

NSUC1611

Single-Phase BLDC Motor Driver with Integrated Hall Sensor

AEC-Q100 Compliant

Preliminary Datasheet (EN) 0.2

Subject to change without notice

Product Overview

The NSUC1611 is a single-phase brushless DC (BLDC) motor driver with integrated power MOSFETs and an embedded Hall sensor, designed to drive single-phase BLDC motors with a peak current of up to 1.4A and hardware overcurrent protection at 2.1A.

The input voltage (VIN) range is 5.5V to 40V (AMR). The PWM pin accepts pulse-width modulation (PWM) signals for motor speed control. The FG/RD pin can function as either a speed feedback signal (FG) or a status indicator signal (RD).

This device features configurable soft switching, lead angle control, adaptive commutation, and speed curve configuration. It also provides comprehensive protection features, including: input overvoltage protection (OVP), fast shutdown under undervoltage conditions, stall protection, overcurrent protection (OCP), overtemperature shutdown.

The NSUC1611E is available in DFN10 packages, compliant with AEC-Q100 Grade 1 certification.

Key Features

- Operating voltage range: 5.5V to 32V
- Maximum drive current: 2.1A
- Integrated Hall sensor
- Supports I2C communication
- Integrated high-side and low-side MOSFETs
- Soft switching, lead angle control, and adaptive commutation
- Configurable transfer curve and clamping values
- Optional open-loop or speed closed-loop control
- Configurable startup duty cycle and duty cycle slew rate
- Supports PWM input frequency from 50Hz to 100kHz
- Configurable current limiting

- Protection features: Over voltage protection (OVP), Stall protection, Over current protection (OCP), Over temperature protection, Under voltage protection (UVP), Fast shutdown.
- Sleep current < 50μA
- Optional FG and RD output
- Operating temperature range: -40°C to +125°C

Applications

- Seat ventilation fans
- Automotive fan control systems
- Cooling fans
- General-purpose fans

Device Information

Part Number	Package	Grade	Body Size
NSUC1611D-Q1DAHR	DFN10	Automotive	3mm × 3mm
NSUC1611D-Q1STGR	SOT23-6L	Automotive	2.9mm × 1.6mm

Functional Block Diagrams

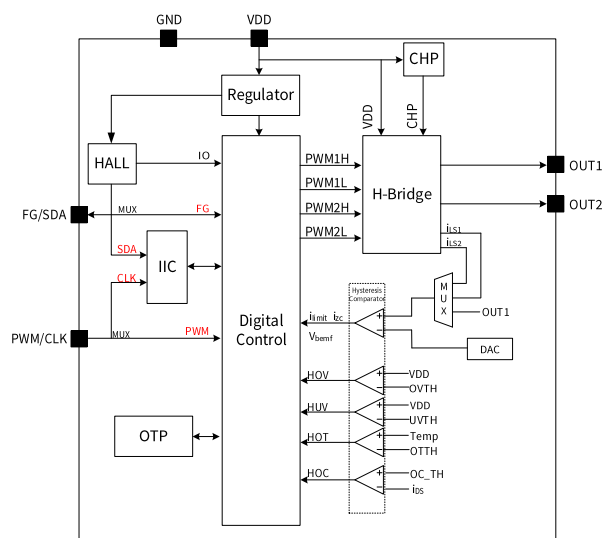


Figure 1. NSUC1611 Block Diagram

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1. Pin Configuration and Functions

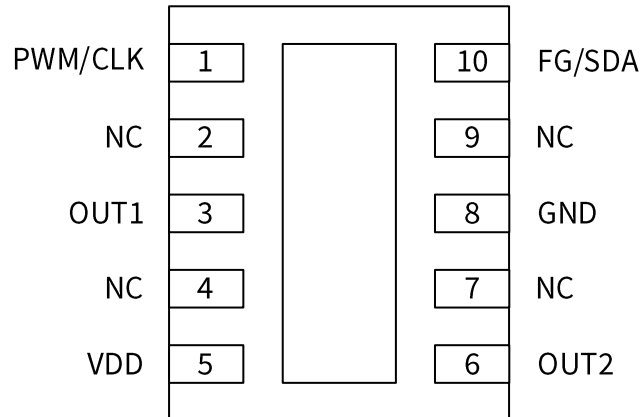


Figure 2 NSUC1611 DFN10 Package

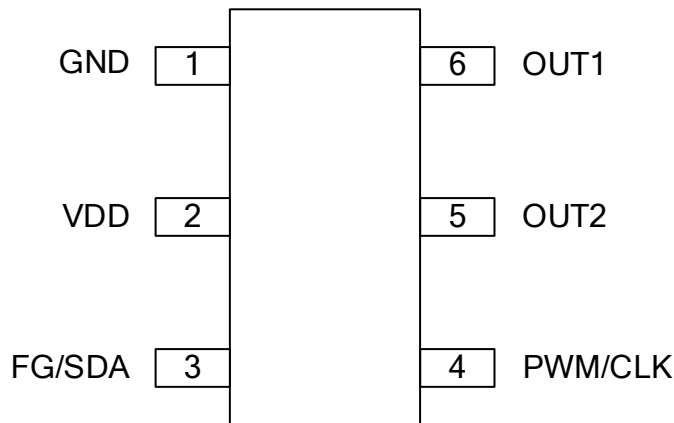


Figure 3 NSUC1611 SOT23-6L Package

DFN10	SOT23-6L	Symbol	IO Type	Function
1	4	PWM/CLK	Signal Input	PWM: PWM input signal for speed or duty control CLK: I ² C clock input
5	2	VDD	Power+	Positive power supply
3	6	OUT1	Power Output	Half-bridge output 1 (connects to fan winding 1)
6	5	OUT2	Power Output	Half-bridge output 2 (connects to fan winding 2)
8	1	GND	Power-	Negative power supply (ground)
10	3	FG/SDA	Signal Output	FG: PWM output signal indicating current speed RD: Motor running status output SDA: I ² C data input/output (bidirectional)
EP	/	Thermal Pad	Thermal Pad	Thermal pad
2,7,8,9	/	NC	NC	No connect pin

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply voltage	V_{DD}	-0.3		40	V	
OUTx pin voltage	V_{OUT}	-0.3		40	V	
PWM pin voltage	V_{PWM}	-0.3		40	V	
FG output voltage	V_{FG}	-0.3		40	V	
Storage temperature	$T_{storage}$	-40		150	°C	
Junction temperature	T_J	-40		150	°C	
Operation temperature	$T_{operation}$	-40		125	°C	
Lead soldering temperature	T_{Lead}		260		°C	

3. ESD Ratings

Ratings			Value	Unit
Electrostatic discharge	Human body model (HBM), per AEC-Q100-002-RevD		±2	kV
	Charged device model (CDM), per AEC-Q100-011-RevB		±1	kV

4. Specifications

4.1. General Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply voltage	V_{DD}	5.5		32	V	
Supply current	I_{DD}		5		mA	
Sleep current	I_{Sleep}			50	uA	

4.2. Driver Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Output PWM frequency	f_{out}		24		kHz	
Output PWM resolution	D_{COUNT_RES}		9		bit	
RCO tolerance	TOLRCO	-5		5	%	-40°C < T_J < 150°C
Closed loop speed tolerance	TOLCLSP		TBD		%	

4.3. Protection Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Over voltage Protection threshold ON	V_{OV_TH}	17.3	18.3	19.3	V	
		20.8	22	23.2	V	
		28.9	30.3	31.8	V	

Over voltage Protection threshold Hysteresis	V_{OV_hyst}		1		V	
Over voltage filter time	t_{OV_flt}		41.6		us	
Over voltage blanking time	t_{OV_blank}		2		ms	
Under voltage threshold	V_{UV_TH}	7	7.5	8	V	
Under voltage hysteresis	V_{UV_hyst}		0.5		V	
Under voltage debounce time	t_{UV_dbc}		1.5		ms	
Over current protection	I_{PROT}		2100		mA	for D version
			1575		mA	for C version
			1050		mA	for B version
			525		mA	for A version
Over current blank time	t_{OC_blank}		2		us	
Over current debounce time	t_{OC_dbc}		2		us	
Time between over current retrials	$t_{Iretrial_PROT}$		5		ms	Auto restart after IPROT event.
Current limit	I_{CLIM}		1400		mA	for D version
			1050		mA	for C version
			700		mA	for B version
			350		mA	for A version
Current limit blank time	t_{CL_blank}		2		us	
Current limit debounce time	t_{CL_dbc}		2		us	
Thermal shutdown threshold	TSD	155	165	175	°C	
Thermal shutdown hysteresis	T_{HYS}		35		°C	

4.4. HALL Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Hall positive magnetic threshold	B_{OP}	0	1.5	3.0	mT	$T_J < 150^{\circ}\text{C}$
Hall negative magnetic threshold	B_{RP}	-3.0	-1.5	0	mT	$T_J < 150^{\circ}\text{C}$

4.5. IO Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	Comments
PWM input low voltage	V_{IL}			1.0	V	
PWM input high Voltage	V_{IH}	2.3			V	$V_{IH} \leq V_{DD}$
PWM internal pull up voltage	V_{PWMPU}		5		V	

PWM internal pull-up resistance	R_{PWM}		100		kΩ	
SDA input low voltage	V_{IL}			1.0	V	IIC mode
SDA input high voltage	V_{IH}	2.3			V	IIC mode
FG output low voltage	V_{FG_OL}			0.4	V	

4.6. INPUT PWM Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Input PWM resolution	D_{CIN_RES}		7		bit	
PWM Input Integration time slow	t_{INT_slow}		85.3		ms	
PWM input frequency range	f_{pwm_input}	50		100k	Hz	

4.7. I²C Timing Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	Comments
SCL Clock Frequency	f_{IIC_CLK}	3		400	kHz	
Bus Free-Time Between Stop/Start	t_{BUF}	1.3			us	
Hold Time Start Condition	$t_{HD:STA}$	0.6			us	
Setup Time for Start Condition	$t_{SU:STA}$	0.6			us	
SCL Low Time	t_{LOW}	1.3			us	
SCL High Time	t_{HIGH}	0.6			us	
Data Setup Time	$t_{SU:DATA}$	100			ns	
Data Hold Time	$t_{HD:DATA}$	0			ns	
Setup Time for Stop Condition	$t_{SU:STO}$	0.6			us	

5. REG / OTP Memory

Address	Bits	Parameter Name	Description	Default Value
0x00	6:0	INPUT_MIN	Transfer curves - The INPUT setting for point MIN	0x0D
	15:7	OUTPUT_MIN	Transfer curves - The OUTPUT setting for point MIN	0x33
0x02	6:0	INPUT_A	Transfer curves - The INPUT setting for point A	0x33
	15:7	OUTPUT_A	Transfer curves - The OUTPUT setting for point A	0xCC
0x04	6:0	INPUT_B	Transfer curves - The INPUT setting for point B	0x59
	15:7	OUTPUT_B	Transfer curves - The OUTPUT setting for point B	0x166
0x06	6:0	INPUT_MAX	Transfer curves - The INPUT setting for point MAX	0x78
	15:7	OUTPUT_MAX	Transfer curves - The OUTPUT setting for point MAX	0x1FF

0x08	2:0	INPUT_LC_VALUE	Transfer curve low clamping input value 0x0: 4.8% (6) 0x1: 7.2% (9) 0x2: 9.6% (12) 0x3: 12.0% (15) 0x4: 14.4% (18) 0x5: 16.8% (21) 0x6: 19.2% (24) 0x7: 21.6% (27)	0x0
	3	OUTPUT_LC_VALUE	Target clamping value for the low clamp region 0x0: 0 0x1: OUTPUT_MIN	0x0
	6:4	INPUT_HC_VALUE	Transfer curve high clamping input value 0x0: 96.0% (122) 0x1: 94.4% (120) 0x2: 93.0% (118) 0x3: 91.4% (116) 0x4: 89.8% (114) 0x5: 88.2% (112) 0x6: 86.6% (110) 0x7: 85.0% (108)	0x0
	7	OUTPUT_HC_VALUE	Target clamping value for the high clamp region 0x0: 0 0x1: OUTPUT_MAX	0x1
	9:8	INPUT_HC_LC_HYST	Transfer curve hysteresis of the clamp threshold values: 0x0: 0.8% (1) 0x1: 1.6% (2) 0x2: 2.4% (3) 0x3: 3.2% (4)	0x0
	12:10	INPUT_PLATEAU	Plateau duty for the jump points 0x0: Plateau is extended with 1.6% (2) 0x1: Plateau is extended with 3.2% (4) 0x2: Plateau is extended with 4.8% (6) 0x3: Plateau is extended with 6.4% (8) 0x4: Plateau is extended with 8.0% (10) 0x5: Plateau is extended with 9.6% (12) 0x6: Plateau is extended with 11.2% (14) 0x7: Plateau is extended with 12.8% (16) PLATEAU HYST is 0.8%	0x0
	13	DRV_DIR	Configure output direction 0x0: The output direction (versus magnetic pole) is default 0x1: The output direction (versus magnetic pole) is inverted	0x0

	14	SLEEP_EN	Sleep mode enable 0x0: disable sleep mode 0x1: device will enter sleep mode automatically, if not no sleep mode is possible (ignored in I2C mode)	0x0
	15	SPEED_FILTER	Speed Filter Enable: 0x0: Disable speed filter 0x1: Enable speed filter	0x0
0x0A	2:0	FG_RD_PIN_MUX	Configure FG/RD output 0x0: FG 0x1: FG FREQ DIV 2 0x3: RD initialized high 0x4: RD initialized low other: RSV	0x0
0x0A	3	CURRENT_LIMIT_EN	Current limit enable 0x0: Disable current limit 0x1: Enable current limit	0x1
	8:4	CURRENT_LIMIT_STARTUP	Current limit for motor operation Threshold = (CURRENT_LIMIT_STARTUP+1)*43.8mA for Version D Threshold = (CURRENT_LIMIT_STARTUP+1)*32.8mA for Version C Threshold = (CURRENT_LIMIT_STARTUP+1)*21.9mA for Version B Threshold = (CURRENT_LIMIT_STARTUP+1)*10.9mA for Version A	0x1F
	15:9	CURRENT_LIMIT_RUN	Current limit for motor operation Threshold = (CURRENT_LIMIT_RUN+1)*10.9mA for Version D Threshold = (CURRENT_LIMIT_RUN+1)*8.2mA for Version C Threshold = (CURRENT_LIMIT_RUN+1)*5.5mA for Version B Threshold = (CURRENT_LIMIT_RUN+1)*2.7mA for Version A	0x7F
0x0C	1:0	STARTUP_DUTY	Startup DC_OUT 0x0: 12.5% 0x1: 25% 0x2: 50% 0x3: 100%	0x0
	3:2	LRP_TIMEOUT	Ton_start: Locked Rotor Protection ON time during start-up 0x0: 0.32s 0x1: 0.41s 0x2: 0.49s 0x3: 0.98s Note : Ton_run = 0.32s (fixed)	0x0

	5:4	LRP_TRI1	Initial number of LRP trials with LRP tOFF = LRP tON_start 0x0: 1 0x1: 2 0x3: 3 0x4: 4	0x0
	7:6	LRP_TRI2	Number of LRP trials with LRP Toff = LRP Ton_start after first Toff activation 0x0: 1 0x1: 2 0x2: 3 0x3: 4	0x0
	10:8	LRP_RATIO	t _{OFF_diagn} /t _{ON_start} ratio selection 0x0: 8 0x1: 10 0x2: 12 0x3: 16 0x4: 24 0x5: 28 0x6: 32 0x7: 36	0x0
	11	OL_CL_SELECT	Open loop or speed loop 0x0: Open loop 0x1: Speed loop	0x1
	12	DC_OUT_CHANGE_RATE	DC_OUT change rate selection 0x0: DC_OUT change rate = 50%/s 0x1: DC_OUT change rate = 100%/s	0x0
	15:13	PI_ACC_FACTOR	Closed loop (PI) speed regulation 0x0: Acceleration factor = 0.075 0x1: Acceleration factor = 0.15 0x2: Acceleration factor = 0.3 0x3: Acceleration factor = 0.6 0x4: Acceleration factor = 1.2 0x5: Acceleration factor = 1.8 0x6: Acceleration factor = 2.4 0x7: Acceleration factor = 3.2	0x4
0x0E	1:0	PI_DEC_FACTOR	Options to reduce PI during deceleration in closed loop 0x0: deceleration = acceleration 0x1: deceleration = acceleration / 2 0x2: deceleration = acceleration / 4 0x3: deceleration = acceleration / 8	0x2
	7:2	SPEED_MAX_FACTOR1 6bit	For OL_CL_SELECT = 1, MAXSP = (120/PP*FOUT) / (2^(SPEED_MAX_FACTOR2) * (32 + SPEED_MAX_FACTOR1))	0x0

	9:8	SPEED_MAX_FACTOR2 2bit	Where MAXSP unit is mRPM, Fout is 24k, PP is Rotor Pole Pairs	0x0
	10	ADAPTIVE_FLAT_DIS	Adaptive flat when run disable 0x0: Enable when run (Init flat time = FLAT_TIME) 0x1: Disable (fixed flat time = FLAT_TIME)	0x1
	11	FLAT_TIME	Init flat time 0x0: Init Flat time is 2/16 of EHP, max 4ms 0x1: Init Flat time is min (2 PWM period)	0x1
	13:12	RISING_SLOPE	Rising slope 0x0: disable 0x1: 1/16 0x2: 2/16 0x3: Super-soft (2/16+4/16)	0x1
	15:14	FALLING_SLOPE	Falling slope 0x0: disable 0x1: 1/16 0x2: 2/16 0x3: Super-soft (2/16+4/16)	0x1
0x10	6:0	LEAD_ANGLE	Lead angle 0x0 = 0 (disable lead time) 0x1 = 0.36 ... 0x3F = 45.64	0x0
	7	MOTOR_IDLE_LSRECIRC	The H-bridge output state during idle mode 0x0: Hi-Z mode 0x1: VBEMF > VMAX_BEMF_BRAKE: H-bridge in Hi-Z to protect it from excessive current VBEMF ≤ VMAX_BEMF_BRAKE: H-bridge in passive brake mode	0x0
	14:8	MAX_BEMF_BRAKE	Maximum BEMF voltage to allow LS recirculation brake (MAX_BEMF_BRAKE[6:0]+1)*250mV	0x0
	15	UV_Enable	Under voltage protection options 0: Disable, motor continuous running 1: Enable, motor stop	0x0
0x12	1:0	RSV	RSV	0x0
	2	OC_RETRY_TIME	IPROT endless repeat enable 0x0: Up to 3 consecutive IPROT activations. 0x1: Unlimited number of IPROT activations.	0x0

	3	RSV	RSV	0x0
	5:4	OV_PROT	Overvoltage level selection 0x0: 18V 0x1: 22V 0x2: 28V 0x3: Disable	0x0
	13:6	CRC	CRC-8	0x0
	14	CRC_DISABLE	CRC check disable 0x0: Enable CRC check. If CRC Check error, motor will not operation 0x1: Disable CRC check.	0x1
	15	OTP_FLAG	0x0: OTP not write 0x1: OTP has written	0x0
0x14	7:0	CHIP ID 0	Chip ID, read only	0x0
	15:8	CHIP ID 1	Chip ID, read only	0x0
0x16	7:0	CHIP ID 2	Chip ID, read only	0x0
	15:8	RSV		0x0

6. Application Note

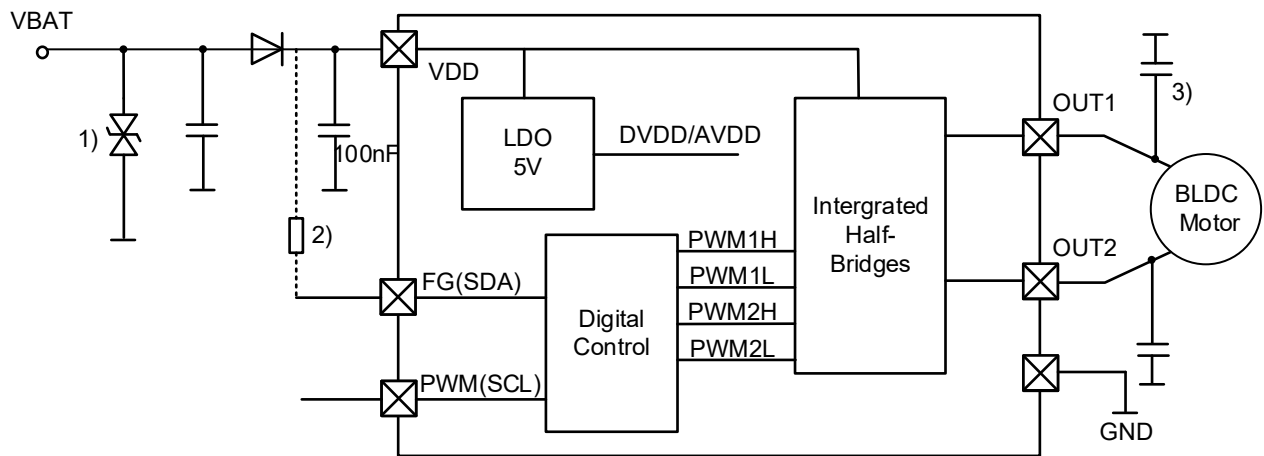


Figure 6.1 Typical application diagram

- 1) TVS diode or decoupled capacitor is recommended with respect to ISO7637-2 Pulse 2a.
- 2) A pull up resistor is necessary to connect FG pin to VDD or other power.
- 3) OUT capacitor is recommended with respect to EMI test.

7. Package Information

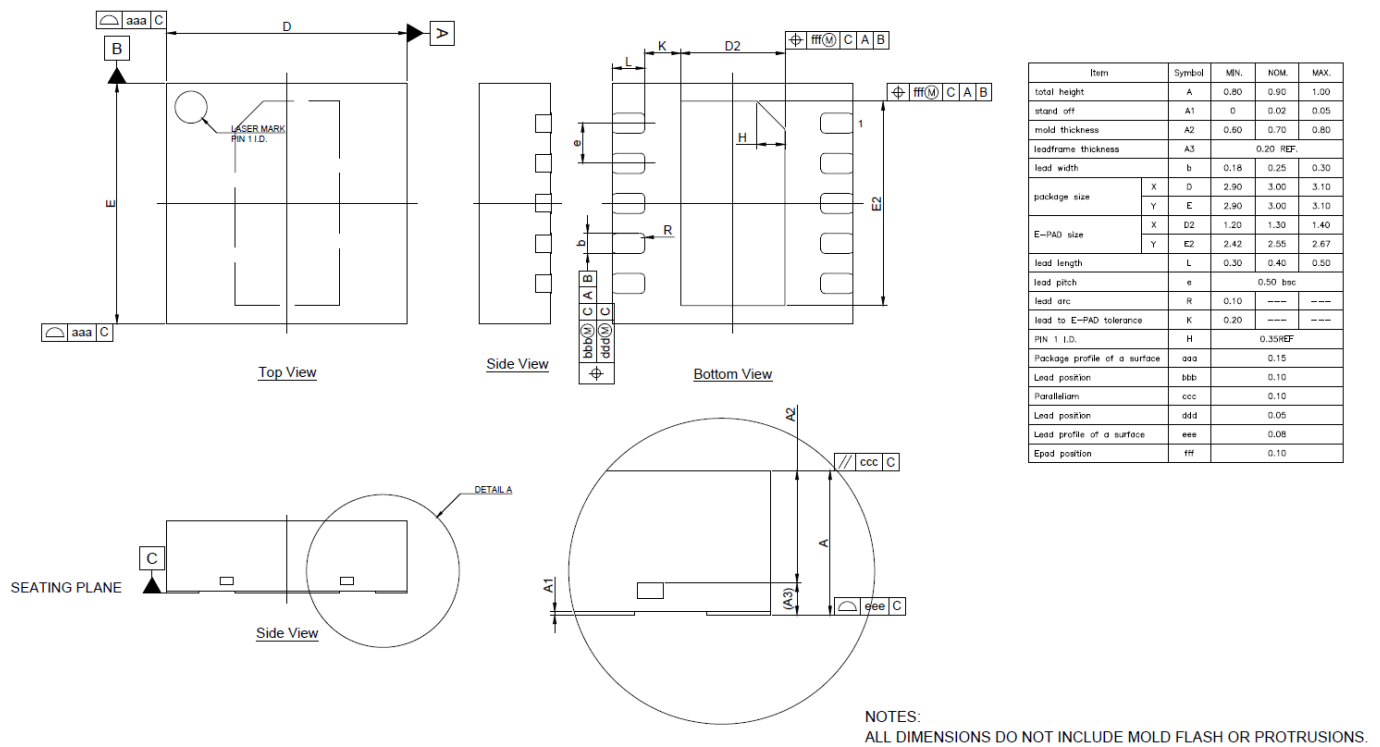


Figure 7.1 DFN10(3*3) Package Shape and Dimension in millimeters

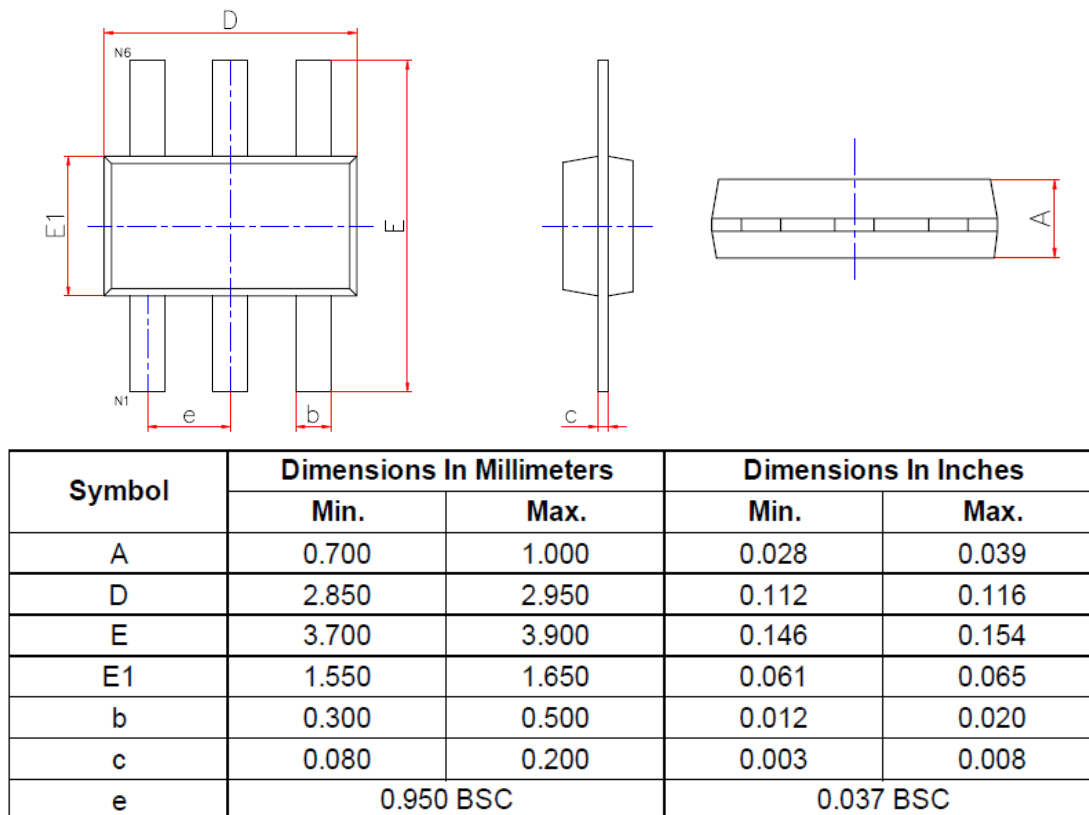


Figure 7.2 SOT23-6L(2.9*1.6) Package Shape and Dimension in millimeters

8. Ordering Information

Standard Ordering Item No.:

<i>Part Number</i>	<i>Temperature</i>	<i>Power Supply Voltage (V)</i>	<i>Package</i>	<i>MSL</i>	<i>SPQ</i>
NSUC1611D-Q1DAHR	-40~125°C	12	DFN10	TBD	5000
NSUC1611D-Q1STGR	-40~125°C	12	SOT23-6L	TBD	5000

9. Revision History

Revision	Description	Date
0.0	Initial version.	2025/10/22
0.1	Add Application and package information	2026/3/24
0.2	Revise the pin description for the SOT23 package.	2026/6/9

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