



NR2049

High Performance Voice Processor
Product Data Sheet

1. General Description

1.1 Overview:

NR2049 is the latest generation of Acoustics's system-on-chip (SOC) solution that provides high performance voice processing for automotive hands-free applications. It delivers state of the art multiple -microphone and single-microphone noise suppression with acoustic echo cancellation technologies for in-vehicle and nomadic device hands-free voice communications.

Incorporating the latest Acoustics technologies for removing ambient noise and acoustic echoes, the NR2049 preserves voice naturalness for greater speech intelligibility in a variety of noisy automotive environments. Designed to accommodate a variety of microphone mounting positions, and staying compatible with a wide range of host processors and blue-tooth devices, the NR2049 voice processor is designed for easy system integration.

The NR2049 provides system designer the flexibilities to customize each processing module and fine-tune the algorithms to the unique needs and acoustic path characteristics of the manufacturer's automotive model cabin or handsfree communication device.

1.1.1 Hardware Features

- 128 Kbytes IRAM (Instruction RAM), 250 Kbytes DRAM (Data RAM), 96 Kbytes SRAM (System RAM) with Auto Voice Buffer Scheme
 - Provide more than 3 seconds of dual voice buffer for seamless operation
 - Hardware assisted auto-buffers for MICs, DAC/TXs and RXs data to reduce system overhead
- Programmable LDO (0.9~1.32V) and PLL (1MHz ~ 150MHz), for MIPS and power efficiency requirements
- Support various sampling rates: 8K/16K/24K/32K/44.1K/48KHz
- Two PDM_DATA Input (support up to 4 Digital MICs) and two PDM_DATA Output pins
- Two TX (microphone) and one RX (AEC reference) of I2S are supported
- Microphone output can be I2S or PDM format
- 32K/512K/768K/1MHz PDM_CLKO with 16KHz sampling rate at power saving mode
- SPI/I²C for program and acoustic model download at speed up to 20MHz/400KHz

1.1.2 Software Features

- VOS (Voice Operating System) for always-on ambience monitoring
- Programmable speech detection and voice triggers
- Beamforming, noise suppression and acoustic echo cancellation
- Acoustic ambience analysis

1.2 Typical Application

- Voice triggering applications for mobile devices
- Voice processing and analysis for wearable devices
- IoT voice control
- Smart Microphone system
- Automotive voice input processing

2. Block Diagram

2.1 Functional Block Diagram

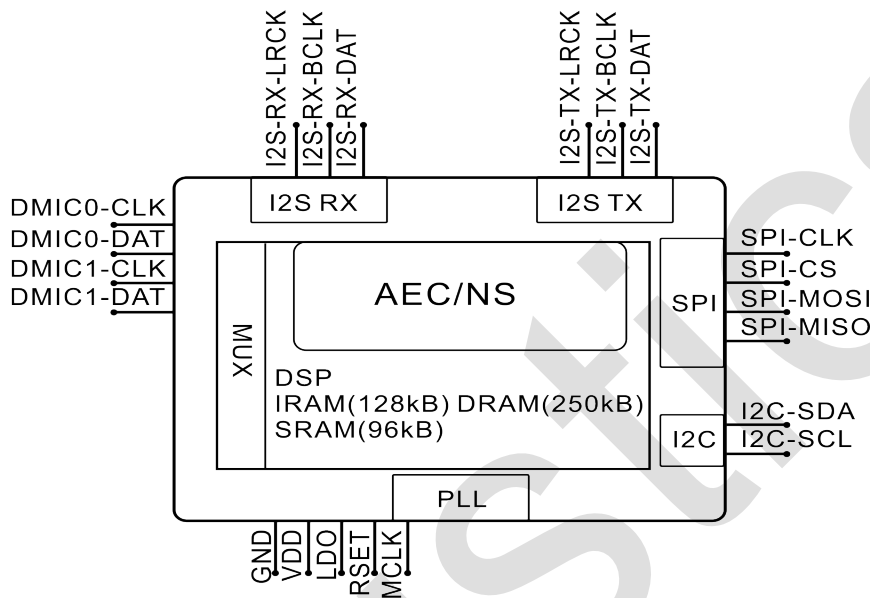


Figure 1. Functional Block Diagram of NR2049

2.2 System Application Diagram

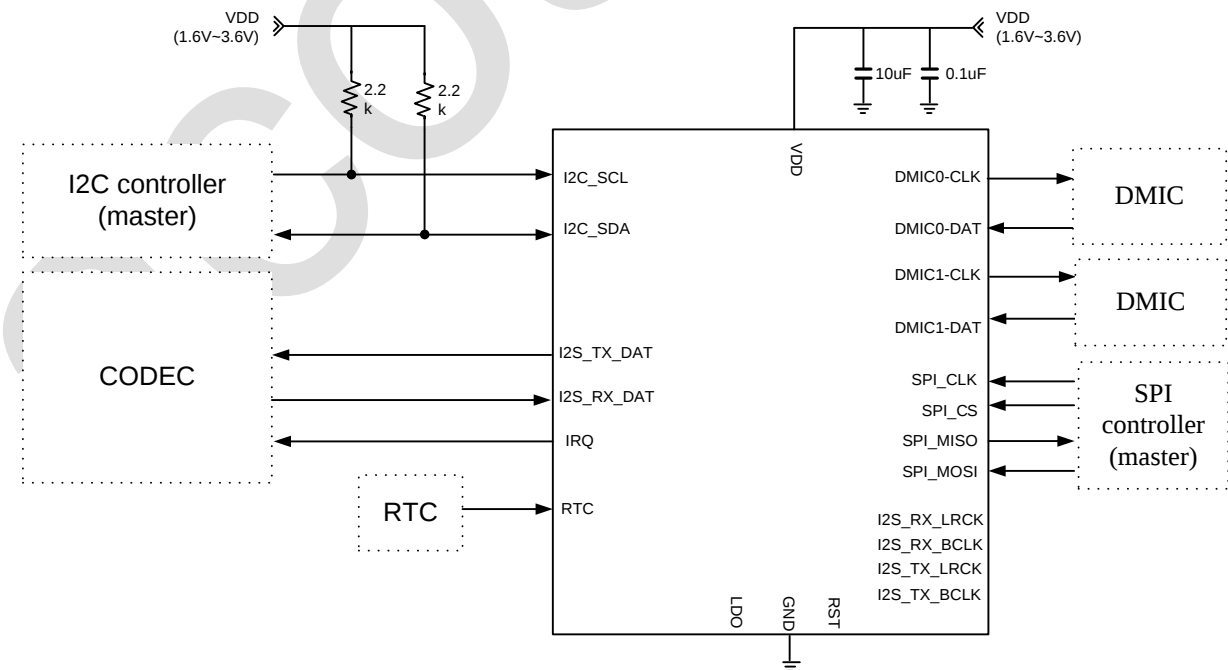


Figure 2. NR2049 System Application Diagram with Microphones and Host

3. PIN Layouts

3.1 QFN32 Package

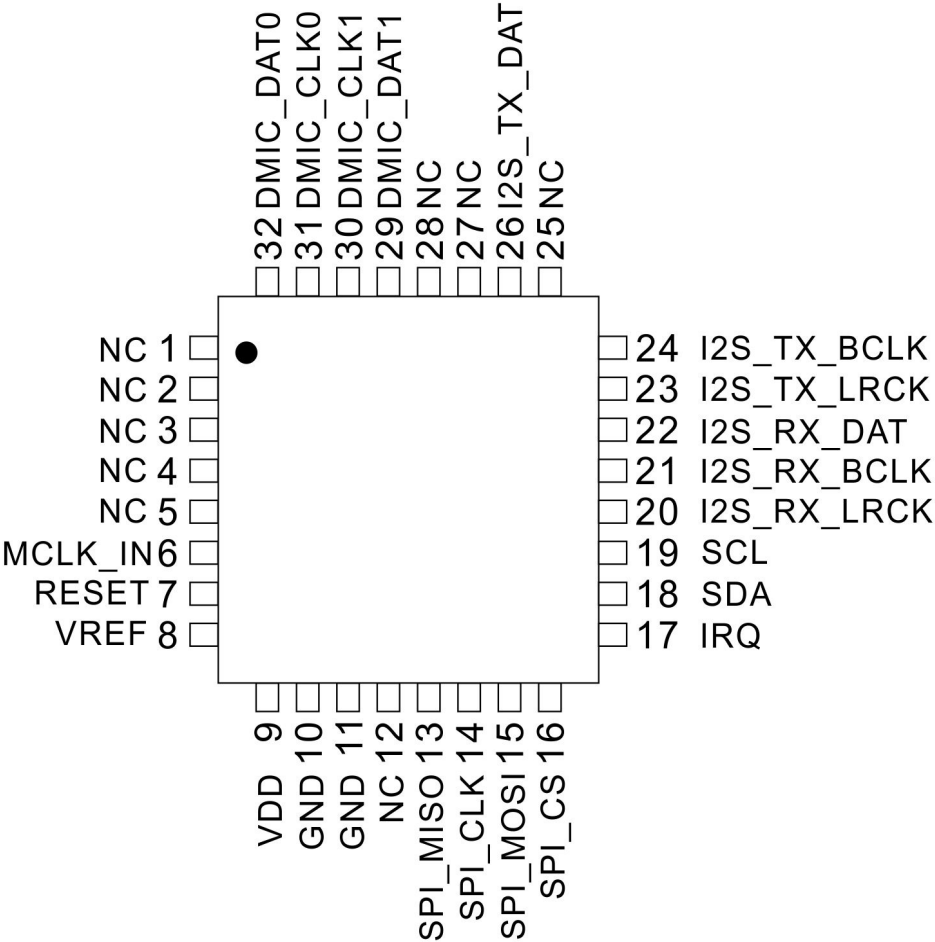


Figure 3. PIN Assignment of NR2049 in QFN Package

4. PIN Description

Table 1. PIN Function Description

Pin Name	IO	Pin# in	Description
		QFN	
DMIC_DAT0	I	30	PDM data from MIC0 and MIC1
DMIC_DAT1	I	29	PDM data from MIC2 and MIC3.
DMIC_CLK0	O	31	PDM clock output to microphone.
DMIC_CLK1	O	32	2 nd PDM clock to microphone.
N.C.		1	
N.C.		2	
N.C.		3	
N.C.		4	
N.C.		5	
MCLK_IN	I	6	clock input as reference in power saving mode.
RSET	I	7	Reset, active low. This pad has internal pull up resistor
VERF	P	8	LDO output for internal core power and test purpose.
VDD	P	9	Power supply 1.6~3.6V
GND	G	10/11	Double bounded ground pads.
N.C.		12	
SPI_MISO	O	13	Data from SPI slave to SPI master
SPI_CLK	I	14	SPI clock.
SPI_MOSI	I	15	Data from SPI master to SPI slave
SPI_CS	I	16	SPI chip select. Active low
IRQ	O	17	Wake-up trigger. Polarity is selectable.
SDA	IO	18	I2C data connected to host.
SCL	I	19	I2C clock connected to host. Up to 400 KBPS.
I2S_RX_LRCK	I	20	Frame of RX of I2S
I2S_RX_BCLK	I	21	BCLK of RX of I2S
I2S_RX_DAT	I	22	RX of I2S
I2X_TX_LRCK	I	23	Frame of TX of I2S
I2S_TX_BCLK	I	24	BCLK of I2S.
N.C.		25	
I2S_TX_DAT	O	26	TX of I2S.
N.C.		27	
N.C.		28	

5. Electrical Characteristics

5.1 DC Characteristics

Table 2. Absolute Maximum Ratings

Parameter	Symbol		Minimum	Typical	Maximum	Units
Power supply voltage	VDDIO		1.6		3.6	V
Ambient Operating Temperature	Ta		-20	-	+85	°C
Storage Temperature	Ts		-40		+125	°C
	HBM ESD (Electrostatic Discharge)					
			Susceptibility Voltage			
All pins			2000			
	MM ESD (Electrostatic Discharge)					
			Susceptibility Voltage			
All pins			200			
	CDM ESD (Electrostatic Discharge)					
			Susceptibility Voltage			
All pins			500			

Table 3. Static Characteristics

Parameter	Symbol	For 1.8V I/O			For 2.5V I/O			For 3.3V I/O			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
IO power supply	VDDIO	1.62	1.8	1.98	2.25	2.5	2.75	2.97	3.3	3.63	V
Hysteresis	-	0.17		0.3	0.2		0.3	0.22		0.3	V
Input low voltage	VIL			0.6			0.7			0.8	V
Input high Voltage	VIH	1.2			1.7			2.0			V
Output low voltage	VOL			0.4			0.4			0.4	V
Output high voltage	VOH	VDDIO-0.4			VDDIO-0.4			VDDIO-0.4			V
Input leakage current	ILI	-10		+10	-10		+10	-10		+10	uA
Output leakage current	ILO	-10		+10	-10		+10	-10		+10	uA
Output High current	Ioh		2.4			3.8			5		mA
Output low current	Iol		2.4			3.8			5		mA
Pull-up resistor	Pull-up		90			57			42		kΩ
Pull-down resistor	Pull-down		97			59			44		kΩ

5.2 AC Timing Characteristics

5.2.1 I²C Control Interface

Table 4. I²C Timing Parameters

Parameter	Symbol	Minimum	Typical	Maximum	Units
Clock Low pulse duration	$T_{w(9)}$	480	-	-	ns
Clock High pulse duration	$T_{w(10)}$	450	-	-	ns
Clock Frequency	f	100	-	400	KHz
Re-Start Setup Time	$T_{su(6)}$	260	-	-	ns
Start Hold Time	$T_{h(5)}$	260	-	-	ns
Data Setup Time	$T_{su(7)}$	50	-	-	ns
Data Hold Time	$T_{h(6)}$	0	-	-	ns
Rising Time	T_r	-	-	60	ns
Falling Time	T_f	-	-	60	ns
Stop Setup Time	$T_{su(8)}$	240	-	-	ns
Bus free time between a STOP and START condition	T_{buf}	500	-	-	ns
Pulse Width of Spikes Suppressed Input Filter	T_{sp}	10	-	-	ns

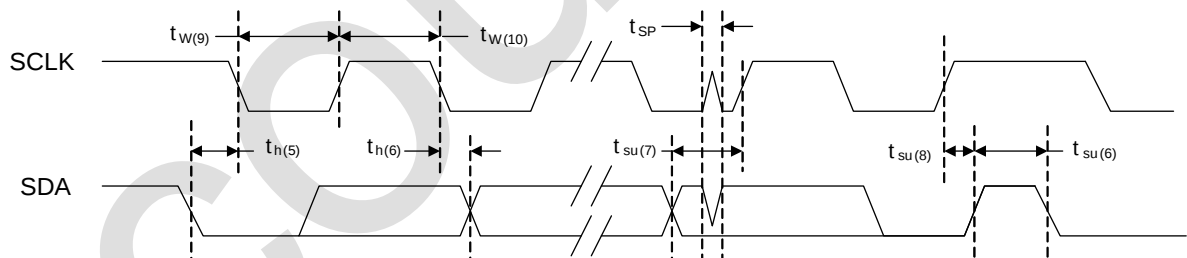


Figure 4. I2C Timing Diagram

5.2.2 PDM Control Interface

Table 5. Digital Microphone Interface Timing

Parameter	Symbol	MIN	TYP	MAX	UNIT
PDM_CLKOn cycle time	TCY_M	1.024	2.048	4.096	Mhz
PDM_CLKOn rise/fall time	TR_M, TF_M	5		30	ns
PDM_CLKOn duty cycle		45		55	%
PDM_DATIn (left) setup time	TLSU_M	15			ns
PDM_DATIn (left) hold time	TLH_M	10			ns
PDM_DATIn (right) setup time	TRSU_M	15			ns
PDM_DATIn (right) hold time	TRH_M	10			ns

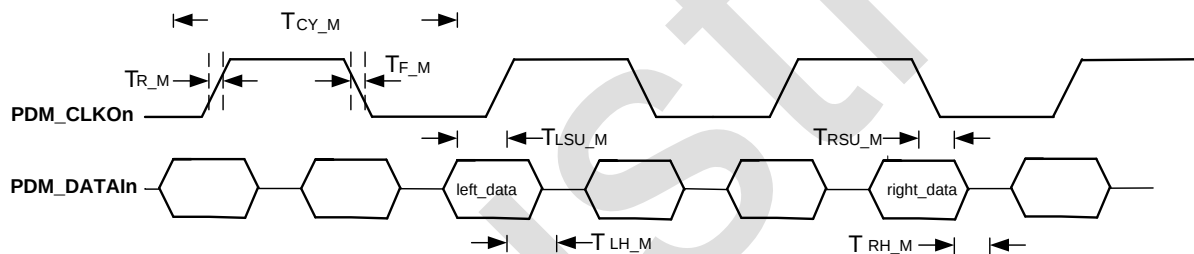


Figure 5 . PDM Timing Diagram

Table 10. PDM (CODEC) Interface Timing

Parameter	Symbol	MIN	TYP	MAX	UNIT
PDM_CLKIn cycle time	TCY_C	1.024	2.048	4.096	Mhz
PDM_CLKIn rise/fall time	TR_C, TF_C		10		ns
PDM_CLKIn duty cycle		45		55	%
PDM_DATOn (left) setup time	TLSU_C	30			ns
PDM_DATOn (left) hold time	TLH_C	15			ns
PDM_DATOn (right) setup time	TRSU_C	30			ns
PDM_DATOn (right) hold time	TRH_C	15			ns
PDM_DATOn data valid from rising edge of PDM_CLKIn	TREN		30		ns
PDM_DATOn data valid from rising edge of PDM_CLKIn	TLEN		30		ns

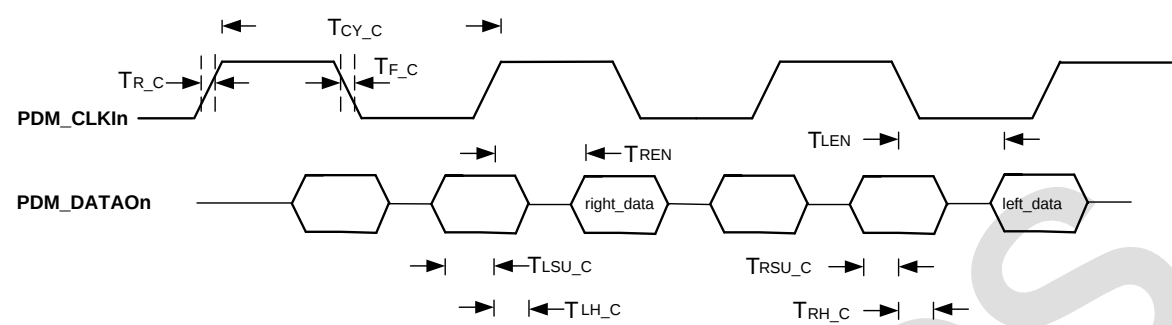


Figure 6 . PDM (CODEC) Timing Diagram

5.2.3 SPI Control Interface

Table 6 . SPI Timing Parameters

Parameter	Symbol	MIN	TYP	MAX	UNIT
SPI_SS_ falling edge to SPI_CLK rising edge	t_{SSU}	2			ns
SPI_CLK falling edge to SPI_SS_ rising edge	t_{SHO}	0			ns
SPI_CLK cycle time	t_{SCY}	50			ns
SPI_CLK pulse width low	t_{SCL}	10			ns
SPI_CLK pulse width high	t_{SCH}	10			ns
SPI_MOSI to SPI_CLK set-up time	t_{DSU}	3			ns
SPI_MOSI to SPI_CLK hold time	t_{DHO}	3			ns
SPI_CLK falling edge to SPI_MISO transition	t_{DL}			9	ns

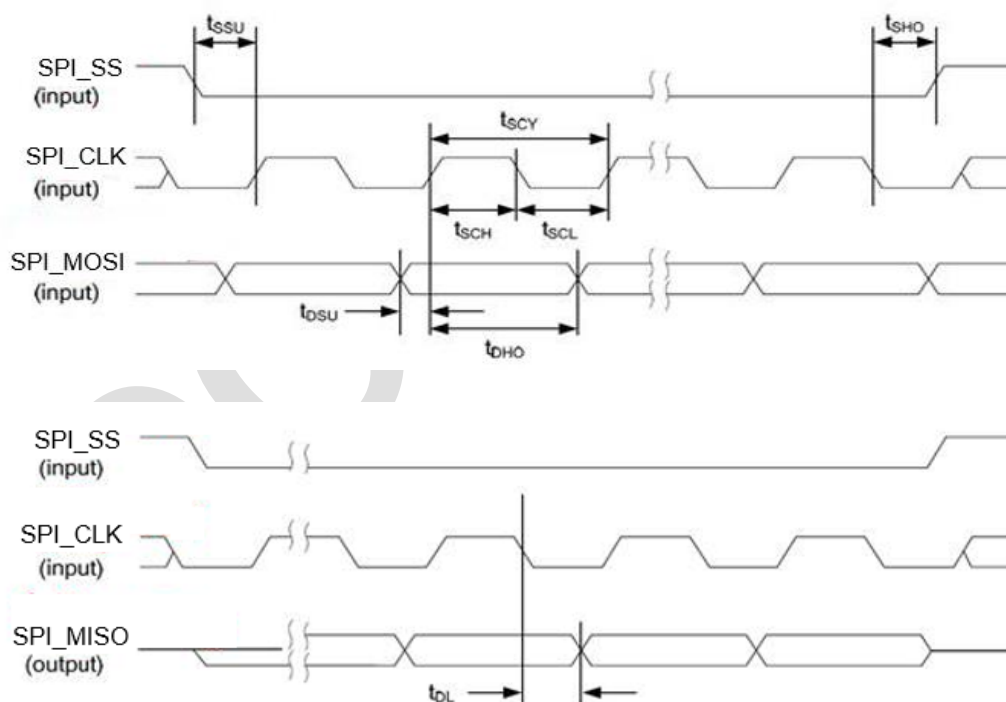


Figure 7 . SPI Timing Diagrams

6. Circuit for NR2049 Application Example

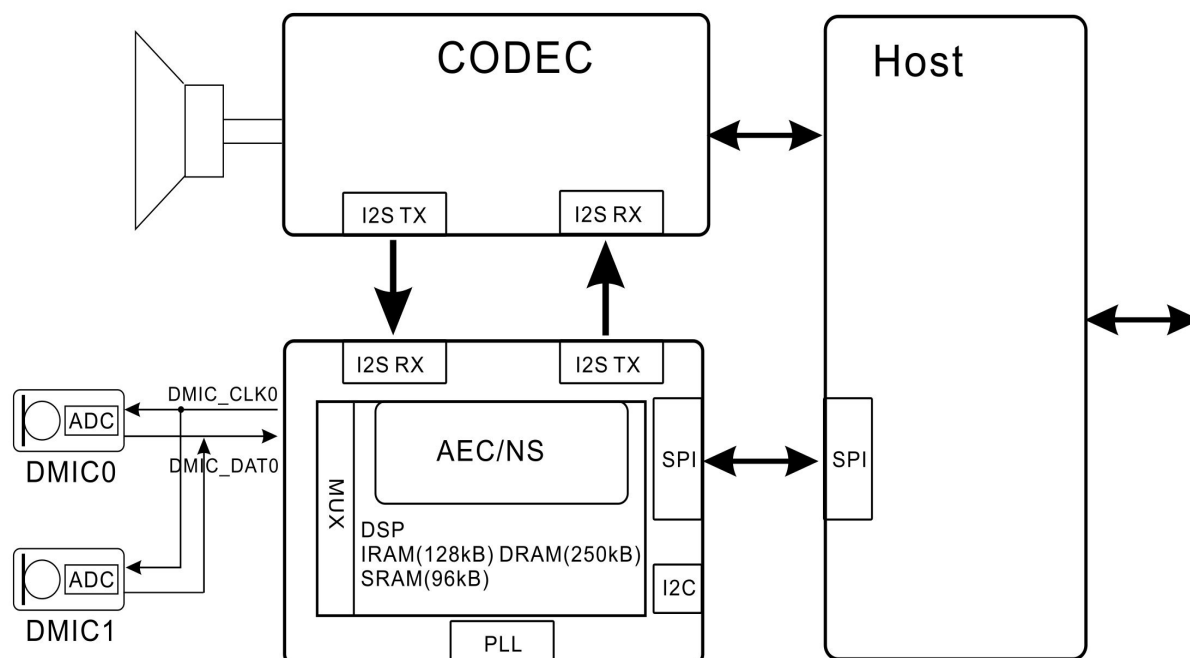


Figure 8 . NR2049 uses 2 DMICs for Call Device AEC/NS via I2S

7. Mechanical Dimensions

QFN Package (QFN32, 5mmx5mm):

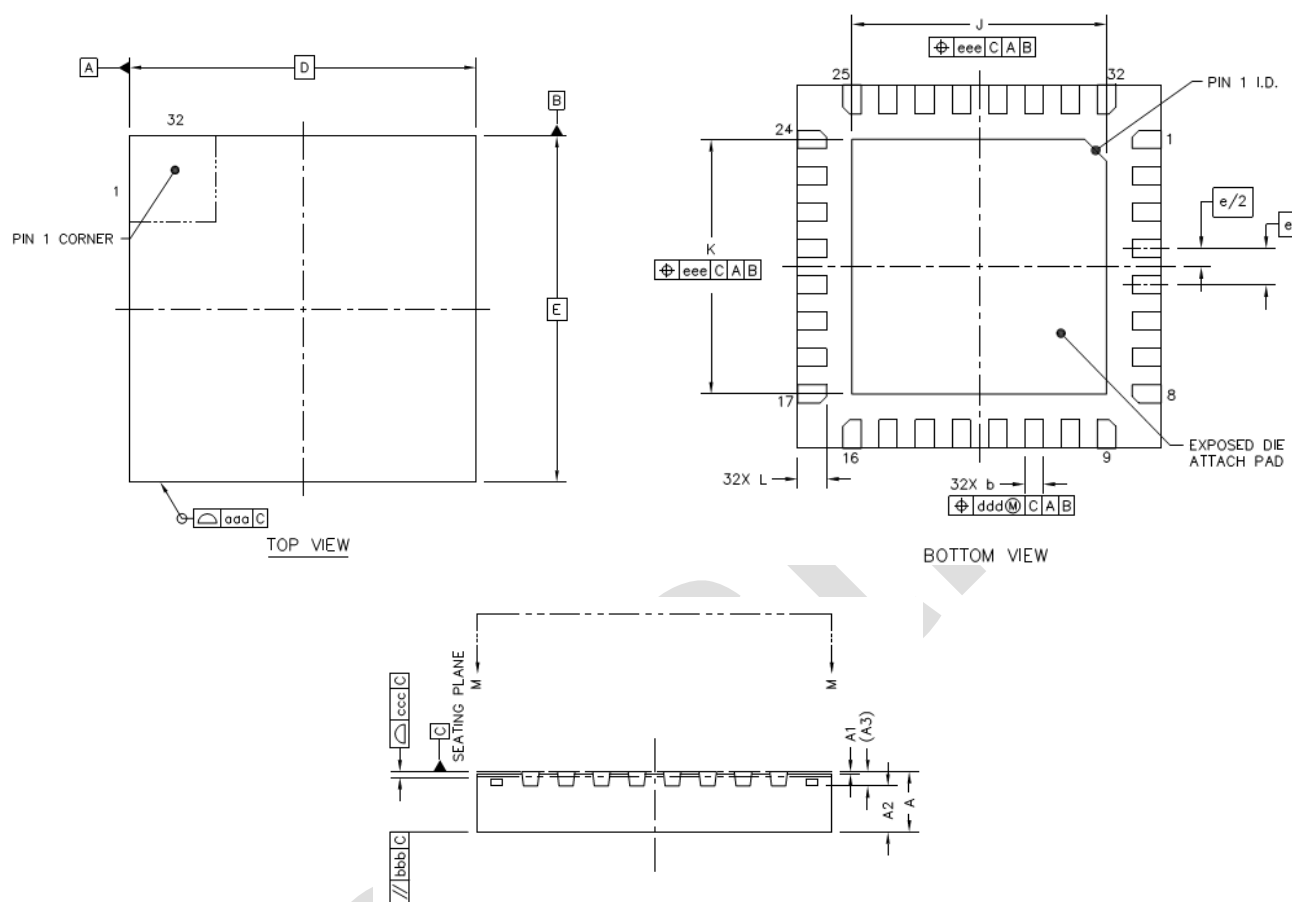


Figure 9 . Top, Bottom and Side View of NR2049 QFN Package

Table 7 . Detailed Dimensions for NR2049 in QFN Package

		Symbol	Dimension in millimeter (mm)		
			Min	Nom	Max
Total Thickness		A	0.8	0.85	0.9
Stand Off		A ₁	0	0.035	0.05
Mold Thickness		A ₂	---	0.65	0.67
L/F Thickness		A ₃	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. Order Information

Table 8 . Ordering Information

Part Number	Package	Status
NR2049-P	QFN-32 (5mmx5mm)	Available