NT95089

Tone Dialer

Features

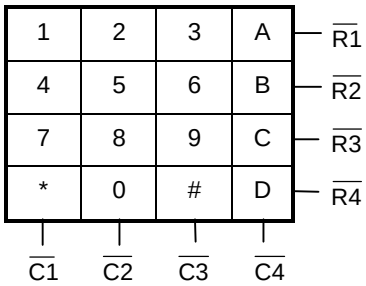
- Wide operating voltage range: 2.5V - 10V
- Optimum use with a constant operating supply voltage (typically 3.5V)
- Tone amplitude stability of ±1.5dB within the suggested operating temperature range
- Device power may be derived directly from telephone lines or from small batteries
- Low total harmonic distortion
- TV crystal standard (3.58MHz) is used to derive all frequencies, providing high accuracy and stability
- Specifically designed for electronic telephone applications
- Interfaces directly with a standard push-button telephone keyboard with common terminal
- Dual tone/single tone capability

General Description

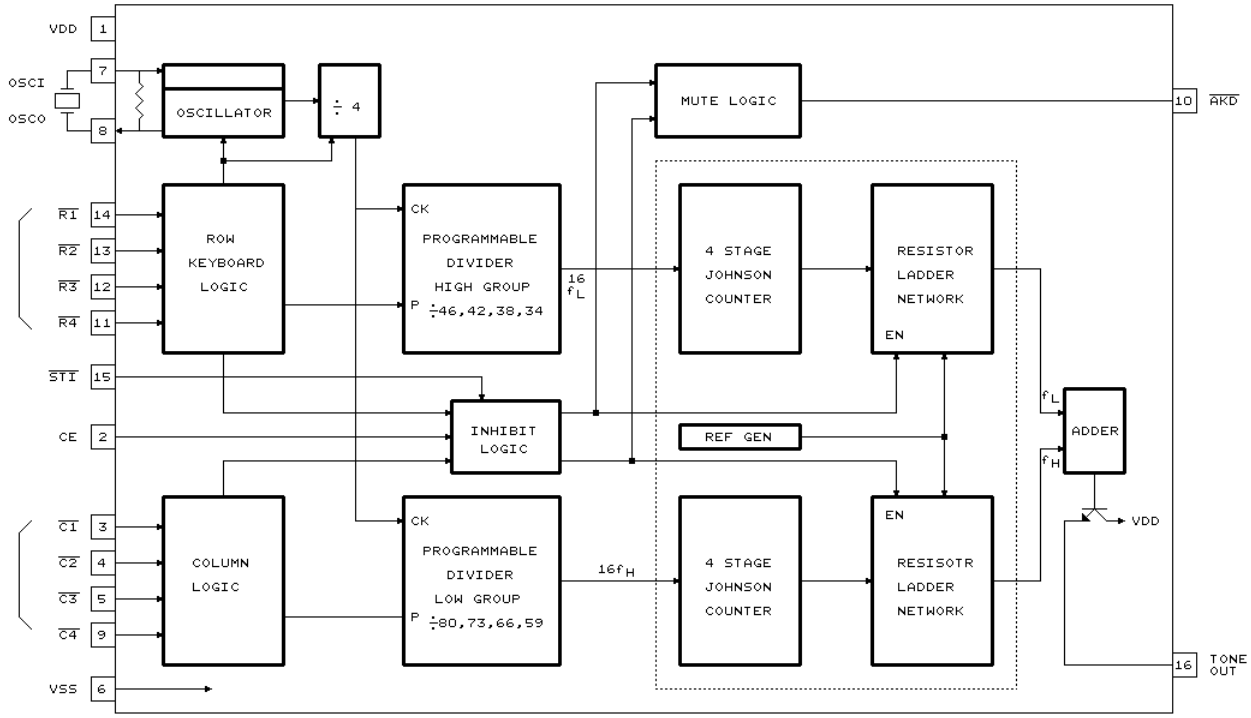
The NT95089 DTMF generator is specifically designed for applications requiring a fixed supply operating voltage and a high stability tone output, making it ideal for electronic telephone applications. The NT95089 interfaces directly to a standard push-button telephone keyboard (common terminal connected to VSS) and operates directly from telephone lines. All necessary dual-tone frequencies are derived from the widely-used TV crystal standard, providing high accuracy and stability. The required sinusoidal waveform for individual tones is digitally synthesized on the chip, resulting in a waveform with low total harmonic distortion. A voltage reference which is stable over the operating temperature range is generated on the chip; this reference is used to regulate the dual tone frequency levels to ensure that they meet recommended telephone industry specifications.

Pin Configuration

Keyboard Assignments



Block Diagram



Absolute Maximum Ratings*

Power Supply Voltage (VDD - VSS) . . . . -0.3V to +10.5V
Input Voltage (V_{IN}). . . . . -0.3V to VDD + 0.3V
Maximum Power Dissipation (at 25°C). 500mW
Operating Temperature. . . . . -20°C to +70°C
Storage Temperature. . . . . -55°C to +150°C

*Comments

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to this device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied or intended. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

DC Electrical Characteristics (T_{OP} = 25°C, Fosc = 3.579MHz, unless otherwise specified.)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Test CKT.
Operating Voltage	VDD1	2.5		10	V	Valid key input (tone output mode)	B
	VDD2	1.6		10	V	$\overline{AKD}$ outputs vary with key input (non-tone output mode)	

DC Electrical Characteristics (continued)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Test CKT.
Supply Operating Current	I_{DD1}		1.0	1.4	mA	VDD = 3V, one key input, all outputs unloaded	B
	I_{DD2}		6.6	10	mA	VDD = 10V, one key input, all outputs unloaded	
Standby Current	I_{SD1}		1	20	μA	VDD = 3V, no key input, all outputs unloaded	A
	I_{SD2}		5	100	μA	VDD = 10V, no key input, all outputs unloaded	
$\overline{AKD}$ Output Sink Current	I_{OL}	0.5	1		mA	VDD = 3V, V_{OL} = 0.5V	C
$\overline{AKD}$ Output off Leadage Current	I_{OH}		1	10	μA	VDD = 10V	C
Input Voltage Range	V_{IH}	0.8		1	VDD		-
	V_{IL}	0		0.2	VDD		
Row & Column Input Current (Pull-up)	I_{IH}	30	90	150	μA	VDD = 3V, V_{IH} = 0V	-
	I_{IH}	100	300	500	μA	VDD = 10V, V_{IH} = 0V	-
Single Column Tone Output Amplitude	V_{OC}	760	830	900	mV_{P-P}	VDD = 2.5V, R_L = 10KΩ	B
		2028	2200	2380	mV_{P-P}	VDD = 10V, R_L = 100KΩ	
Single Row Tone Output Amplitude	V_{OR}	550	600	650	mV_{P-P}	VDD = 2.5V, R_L = 10KΩ	B
		1520	1650	1780	mV_{P-P}	VDD = 10V, R_L = 100KΩ	
Pre-Emphasis	Twist	1	2	3	dB		B
Distortion	DIS%		1	5	%	VDD = 5V, * Note	B
Oscillator Output Drive Current	I_{OH1}	0.13	0.31		mA	VDD = 3V, V_{OH} = 2.5V, one key input	C
	I_{OH2}	0.42	1.1		mA	VDD = 10V, V_{OH} = 9.5V, one key input	C

DC Electrical Characteristics (continued)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Test CKT.
Oscillator Output Sink Current	I_{OL1}	0.21	0.52		mA	VDD = 3V, V_{OH} = 0.5V, one key input	C
	I_{OL2}	0.8	2.1		mA	VDD = 10V, V_{OH} = 0.5V, one key input	C
Input/Output Capacitance	C1/01		12	16	pF	VDD = 3V	-
	C1/02		10	14	pF	VDD = 10V	-

Note:

$$DIS\% = \frac{100 * (V_1^2 + V_2^2 + \ldots + V_N^2)^{1/2}}{(V_{IL}^2 + V_{IH}^2)^{1/2}}$$

1. V_1. . . . V_n are the intermodulations or the harmonic frequencies in the 500Hz to 3400Hz band.
2. V_{IL} and V_{IH} are the individual frequency components of the DTMFsignal.

AC Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Oscillator Start up Time	T_{START}		2	5	ms	VDD = 3.0V - 10.0V
Tone Output Rise Time	T_R		2	5	ms	
Pre-Digit Pause	T_{PDP}		0	0	ms	

Frequency Tolerance of the Output Tones for DTMF Signaling

R/C	Spec.	Actual	Error(%)	Unit	Conditions
R1	697	699.2	+0.32	Hz	Fosc = 3.579MHZ
R2	770	766.27	-0.48	Hz	
R3	852	847.54	-0.64	Hz	
R4	941	948.09	-0.75	Hz	
C1	1,209	1,216	+0.58	Hz	
C2	1,336	131.8	-0.33	Hz	
C3	1,477	1,472	-0.34	Hz	
C4	1,633	1,645	+0.73	Hz	

Pin Description

Pin No.	Designation	Description
1 6	VDD VSS	Positive power supply input Negative power supply input The NT95089 is designed to operate within a range of 2.5V to 10.0V.
2	CE	Chip enable input The chip enable input has an internal pullup to VDD. When this input is left unconnected or connected to VDD, the NT95089 operates normally. When this input is connected to VSS, tone generation is inhibited; however, all other chip functions continue to operate normally.
3 - 5, 9 11 - 14	$\overline{C1}$ - $\overline{C4}$ $\overline{R4}$ - $\overline{R1}$	Keyboard inputs Internal pullup resistors are present on the row and column inputs (20KΩ - 10KΩ); low levels on a particular row and column input correspond to a key entry. The NT95089 interfaces with the standard push-button telephone keyboard (see Figure 1).(Keyboard common terminal must be connected to VSS).
7 8	OSCI OSCO	Oscillator input Oscillator output The NT95089 contains an oscillator circuit with the necessary parasitic capacitances and feedback resistor on chip, making it necessary to connect only a standard 3.58MHz TV crystal across the OSCI and OSCO terminals to implement the oscillator function. The oscillator is enabled whenever a row input is activated.
10	$\overline{AKD}$	Any key down output The $\overline{AKD}$ output consists of an open drain N-channel device. When no keys are pressed, the $\overline{AKD}$ output is open. When a key is pressed, the $\overline{AKD}$ output = VSS.
15	$\overline{STI}$	Single tone inhibit input The $\overline{STI}$ input is used to inhibit the generation of tones other than dual tones. It has an internal pull-down to VSS. When this input is left unconnected or connected to VSS, the SINGLE TONE mode is disabled. When this input is connected to VDD, single as well as dual tones may be generated as follows: DUAL TONE mode: When one row and one column are selected, a dual tone output consisting of an appropriate low group tone and high group tone is generated. If two digit keys that are not in the same row or same column are pressed, the dual tone mode is disabled and no output is provided. SINGLE TONE mode: Low group tones can be generated by pressing two digit keys in the appropriate row. High group tones can be generated by pressing two digit keys in the appropriate column, i.e., selecting the appropriate column input and pressing two row inputs in that column.

Pin Descriptions (continued)

Pin No.	Designation	Description
16	TONE	DTMF signal output The NT95089 uses a Johnson counter and resistor ladder network (see block diagram) to synthesize the two desired frequencies in sinewaves. The ladder network is then used to mix the two. The NT95089 uses a bipolar NPN transistor, connected as emitter follower, to allow proper impedance transformation and at the same time preserve signal level

Functional Description

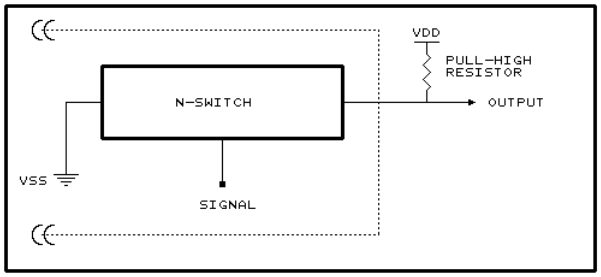
Crystal Specification

Standard TV color burst crystals have a much tighter tolerance specification than is necessary for tone generation applications. Because the required tolerance specification for this type of application is more relaxed, lower-cost crystals can be used. Crystals with the following specifications are suggested for use with the NT95089:

Frequency: 3.58MHz ± 0.02%.

$R_S \leq 100\Omega$, L_M = 96 mH, C_M = 0.02pF, C_H = 5pF, C_L = 12pF.

$\overline{AKD}$ Output Structure



N-CHANNEL OPEN DRAIN OUTPUT

DTMF Generator

The NT95089 has a well designed, digitally-synthesized sinewave with an 8-level, 16-segment structure. (See Figure 2.)

Reference Voltage

The structure of the reference voltage employed in the NT95089 is shown in Figure 3. It has the following characteristics:

a) V is proportional to the supply voltage. Output tone amplitude, which is a function of (VDD - V_{REF}), increases with supply voltage. (Figure 4).
b) The temperature coefficient of V_{REF} is low due to a single V_{BE} drop. Use of a resistor divider also contributes to providing an accuracy of better than 10%. As a result, tone amplitude variations over temperature and unit to unit differences are held to less than ±1.0dB.
c) Resistor values in the divider network are chosen so that V_{REF} is above the V_{BE} drop of the tone output transistor even at the low end of the supply voltage range. This eliminates tone output clipping at low supply voltage and improves distortion performance.

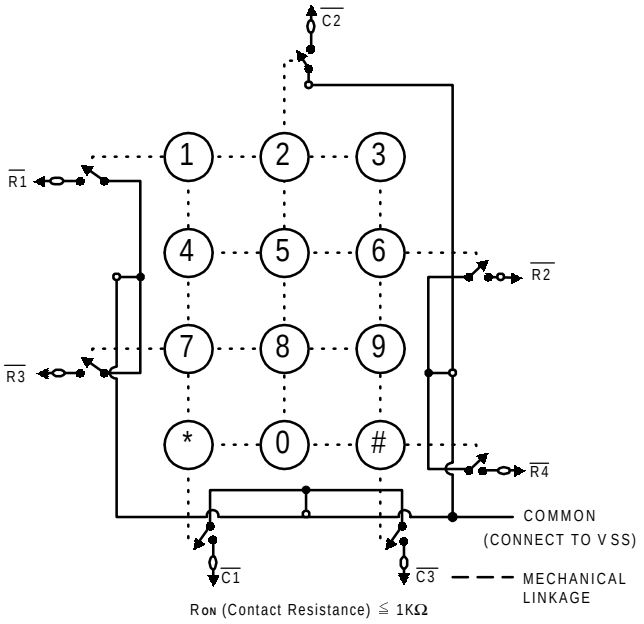


Figure 1. Standard Telephone Push-Button Keyboard

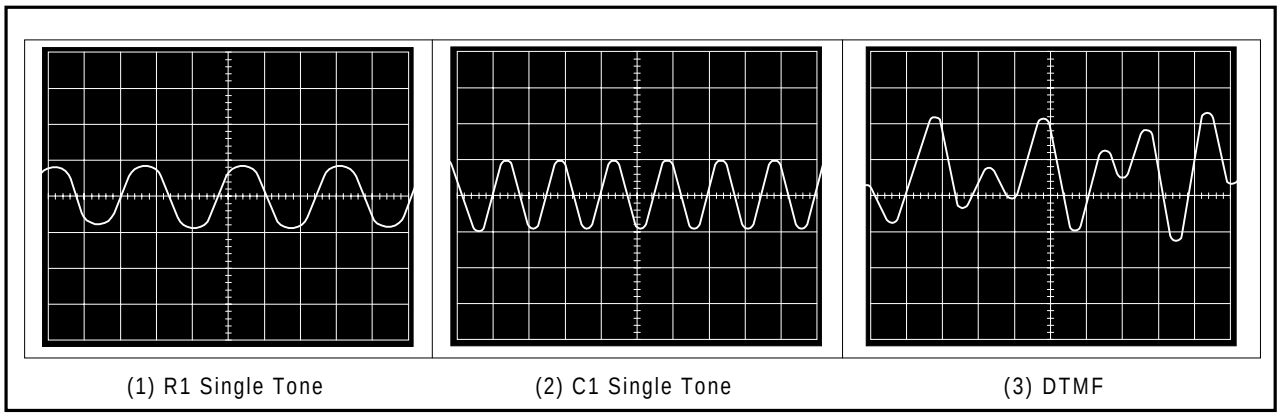


Figure 2. DTMF Waveforms

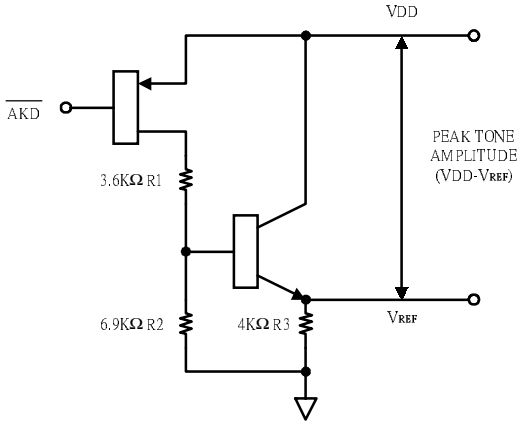


Figure 3. Structure of the Reference Voltage

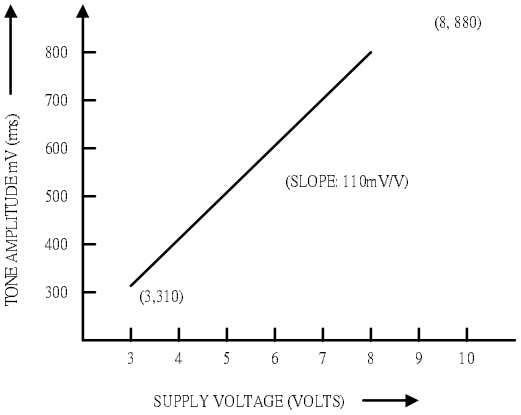
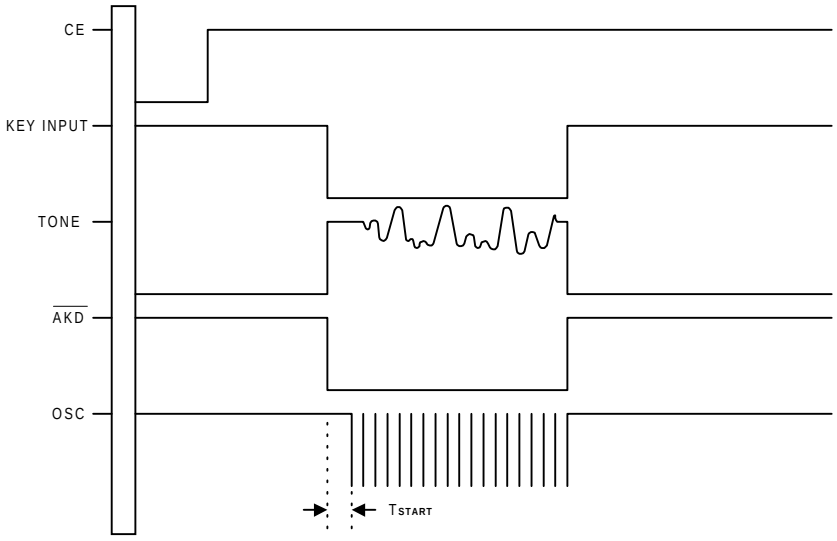
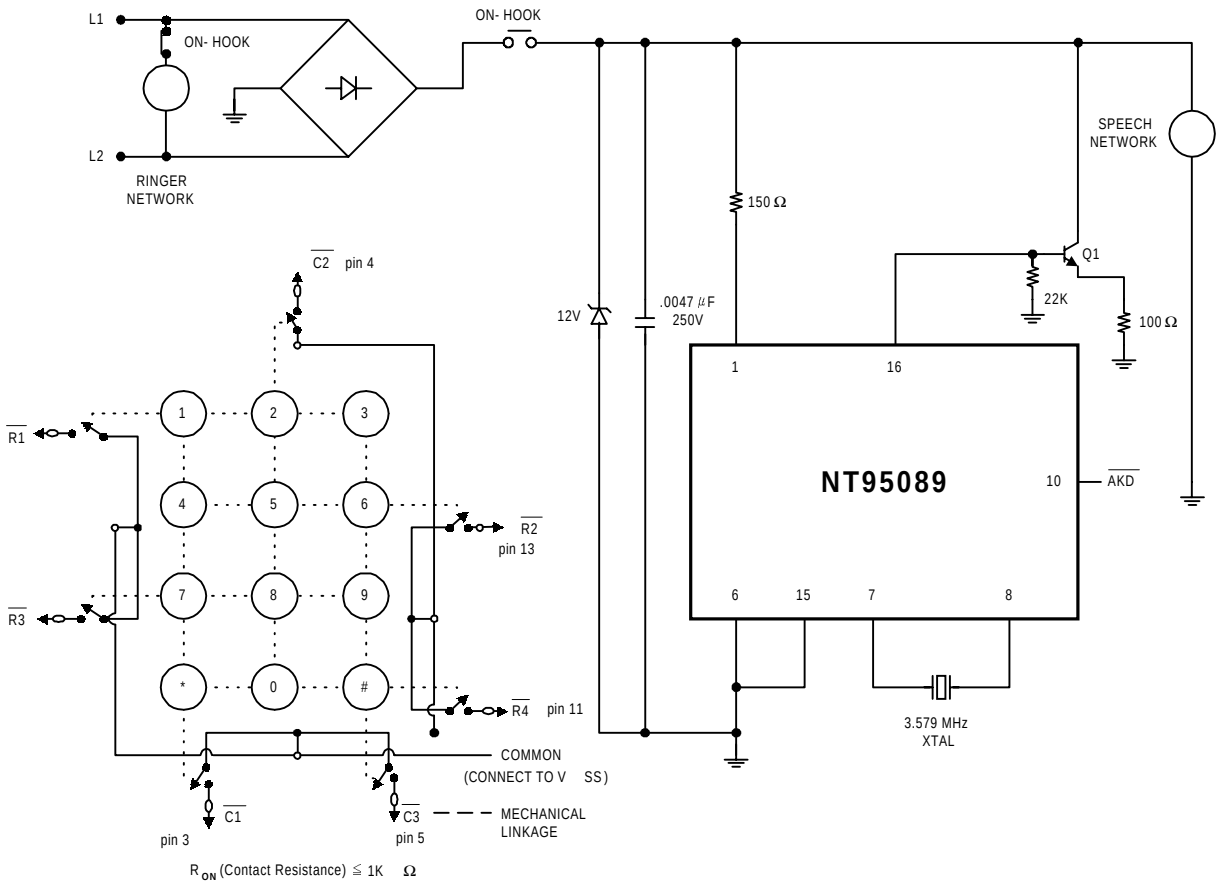


Figure 4. Typical Single Tone Output Amplitude vs. Supply Voltage (R_L = 10K)

Timing Waveform



Application Circuit (for reference only)

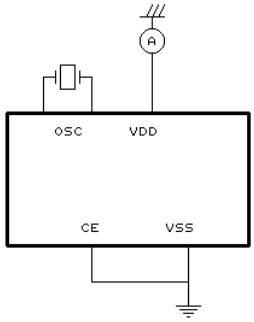


R_{ON} (Contact Resistance) ≦ 1K Ω

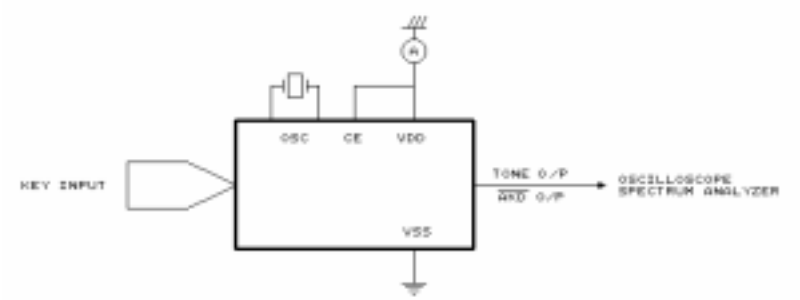
Standard Telephone Push Button Keyboard

Test Circuits

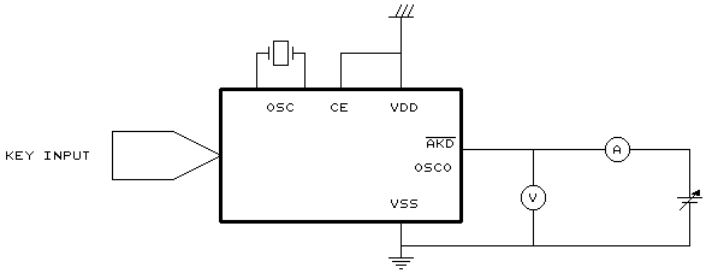
(A)



(B)



(C)



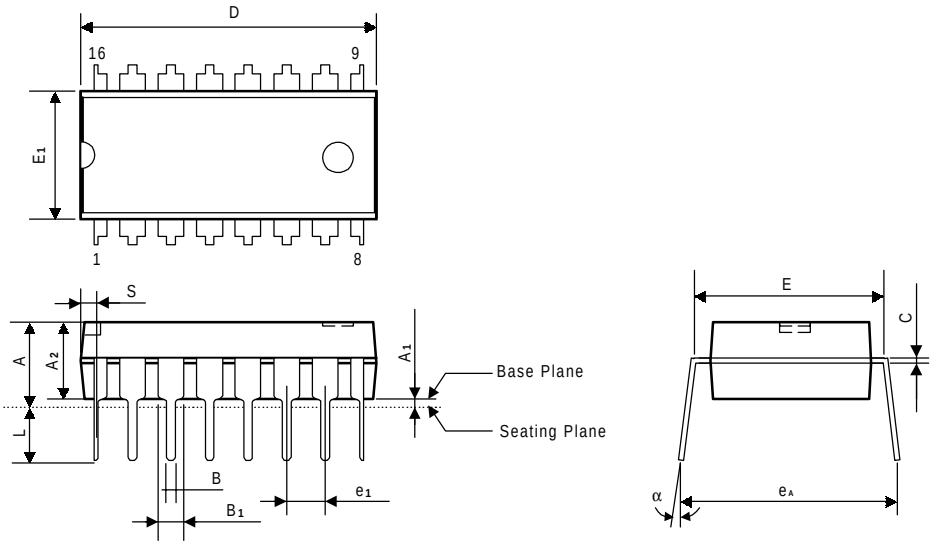
Ordering Information

Part No.	Package
NT95089	16L DIP

Package Information

DIP 16L Outline Dimensions

unit: inches/mm



Symbol	Dimensions in inches	Dimensions in mm
A	0.175 Max.	4.45 Max.
A_1	0.010 Min.	0.25 Min.
A_2	0.130±0.010	3.30±0.25
B	0.018 +0.004 -0.002	0.46 +0.10 -0.05
B_1	0.060 +0.004 -0.002	1.52 +0.10 -0.05
C	0.010 +0.004 -0.002	0.25 +0.10 -0.05
D	0.750 Typ. (0.770 Max.)	19.05 Typ. (19.56 Max.)
E	0.300±0.010	7.62±0.25
E_1	0.250 Typ. (0.262 Max.)	6.35 Typ. (6.65 Max.)
e_1	0.100±0.010	2.54±0.25
L	0.130±0.010	3.30±0.25
α	0° ~ 15°	0° ~ 15°
e_A	0.345±0.035	8.76±0.89
S	0.040 Max.	1.02 Max.

Notes:

1. The maximum value of dimension D includes end flash.
2. Dimension E_1 does not include resin fins.
3. Dimension S includes end flash.