



## 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

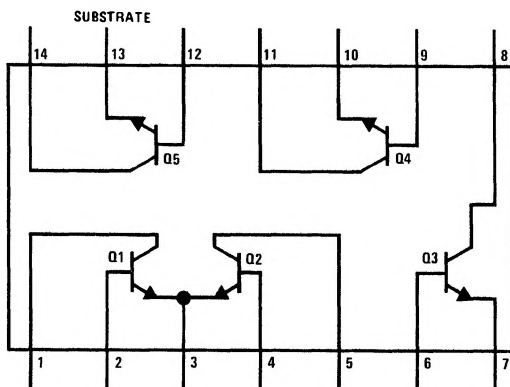
- Two matched pairs of transistors  
 $V_{BE}$  matched  $\pm 5$  mV  
 Input offset current  $2 \mu\text{A}$  max at  $I_C = 1 \text{ mA}$
- Five general purpose monolithic transistors
- Operation from DC to 120 MHz
- Wide operating current range
- Low noise figure 3.2 dB typ at 1 kHz
- Full military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



TL/H/7950-1

Top View

Order Number LM3045J, LM3046M, LM3086M, LM3046N or LM3086N  
 See NS Package Number J14A, M14A or N14A

**Absolute Maximum Ratings** ( $T_A = 25^\circ\text{C}$ )

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                                    | 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, $V_{CE0}$            | 15                                         |               | 15                                        |               | V                    |
| Collector to Base Voltage, $V_{CB0}$               | 20                                         |               | 20                                        |               | V                    |
| Collector to Substrate Voltage, $V_{C10}$ (Note 1) | 20                                         |               | 20                                        |               | V                    |
| Emitter to Base Voltage, $V_{EB0}$                 | 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 ( $V_{(BR)CBO}$ )                                                                            | $I_C = 10\text{ }\mu\text{A}$ , $I_E = 0$                                                                                  | 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 ( $V_{(BR)C10}$ )                                                                       | $I_C = 10\text{ }\mu\text{A}$ , $I_{C1} = 0$                                                                               | 20             | 60    |     | 20     | 60    |     | V                              |
| Emitter to Base Breakdown Voltage ( $V_{(BR)EBO}$ )                                                                              | $I_E 10\text{ }\mu\text{A}$ , $I_C = 0$                                                                                    | 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) ( $h_{FE}$ )                                                                 | $V_{CE} = 3\text{V}$<br>$\begin{cases} I_C = 10\text{ mA} \\ I_C = 1\text{ mA} \\ I_C = 10\text{ }\mu\text{A} \end{cases}$ |                | 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 ( $V_{BE}$ )                                                                                             | $V_{CE} = 3\text{V}$<br>$\begin{cases} I_E = 1\text{ mA} \\ I_E = 10\text{ mA} \end{cases}$                                |                | 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/ $^{\circ}\text{C}$         |
| Collector to Emitter Saturation Voltage ( $V_{CE(\text{SAT})}$ )                                                                 | $I_B = 1\text{ mA}$ , $I_C = 10\text{ mA}$                                                                                 |                | 0.23  |     |        | 0.23  |     | V                              |
| Temperature Coefficient of Input Offset Voltage $\left(\frac{\Delta V_{10}}{\Delta T}\right)$                                    | $V_{CE} = 3\text{V}$ , $I_C = 1\text{ mA}$                                                                                 |                | 1.1   |     |        |       |     | $\mu\text{V}/^{\circ}\text{C}$ |

Note 1: 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 (Continued)

| Parameter                       | Conditions                                                                                            | Min | Typ  | Max | Units |
|---------------------------------|-------------------------------------------------------------------------------------------------------|-----|------|-----|-------|
| Low Frequency Noise Figure (NF) | $f = 1 \text{ kHz}$ , $V_{CE} = 3 \text{ V}$ ,<br>$I_C = 100 \mu\text{A}$ , $R_S = 1 \text{ k}\Omega$ |     | 3.25 |     | dB    |

## LOW FREQUENCY, SMALL SIGNAL EQUIVALENT CIRCUIT CHARACTERISTICS

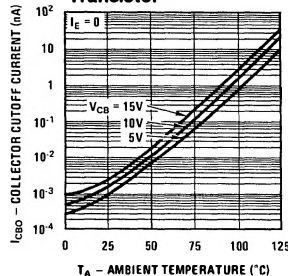
|                                                          |                                                                        |                                  |  |  |                  |
|----------------------------------------------------------|------------------------------------------------------------------------|----------------------------------|--|--|------------------|
| Forward Current Transfer Ratio ( $h_{fe}$ )              | $f = 1 \text{ kHz}$ , $V_{CE} = 3 \text{ V}$ ,<br>$I_C = 1 \text{ mA}$ | 110 (LM3045, LM3046)<br>(LM3086) |  |  |                  |
| Short Circuit Input Impedance ( $h_{ie}$ )               |                                                                        | 3.5                              |  |  | $\text{k}\Omega$ |
| Open Circuit Output Impedance ( $h_{oe}$ )               |                                                                        | 15.6                             |  |  | $\mu\text{mho}$  |
| Open Circuit Reverse Voltage Transfer Ratio ( $h_{re}$ ) |                                                                        | $1.8 \times 10^{-4}$             |  |  |                  |

## ADMITTANCE CHARACTERISTICS

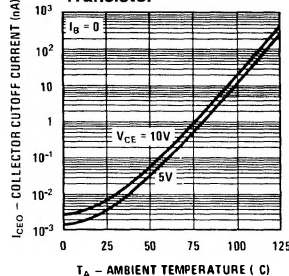
|                                                 |                                                                        |                  |      |  |    |
|-------------------------------------------------|------------------------------------------------------------------------|------------------|------|--|----|
| Forward Transfer Admittance ( $Y_{fe}$ )        | $f = 1 \text{ MHz}$ , $V_{CE} = 3 \text{ V}$ ,<br>$I_C = 1 \text{ mA}$ | $31 - j 1.5$     |      |  |    |
| Input Admittance ( $Y_{ie}$ )                   |                                                                        | $0.3 + j 0.04$   |      |  |    |
| Output Admittance ( $Y_{oe}$ )                  |                                                                        | $0.001 + j 0.03$ |      |  |    |
| Reverse Transfer Admittance ( $Y_{re}$ )        |                                                                        | See Curve        |      |  |    |
| Gain Bandwidth Product ( $f_T$ )                | $V_{CE} = 3 \text{ V}$ , $I_C = 3 \text{ mA}$                          | 300              | 550  |  |    |
| Emitter to Base Capacitance ( $C_{EB}$ )        | $V_{EB} = 3 \text{ V}$ , $I_E = 0$                                     |                  | 0.6  |  | pF |
| Collector to Base Capacitance ( $C_{CB}$ )      | $V_{CB} = 3 \text{ V}$ , $I_C = 0$                                     |                  | 0.58 |  | pF |
| Collector to Substrate Capacitance ( $C_{CI}$ ) | $V_{CS} = 3 \text{ V}$ , $I_C = 0$                                     |                  | 2.8  |  | pF |

## Typical Performance Characteristics

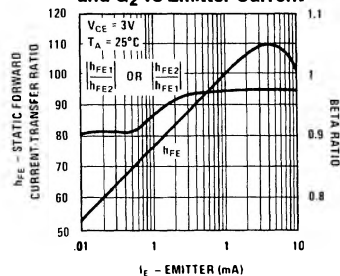
Typical Collector To Base Cutoff Current vs Ambient Temperature for Each Transistor



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

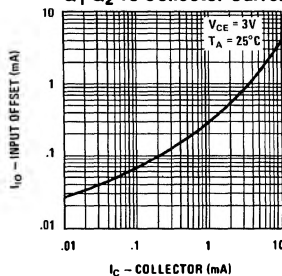


Typical Static Forward Current-Transfer Ratio and Beta Ratio for Transistors Q<sub>1</sub> and Q<sub>2</sub> vs Emitter Current

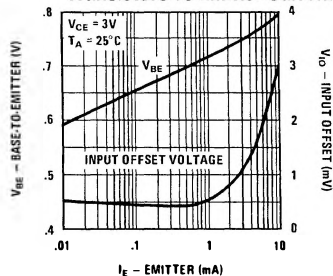


TL/H/7950-2

Typical Input Offset Current for Matched Transistor Pair Q<sub>1</sub> Q<sub>2</sub> vs Collector Current



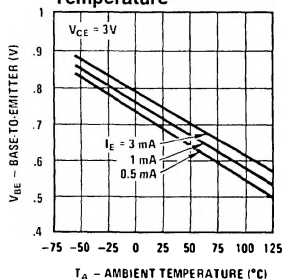
Typical Static Base To Emitter Voltage Characteristic and Input Offset Voltage for Differential Pair and Paired Isolated Transistors vs Emitter Current



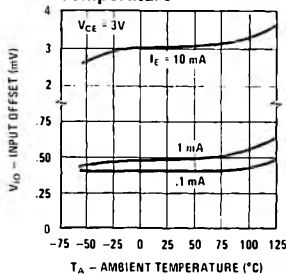
TL/H/7950-3

# Typical Performance Characteristics (Continued)

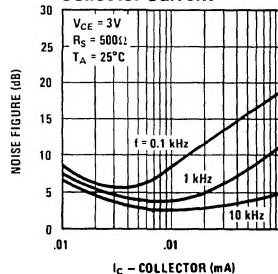
**Typical Base To Emitter Voltage Characteristic for Each Transistor vs Ambient Temperature**



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

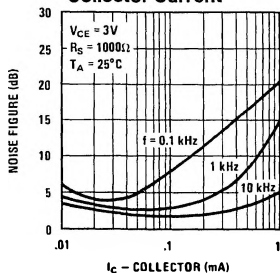


**Typical Noise Figure vs Collector Current**

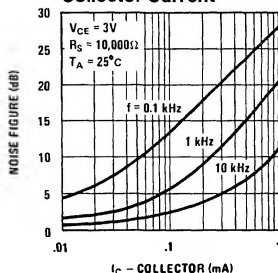


TL/H/7950-4

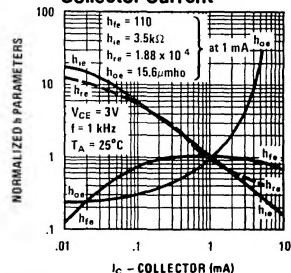
**Typical Noise Figure vs Collector Current**



**Typical Noise Figure vs Collector Current**

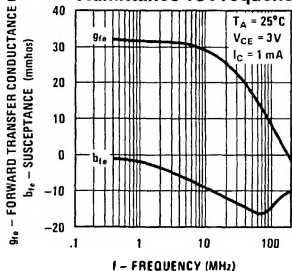


**Typical Normalized Forward Current Transfer Ratio, Short Circuit Input Impedance, Open Circuit Output Impedance, and Open Circuit Reverse Voltage Transfer Ratio vs Collector Current**

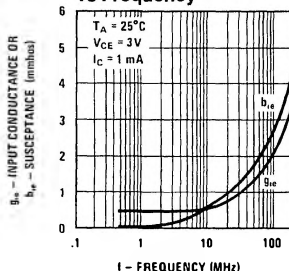


TL/H/7950-5

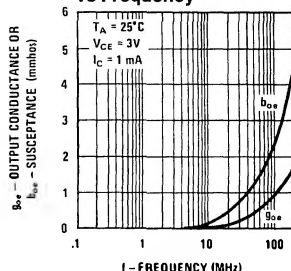
**Typical Forward Transfer Admittance vs Frequency**



**Typical Input Admittance vs Frequency**

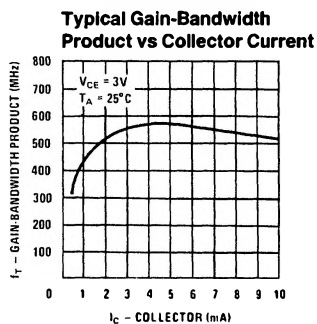
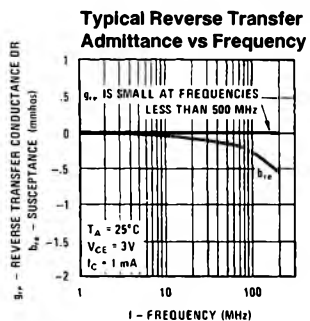


**Typical Output Admittance vs Frequency**



TL/H/7950-6

# Typical Performance Characteristics (Continued)



TL/H/7950-7