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## NTE123A (NPN) & NTE159M (PNP) Silicon Complementary Transistors General Purpose

### **Description:**

The NTE123A (NPN) and NTE159M (PNP) are widely used "Industry Standard" complementary transistors in a TO18 type case designed for applications such as medium-speed switching and amplifiers from audio to VHF frequencies.

### **Features:**

- Low Collector Saturation Voltage: 1V (Max)
- High Current Gain-Bandwidth Product:  $f_T = 300\text{MHz}$  (Min) @  $I_C 20\text{mA}$

### **Absolute Maximum Ratings:**

Collector-Emitter Voltage, $V_{CE0}$	
NTE123A .....	40V
NTE159M .....	60V
Collector-Base Voltage, $V_{CBO}$	
NTE123A .....	75V
NTE159M .....	60V
Emitter-Base Voltage, $V_{EBO}$	
NTE123A .....	6V
NTE159M .....	5V
Continuous Collector Current, $I_C$	
NTE123A .....	800mA
NTE159M .....	600mA
Total Device Dissipation ( $T_A = +25^\circ\text{C}$ ), $P_D$	0.4W
Derate Above $+25^\circ\text{C}$ .....	2.28mW/ $^\circ\text{C}$
Total Device Dissipation ( $T_C = +25^\circ\text{C}$ ), $P_D$	
NTE123A .....	1.2W
Derate Above $+25^\circ\text{C}$ .....	6.85mW/ $^\circ\text{C}$
NTE159M .....	1.8W
Derate Above $+25^\circ\text{C}$ .....	10.3mW/ $^\circ\text{C}$
Operating Temperature Range, $T_J$ .....	$-65^\circ$ to $+200^\circ\text{C}$
Storage Temperature Range, $T_{stg}$ .....	$-65^\circ$ to $+200^\circ\text{C}$

**Electrical Characteristics:** ( $T_A = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit		
<b>OFF Characteristics</b>								
Collector–Emitter Breakdown Voltage NTE123A	$V_{(BR)CEO}$	$I_C = 10\text{mA}, I_B = 0$	40	–	–	V		
NTE159M			60	–	–	V		
Collector–Base Breakdown Voltage NTE123A	$V_{(BR)CBO}$	$I_C = 10\mu\text{A}, I_E = 0$	75	–	–	V		
NTE159M			60	–	–	V		
Emitter–Base Breakdown Voltage NTE123A	$V_{(BR)EBO}$	$I_E = 10\mu\text{A}, I_C = 0$	6	–	–	V		
NTE159M			5	–	–	V		
Collector Cutoff Current NTE123A	$I_{CEX}$	$V_{CE} = 60\text{V}, V_{EB(off)} = 3\text{V}$	–	–	10	nA		
NTE159M		$V_{CE} = 30\text{V}, V_{BE} = 500\text{mV}$	–	–	50	nA		
Collector Cutoff Current NTE123A	$I_{CBO}$	$V_{CB} = 60\text{V}, I_E = 0$	–	–	0.01	$\mu\text{A}$		
NTE159M		$V_{CB} = 60\text{V}, I_E = 0, T_A = +150^\circ\text{C}$	–	–	10	$\mu\text{A}$		
		$V_{CB} = 50\text{V}, I_E = 0$	–	–	0.01	$\mu\text{A}$		
		$V_{CB} = 50\text{V}, I_E = 0, T_A = +150^\circ\text{C}$	–	–	10	$\mu\text{A}$		
Emitter Cutoff Current (NTE123A Only)	$I_{EBO}$	$V_{EB} = 3\text{V}, I_C = 0$	–	–	10	nA		
Base Cutoff Current NTE123A	$I_{BL}$	$V_{CE} = 60\text{V}, V_{EB(off)} = 3\text{V}$	–	–	20	nA		
NTE159M		$V_{CE} = 30\text{V}, V_{EB(off)} = 500\text{mV}$	–	–	50	nA		
<b>ON Characteristics</b>								
DC Current Gain NTE123A	$h_{FE}$	$V_{CE} = 10\text{V}$	$I_C = 0.1\text{mA}, \text{Note 1}$	35	–	–		
			$I_C = 1\text{mA}$	50	–	–		
			$I_C = 10\text{mA}, \text{Note 1}$	75	–	–		
			$I_C = 10\text{mA}, T_A = -55^\circ\text{C}$	35	–	–		
			$I_C = 150\text{mA}, \text{Note 1}$	100	–	300		
		NTE159M	$V_{CE} = 10\text{V}$	$I_C = 150\text{mA}, \text{Note 1}$	50	–	–	
				$I_C = 500\text{mA}, \text{Note 1}$	40	–	–	
				$I_C = 0.1\text{mA}$	75	–	–	
				$I_C = 1\text{mA}$	100	–	–	
				$I_C = 10\text{mA}$	100	–	–	
				$I_C = 150\text{mA}, \text{Note 1}$	100	–	300	
Collector–Emitter Saturation Voltage NTE123A	$V_{CE(sat)}$	$I_C = 150\text{mA}, I_B = 15\text{mA}, \text{Note 1}$	–	–	0.3	V		
		$I_C = 500\text{mA}, I_B = 50\text{mA}, \text{Note 1}$	–	–	1.0	V		
		NTE159M	$I_C = 150\text{mA}, I_B = 15\text{mA}, \text{Note 1}$	–	–	0.4	V	
			$I_C = 500\text{mA}, I_B = 50\text{mA}, \text{Note 1}$	–	–	1.6	V	

Note 1. Pulse Test: Pulse Width  $\leq 300\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

**Electrical Characteristics (Cont'd):** ( $T_A = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
<b>ON Characteristics (Cont'd)</b>							
Base–Emitter Saturation Voltage NTE123A	$V_{BE(sat)}$	$I_C = 150\text{mA}, I_B = 15\text{mA}, \text{Note 1}$	0.6	–	1.2	V	
		$I_C = 500\text{mA}, I_B = 50\text{mA}, \text{Note 1}$	–	–	2.0	V	
NTE159M		$I_C = 150\text{mA}, I_B = 15\text{mA}, \text{Note 1}$	–	–	1.3	V	
		$I_C = 500\text{mA}, I_B = 50\text{mA}$	–	–	2.6	V	
<b>Small–Signal Characteristics</b>							
Current Gain–Bandwidth Product NTE123A	$f_T$	$I_C = 20\text{mA}$	$V_{CE} = 20\text{V}, f = 100\text{MHz}, \text{Note 2}$	300	–	–	MHz
		NTE159M		$I_C = 50\text{mA}$	200	–	–
Output Capacitance	$C_{obo}$	$V_{CB} = 10\text{V}, I_E = 0, f = 100\text{kHz}$	–	–	8	pF	
Input Capacitance NTE123A	$C_{ibo}$	$V_{BE} = 0.5\text{V}$	$I_C = 0, f = 100\text{kHz}$	–	–	25	pF
		NTE159M		$V_{BE} = 2\text{V}$	–	–	30
Input Impedance (NTE123A Only)	$h_{ie}$	$I_C = 1\text{mA}$	$V_{CE} = 10\text{V}, f = 1\text{kHz}$	2.0	–	8.0	$\text{k}\Omega$
		$I_C = 10\text{mA}$		0.25	–	1.25	$\text{k}\Omega$
Voltage Feedback Ratio (NTE123A Only)	$h_{re}$	$I_C = 1\text{mA}$	$V_{CE} = 10\text{V}, f = 1\text{kHz}$	–	–	8	$\times 10^{-4}$
		$I_C = 10\text{mA}$		–	–	4	$\times 10^{-4}$
Small–Signal Current Gain (NTE123A Only)	$h_{fe}$	$I_C = 1\text{mA}$	$V_{CE} = 10\text{V}, f = 1\text{kHz}$	50	–	300	
		$I_C = 10\text{mA}$		75	–	375	
Output Admittance (NTE123A Only)	$h_{oe}$	$I_C = 1\text{mA}$	$V_{CE} = 10\text{V}, f = 1\text{kHz}$	5	–	35	$\mu\text{mhos}$
		$I_C = 10\text{mA}$		25	–	200	$\mu\text{mhos}$
Collector–Base Time Constant (NTE123A Only)	$r_b' C_c$	$I_E = 20\text{mA}, V_{CB} = 20\text{V}, f = 31.8\text{MHz}$	–	–	150	ps	
Noise Figure (NTE123A Only)	NF	$I_C = 100\mu\text{A}, V_{CE} = 10\text{V}, R_S = 1\text{k}\Omega, f = 1\text{kHz}$	–	–	4	dB	
Real Part of Common–Emitter High Frequency Input Impedance (NTE123A Only)	$\text{Re}(h_{ie})$	$I_C = 20\text{mA}, V_{CE} = 20\text{V}, f = 300\text{MHz}$	–	–	60	$\Omega$	
<b>Switching Characteristics</b>							
NTE123A	Delay Time	$V_{CC} = 30\text{V}, V_{BE(off)} = 500\text{mV}, I_C = 150\text{mA}, I_{B1} = -15\text{mA}$	–	–	10	ns	
	Rise Time		–	–	25	ns	
	Storage Time		$V_{CC} = 30\text{V}, I_C = 150\text{mA}, I_{B1} = I_{B2} = 15\text{mA}$	–	–	225	ns
	Fall Time			–	–	60	ns
NTE159M	Turn–On Time	$V_{CC} = 30\text{V}, I_C = 150\text{mA}, I_{B1} = 15\text{mA}$	–	26	45	ns	
	Delay Time		–	6	10	ns	
	Rise Time		–	20	40	ns	
	Turn–Off Time	$V_{CC} = 6\text{V}, I_C = 150\text{mA}, I_{B1} = I_{B2} = 15\text{mA}$	–	70	100	ns	
	Storage Time		–	50	80	ns	
	Fall Time		–	20	30	ns	

Note 1. Pulse Test: Pulse Width  $\leq 300\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

Note 2.  $f_T$  is defined as the frequency at which  $|h_{fe}|$  extrapolates to unity.

