheet

For additional information or questions, please contact: Nuvoton Technology Corporation.

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1 GENERAL DESCRIPTION

The ISD9100 series is a system-on-chip product optimized for low power, audio record and playback with an embedded ARM® Cortex®-M0 32-bit microcontroller core.

The ISD9100 series embeds a Cortex®-M0 core running up to 50 MHz with 145K-byte of non-volatile flash memory and 12K-byte of embedded SRAM. It also comes equipped with a variety of peripheral devices, such as Timers, Watchdog Timer (WDT), Real-time Clock (RTC), Peripheral Direct Memory Access (PDMA), a variety of serial interfaces (UART, SPI/SSP, I^2C, I^2S), PWM modulators, GPIO, Analog Comparator, Low Voltage Detector and Brown-out detector.

The ISD9100 comes equipped with a rich set of power saving modes including a Deep Power Down (DPD) mode drawing less than 1μA. A micro-power 16KHz oscillator can periodically wake up the device from deep power down to check for other events. A Standby Power Down (SPD) mode can maintain a real time clock function at less than 10 μA.

For audio functionality the ISD9100 includes a Sigma-Delta ADC with 92dB SNR performance coupled with a Programmable Gain Amplifier (PGA) capable of a maximum gain of 61dB to enable direct connection of a microphone. Audio output is provided by a Differential Class D amplifier (DPWM) that can deliver 1W of power to an 8Ω speaker.

The ISD9100 provides eight analog enabled general purpose IO pins (GPIO). These pins can be configured to connect to an analog comparator, can be configured as analog current sources or can be routed to the SDADC for analog conversion. They can also be used as a relaxation oscillator to perform capacitive touch sensing.

2 FEATURES

- Core
  - ARM® Cortex®-M0 core runs up to 49MHz.
  - One 24-bit System tick timer for operating system support.
  - Supports a variety of low power sleep and power down modes.
  - Single-cycle 32-bit hardware multiplier.
  - NVIC (Nested Vector Interrupt Controller) for 32 interrupt inputs, each with 4-levels of priority.
  - Serial Wire Debug (SWD) support with 2 watchpoints/4 breakpoints.
- Power Management
  - Wide operating voltage range from 2.4V to 5.5V.
  - Power management Unit (PMU) providing four levels of power control.
  - Deep Power Down (DPD) mode with sub micro-amp leakage (<1μA).
  - Wakeup from Deep Power Down via dedicated WAKEUP pin or timed operation from internal low power 16kHz oscillator.
  - Standby mode with limited RAM retention and RTC operation (<10μA).
  - Wakeup from Standby can be from any GPIO interrupt, RTC or BOD.
  - Sleep mode with minimal dynamic power consumption.
  - 3V LDO for operation of external 3V devices such as serial flash.
- Flash EPROM Memory
  - 68/100/145K bytes Flash EPROM for program code and data storage.
  - 4KB of flash can be configured as boot sector for ISP loader.
  - Support In-system program (ISP) and In-circuit program (ICP) application code update
  - 1K byte page erase for flash
  - Configurable boundary to delineate code and data flash.
  - Support 2 wire In-circuit Programming (ICP) update from SWD ICE interface
- SRAM Memory
  - 12K bytes embedded SRAM.
- Clock Control
  - One high speed and two low speed oscillators providing flexible selection for different applications. No external components necessary.
  - Built-in trimmable oscillator with range of 16-49MHz. Factory trimmed within 1% to settings of 49.152MHz and 32.768MHz. User trimmable with in-built frequency measurement block (OSCFM) using reference clock of 32kHz crystal or external reference source.
  - Ultra-low power (<1uA) 16kHz oscillator for watchdog and wakeup from power-down or sleep operation.
  - External 32kHz crystal input for RTC function and low power system operation.
- GPIO
  - Four I/O modes:
    - Quasi bi-direction
    - Push-Pull output
    - Open-Drain output
    - Input only with high impendence
  - TTL/Schmitt trigger input selectable.
  - I/O pin can be configured as interrupt source with edge/level setting.
  - Switchable pull-up.
- Audio Analog to Digital converter
  - Sigma Delta ADC with configurable decimation filter and 16 bit output.
  - 92dB Signal-to-Noise (SNR) performance.
  - Programmable gain amplifier with 32 steps from -12 to 35.25dB in 0.75dB steps.
  - Boost gain stage of 26dB, giving maximum total gain of 61dB.

  - Input selectable from dedicated MIC pins or analog enabled GPIO.
  - Programmable biquad filter to support multiple sample rates from 8-32kHz.
  - DMA support for minimal CPU intervention.

- Differential Audio PWM Output (DPWM)
  - Direct connection of speaker
  - 1W drive capability into 8Ω load.
  - High efficiency 88%
  - Configurable up-sampling to support sample rates from 8-32kHz.
  - DMA support for minimal CPU intervention.

- Timers
  - Two timers with 8-bit pre-scaler and 24-bit resolution.
  - Counter auto re-load.

- Watch Dog Timer
  - Default ON/OFF by configuration setting
  - Multiple clock sources
  - 8 selectable time out period from micro seconds to seconds (depending on clock source)
  - WDT can wake up power down/sleep.
  - Interrupt or reset selectable on watchdog time-out.

- RTC
  - Real Time Clock counter (second, minute, hour) and calendar counter (day, month, year)
  - Alarm registers (second, minute, hour, day, month, year)
  - Selectable 12-hour or 24-hour mode
  - Automatic leap year recognition
  - Time tick and alarm interrupts.
  - Device wake up function.
  - Supports software compensation of crystal frequency by compensation register (FCR)

- PWM/Capture
  - Built-in up to two 16-bit PWM generators provide two PWM outputs or one complementary paired PWM outputs.
  - The PWM generator equipped with a clock source selector, a clock divider, an 8-bit pre-scaler and Dead-Zone generator for complementary paired PWM.
  - PWM interrupt synchronous to PWM period.
  - 16-bit digital Capture timers (shared with PWM timers) provide rising/falling capture inputs.
  - Support Capture interrupt

- UART
  - UART ports with flow control (TX, RX, CTS and RTS)
  - 8-byte FIFO.
  - Support IrDA (SIR) and LIN function
  - Programmable baud-rate generator up to 1/16 of system clock.

- SPI
  - Master up to 20 Mbps / Slave up to 10 Mbps.
  - Support MICROWIRE/SPI master/slave mode (SSP)
  - Full duplex synchronous serial data transfer
  - Variable length of transfer data from 1 to 32 bits
  - MSB or LSB first data transfer
  - 2 slave/device select lines when used in master mode.
  - Hardware CRC calculation module available for CRC calculation of data stream.
  - DMA support for burst transfers.

- I2C

  - Master/Slave up to 1Mbit/s
  - Bidirectional data transfer between masters and slaves
  - Multi-master bus (no central master).
  - Arbitration between simultaneously transmitting masters without corruption of serial data on the bus
  - Serial clock synchronization allows devices with different bit rates to communicate via one serial bus.
  - Serial clock synchronization can be used as a handshake mechanism to suspend and resume serial transfer.
  - Programmable clock allowing versatile rate control.
  - I2C-bus controller supports multiple address recognition.

- I^2S
  - Interface with external audio CODEC.
  - Operate as either master or slave.
  - Capable of handling 8, 16, 24 and 32 bit word sizes
  - Mono and stereo audio data supported
  - I^2S and MSB justified data format supported
  - Two 8 word FIFO data buffers are provided, one for transmit and one for receive
  - Generates interrupt requests when buffer levels cross a programmable boundary
  - Supports DMA requests, for transmit and receive

- Brown-out detector
  - With 8 levels: 2.1V, 2.2V, 2.4V, 2.5V, 2.625V, 2.8V, 3.0V, and 4.6V
  - Supports time-multiplex operation to minimize power consumption.
  - Supports Brownout Interrupt and Reset option

- Built in Low Dropout Voltage Regulator (LDO)
  - Capable of delivering 30mA load current.
  - Configurable for output voltage of 1.8V, 2.4V, 3.0V and 3.3V
  - Eight GPIO (GPIOA<7:0>) operate from LDO voltage domain allowing direct interface to, for example, 3V SPI Flash.
  - Can be bypassed and voltage domain supplied directly from system power.

- Additional Features
  - Over temperature alarm. Can generate interrupt if device exceeds safe operating temperature.
  - Temperature proportional voltage source which can be routed to ADC for temperature measurements.
  - Digital Microphone interface.

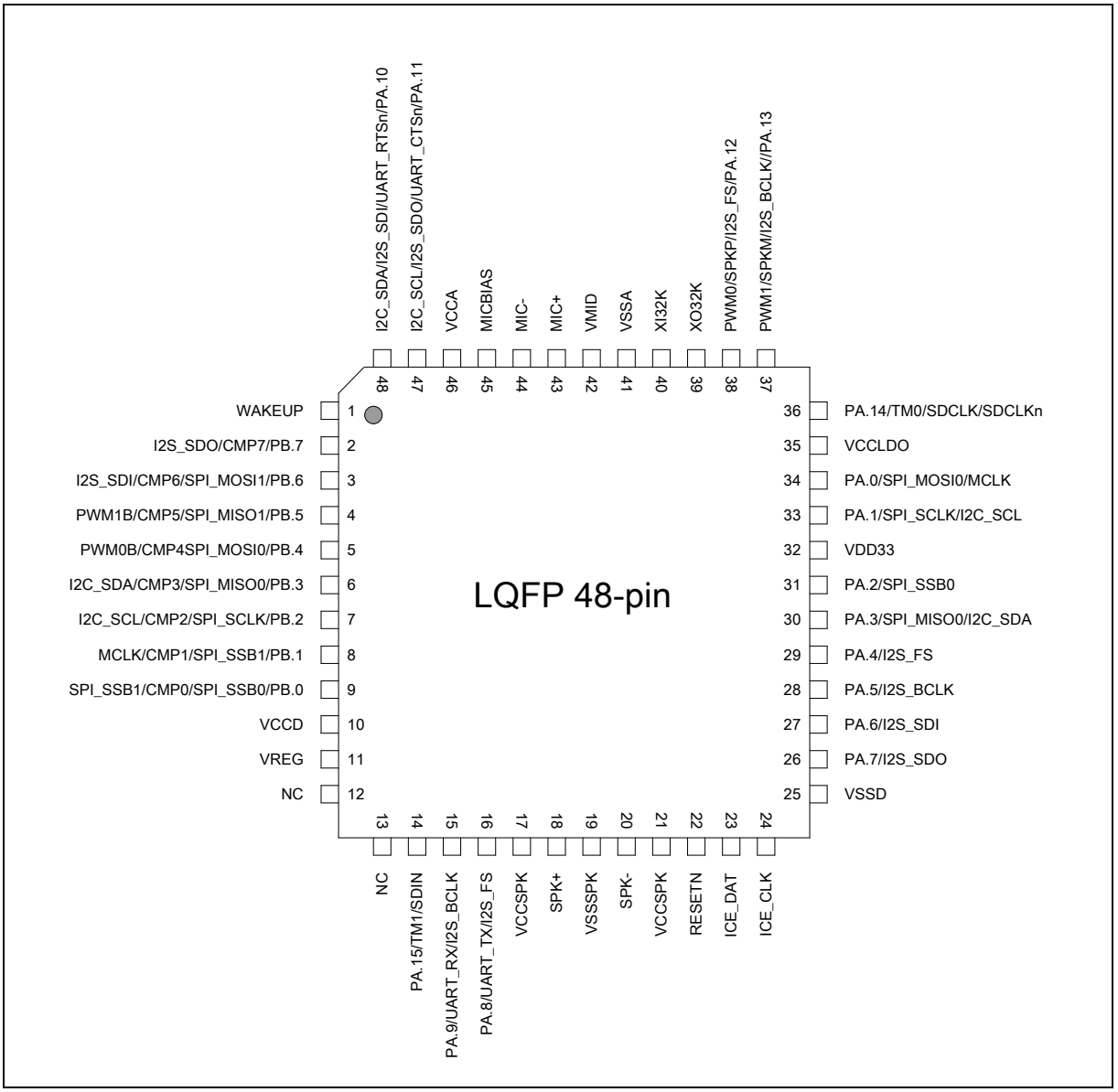
- Operating Temperature: -40C~85C

- Package:
  - LQFP 48-pin
  - QFN 33-pin
  - Package is Halogen-free, RoHS-compliant and TSCA-compliant

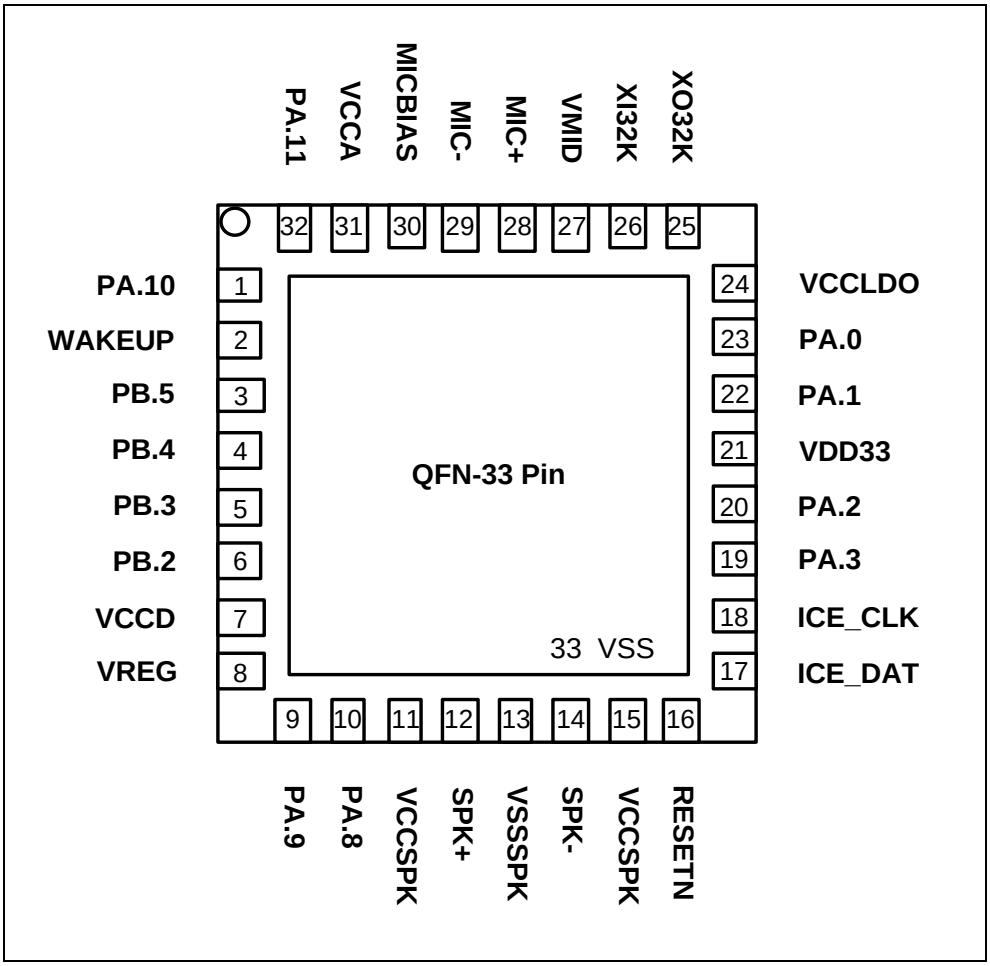
3 PART INFORMATION AND PIN CONFIGURATION

3.1 Pin Configuration

3.1.1 ISD9100 LQFP 48 pin



3.1.2 ISD9100 QFN 33 pin



3.1.3 Pin Description

The ISD9100 is a low pin count device where many pins are configurable to alternative functions. All General Purpose Input/Output (GPIO) pins can be configured to alternate functions as described in the table below.

Pin No.		Pin Name	Pin Type	Alt CFG	Description
LQFP 48	QFN 33				
1	2	WAKEUP	**I**		Pull low to wake part from deep power down
2	-	PB.7	**A/I/O**	0	General purpose input/output pin, analog capable; Port B, bit 7
		I2S_SDO	**O**	1	Serial Data Output for I2S interface
		CMP7	**AIO**	2	Configure as relaxation oscillator for capacitive touch sensing
3	-	PB.6	**A/I/O**	0	General purpose input/output pin, analog capable; Port B, bit 6
		I2S_SDI	**I**	1	Serial Data Input for I2S interface
		CMP6	**AIO**	2	Configure as relaxation oscillator for capacitive touch sensing
		SPI_MOSI1	**O**	3	Master Out, Slave In channel 1 for SPI interface
4	3	PB.5	**A/I/O**	0	General purpose input/output pin, analog capable; Port B, bit 5
		PWM1B	**O**	1	PWM channel 1 complementary output pin
		CMP5	**AIO**	2	Configure as relaxation oscillator for capacitive touch sensing
		SPI_MISO1	**I**	3	Master In, Slave Out channel 1 for SPI interface
5	4	PB.4	**A/I/O**	0	General purpose input/output pin, analog capable; Port B, bit 4
		PWM0B	**O**	1	PWM channel 0 complementary output pin
		CMP4	**AIO**	2	Configure as relaxation oscillator for capacitive touch sensing
		SPI_MOSI0	**O**	3	Master Out, Slave In channel 0 for SPI interface
6	5	PB.3	**A/I/O**	0	General purpose input/output pin, analog capable; Port B, bit 3
		I2C_SDA	**I/O**	1	Serial Data, I2C interface
		CMP3	**AIO**	2	Configure as relaxation oscillator for capacitive touch sensing
		SPI_MISO0	**I**	3	Master In, Slave Out channel 0 for SPI interface
7	6	PB.2	**A/I/O**	0	General purpose input/output pin, analog capable; Port B, bit 2
		I2C_SCL	**I/O**	1	Serial Clock, I2C interface
		CMP2	**AIO**	2	Configure as relaxation oscillator for capacitive touch sensing
		SPI_SCLK	**I/O**	3	Serial Clock for SPI interface
8	-	PB.1	**A/I/O**	0	General purpose input/output pin, analog capable; Port B, bit 1. Triggers external interrupt 1 (EINT1/IRQ3)
		MCLK	**O**	1	Master clock output for synchronizing external device
		CMP1	**AIO**	2	Configure as relaxation oscillator for capacitive touch sensing

Pin No.		Pin Name	Pin Type	Alt CFG	Description
LQFP 48	QFN 33				
		SPI_SSB1	**O**	3	Slave Select Bar 1 for SPI interface
9	-	PB.0	**A/I/O**	0	General purpose input/output pin, analog capable; Port B, bit 0. Triggers external interrupt 0 (EINT0/IRQ2)
		SPI_SSB1	**O**	3	Slave Select Bar 1 for SPI interface
		CMP0	**AIO**	2	Configure as relaxation oscillator for capacitive touch sensing
		SPI_SSB0	**I/O**	3	Slave Select Bar 0 for SPI interface
10	7	VCCD	**P**		Main Digital Supply for Chip. Supplies all IO except analog, Speaker Driver and PA<7:0>
11	8	VREG	**P**		Logic regulator output decoupling pin. A 1µF capacitor returning to VSSD must be placed on this pin.
12	-	NC			Should remain unconnected.
13	-	NC			Should remain unconnected.
14	-	PA.15	**I/O**	0	General purpose input/output pin; Port A, bit 15
		TM1	**I**	1	External input to Timer 1
		SDIN	**I**	2	Sigma Delta bit stream input for digital MIC mode
15	9	PA.9	**I/O**	0	General purpose input/output pin; Port A, bit 9
		UART_RX	**I**	1	Receive channel of UART
		I2S_BCLK	**I/O**	2	Bit Clock for I2S interface
16	10	PA.8	**I/O**	0	General purpose input/output pin; Port A, bit 8
		UART_TX	**O**	1	Transmit channel of UART
		I2S_FS	**I/O**	2	Frame Sync Clock for I2S interface
17	11	VCCSPK	**P**		Power Supply for PWM Speaker Driver
18	12	SPK+	**O**		Positive Speaker Driver Output
19	13	VSSSPK	**P**		Ground for PWM Speaker Driver
20	14	SPK-	**O**		Negative Speaker Driver Output
21	15	VCCSPK	**P**		Power Supply for PWM Speaker Driver
22	16	RESETN	**I**		External reset input. Pull this pin low to reset device to initial state. Has internal weak pull-up.
23	17	ICE_DAT	**I/O**		Serial Wire Debug port data pin. Has internal weak pull-up.
24	18	ICE_CLK	**I**		Serial Wire Debug port clock pin. Has internal weak pull-up.
25	-	VSSD	**P**		Digital Ground.
26	-	PA.7	**I/O**	0	General purpose input/output pin; Port A, bit 7

Pin No.		Pin Name	Pin Type	Alt CFG	Description
LQFP 48	QFN 33				
		I2S_SDO	**O**	1	Serial Data Out for I2S interface
27	-	PA.6	**I/O**	0	General purpose input/output pin; Port A, bit 6
		I2S_SDI	**I**	1	Serial Data In for I2S interface
28	-	PA.5	**I/O**	0	General purpose input/output pin; Port A, bit 5
		I2S_BCLK	**I/O**	1	Bit Clock for I2S interface
29	-	PA.4	**I/O**	0	General purpose input/output pin; Port A, bit 4
		I2S_FS	**I/O**	1	Frame Sync Clock for I2S interface
30	19	PA.3	**I/O**	0	General purpose input/output pin; Port A, bit 3
		SPI_MISO0	**I**	1	Master In, Slave Out channel 0 for SPI interface
		I2C_SDA	**I/O**	2	Serial Data, I2C interface
31	20	PA.2	**I/O**	0	General purpose input/output pin; Port A, bit 2
		SPI_SSB0	**I/O**	1	Slave Select Bar 0 for SPI interface
32	21	VDD33	**P**		LDO Regulator Output. If used, a 1µF capacitor must be placed to ground. If not used then tie to VCCD.
33	22	PA.1	**I/O**	0	General purpose input/output pin; Port A, bit 1
		SPI_SCLK	**I/O**	1	Serial Clock for SPI interface
		I2C_SCL	**I/O**	2	Serial Clock, I2C interface
34	23	PA.0	**I/O**	0	General purpose input/output pin; Port A, bit 2
		SPI_MOSI0	**O**	1	Master Out, Slave In channel 0 for SPI interface
		MCLK	**O**	2	Master clock output.
35	24	VCCLDO	**P**		Power Supply for LDO, should be connected to VCCD
36	-	PA.14	**I/O**	0	General purpose input/output pin; Port A, bit 14
		SDCLK	**O**	1	Clock output for digital microphone mode.
		SDCLKn	**O**	2	Inverse Clock output for digital microphone mode.
37	-	PA.13	**I/O**	0	General purpose input/output pin; Port A, bit 13
		PWM1	**O**	1	PWM1 Output.
		SPKM	**O**	2	Equivalent to SPK-.
		I2S_BCLK	**I/O**	3	Bit Clock for I2S interface
38	-	PA.12	**I/O**	0	General purpose input/output pin; Port A, bit 12
		PWM0	**O**	1	PWM0 Output.

Pin No.		Pin Name	Pin Type	Alt CFG	Description
LQFP 48	QFN 33				
		SPKP	**O**	2	Equivalent to SPK+
		I2S_FS	**I/O**	3	Frame Sync Clock for I2S interface
39	25	XO32K	**O**		32.768kHz Crystal Oscillator Output
40	26	XI32K	**I**		32.768kHz Crystal Oscillator Input. Max Voltage 1.8V
41		VSSA	**AP**		Ground for analog circuitry.
42	27	VMID	**O**		Mid rail reference. Connect 4.7µF to VSSA.
43	28	MIC+	**AI**		Positive microphone input.
44	29	MIC-	**AI**		Negative microphone input.
45	30	MICBIAS	**AO**		Microphone bias output.
46	31	VCCA	**AP**		Analog power supply.
47	32	PA.11	**I/O**	0	General purpose input/output pin; Port A, bit 11
		I2C_SCL	**I/O**	1	Serial Clock, I2C interface
		I2S_SDO	**O**	2	Serial Data Out I2S interface
		UART_CTSn	**I**	3	UART Clear to Send Input.
48	-	PA.10	**I/O**	0	General purpose input/output pin; Port A, bit 10
		I2C_SDA	**I/O**	1	Serial Data, I2C interface
		I2S_SDI	**I**	2	Serial Data In I2S interface
		UART_RTSn	**O**	3	UART Request to Send Output.
-	33	VSS	**P**		Ground for both digital and analog. Center pad underneath.

Note:

- Pin Type I=Digital Input, O=Digital Output; AI=Analog Input; P=Power Pin; AP=Analog Power

4 BLOCK DIAGRAM

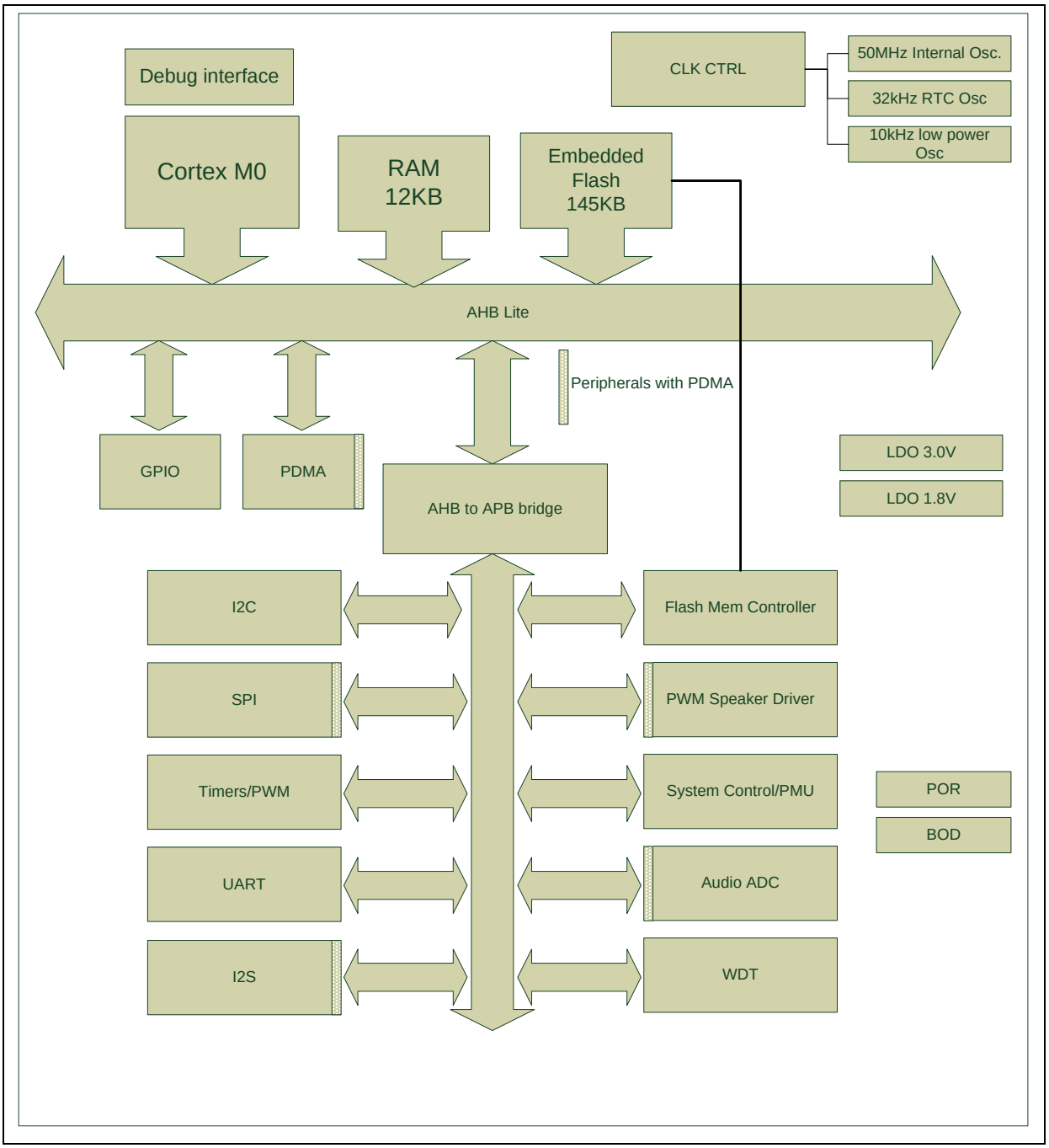
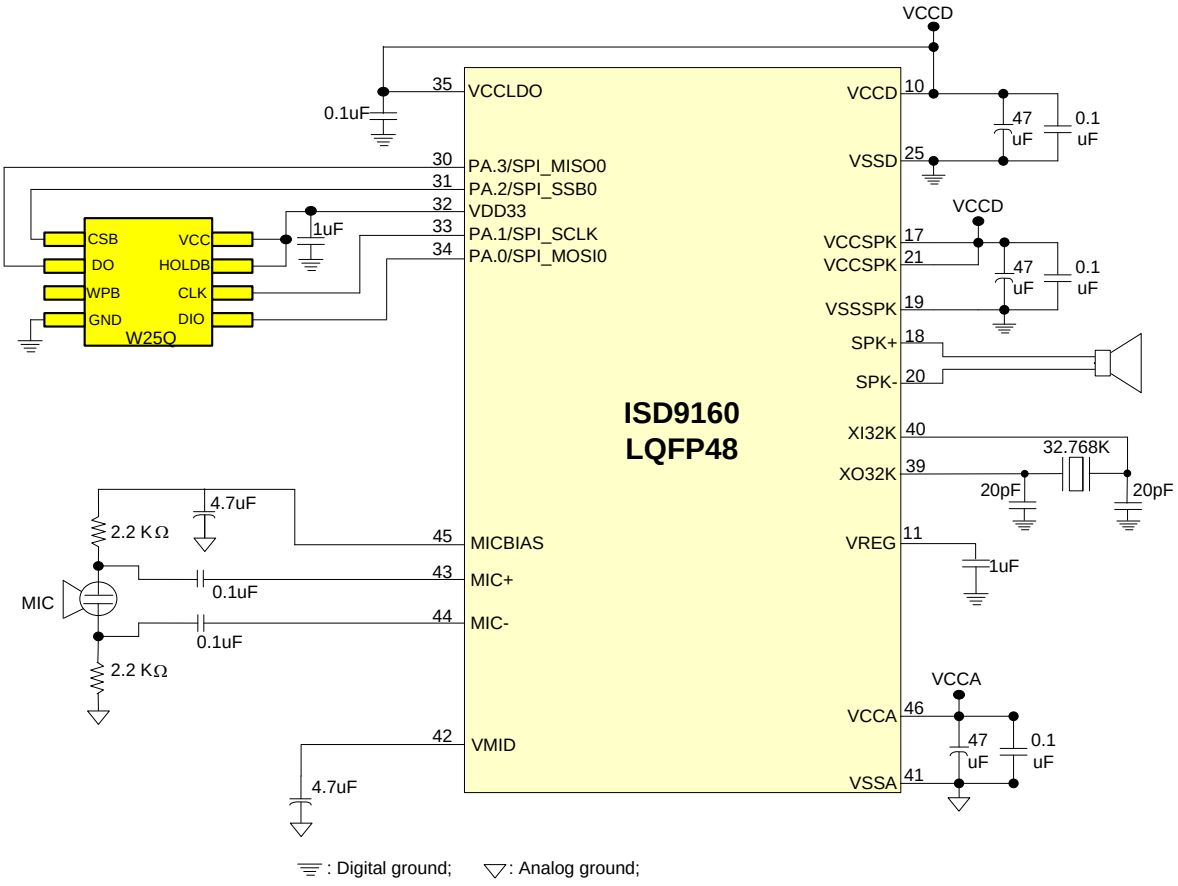


Figure 4-1 ISD9100 Block Diagram

5 APPLICATION DIAGRAM



6 ELECTRICAL CHARACTERISTICS

6.1 Absolute Maximum Ratings

SYMBOL	PARAMETER	MIN	MAX	UNIT
DC Power Supply	VDD–VSS	-0.3	+6.0	V
Input Voltage	VIN	VSS-0.3	VDD+0.3	V
Oscillator Frequency	$1/t_{CLCL}$	0	40	MHz
Operating Temperature	TA	-40	+85	°C
Storage Temperature	TST	-55	+150	°C
Maximum Current into V_{DD}		-	120	mA
Maximum Current out of V_{SS}			120	mA
Maximum Current sunk by a I/O pin			35	mA
Maximum Current sourced by a I/O pin			35	mA
Maximum Current sunk by total I/O pins			100	mA
Maximum Current sourced by total I/O pins			100	mA

Note: Exposure to conditions beyond those listed under absolute maximum ratings may adversely affects the lift and reliability of the device.

6.2 DC Electrical Characteristics

(VDD-VSS=3.3V, TA = 25°C, F_{OSC} = 49.152 MHz unless otherwise specified.)

PARAMETER	SYM.	SPECIFICATION				TEST CONDITIONS
		MIN.	TYP.	MAX.	UNIT	
Operation voltage	V_{DD}	2.4		5.5	V	V_{DD} =2.4V ~ 5.5V up to 49 MHz
Power Ground	V_{SS} AV_{SS}	-0.3			V	
Analog Operating Voltage	AV_{DD}	0		V_{DD}	V	
Analog Reference Voltage	Vref	0		AV_{DD}	V	
Operating Current Normal Run Mode @ 49.152 MHz	I_{DD1}		24.8		mA	V_{DD}= 5.5V, Enable all IP.
	I_{DD2}		19.7		mA	V_{DD}=5.5V, disable all IP
	I_{DD3}		23.6		mA	V_{DD} = 3V, enable all IP
	I_{DD4}		18.3		mA	V_{DD} = 3V, disable all IP
Operating Current Normal Run Mode @ 32.768Mhz	I_{DD5}		18.8		mA	V_{DD} = 5.5V, Enable all IP.
	I_{DD6}		15.0		mA	V_{DD} = 5.5V, Disable all IP.
	I_{DD7}		17.6		mA	V_{DD} = 3V, Enable all IP.
	I_{DD8}		13.8		mA	V_{DD} = 3V, Disable all IP.

Operating Current Normal Run Mode @ 12.288MHz	I_{DD9}		12.5		mA	V_{DD} = 5.5V enable all IP
	I_{DD10}		10.3		mA	V_{DD} = 5.5V, disable all IP
	I_{DD11}		11.4		mA	V_{DD} = 3V enable all IP
	I_{DD12}		9		mA	V_{DD} = 3V, disable all
Operating Current Normal Run Mode @ 4.9152Mhz	I_{DD13}		9.7		mA	V_{DD} = 5.5V, Enable all IP.
	I_{DD14}		8.1		mA	V_{DD} = 5.5V, Disable all IP.
	I_{DD15}		8.7		mA	V_{DD} = 3V, Enable all IP.
	I_{DD16}		7.0		mA	V_{DD} = 3V, Disable all IP.
Operating Current Sleep Mode	I_{IDLE1}		10		mA	V_{DD}= 5.5V
	I_{IDLE1}		9		mA	V_{DD}= 3.3V
Operating Current Deep Sleep Mode	I_{IDLE1}		10		mA	V_{DD}=5.5V
	I_{IDLE1}		8		mA	V_{DD}= 3.3V
Standby Power down mode(SPD)	I_{IDLE1}		3		uA	V_{DD}=3.3V 32K running with RTC
	I_{IDLE1}		1		uA	V_{DD}= 3.3V 16K running
Operating Current Deep Power down mode(DPD)	I_{IDLE1}		500		nA	V_{DD}=3.3V Wakeup with16K
	I_{IDLE1}				nA	V_{DD}= 3.3V wakeup with wakeup pin

Input Current PA, PB (Quasi-bidirectional mode)	I_{IN1}	-60	-	+15	μA	V_{DD} = 5.5V, V_{IN} = 0V or V_{IN}=V_{DD}
Input Current at /RESET [1]	I_{IN2}	-55	-45	-30	μA	V_{DD} = 3.3V, V_{IN} = 0.45V
Input Leakage Current PA, PB	I_{LK}	-2	-	+2	μA	V_{DD} = 5.5V, 0<V_{IN}<V_{DD}
Logic 1 to 0 Transition Current PA~PB (Quasi-bidirectional mode)	I_{TL} [3]	-650	-	-200	μA	V_{DD} = 5.5V, V_{IN}<2.0V
Input Low Voltage PA, PB (TTL input)	V_{IL1}	-0.3	-	0.8	V	V_{DD} = 4.5V
		-0.3	-	0.6		V_{DD} = 2.5V
Input High Voltage PA, PB (TTL input)	V_{IH1}	2.0	-	V_{DD} +0.2	V	V_{DD} = 5.5V
		1.5	-	V_{DD} +0.2		V_{DD} =3.0V
Input Low Voltage XT1[*2]	V_{IL3}	0	-	0.8	V	V_{DD} = 4.5V
		0	-	0.4		V_{DD} = 3.0V
Input High Voltage XT1[*2]	V_{IH3}	3.5	-	V_{DD} +0.2	V	V_{DD} = 5.5V
		2.4	-	V_{DD} +0.2		V_{DD} = 3.0V
Input Low Voltage X32I[*2]	V_{IL4}	0	-	0.4	V	
Input High Voltage X32I[*2]	V_{IH4}	1.7		2.5	V	
Negative going threshold (Schmitt input), /REST	V_{ILS}	-0.5	-	0.3V_{DD}	V	
Positive going threshold (Schmitt input), /REST	V_{IHS}	0.7V_{DD}	-	V_{DD}+0.5	V	
Hysteresis voltage of PA~PB(Schmitt input)	V_{HY}		0.2V_{DD}		V	

Source Current PA, PB Quasi-bidirectional Mode)	I_{SR11}	-300	-370	-450	μA	V_{DD} = 4.5V, V_S = 2.4V
	I_{SR12}	-50	-70	-90	μA	V_{DD} = 2.7V, V_S = 2.2V
	I_{SR12}	-40	-60	-80	μA	V_{DD} = 2.5V, V_S = 2.0V
Source Current PA, PB (Push-pull Mode)	I_{SR21}	-20	-24	-28	mA	V_{DD} = 4.5V, V_S = 2.4V
	I_{SR22}	-4	-6	-8	mA	V_{DD} = 2.7V, V_S = 2.2V
	I_{SR22}	-3	-5	-7	mA	V_{DD} = 2.5V, V_S = 2.0V
Sink Current PA, PB (Quasi-bidirectional and Push-pull Mode)	I_{SK1}	10	16	20	mA	V_{DD} = 4.5V, V_S = 0.45V
	I_{SK1}	7	10	13	mA	V_{DD} = 2.7V, V_S = 0.45V
	I_{SK1}	6	9	12	mA	V_{DD} = 2.5V, V_S = 0.45V
Brownout voltage with BOV_VL [2:0] =000b	$V_{BO2.1}$		2.15		V	
Brownout voltage with BOV_VL [2:0] =001b	$V_{BO2.2}$		2.25		V	
Brownout voltage with BOV_VL [2:0] =010b	$V_{BO2.4}$		2.45		V	
Brownout voltage with BOV_VL [2:0] =011b	$V_{BO2.5}$		2.55		V	
Brownout voltage with BOV_VL [2:0] =100b	$V_{BO2.7}$		2.7		V	
Brownout voltage with BOV_VL [2:0] =101b	$V_{BO2.8}$		2.8		V	
Brownout voltage with BOV_VL [2:0] =110b	$V_{BO3.0}$		3.0		V	
Brownout voltage with BOV_VL [2:0] =111b	$V_{BO4.5}$		4.55		V	

Notes:

1. /REST pin is a Schmitt trigger input.
2. Crystal Input is a CMOS input.
3. Pins of P0, P1, P2, P3 and P4 can source a transition current when they are being externally driven from 1 to 0. In the condition of V_{DD}=5.5V, 5he transition current reaches its maximum value when Vin approximates to 2V.

6.3 AC Electrical Characteristics

6.3.1 External 32kHz XTAL Oscillator

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Input clock frequency	External crystal	-	32.768	-	kHz
Temperature	-	-40	-	85	℃
V_{DD}	-	2.4	-	5.5	V

6.3.2 Internal 49.152MHz Oscillator

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply voltage[1]	-	2.4	-	5.5	V
Center Frequency	-	-	49.152		MHz
Calibrated Internal Oscillator Frequency	+25°C; V_{DD} =5V	-1	-	1	%
	-40°C~+85°C; V_{DD}=2.5V~5.5V	-4	-	4	%

6.3.3 Internal 16 kHz Oscillator

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply voltage	-	2.4	-	5.5	V
Center Frequency	-	-	10	-	kHz
Calibrated Internal Oscillator Frequency	+25°C; V_{DD} =5V	-10	-	10	%
	-40°C~+85°C; V_{DD}=2.5V~5.5V	-20	-	20	%

Notes:

*1. Internal operation voltage comes from LDO.

6.4 Analog Characteristics

6.4.1 Specification of ADC and Speaker Driver

Conditions: VCCD = 3.3V, VCCA = 3.3V, T_A = +25°C, 1kHz signal, fs = 16kHz, 16-bit audio data, unless otherwise stated.

Parameter	Symbol	Comments/Conditions	Min	Typ	Max	Units
Analog to Digital Converter (ADC)						
Full scale input signal [1]	V_{INFS}	PGABST = 0dB PGAGAIN = 0dB		1.0 0		Vrms dBV
Signal-to-noise ratio	SNR	Gain = 0dB, A-weighted		92		dB
Total harmonic distortion [2]	THD+N	Input = -3dB FS input		-80		dB
PWM Speaker Output (8Ω bridge-tied-load)						
Full scale output [4]		SPKBST = 1	VCCSPK / 3.3			V_{rms}

Parameter	Symbol	Comments/Conditions	Min	Typ	Max	Units
Total harmonic distortion [2]	THD+N	P_o = 200mW, VDDSPK=3.3V		*63		dB
		P_o = 320mW, VDDSPK = 3.3V		-64		dB
		P_o = 860mW, VDDSPK = 5V		-60		dB
		P_o = 1000mW, VDDSPK = 5V		-36		dB
Signal-to-noise ratio	SNR	VDDSPK = 3.3V		91		dB
		VDDSPK=5V		90		dB

6.4.2 Specification of PGA and BOOST

Conditions: VCCD = 3.3V, VCCA = 3.3V, T_A = +25°C, 1kHz signal, fs = 16kHz, 16-bit audio data, unless otherwise stated.

Parameter	Symbol	Comments/Conditions	Min	Typ	Max	Units
Microphone Inputs (MICP, MICN) and Programmable Gain Amplifier (PGA)						
Full scale input signal [1]		PGABST = 0dB PGAGAIN = 0dB		1.0 0		Vrms dBV
Programmable gain			-12		35.25	dB
Programmable gain step size		Guaranteed Monotonic		0.75		dB
Mute Attenuation				120		dB
Input resistance		Inverting Input PGA Gain = 35.25dB PGA Gain = 0dB PGA Gain = -12dB **Non-inverting Input**		 1.6 47 75 94		 kΩ kΩ kΩ kΩ
Input capacitance				10		pF
PGA equivalent input noise		0 to 20kHz, Gain set to 35.25dB		120		μV
Input Boost						
Gain boost		Boost disabled Boost enabled		0 26		dB dB

6.4.3 Specification of ALC an MICBIAS

Conditions: VCCD = 3.3V, VCCA = 3.3V, T_A = +25°C, 1kHz signal, fs = 16kHz, 16-bit audio data, unless otherwise stated.

Parameter	Symbol	Comments/Conditions	Min	Typ	Max	Units
Automatic Level Control (ALC) & Limiter:						
Target record level			-22.5		-1.5	dBFS
Programmable gain			-12		35.25	dB
Gain hold time [3]	t_{HOLD}	Doubles every gain step, with 16 steps total	0 / 2.67 / 5.33 / … / 43691			ms
Gain ramp-up (decay) [3]	t_{DCY}	ALC Mode ALC = 0	4 / 8 / 16 / … / 4096			ms
		Limiter Mode ALC = 1	1 / 2 / 4 / … / 1024			ms
Gain ramp-down (attack) [3]	t_{ATK}	ALC Mode ALC = 0	1 / 2 / 4 / … / 1024			ms
		Limiter Mode ALC = 1	0.25 / 0.5 / 1 / … / 128			ms
Mute Attenuation				120		dB
Microphone Bias						
Bias voltage	$V_{MICBIAS}$		0.90, 0.65 ,0.75, 0.50, 2.4, 1.7,2.0			VDDA V
Bias current source	$I_{MICBIAS}$			3		mA
Output noise voltage	V_n	1kHz to 20kHz		14		nV/√Hz

Notes

1. Full Scale is relative to the magnitude of VCCA and can be calculated as FS = VDDA/3.3.
2. Distortion is measured in the standard way as the combined quantity of distortion products plus noise. The signal level for distortion measurements is at 3dB below full scale, unless otherwise noted.
3. Time values scale proportionally with HCLK. Complete descriptions and definitions for these values are contained in the detailed descriptions of the ALC functionality.

6.4.4 Specification of LDO & Power management

PARAMETER	MIN	TYP	MAX	UNIT	NOTE
Input Voltage	2.4	5	5.5	V	V_{DD} input voltage
Output Voltage	-10%	1.8	+10%	V	V_{DD} > 1.8V

Note:

1. It is recommended that a 10uF or higher capacitor and a 100nF bypass capacitor are connected between VCCD and the VSSD pin of the device.
2. For ensuring power stability, a 1.0uF or higher capacitor must be connected between LDO pin and the VSSD pin of the device. Also a 100nF bypass capacitor between LDO and VSSD will help suppress output noise.

6.4.5 Specification of Brownout Detector

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Operation voltage	-	2.2	-	5.5	V
Quiescent current	AVDD=5.5V	-	-	125	μA
Temperature	-	-40	25	85	℃
Brown-out voltage	BOV_VL[1:0]=11		2.15		V
	BOV_VL [1:0]=10		2.25		V
	BOV_VL [1:0]=01		2.45		V
	BOV_VL [1:0]=00		2.55		V
	BOV_VL [2:0]=011		2.7		V
	BOV_VL[2:0]=010		2.8		V
	BOV_VL [2:0]=001		3.0		V
	BOV_VL [2:0]=000		4.55		V
Hysteresis	-				V

6.4.6 Specification of Power-On Reset (VCCD)

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Temperature	-	-40	25	85	℃
Reset voltage	VCC ramping down	-	1.0	-	V
Reset Release voltage	VCC ramping up		1.5		V
Quiescent current	Vin>reset voltage	-	60	-	nA

6.4.7 Specification of Temperature Sensor

PARAMETER	MIN	TYP	MAX	UNIT	CONDITIONS
Supply voltage[1]	2.4	-	5.5	V	
Temperature	-40	-	125	℃	
Current consumption				uA	
Gain				mV/℃	
Offset				mV	Temp=0 ℃

Notes:

1. Internal operation voltage comes from LDO.

6.4.8 Specification of Comparator

PARAMETER	MIN.	TYP.	MAX.	CONDITION
Temperature	-40℃	25 ℃	85℃	-
VCCA	2.4	3	5.5	-
VCCA current	-	20uA	40uA	20uA@VDD=3V
Input offset voltage	-	5mV	15mV	-
Input common mode range	0.1	-	VDD-1.2	-
DC gain	-	70dB	-	-
Propagation delay	-	200ns	-	@VCM=1.2V & VDIFF=0.1V
Comparison voltage	10mV	20mV	-	20mV@VCM=1V 50mV@VCM=0.1V 50mV@VCM=VDD-1.2 @10mV for non-hysteresis
Hysteresis	-	±10mV	-	One bit control W/O & W. hysteresis @VCM=0.4V ~ VDD-1.2V
Wake up time	-	-	2us	@CINP=1.3V CINN=1.2V

6.5 Reset Characteristics

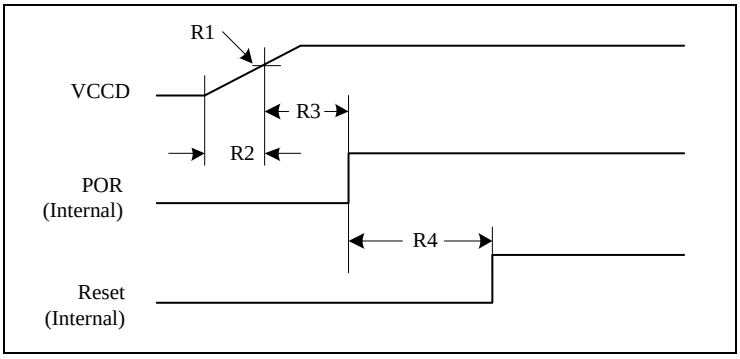
(VDD-VSS=5V, TA = 25°C, F_{OSC} = 49.152 MHz unless otherwise specified.)

Parameter No.	Parameter	Parameter Name	Min	Typ	Max	Unit
R1	V_{TH}	Reset threshold	1	1.7	2	V
R2	$T_{VDDRISE}$	Supply voltage (VDD) rise time (0V-5V), power on reset	-	-	100	ms
R3	T_{POR}	Power-On Reset timeout	-	-	12	µs
R4	T_{IRPOR}	Internal reset timeout after POR	-	-	45	µs
R5	T_{MIN}	Minimum RESETN pulse width	100	-	-	ns
R6	T_{IRHWR}	Internal reset timeout after hardware reset (RESETN pin)	-	-	20	µs
R7	T_{IRSWR}	Internal reset timeout after software-initiated system reset	-	-	2	µs
R8	T_{IRWDR}	Internal reset timeout after watchdog reset	-	-	3 *2	µs

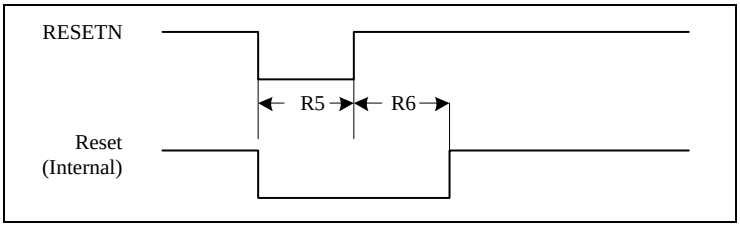
*Notes:

2. It will be 6500us when use OSC_10K as the WDG clock.

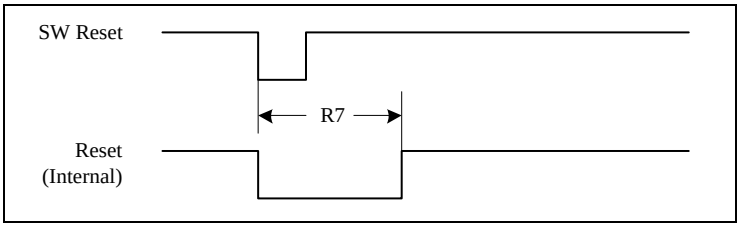
6.5.1.1 *Power-On Reset Timing*



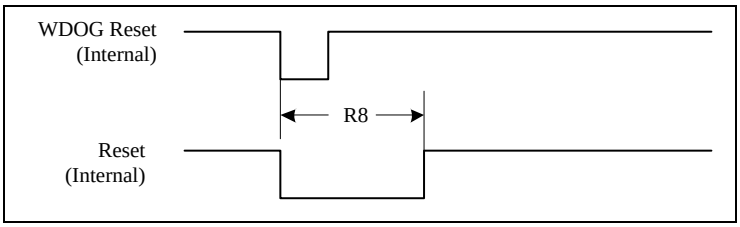
6.5.1.2 *External Reset Timing (RESETN)*



6.5.1.3 *Software Reset Timing*

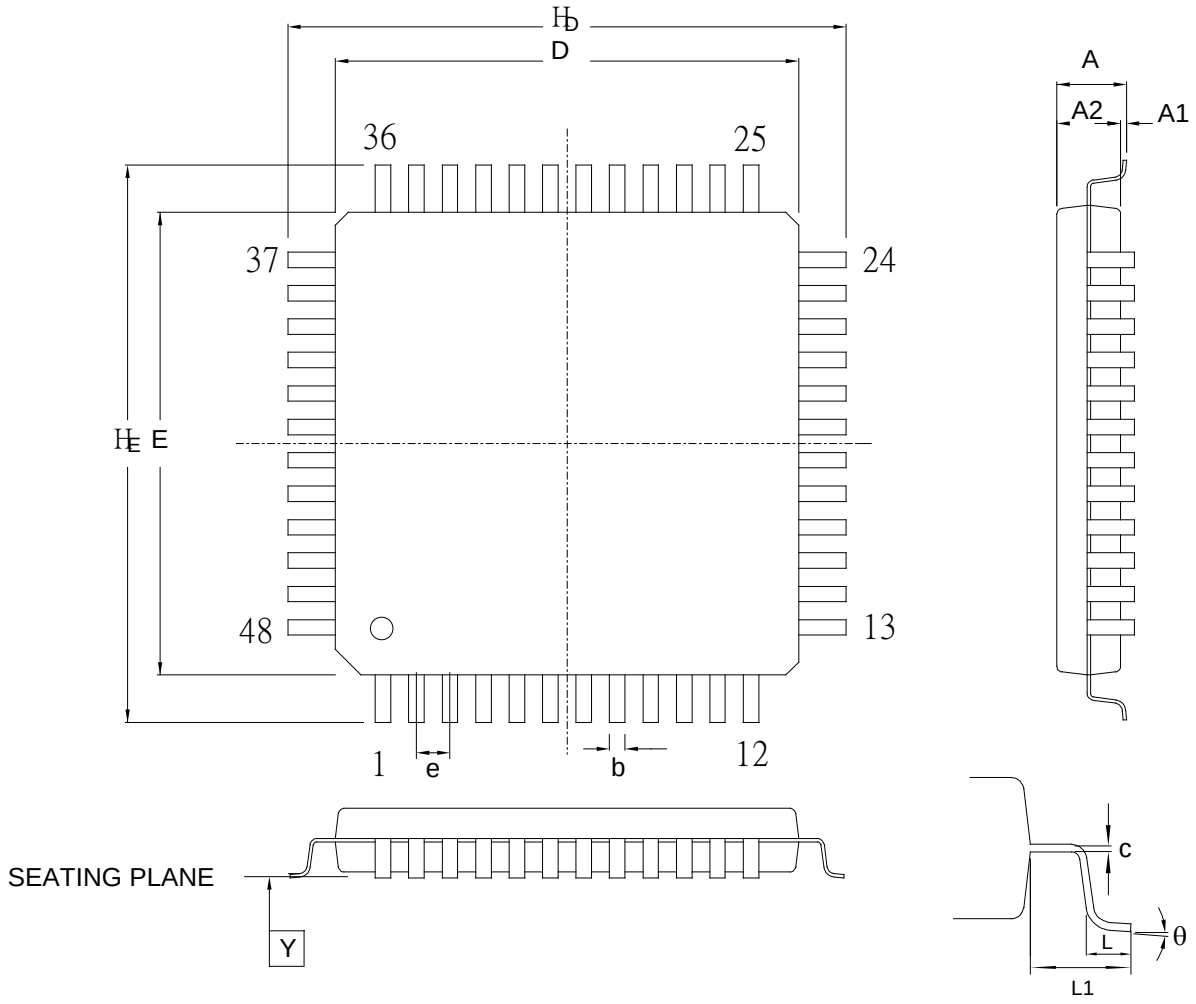


6.5.1.4 *Watchdog Reset Timing*



7 PACKAGE DIMENSIONS

7.1.1 48L LQFP (7x7x1.4mm footprint 2.0mm)

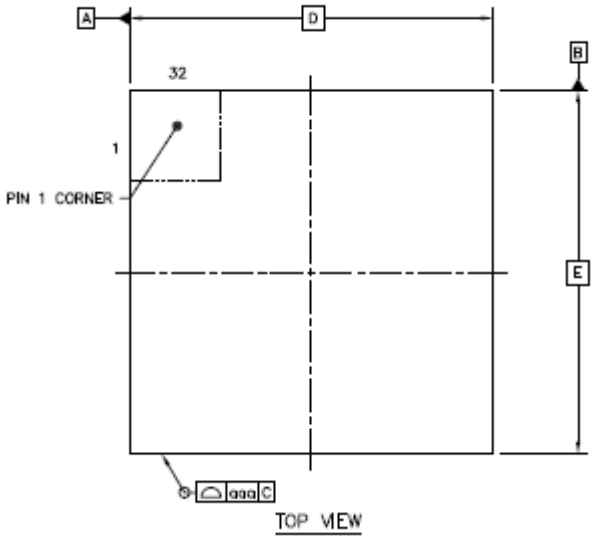


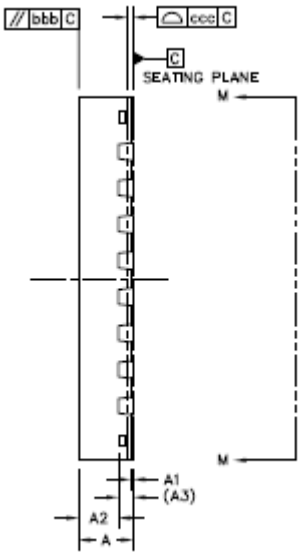
Controlling dimension : Millimeters

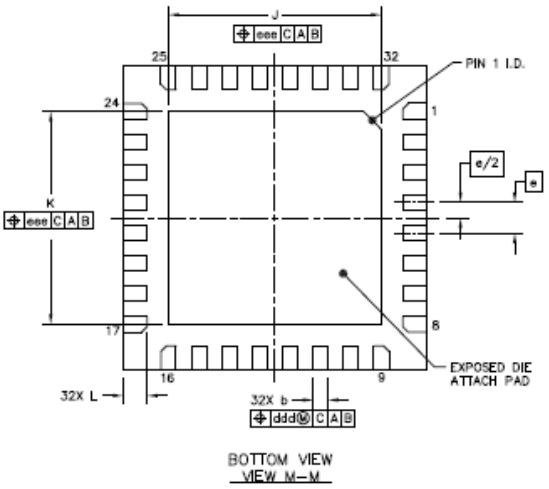
Symbol	Dimension in inch			Dimension in mm		
	Min	Nom	Max	Min	Nom	Max
A	—	—	—	—	—	—
A_1	0.002	0.004	0.006	0.05	0.10	0.15
A_2	0.053	0.055	0.057	1.35	1.40	1.45
b	0.006	0.008	0.010	0.15	0.20	0.25
c	0.004	0.006	0.008	0.10	0.15	0.20
D	0.272	0.276	0.280	6.90	7.00	7.10
E	0.272	0.276	0.280	6.90	7.00	7.10
e	0.014	0.020	0.026	0.35	0.50	0.65
H_D	0.350	0.354	0.358	8.90	9.00	9.10
H_E	0.350	0.354	0.358	8.90	9.00	9.10
L	0.018	0.024	0.030	0.45	0.60	0.75
L_1	—	0.039	—	—	1.00	—
Y	—	—	0.004	—	—	0.10
θ	0°	—	7°	0°	—	7°

7.1.2 33-pin QFN

5x5 mm², Thickness 0.8mm (MAX), Pitch 0.5 mm (SAW Type), EP SIZE 3.5X3.5 mm

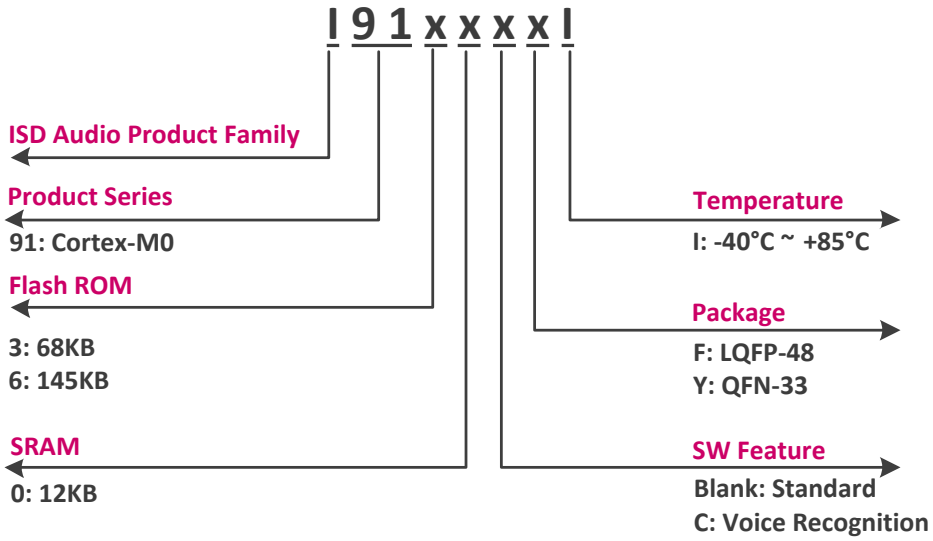






		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.7	0.75	0.8
STAND OFF		A1	0	0.035	0.05
MOLD THICKNESS		A2	---	0.55	0.57
L/F THICKNESS		A3		0.203 REF	
LEAD WIDTH		b	0.2	0.25	0.3
BODY SIZE	X	D		5 BSC	
	Y	E		5 BSC	
LEAD PITCH		e		0.5 BSC	
EP SIZE	X	J	3.4	3.5	3.6
	Y	K	3.4	3.5	3.6
LEAD LENGTH		L	0.35	0.4	0.45
PACKAGE EDGE TOLERANCE		aaa		0.1	
MOLD FLATNESS		bbb		0.1	
COPLANARITY		ccc		0.08	
LEAD OFFSET		ddd		0.1	
EXPOSED PAD OFFSET		eee		0.1	

8 ORDERING INFORMATION



9 REVISION HISTORY

VERSION	DATE	PAGE/ CHAP.	DESCRIPTION
V0.1	May 25, 2011	-	First Release.
V1.01	Sep 06, 2011	-	• Add better description of EINT0/1 and PB0/1 interrupts. • Unify the naming of capacitive touch sensing.
V1.10	Sep 30, 2011	-	• Revise the level value of Brown-out detector in Feature. • Correct the maximum voltage of DC Power Supply in section 6.1 Absolute Maximum Ratings
V1.22	Nov 17, 2011	-	• Update DC spec. • Add ordering information.
V1.23	Sep 10, 2012		• Remove “Preliminary” • Change internal oscillation 10K to 16K • Change minimum voltage (to 2.4V) in chapter 9 Electrical Characteristics
V1.24	July 17,2013		• Change SNR to 92dB • Add RESET low specification in DC characteristic.
V1.25	July 31, 2013		• Update RESET timing spec.
V1.30	Oct 24, 2014		• Add ISD9130 and ISD9140 into the ISD9100 series.
V1.40	July 20, 2015		• Add QFN-33 pin package.
V1.41	Jan 08, 2016		• Fix ordering info, QFN-33 pin dimension data.
V1.42	Aug 08, 2019		• Add QFN-33 pin description.
V1.5	Mar. 13, 2023		• Added “Package is Halogen-free, RoHS-compliant and TSCA-compliant” in section 2

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