

# N589E

## Data Sheet

### 1-ch Speech

The information described in this document is the exclusive intellectual property of Nuvoton Technology Corporation and shall not be reproduced without permission from Nuvoton.

Nuvoton is providing this document only for reference purposes of *PowerSpeech*<sup>®</sup> based system design. Nuvoton assumes no responsibility for errors or omissions.

All data and specifications are subject to change without notice.

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

[www.nuvoton.com](http://www.nuvoton.com)

# Table of Contents

1.	General Description .....	3
2.	Features .....	3
3.	Block Diagram .....	4
4.	PAD Description .....	5
5.	Alternative Function of I/O Port .....	6
6.	Electrical Characteristics .....	6
	6.1 Absolute Maximum Ratings .....	6
	6.2 D.C. Characteristics .....	7
	6.3 A.C. Characteristics .....	7
7.	Typical Application Circuit .....	8
	7.1 PCB Layout Notice: .....	8
8.	Package Information .....	9
	8.1 PIN Assignment .....	9
	8.2 Package Dimension .....	10
9.	Ordering Information .....	12
10.	Revision History .....	13

## 1. General Description

N589E series is an advanced 1-ch Voice IC that equips with Nuvoton 8-bit 65C02 core, embedded 128K~256KB Flash. N589E series provides 8 I/Os to share 3 output pins with 256-level control for the applications of LED or motors, and equips with capture timer to implement up to x 4 CapTouch input. It also builds in Watch Dog Timer and Low Voltage Reset to prevent latch-up situation occurring.

The N589E family shown as below table:

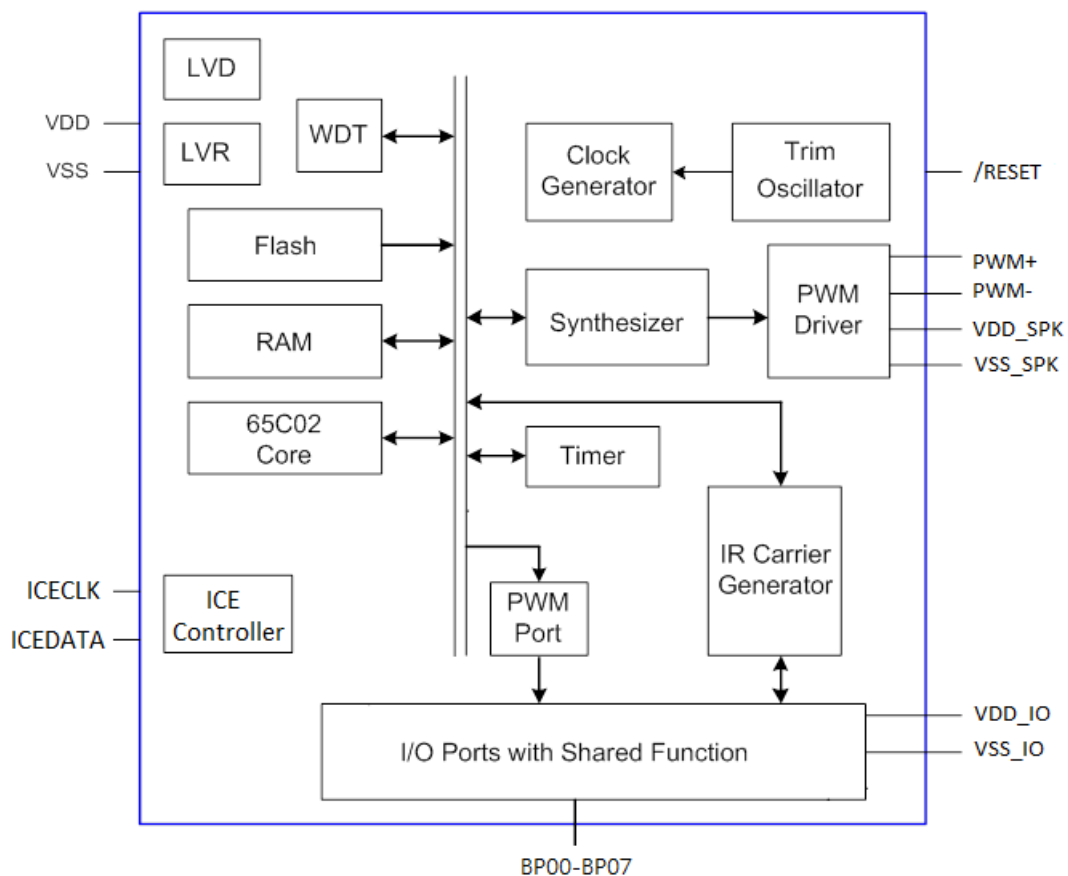
Part No.	Duration (Sec) @NM4		Flash (KByte)	V <sub>DD</sub> (V)	LVR (V)	Speech CH	Audio	RAM (Byte)	GPIO	PWM Output	Touch I/O	LVD	IR Carrier
	8KHz	12KHz					PWM						
N589E041	28	19	128	2.0~5.5	1.9	1	13-bit	384	8 I/O	3	4	V	V
N589E061	44	29	192										
N589E081	60	40	256										

## 2. Features

- MCU: 8-bit 65C02
- Operating voltage: 2.0~5.5V
- Oscillator: builds in internal Rosc (TRIM)
  - Frequency deviation: +/-1.5% (at 4.5V)
- RAM: 384B
- 8 bi-directional I/O pins
  - Each I/O pin can be set as Input or Output status individually
  - All I/O pins can be as wake-up interrupt source
  - Internal pull high/low resistor: 1M ohm or 150K ohm (at 4.5V)
- Up to 3 x H/W PWM output pins with 8-bit resolutions to control LED or motor
- Provide 4 x CapTouch pad
- Builds in IR carrier generation circuit for simplifying firmware IR application
- Audio output:
  - 13-bit PWM
- Voice channel
  - 1-ch Voice
- Built-in Watch-Dog Timer (WDT)
- Low Voltage Reset (LVR)
- Low Voltage Detection (LVD)
  - LVD: 2.1V, 2.4V, 2.7V, 3.0V, 3.3V, and external level input
- 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
- Package form:
  - SOP8 (150 mil), 3 IO
  - TSSOP20 (4.4x6.5 mm<sup>2</sup>), 8 IO

### 3. Block Diagram



## 4. PAD Description

Pin Name	I/O	Function
BP00 BP01 BP02 BP03 BP04 BP05 BP06 BP07	I/O	<ul style="list-style-type: none"> <li>● General input/output pins.</li> <li>● Each pin can be set as Input or Output individually</li> <li>● For input pin, it can be set as pull-high, pull-low or floating</li> <li>● BP00~02 can be set as 3-pin H/W PWM output with 256-level resolution</li> <li>● BP00~01 or BP03/04/05/06 with timer capture for CapTouch application</li> <li>● BP02 or BP07 share with IR carrier output</li> <li>● BP0 can generate interrupt request to release IC from STOP mode</li> <li>● BP00, BP01 share with ICPCLK and ICPDATA</li> </ul>
VDD	Power	Positive power supply for core, peripherals, regulator.
REG	Power	Internal regulator, 0.1uF capacitor is needed
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
PWM+	O	PWM driver positive output to drive speaker directly
PWM-	O	PWM driver negative output to drive speaker directly
VDD_SPK	Power	Positive power supply for speaker driver
VSS_SPK	Power	Negative power supply for speaker driver
/RESET	I	IC reset input, low active
ICECLK	I	ICE interface clock input with an internal pull-low resistor
ICEDATA	I/O	ICE interface data input/output with an internal pull-low resistor

Note: Program pad includes BP00 (ICPCLK), BP01(ICPDATA), /RESET, VDD/VDD\_IO, VSS

## 5. Alternative Function of I/O Port

I/O Port	Alternate Function 0	Alternate Function 1	Alternate Function 2	Serial Writer Interface
BP00	GPIO	PWM port 0	CapTouch 0	ICPCLK
BP01	GPIO	PWM port 1	CapTouch 1	ICPDATA
BP02	GPIO	PWM port 2	IR carrier output	
BP03	GPIO	CapTouch 0		
BP04	GPIO	CapTouch 1		
BP05	Input	CapTouch 2		
BP06	GPIO	CapTouch 3		
BP07	GPIO	IR carrier output	LVD external input	

## 6. Electrical Characteristics

### 6.1 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.

**6.2 D.C. Characteristics**

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

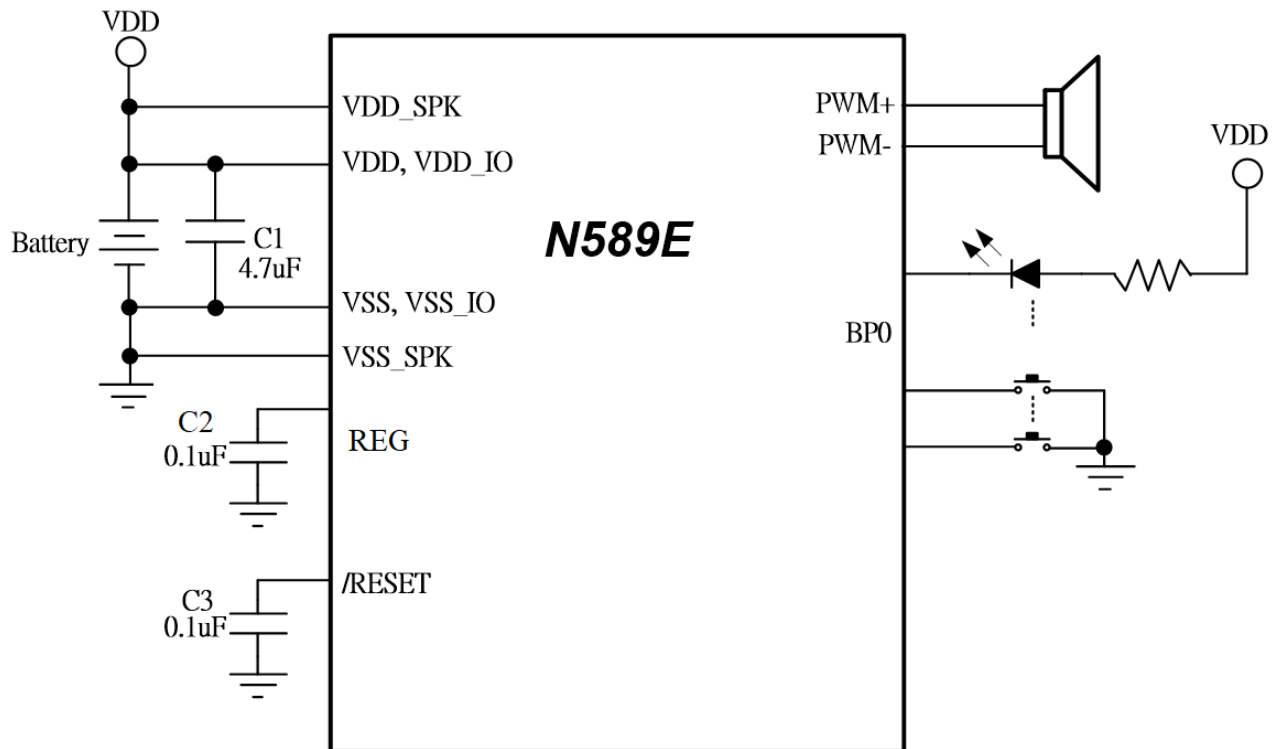
Parameter	Sym	Conditions	Min	Typ	Max	Unit
Operating Voltage	V <sub>DD</sub>		2.0	-	5.5	V
Operating Current	I <sub>OP1</sub>	No load	-	5	6	mA
Standby Current (STOP)	I <sub>DD1</sub>	No load	-	-	1	μA
Input Low Voltage	V <sub>IL</sub>	All input pins	V <sub>SS</sub>	-	0.3 V <sub>DD</sub>	V
Input High Voltage	V <sub>IH</sub>	All input pins	0.7 V <sub>DD</sub>	-	V <sub>DD</sub>	V
Pull High resistor (BP0)	RPH	VDD = 4.5V	90K 0.6M	150K 1M	210K 1.4M	Ω
Pull Low resistor (BP0)	RPL	VDD = 4.5V	90K 0.6M	150K 1M	210K 1.4M	Ω
Output Current (BP0)	I <sub>OL</sub>	V <sub>DD</sub> = 3V, V <sub>OUT</sub> = 0.4V	8	12	-	mA
	I <sub>OH</sub>	V <sub>DD</sub> = 3V, V <sub>OUT</sub> = 2.6V	-4	-6	-	mA
Output Current PWM+ / PWM-	I <sub>OL1</sub>	RL= 8Ω [PWM+]---[RL]---[PWM-]	+250	-	-	mA
	I <sub>OH1</sub>		-250	-	-	mA
LVD detect voltage	V <sub>LVD</sub>		-	2.1	-	V
				2.4		
				2.7		
				3.0		
				3.3		

**6.3 A.C. Characteristics**

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

Parameter	Sym	Conditions	Min	Typ	Max	Unit
Frequency Deviation by Voltage Drop	ΔF/F	(Fmax – Fmin)/Fmin @VDD: 2.4 ~ 5.5V	-	-	1	%

## 7. Typical Application Circuit



### 7.1 PCB Layout Notice:

Please refer to AN-N589-006-PCB Layout Guide\_ApplicationNote\_EN.pdf.

1. The IC substrate should be only connected to VSS.
2. Do not connect VSS\_SPK pad to the IC substrate.
3. The 4.7uF for battery connected to the IC pad as near as possible.
4. The VSS\_SPK, and VSS/VSS\_IO should have its own path to connect with negative of battery
5. The VDD\_SPK, and VDD/VDD\_IO should have its own path to connect with positive of battery.

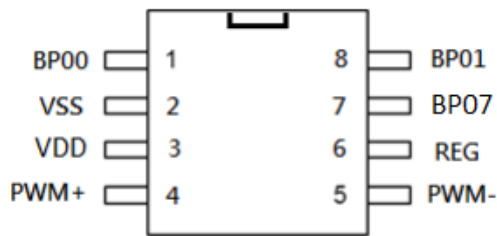


## 8. Package Information

### 8.1 PIN Assignment

N589E041/061/081

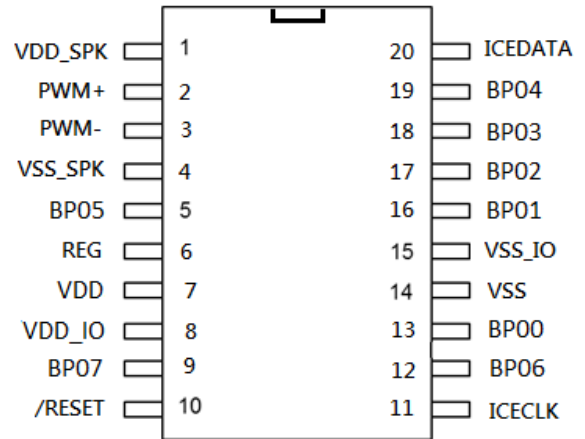
SOP8 (150 mil), 3 I/O



Note: SOP8 Program pin includes BP00 (ICPCLK), BP01 (ICPDATA), PWM-, VDD/VDD\_IO, VSS

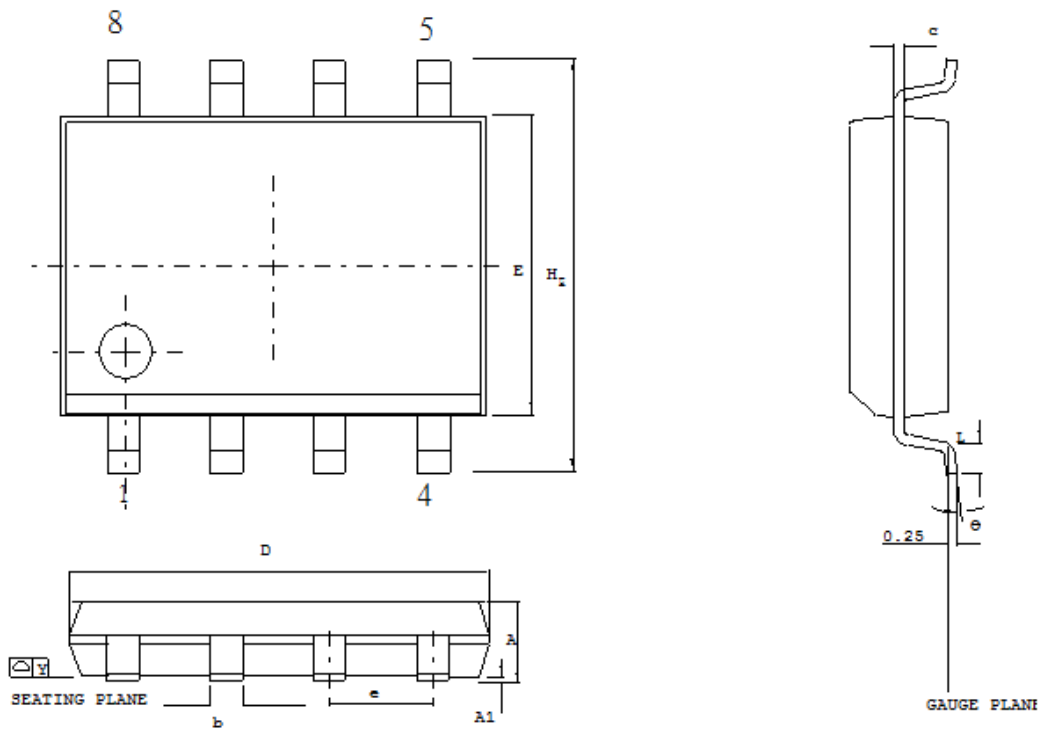
N589E041/061/081

TSSOP20 (4.4x6.5mm<sup>2</sup>), 8 I/O



8.2 Package Dimension

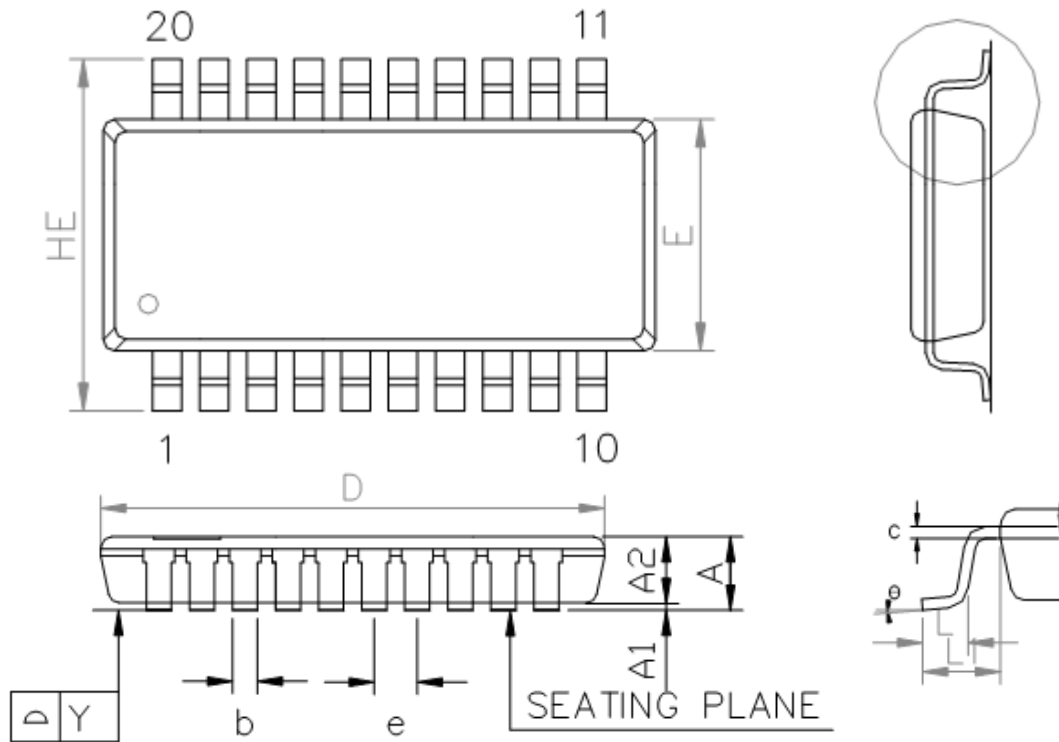
SOP8, 150 mil



Control dimensions are in millimeters .

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	4.80	5.00	0.188	0.196
e	1.27 BSC		0.050 BSC	
H <sub>z</sub>	5.80	6.20	0.228	0.244
Y	—	0.10	—	0.004
L	0.40	1.27	0.016	0.050
θ	0	10	0	10

TSSOP20, 4.4 x 6.5mm<sup>2</sup>



SYMBOL	DIMENSION (MM)			DIMENSION (INCH)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	-	-	1.20	-	-	0.047
A1	0.05	-	0.15	0.002	-	0.006
A2	0.80	0.90	1.05	0.031	0.035	0.041
E	4.30	4.40	4.50	0.169	0.173	0.177
HE	6.40 BSC			0.252 BSC		
D	6.40	6.50	6.60	0.252	0.256	0.260
L	0.50	0.60	0.75	0.020	0.024	0.030
L1	1.00 REF			0.039 REF		
b	0.19	-	0.30	0.007	-	0.012
e	0.65 BSC			0.026 BSC		
c	0.09	-	0.20	0.004	-	0.008
θ	0°	-	8°	0°	-	8°
Y	0.10 BASIC			0.004 BASIC		

**9. Ordering Information**

<b>Part No. (Blank)</b>	<b>Part No. (Pre-Code)</b>	<b>Type</b>	<b>Remark</b>
N589E041 N589E061 N589E081	N589E041XXXX N589E061XXXX N589E081XXXX	Wafer Form, Die Form	8 I/O
N589E04A N589E06A N589E08A	N589E04AXXXX N589E06AXXXX N589E08AXXXX	SOP8 (150mil)	3 I/O
N589E04F N589E06F N589E08F	N589E04FXXXX N589E06FXXXX N589E08FXXXX	TSSOP20 (4.4x6.5mm <sup>2</sup> )	8 I/O

## 10. Revision History

Revision	Date	Substantial Changes	Page
1.0	Jan. 2021	Initial Release	All
1.1	Feb. 2021	Update SOP8 Pin Assignment	4,9,12
2.0	Oct. 2021	Update BP05 as Input Pin	3~7, 13
3.0	Jan. 2023	Update Product Selection Guide and Application Circuit	3, 9

### Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, “Insecure Usage”.

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer’s risk, and in the event that third parties lay claims to Nuvoton as a result of customer’s Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.

---

*Please note that all data and specifications are subject to change without notice.  
All the trademarks of products and companies mentioned in this datasheet belong to their respective owners.*