3-CHANNEL SPEECH+MELODY
POWERSPEECH® SERIES

N588H

DATA SHEET

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1. General Description

The N588Hxxx is an advanced 3-ch Voice/Melody IC that combines with the technology of 8-bit 65C02 core and new 4-bit or 5-bit MDPCM synthesizer to implement sophisticated applications in high level of sound quality.

The N588Hxxx improves the structure to minimize the external components for various applications. In addition, it allows customers to use internal Rosc with precise frequency control to save BOM cost and gain lower frequency deviation.

Furthermore, the N588Hxxx provides lots of function includes 16 ~ 24 I/Os where one port with high drive current, 128 ~ 192 Bytes RAM, H/W IR carrier, 2-ch Comparator and Low Voltage Detection. Meanwhile, N588Hxxx builds in 3-pair output pins with 64-level control for the applications of motors tiny control. The N588Hxxx also build in Watch Dog Timer and Low Voltage Reset to prevent latch-up situation occurring.

The N588Hxxx family contains several items with different playback ROM size and duration as shown below table:

N588Hxxx	H061	H081	H120	H170	H200	*H201	H250	*H251	H340	*H341	H480	H650
ROM (KB)	206	254	414	510	704	704	830	830	1020	1020	1534	2044
Sec. (NM4, 6KHz)	65	80	131	162	223	223	263	263	324	324	486	648
I/O	16	16	16	16	24	24	24	24	24	24	24	24

*N588H201, N588H251, N588H341 no support LVD

2. Features

- VDD range:
  - 4MHz/6MHz: 2.2 ~ 5.5V
  - 8MHz: 2.6 ~ 5.5V
- System clock: 4, 6, 8 MHz
- Oscillator: builds in internal Rosc (TRIM)
- RAM: 128B ~ 192B
- 16 ~ 24 bi-directional I/O pins
  - BP00 ~ BP07, BP10 ~ BP17 can be set as Input or Output status individually
- Provides 8-pin with high sink current capability to drive LEDs
- 3-pair H/W PWM I/O pins with 6-bit resolutions to control motor
  - BP00/02/04 are defined as 3 H/W PWM I/O pins. They can be paired with BP01/03/05 respectively by same (or opposite) phase of output waveform
- Builds in IR carrier generation circuit for simplifying firmware IR application
- Algorithm: 4-bit NM4, 4-bit NM4S, 5-bit MDM
- Audio output: 12-bit PWM
- Channel: 3-channel Voice or Melody
  - 3-ch Voice
  - 3-ch Melody
  - 1-ch Voice + Dual tone melody
- Built-in Watch-Dog Timer (WDT)
- 3 voltage levels of Low Voltage Reset (LVR) by mask option
  - LVR: 2.0V, 2.2V, 2.7V
- Builds in Low Voltage Detection (LVD) with 4 voltage levels
  - LVD: 2.2V, 2.4V, 2.7V, 3.3V (N588H201, N588H251, N588H341 no support LVD)
- Built-in 2-channel comparator
- Support ***PowerScript™*** for developing codes in easy way
- Full-fledged development system
  - Source-level ICE debugger (Assembly & ***PowerScript™*** format)
  - ***Ultra I/O™*** tool for event synchronization mechanism
- Available package form:
  - COB is essential
  - Package SOP14 (150 mil): N588H061, N588H081; 5 x IO

- Package SOP14 (150 mil): N588H120, N588H170; 4 x IO
- Package SOP20 (300 mil): N588H061, N588H081, N588H120, N588H170; 8 x IO
- Package LQFP48 (7x7 mm): N588H061, N588H081, N588H120, N588H170; 16 x IO
- Package LQFP48 (7x7 mm): N588H200, N588H250, N588H340; 20 x IO
- Package LQFP64 (7x7 mm): N588H200, N588H250, N588H340; 24 x IO
- Package LQFP64 (10x10 mm): N588H480, N588H650; 17 x IO
- Package LQFP128 (14 x 14 mm): N588H480, N588H650; 24 x IO

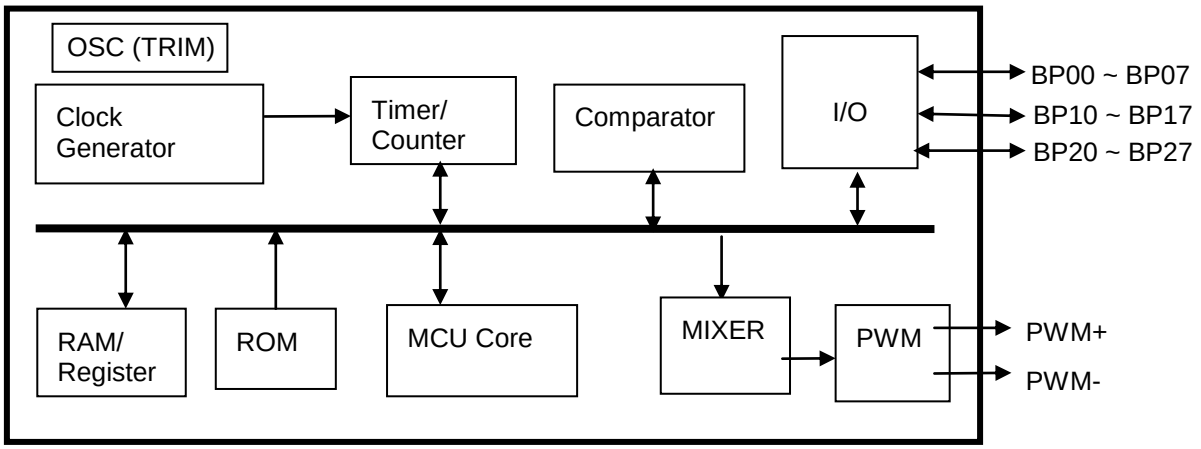
3. Pin Description

Pin Name	I/O	Function
/RESET	I	IC reset input, low active.
BP00 ~ BP07	I/O	● General input/output pins. ● Each pin can be set as Input or Output individually. ● When the pin will be set output by BP0D, user needs to set BP0x value of 0/1 first. ● For output pin, BP0 provides high-sink current. ● For input pin, it can be set as pull-high or floating ● BP00/02/04 can be set as 3-pin H/W PWM output with 64-level resolution. They can be paired with BP01/03/05 (also H/W PWM output) respectively with same or opposite phase of output waveform ● BP07 can be configured as IR carrier output
BP10 ~ BP17	I/O	● General input/output pins. ● Each pin can be set as Input or Output individually. ● When the pin will be set output by BP1D, user needs to set BP1x value of 0/1 first. ● For input pin, it can be set as pull-high or floating. ● BP1 can generate interrupt request to release IC from STOP mode
*BP20 ~ BP27	I/O	● General input/output pins. ● Each pin can be set as Input or Output by group, BP20 ~ BP23 configured by BP2D[0], and BP24 ~ BP27 by BP2D[1]. ● When the pin will be set output by BP2D, user needs to set BP2x value of 0/1 first.
PWM+	O	PWM driver positive output to drive speaker directly
PWM-	O	PWM driver negative output to drive speaker directly
VDD	Power	Positive power supply for uP and peripherals
VSS	Power	Negative power supply for oscillation, uP and peripherals
VDD_IO	Power	Positive power supply for I/O
VSS_IO	Power	Negative power supply for I/O

Pin Name	I/O	Function
VDD_SPK	Power	Positive power supply for speaker driver
VSS_SPK	Power	Negative power supply for speaker driver

Note: BP20 ~ BP27 only provides in N588H200/201, N588H250/251, N588H340/341, N588H480 and N588H650

4. Block Diagram



5. Electrical Characteristics

5.1 Absolute Maximum Ratings

Parameter	Symbol	Conditions	Rated Value	Unit
Power Supply	VDD–VSS	-	-0.3 to +7.0	V
Input Voltage	VIN	All Inputs	VSS -0.3 to VDD +0.3	V
Storage Temp.	TSTG	-	-55 to +150	°C
Operating Temp.	TOPR	-	0 to +70	°C

Note: Exposure to conditions beyond those listed under the Absolute Maximum Ratings table may adversely affect the life and reliability of the device.

5.2 D.C. Characteristics

(VDD – VSS = 4.5V, TA = 25° C, No Load unless otherwise specified)

Parameter	Sym	Conditions	Min	Typ	Max	Unit
Operating Voltage	V_{DD}	F_{OSC} = 4 MHz	2.2	-	5.5	V
		F_{OSC} = 6 MHz	2.2	-	5.5	V
		F_{OSC} = 8 MHz	2.6		5.5	V
Operating Current	I_{OP1}	No load, F_{OSC} = 6 MHz N588H061 ~ N588H341	-	5	7	mA
		No load, F_{OSC} = 6 MHz N588H480, N588H650	-	7.5	9.5	mA
Standby Current (STOP)	I_{DD1}	No load	-	1	2	µA

Input Low Voltage	V_{IL}	All input pins	V_{SS}	-	0.3 V_{DD}	V
Input High Voltage	V_{IH}	All input pins	0.7 V_{DD}	-	V_{DD}	V
Input Current BP0, BP1, BP2	IIN1	VIN = 0V, pulled-high resistor = 500KΩ	-5	-9	-14	µA
Input Current BP0,BP1, BP2	IIN2	VIN = 0V, pulled-high resistor = 150KΩ	-15	-30	-45	µA
Output Current (BP0)	I_{OL}	V_{DD} = 3V, V_{OUT} = 0.4V	8	12	-	mA
	I_{OH}	V_{DD} = 3V, V_{OUT} = 2.6V	-4	-6	-	mA
	I_{OL}	V_{DD} = 4.5V, V_{OUT} = 1.0V	-	25	-	mA
	I_{OH}	V_{DD} = 4.5V, V_{OUT} = 3.5V	-	-12	-	mA
Output Current (BP1, BP2)	I_{OL}	V_{DD} = 3V, V_{OUT} = 0.4V	4	5	-	mA
	I_{OH}	V_{DD} = 3V, V_{OUT} = 2.6V	-4	-6	-	mA
	I_{OL}	V_{DD} = 4.5V, V_{OUT} = 1.0V	-	12	-	mA
	I_{OH}	V_{DD} = 4.5V, V_{OUT} = 3.5V	-	-12	-	mA
Output Current PWM+ / PWM-	I_{OL1}	RL= 8Ω [PWM+]---[RL]----[PWM-]	+250	-	-	mA
	I_{OH1}		-250	-	-	mA
Comparator input common mode range	VCM	VDD=2.2 ~ 5.5V	0.1		VDD-1.5	V
Comparator input offset voltage	V_{OS}	External (Vcm=2.5V)		50	-	mV
*LVD detect voltage	V_{LVD}	CTL_CPU [5,3] = 0_1 CTL_CPU [5,3] = 1_1 CTL_CPU [5,3] = 0_0 CTL_CPU [5,3] = 1_0	-	2.2 2.4 2.7 3.3	-	V

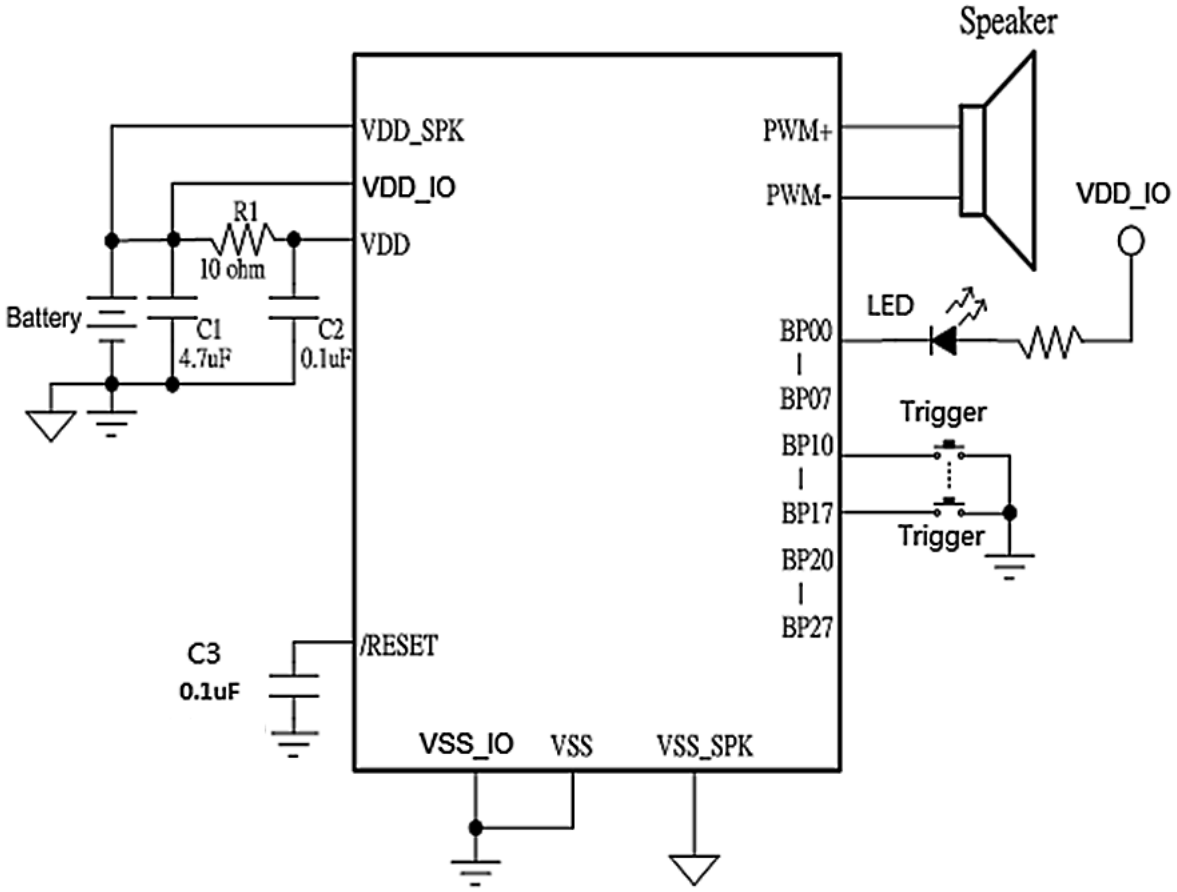
Note*: N588H201, N588H251, N588H341 no support LVD

5.3 A.C. Characteristics

(VDD = 4.5V, TA = 25°C, No Load unless otherwise specified)

Parameter	Sym	Conditions	Min	Typ	Max	Unit
Main Clock Frequency	FM	F_{OSC} = 4 MHz F_{OSC} = 6 MHz F_{OSC} = 8 MHz	3973 5960 7946	4096 6144 8192	4219 6328 8438	KHz
Frequency Deviation by Voltage Drop	ΔF/F	(Fmax – Fmin)/Fmin @VDD: 2.4 ~ 4.5V	-	2	-	%

6. Application Circuit



Note:

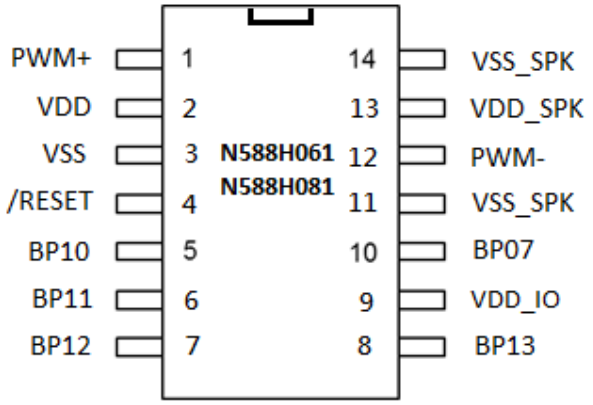
- For general applications, C1 (4.7uF) is must to stable system power
- For motor application, the C1 (4.7uF), C2 (0.1uF), and R1 (10Ω) are all necessary
- C1 value need to be adjusted according to the loading, such as motor control application.
- C3 (0.1uF) is required to stabilize reset signal

7. Package Information

N588H061 / N588H081

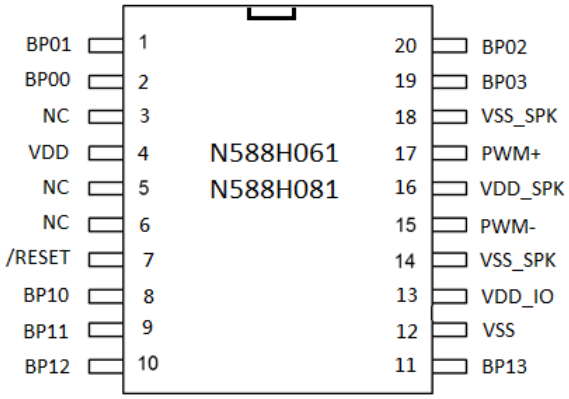
SOP14 (150 mil)

GPIO: BP10 ~ BP13, BP07, (5 x I/O)



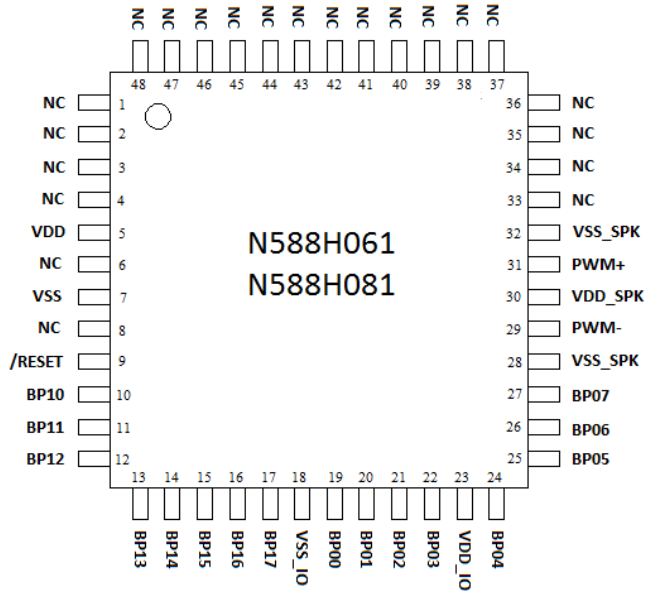
SOP20 (300 mil)

GPIO: BP00 ~ BP03, BP10 ~ BP13, (8 x I/O)



LQFP48 (7x7x1.4mm footprint 2.0mm)

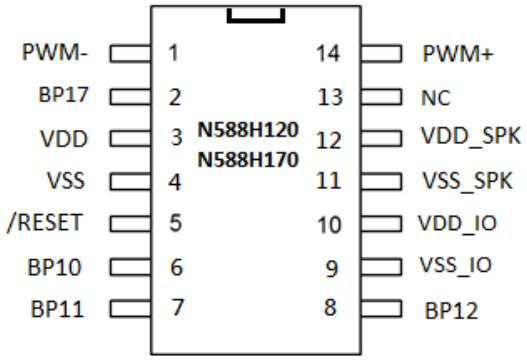
GPIO: BP00 ~ BP07, BP10 ~ BP17, (16 x I/O)



N588H120 / N588H170

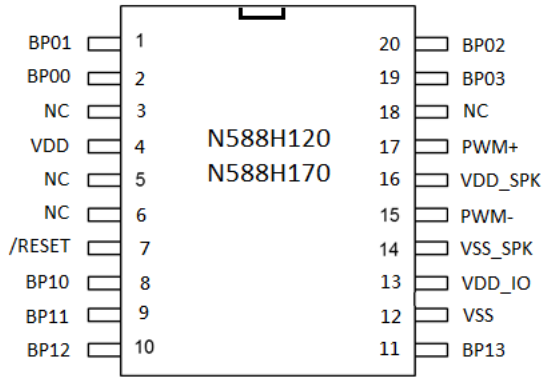
SOP14 (150 mil)

GPIO: BP10, 11, 12, 17 (4 x I/O)



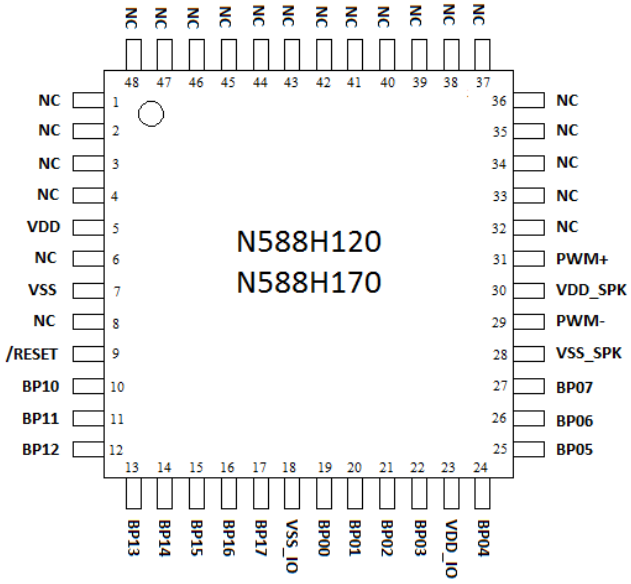
SOP20 (300 mil)

GPIO: BP00~ 03, BP10 ~ 13, (8 x I/O)



LQFP48 (7x7x1.4mm footprint 2.0mm)

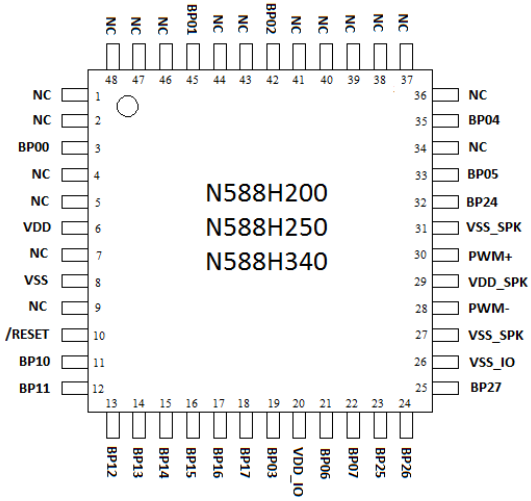
GPIO: BP00 ~ BP07, BP10 ~ BP17, (16 x I/O)



N588H200 / N588H250 / N588H340

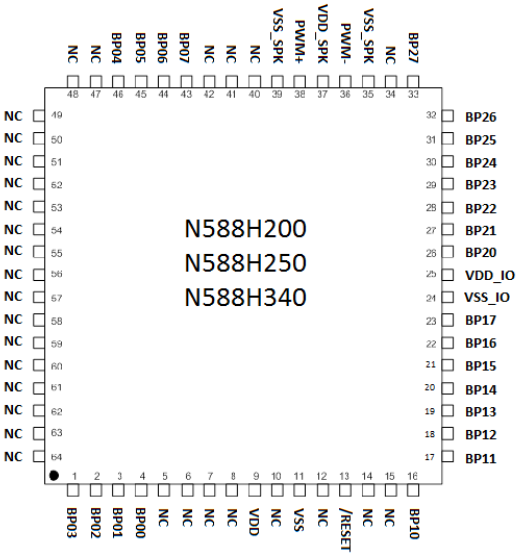
LQFP48 (7x7x1.4mm footprint 2.0mm)

GPIO: BP00 ~ BP07, BP10 ~ BP17, BP24 ~ BP27 (20 x I/O)



LQFP64 (7x7x1.4mm footprint 2.0mm)

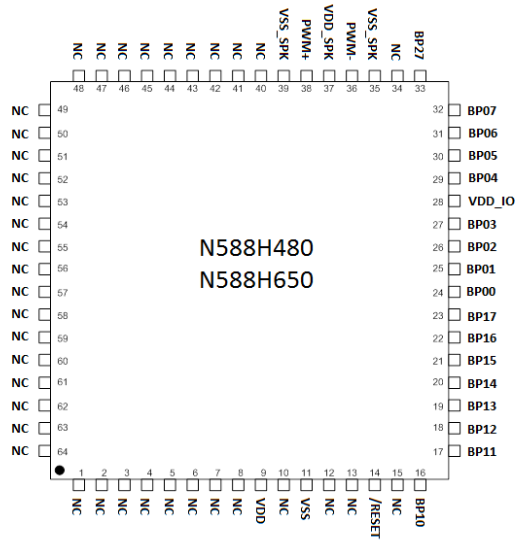
GPIO: BP0, BP1, BP2 (24 x I/O)



N588H480 / N588H650

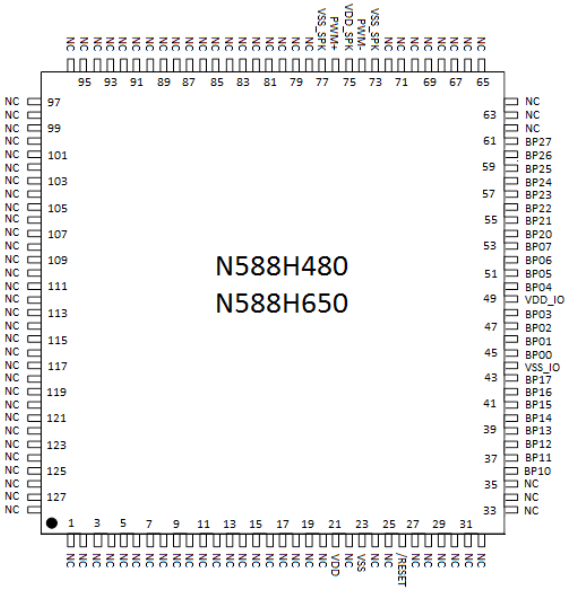
LQFP64 (10x10x1.4mm footprint 2.0mm)

GPIO: BP00 ~ 07, BP10 ~ 17, BP27 (17 x I/O)

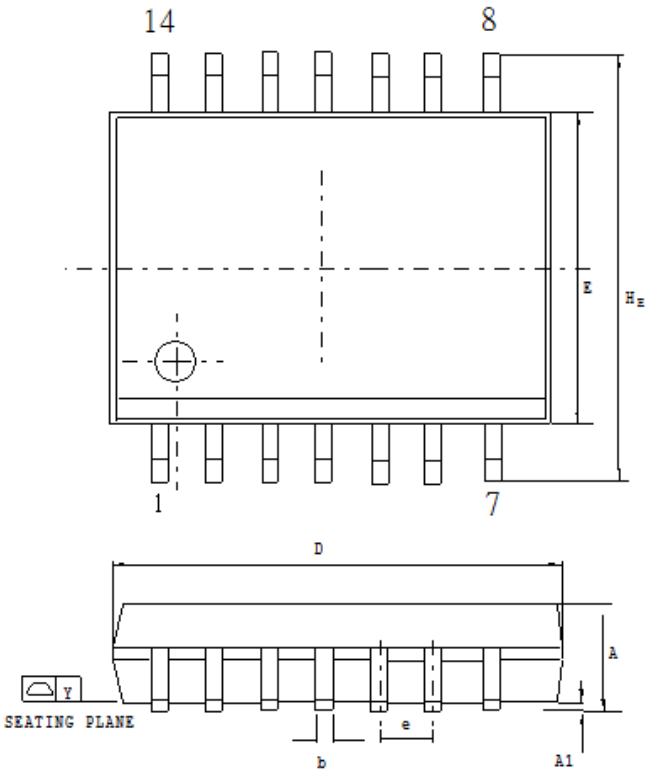


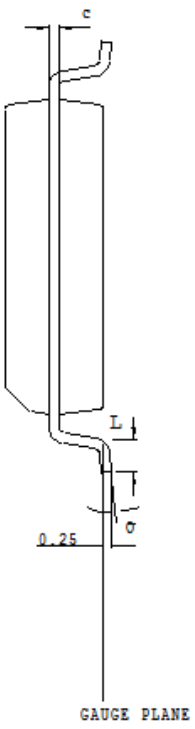
LQFP128 (14 x 14 x 1.4mm footprint 2.0 mm)

GPIO: BP0, BP1, BP2 (24 x I/O)



Package Dimension (SOP14, 150 mil)

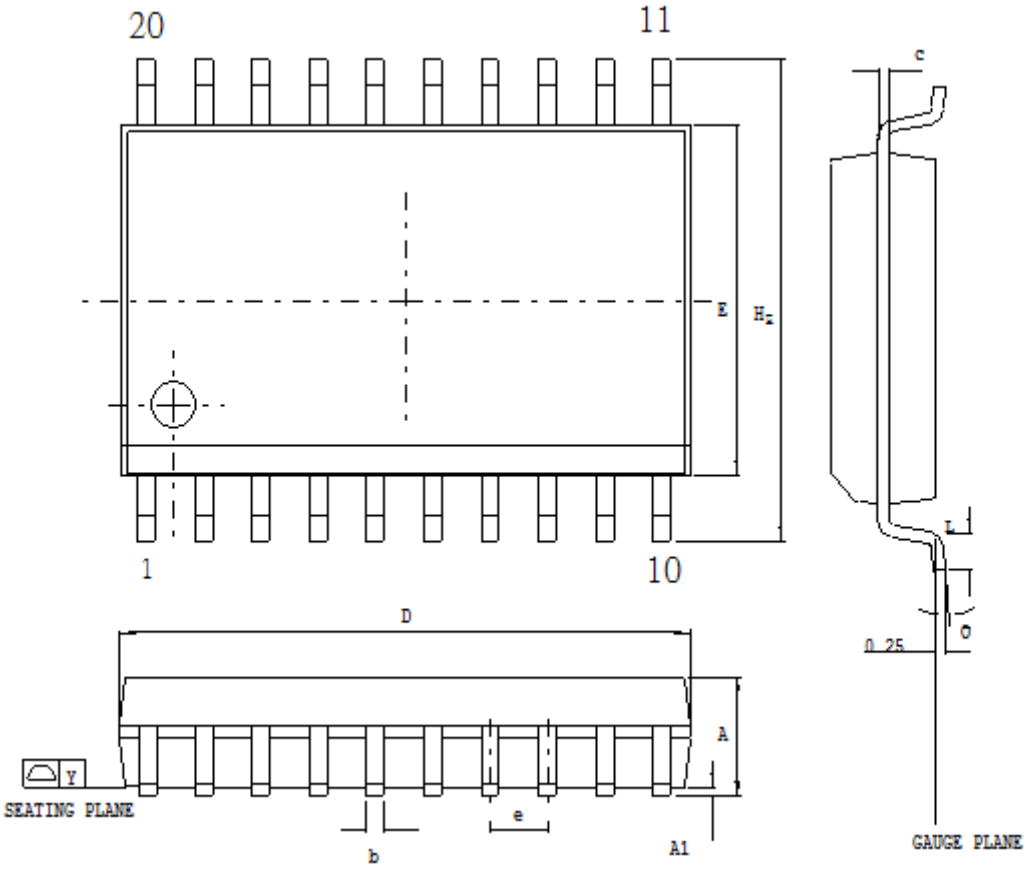




Control demensions are in milmeters .

SYMBOL	DIMENSION IN MM		DIMENSION IN INCH	
	MIN.	MAX.	MIN.	MAX.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
b	0.33	0.51	0.013	0.020
c	0.19	0.25	0.008	0.010
E	3.80	4.00	0.150	0.157
D	8.55	8.75	0.337	0.344
e	1.27 BSC		0.050 BSC	
H_E	5.80	6.20	0.228	0.244
Y	—	0.10	—	0.004
L	0.40	1.27	0.016	0.050
θ	0	8	0	8

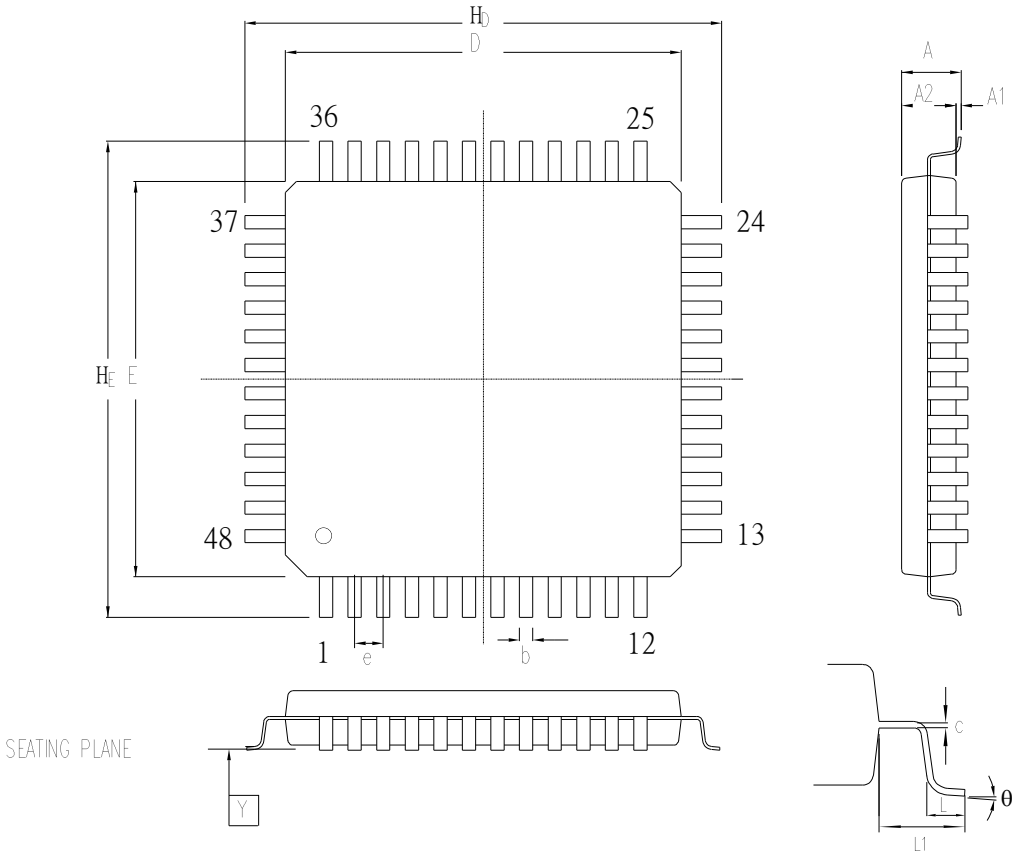
Package Dimension (SOP20, 300 mil)



Control demensions are in milmeters .

SYMBOL	DIMENSION IN MM		DIMENSION IN INCH	
	MIN.	MAX.	MIN.	MAX.
A	2.35	2.65	0.093	0.104
A1	0.10	0.30	0.004	0.012
b	0.33	0.51	0.013	0.020
c	0.23	0.32	0.009	0.013
E	7.40	7.60	0.291	0.299
D	12.60	13.00	0.496	0.512
e	1.27 BSC		0.050 BSC	
H_E	10.00	10.65	0.394	0.419
Y	—	0.10	—	0.004
L	0.40	1.27	0.016	0.050
θ	0	8	0	8

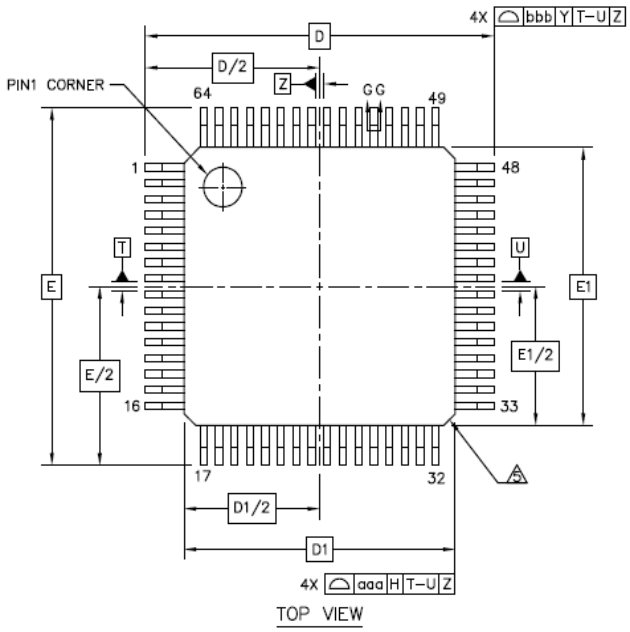
Package Dimension (LQFP48, 7x7x1.4mm, footprint 2.0mm)

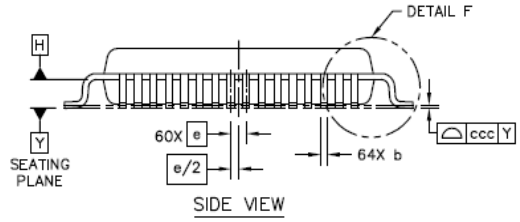


Controlling dimension : Millimet

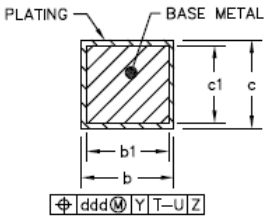
Symbol	Dimension in inch			Dimension in mm		
	Min	Nom	Max	Min	Nom	Max
A	—	—	—	—	—	—
A_1	0.002	0.004	0.006	0.05	0.10	0.15
A_2	0.053	0.055	0.057	1.35	1.40	1.45
b	0.006	0.008	0.010	0.15	0.20	0.25
c	0.004	0.006	0.008	0.10	0.15	0.20
D	0.272	0.276	0.280	6.90	7.00	7.10
E	0.272	0.276	0.280	6.90	7.00	7.10
e	0.014	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

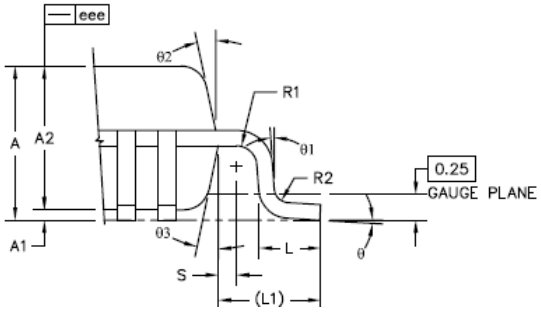
Package Dimension (LQFP64, 7x7x1.4mm, footprint 2.0mm)



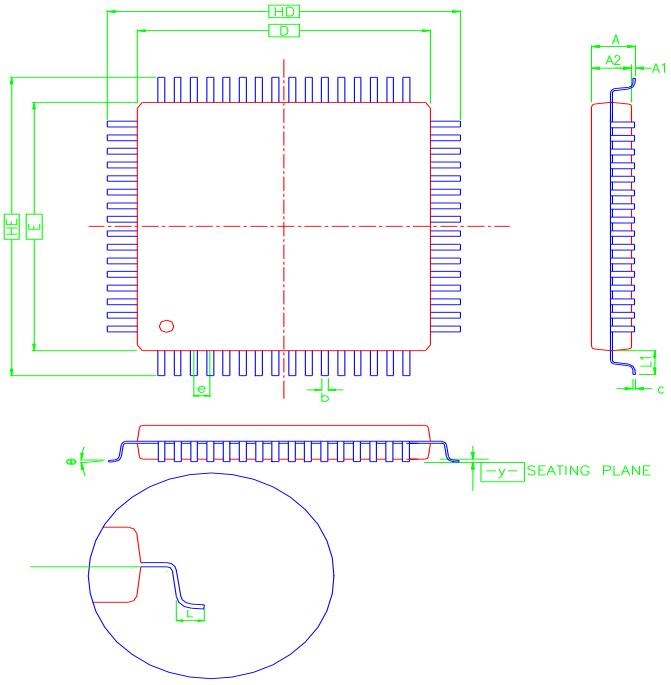


		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	---	---	1.6
STAND OFF		A1	0.05	---	0.15
MOLD THICKNESS		A2	1.35	1.4	1.45
LEAD WIDTH(PLATING)		b	0.13	0.18	0.23
LEAD WIDTH		b1	0.13	0.16	0.19
L/F THICKNESS(PLATING)		c	0.09	---	0.2
L/F THICKNESS		c1	0.09	---	0.16
BODY SIZE	X	D	9 BSC		
	Y	E	9 BSC		
	X	D1	7 BSC		
	Y	E1	7 BSC		
LEAD PITCH		e	0.4 BSC		
		L	0.45	0.6	0.75
FOOTPRINT		L1	1 REF		
		θ	0°	3.5°	7°
		θ1	0°	---	---
		θ2	11°	12°	13°
		θ3	11°	12°	13°
		R1	0.08	---	---
		R2	0.08	---	0.2
		S	0.2	---	---
PACKAGE EDGE TOLERANCE		aaa	0.2		
LEAD EDGE TOLERANCE		bbb	0.2		
COPLANARITY		ccc	0.08		
LEAD OFFSET		ddd	0.07		
MOLD FLATNESS		eee	0.05		



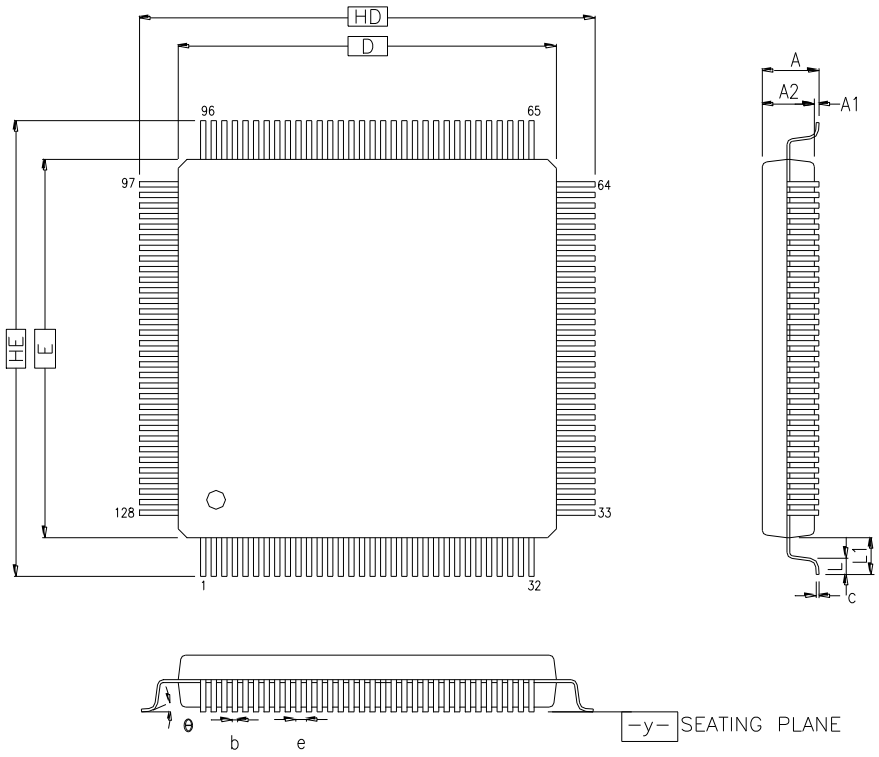


Package Dimension (LQFP64, 10x10x1.4mm, footprint 2.0mm)



Symbol	Dimension in inch			Dimension in mm		
	Min	Nom	Max	Min	Nom	Max
A	—	—	0.063	—	—	1.60
A_1	0.002	—	0.006	0.05	—	0.15
A_2	0.053	0.055	0.057	1.35	1.40	1.45
b	0.007	0.008	0.011	0.17	0.20	0.27
c	0.004	—	0.008	0.09	—	0.20
D	—	0.393	—	—	10.00	—
E	—	0.393	—	—	10.00	—
e	—	0.020	—	—	0.50	—
H_D	—	0.472	—	—	12.00	—
H_E	—	0.472	—	—	12.00	—
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	3.5	7	0	3.5	7

Package Dimension (LQFP128, 14 x 14 x 1.4 mm, footprint 2.0mm)



COTROL DIMENSIONS ARE IN MILLIMETERS.

SYMBOL	MILLIMETER			INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	—	—	1.60	—	—	0.063
A1	0.05	—	0.15	0.002	—	0.006
A2	1.35	1.40	1.45	0.053	0.055	0.057
HD	16.00 BSC.			0.630 BSC.		
D	14.00 BSC.			0.551 BSC.		
HE	16.00 BSC.			0.630 BSC.		
E	14.00 BSC.			0.551 BSC.		
b	0.13	0.16	0.23	0.005	0.006	0.009
e	0.40 BSC.			0.016 BSC.		
θ	0°	3.5°	7°	0°	3.5°	7°
c	0.09	—	0.20	0.004	—	0.008
L	0.45	0.60	0.75	0.018	0.024	0.030
L_1	1.00 REF			0.039 REF		
y	–	–	0.1	–	–	0.004

8. Revision History

Version	Date	Substantial Changes	Page
A1.0	Jan. 2012	Initial release.	All
A2.0	Feb. 2012	Revise N588H060 ROM size	2
		Revise Working Voltage	3
		Revise AC characteristic table	6
A2.1	Mar. 2012	Revise BP0, BP2 input description	4
		Revise BP1, BP2 output current	5
		Revise frequency deviation (by voltage drop)	6
A2.2	May 2012	Revise VDD range in 8MHz and 6MHz	3, 5
		ADD LVR value	3
		Add output current of BP1, BP2 at VDD 4.5V	5
		Add comparator and LVD spec	5, 6
		Revise AP circuit 0.1uF as 4.7uF	6
A2.3	Jun. 2012	Revise duration	2
A3.0	Oct. 2012	Remove the word of “preliminary”	
		Rename part number of N588H060, H080 as N588H061, H081	
A4.0	Dec. 2012	Resume N588H060, N588H080	2
		Add availability note of N588H061, N588H081	2
A5.0	Dec. 2012	Revise ROM size on N588H060, N588H120, N588H250	2
A6.0	Sep. 2013	Remove N588H060, N588H080	2
		Revise application circuit in	7, 8
A7.0	Feb. 2014	Modify the description of 3-pair H/W PWM I/O	
A8.0	Mar. 2014	Revise AP circuit: C1 4.7uF change as 0.1uF	7
A9.0	Dec. 2014	Add N588H200 part number, revise duration and LVD level	2~8
		Update application circuits	
A10.0	Mar. 2015	Revise VDD range and LVD level	3, 6
A11.0	Sep. 2015	Add item of N588H201, N588H251, N588H341, N588H480, N588H650	2
A12.0	Nov. 2015	Revise application circuit	7
A13.0	Dec. 2015	Update pad name of VDD_IO and VSS_IO	4, 7
A14.1	Feb. 2016	Revise operation current in DC Characteristics	6
A15.0	Jun. 2016	Modify note	8
A16.0	Sep. 2016	Update Note of Application Circuit	8
A17.0	May.2017	Add package information	9~14
A18.0	Jul. 2017	Revise LQFP64 pin assignment, add SOP14, SOP20, LQFP128 package	9 ~ 21
A19.0	Aug. 2017	Update package information	9 ~ 17

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