

## LM3045/LM3046/LM3086 Transistor Arrays

### General Description

The LM3045, LM3046 and LM3086 each consist of five general purpose silicon NPN transistors on a common monolithic substrate. Two of the transistors are internally connected to form a differentially-connected pair. The transistors are well suited to a wide variety of applications in low power system in the DC through VHF range. They may be used as discrete transistors in conventional circuits however, in addition, they provide the very significant inherent integrated circuit advantages of close electrical and thermal matching. The LM3045 is supplied in a 14-lead cavity dual-in-line package rated for operation over the full military temperature range. The LM3046 and LM3086 are electrically identical to the LM3045 but are supplied in a 14-lead molded dual-in-line package for applications requiring only a limited temperature range.

### Features

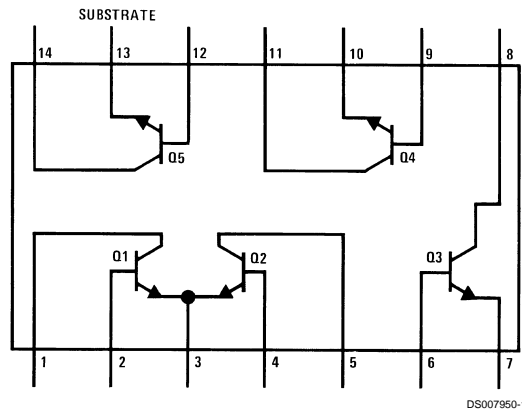
- Two matched pairs of transistors  
 $V_{BE}$  matched  $\pm 5$  mV  
 Input offset current 2  $\mu$ A max at  $I_C = 1$  mA
- Five general purpose monolithic transistors
- Operation from DC to 120 MHz
- Wide operating current range
- Low noise figure: 3.2 dB typ at 1 kHz
- Full military temperature range (LM3045):  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

### Applications

- General use in all types of signal processing systems operating anywhere in the frequency range from DC to VHF
- Custom designed differential amplifiers
- Temperature compensated amplifiers

## Schematic and Connection Diagram

Dual-In-Line and Small Outline Packages



DS007950-1

Top View

Order Number LM3045J, LM3046M, LM3046N or LM3086N  
 See NS Package Number J14A, M14A or N14A

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications. ( $T_A = 25^\circ\text{C}$ )

	LM3045		LM3046/LM3086		Units
	Each Transistor	Total Package	Each Transistor	Total Package	
Power Dissipation:					
$T_A = 25^\circ\text{C}$	300	750	300	750	mW
$T_A = 25^\circ\text{C}$ to $55^\circ\text{C}$			300	750	mW
$T_A > 55^\circ\text{C}$			Derate at 6.67		mW/ $^\circ\text{C}$
$T_A = 25^\circ\text{C}$ to $75^\circ\text{C}$	300	750			mW
$T_A > 75^\circ\text{C}$	Derate at 8				mW/ $^\circ\text{C}$
Collector to Emitter Voltage, $V_{CEO}$	15		15		V
Collector to Base Voltage, $V_{CBO}$	20		20		V
Collector to Substrate Voltage, $V_{CIO}$ (Note 2)	20		20		V
Emitter to Base Voltage, $V_{EBO}$	5		5		V
Collector Current, $I_C$	50		50		mA
Operating Temperature Range	$-55^\circ\text{C}$ to $+125^\circ\text{C}$		$-40^\circ\text{C}$ to $+85^\circ\text{C}$		
Storage Temperature Range	$-65^\circ\text{C}$ to $+150^\circ\text{C}$		$-65^\circ\text{C}$ to $+85^\circ\text{C}$		
Soldering Information					
Dual-In-Line Package Soldering (10 Sec.)	260 $^\circ\text{C}$		260 $^\circ\text{C}$		
Small Outline Package					
Vapor Phase (60 Seconds)			215 $^\circ\text{C}$		
Infrared (15 Seconds)			220 $^\circ\text{C}$		

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

## Electrical Characteristics

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

Parameter	Conditions	Limits			Limits			Units
		LM3045, LM3046			LM3086			
		Min	Typ	Max	Min	Typ	Max	
Collector to Base Breakdown Voltage ( $V_{(BR)CBO}$ )	$I_C = 10\ \mu\text{A}$ , $I_E = 0$	20	60		20	60		V
Collector to Emitter Breakdown Voltage ( $V_{(BR)CEO}$ )	$I_C = 1\ \text{mA}$ , $I_B = 0$	15	24		15	24		V
Collector to Substrate Breakdown Voltage ( $V_{(BR)CIO}$ )	$I_C = 10\ \mu\text{A}$ , $I_{CI} = 0$	20	60		20	60		V
Emitter to Base Breakdown Voltage ( $V_{(BR)EBO}$ )	$I_E = 10\ \mu\text{A}$ , $I_C = 0$	5	7		5	7		V
Collector Cutoff Current ( $I_{CBO}$ )	$V_{CB} = 10\text{V}$ , $I_E = 0$		0.002	40		0.002	100	nA
Collector Cutoff Current ( $I_{CEO}$ )	$V_{CE} = 10\text{V}$ , $I_B = 0$			0.5			5	$\mu\text{A}$
Static Forward Current Transfer Ratio (Static Beta) ( $h_{FE}$ )	$V_{CE} = 3\text{V}$ $I_C = 10\ \text{mA}$ $I_C = 1\ \text{mA}$ $I_C = 10\ \mu\text{A}$		100			100		
		40	100		40	100		
			54			54		
Input Offset Current for Matched Pair $Q_1$ and $Q_2$ $ I_{O1} - I_{O2} $	$V_{CE} = 3\text{V}$ , $I_C = 1\ \text{mA}$		0.3	2				$\mu\text{A}$
Base to Emitter Voltage ( $V_{BE}$ )	$V_{CE} = 3\text{V}$ $I_E = 1\ \text{mA}$ $I_E = 10\ \text{mA}$		0.715			0.715		V
			0.800			0.800		
Magnitude of Input Offset Voltage for Differential Pair $ V_{BE1} - V_{BE2} $	$V_{CE} = 3\text{V}$ , $I_C = 1\ \text{mA}$		0.45	5				mV
Magnitude of Input Offset Voltage for Isolated Transistors $ V_{BE3} - V_{BE4} $ , $ V_{BE4} - V_{BE5} $ , $ V_{BE5} - V_{BE3} $	$V_{CE} = 3\text{V}$ , $I_C = 1\ \text{mA}$		0.45	5				mV
Temperature Coefficient of Base to Emitter Voltage $\left(\frac{\Delta V_{BE}}{\Delta T}\right)$	$V_{CE} = 3\text{V}$ , $I_C = 1\ \text{mA}$		-1.9			-1.9		mV/ $^\circ\text{C}$

## Electrical Characteristics (Continued)

(T<sub>A</sub> = 25°C unless otherwise specified)

Parameter	Conditions	Limits			Limits			Units
		LM3045, LM3046			LM3086			
		Min	Typ	Max	Min	Typ	Max	
Collector to Emitter Saturation Voltage (V <sub>CE(SAT)</sub> )	I <sub>B</sub> = 1 mA, I <sub>C</sub> = 10 mA		0.23			0.23		V
Temperature Coefficient of Input Offset Voltage $\left(\frac{\Delta V_{10}}{\Delta T}\right)$	V <sub>CE</sub> = 3V, I <sub>C</sub> = 1 mA		1.1					μV/°C

**Note 1:** "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

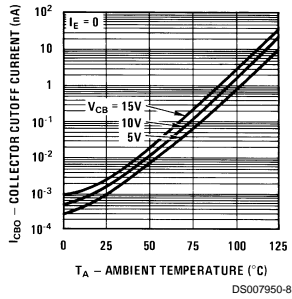
**Note 2:** The collector of each transistor of the LM3045, LM3046, and LM3086 is isolated from the substrate by an integral diode. The substrate (terminal 13) must be connected to the most negative point in the external circuit to maintain isolation between transistors and to provide for normal transistor action.

## Electrical Characteristics

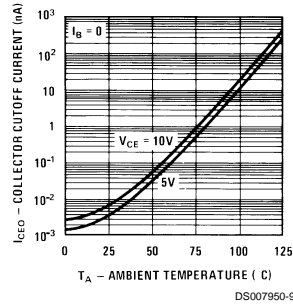
Parameter	Conditions	Min	Typ	Max	Units
Low Frequency Noise Figure (NF)	f = 1 kHz, V <sub>CE</sub> = 3V, I <sub>C</sub> = 100 μA, R <sub>S</sub> = 1 kΩ		3.25		dB
<b>LOW FREQUENCY, SMALL SIGNAL EQUIVALENT CIRCUIT CHARACTERISTICS</b>					
Forward Current Transfer Ratio (h <sub>fe</sub> )	f = 1 kHz, V <sub>CE</sub> = 3V, I <sub>C</sub> = 1 mA		110 (LM3045, LM3046) (LM3086)		
Short Circuit Input Impedance (h <sub>ie</sub> )			3.5		kΩ
Open Circuit Output Impedance (h <sub>oe</sub> )			15.6		μmho
Open Circuit Reverse Voltage Transfer Ratio (h <sub>re</sub> )			1.8 × 10 <sup>-4</sup>		
<b>ADMITTANCE CHARACTERISTICS</b>					
Forward Transfer Admittance (Y <sub>fe</sub> )	f = 1 MHz, V <sub>CE</sub> = 3V, I <sub>C</sub> = 1 mA		31 - j 1.5		
Input Admittance (Y <sub>ie</sub> )			0.3 + j 0.04		
Output Admittance (Y <sub>oe</sub> )			0.001 + j 0.03		
Reverse Transfer Admittance (Y <sub>re</sub> )			See Curve		
Gain Bandwidth Product (f <sub>T</sub> )	V <sub>CE</sub> = 3V, I <sub>C</sub> = 3 mA	300	550		
Emitter to Base Capacitance (C <sub>EB</sub> )	V <sub>EB</sub> = 3V, I <sub>E</sub> = 0		0.6		pF
Collector to Base Capacitance (C <sub>CB</sub> )	V <sub>CB</sub> = 3V, I <sub>C</sub> = 0		0.58		pF
Collector to Substrate Capacitance (C <sub>CI</sub> )	V <sub>CS</sub> = 3V, I <sub>C</sub> = 0		2.8		pF

## Typical Performance Characteristics

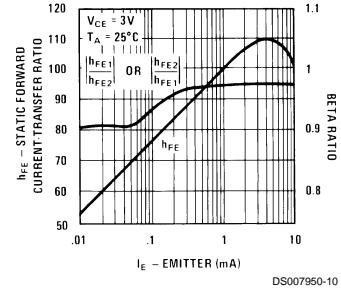
Typical Collector To Base Cutoff Current vs Ambient Temperature for Each Transistor



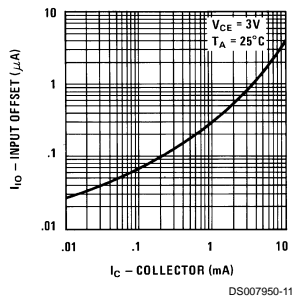
Typical Collector To Emitter Cutoff Current vs Ambient Temperature for Each Transistor



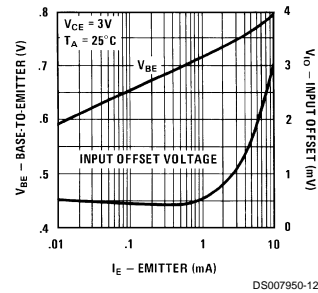
Typical Static Forward Current-Transfer Ratio and Beta Ratio for Transistors  $Q_1$  and  $Q_2$  vs Emitter Current



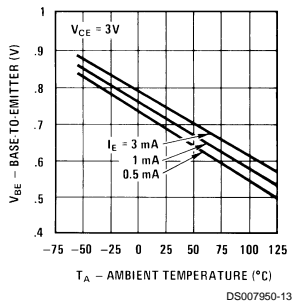
Typical Input Offset Current for Matched Transistor Pair  $Q_1$   $Q_2$  vs Collector Current



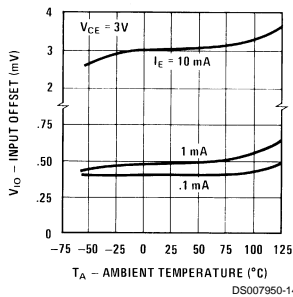
Typical Static Base To Emitter Voltage Characteristic and Input Offset Voltage for Differential Pair and Paired Isolated Transistors vs Emitter Current



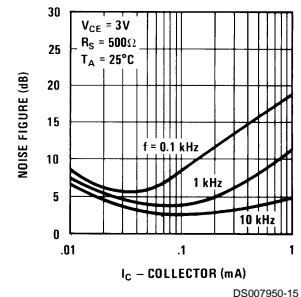
Typical Base To Emitter Voltage Characteristic for Each Transistor vs Ambient Temperature



Typical Input Offset Voltage Characteristics for Differential Pair and Paired Isolated Transistors vs Ambient Temperature

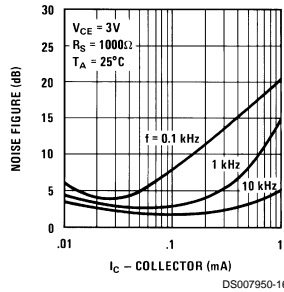


Typical Noise Figure vs Collector Current

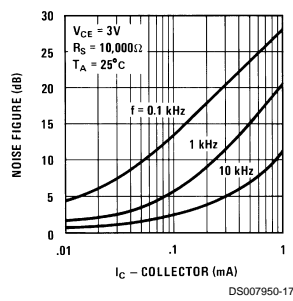


## Typical Performance Characteristics (Continued)

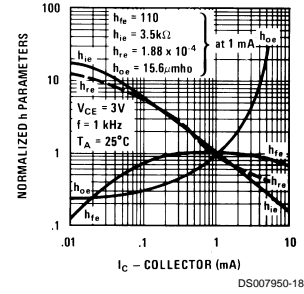
Typical Noise Figure vs Collector Current



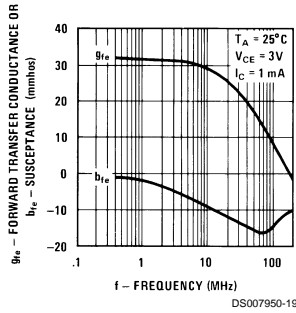
Typical Noise Figure vs Collector Current



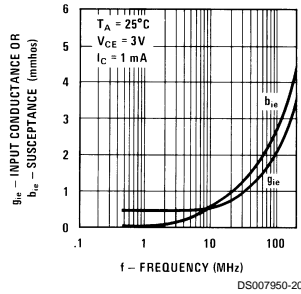
Typical Normalized Forward Current Transfer Ratio, Short Circuit Input Impedance, Open Circuit Output Impedance, and Open Circuit Reverse Voltage Transfer Ratio vs Collector Current



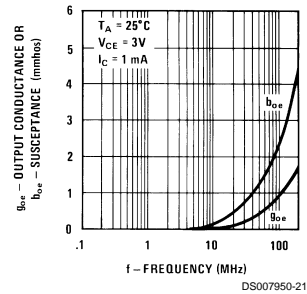
Typical Forward Transfer Admittance vs Frequency



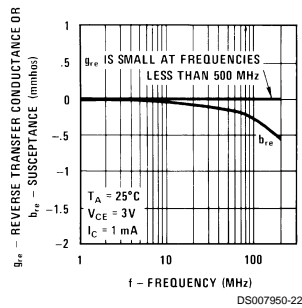
Typical Input Admittance vs Frequency



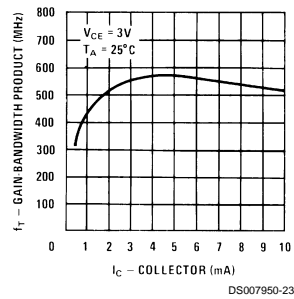
Typical Output Admittance vs Frequency



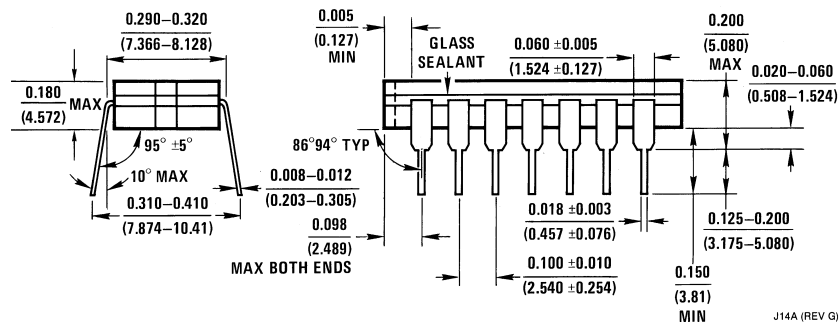
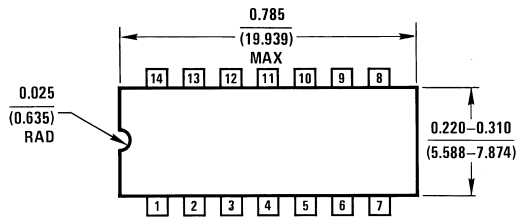
Typical Reverse Transfer Admittance vs Frequency



Typical Gain-Bandwidth Product vs Collector Current

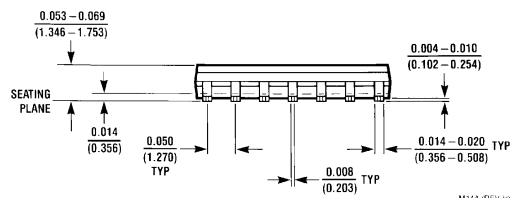
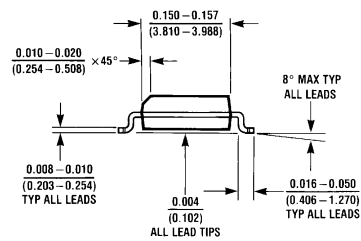
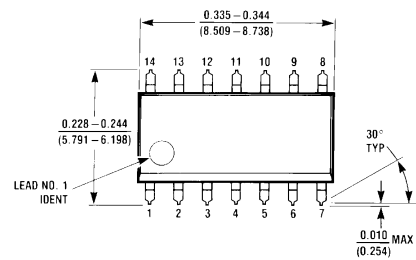


**Physical Dimensions** inches (millimeters) unless otherwise noted



**Ceramic Dual-In-Line Package (J)**  
Order Number LM3045J  
NS Package Number J14A

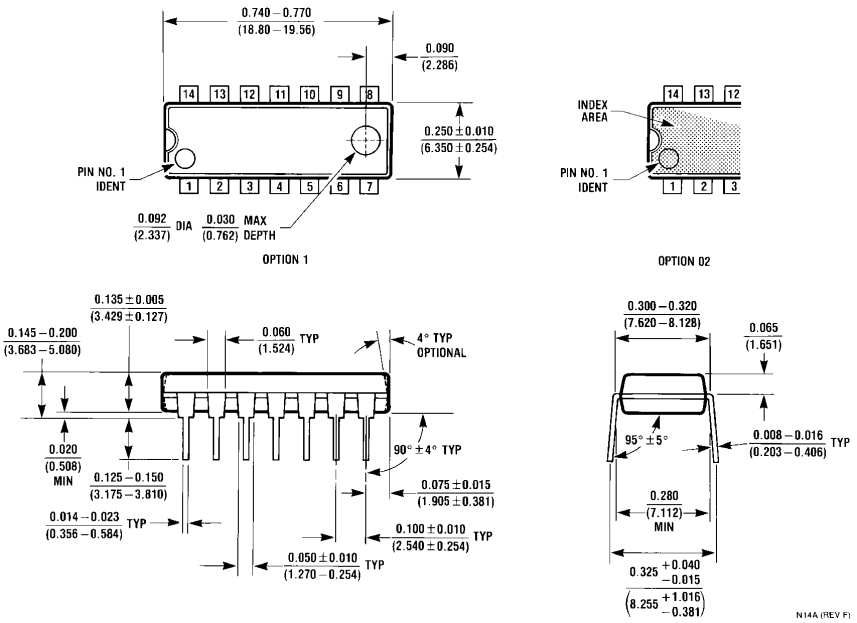
J14A (REV G)



**Molded Small Outline Package (M)**  
Order Number LM3046M  
NS Package Number M14A

M14A (REV H)

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)




**Molded Dual-In-Line Package (N)  
Order Number LM3046N or LM3086N  
NS Package Number N14A**

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