

Silicon Bipolar High f_T Low Noise Microwave Transistors

MP4T645

Features

- f_T to 9 GHz
- Low Noise Figure
- High Associated Gain
- Hermetic and Surface Mount Packages Available
- Can be Screened to JANTX, JANTXV Equivalent Levels
- Industry Standard

Description

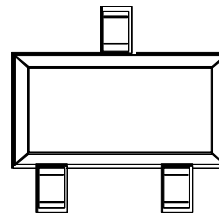
The MP4T645 family of high gain-bandwidth, small signal silicon bipolar transistors is well suited for use in amplifiers to approximately 4 GHz, and in oscillators to approximately 10 GHz. These industry standard transistors feature low noise figure at high collector current, which produces very good associated gain and wide dynamic range. The MP4T645 series transistors are available in a hermetic microstrip package (MP4T64535), in the plastic SOT-23 package (MP4T64533), in chip form (MP4T64500), and in the SOT-143 package (MP4T64539). The MP4T645 series is available in other plastic and hermetic packages as well. The chip and hermetically packaged transistors can be screened to a JANTXV equivalent level.

Applications

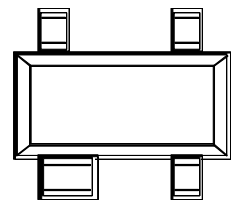
The MP4T645 family of bipolar NPN transistors can be used for low noise, high associated gain, large dynamic range amplifiers up to approximately 4 GHz. These transistors can also be used as preamplifier or driver stages in the same frequency range.

The MP4T645 family of bipolar NPN transistors can also be used for oscillators or VCOs up to approximately 10 GHz. The passivation consists of silicon dioxide, commonly known as thermal oxide, and silicon nitride to produce very low $1/f$ noise in both amplifiers and oscillators.

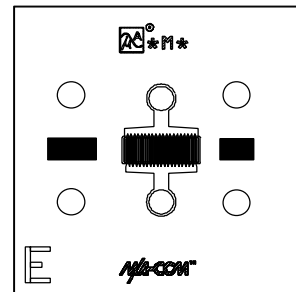
Case Styles



SOT-23



SOT-143



Chip

Micro-X

Specification Subject to Change Without Notice

Absolute Maximum Ratings**MP4T645 Series**

| | | |
|---|-----------|------------------------------------|
| Collector-Base Voltage | V_{CBO} | 25 V |
| Collector-Emitter Voltage | V_{CEO} | 12 V |
| Emitter-Base Voltage | V_{EBO} | 1.5 V |
| Collector Current | I_C | 65 mA |
| Junction Operating Temperature | T_j | 200°C |
| Storage Temperature Chip or Ceramic Packages Plastic Packages | | -65°C to +200°C -65°C to +125°C |
| Total Power Dissipation at 25°C Derate Linearly to: | | |
| +150°C Chip | | 400 mW |
| +125°C Plastic Package (SOT-23) | | 200 mW |
| +150°C Ceramic Package (Micro-X) | | 300 mW |

Electrical Specifications @ 25°C**MP4T645 Series**

| Parameter of Test | Condition | Symbol | Units | MP4T64500 Chip | MP4T64535 SOT-23 | MP4T64533 Micro-X |
|----------------------------------|--|---------------|-------|---------------------------|---------------------|-----------------------------|
| Gain Bandwidth Product | $V_{CE} = 8$ volts $I_C = 20$ mA | f_T | GHz | 10 typ | 8 typ | 9 typ |
| Insertion Power Gain | $V_{CE} = 8$ volts $I_C = 20$ mA $f = 1$ GHz $f = 2$ GHz $f = 4$ GHz | $ S_{21E} ^2$ | dB | 18 typ 11 min 7 typ | 16 typ 10 min | 17 typ 10 min 6.5 typ |
| Noise Figure | $V_{CE} = 8$ volts $I_C = 7$ mA $f = 1$ GHz $f = 2$ GHz | NF | dB | 1.7 max 2.0 typ | 1.7 max 2.5 typ | 1.7 max 2.0 typ |
| Unilateral Gain | $V_{CE} = 8$ volts $I_C = 7$ mA $f = 1$ GHz $f = 2$ GHz | GTU (max) | dB | 18 typ 11 typ | 16 typ 10 typ | 17 typ 11 typ |
| Maximum Available Gain | $V_{CE} = 8$ volts $I_C = 10$ mA $f = 2$ GHz $f = 4$ GHz | MAG | dB | 14 typ 12 typ | 13 typ 10 typ | 14 typ 11.5 typ |
| Power Out at 1 dB Compression | $V_{CE} = 8$ volts $I_C = 10$ mA $f = 1$ GHz $f = 4$ GHz | P_{1dB} | dBm | 16 typ 11 typ | 16 typ 11 typ | 16 typ 11 typ |

Note: The electrical characteristics of the MP4T64539 (SOT-143) are very similar to those of the MP4T64533 (SOT-23).

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Electrical Specifications @ 25°C
MP4T645 Series

| Parameter | Condition | Symbol | Min | Typical | Max | Units |
|-------------------------------------|---|-----------|-----|---------|-----|---------|
| Collector Cut-off Current | $V_{CB} = 8$ volts $I_E = 0$ μ A | I_{CBO} | — | — | 100 | nA |
| Emitter Cut-off Current | $V_{EB} = 1$ volt $I_C = 0$ μ A | I_{EBO} | — | — | 1 | μ A |
| Forward Current Gain | $V_{CE} = 8$ volts $I_C = 7$ mA | h_{FE} | 30 | 125 | 250 | — |
| Collector-Base Junction Capacitance | $V_{CB} = 10$ volts $I_E = 0$ μ A $f = 1$ MHz | C_{CO} | — | 0.3 | 0.6 | pF |

Typical Scattering Parameters in the Micro-X Package
MP4T64535, $V_{CE} = 8$ Volts, $I_C = 7$ mA

| Frequency (MHz) | S_{11E} | | S_{21E} | | S_{12E} | | S_{22E} | |
|-----------------|-----------|-------|-----------|-------|-----------|-------|-----------|--------|
| | Mag. | Angle | Mag. | Angle | Mag. | Angle | Mag. | Angle |
| 500 | 0.583 | -114 | 9.315 | 116.1 | 0.052 | 43.6 | 0.573 | -42.6 |
| 1000 | 0.569 | -153 | 5.399 | 94.7 | 0.063 | 39.0 | 0.406 | -53.0 |
| 1500 | 0.573 | -173 | 3.807 | 82.0 | 0.072 | 40.0 | 0.357 | -57.1 |
| 2000 | 0.587 | 170 | 2.980 | 72.0 | 0.082 | 42.5 | 0.313 | -61.8 |
| 2500 | 0.598 | 159 | 2.479 | 62.7 | 0.092 | 44.0 | 0.299 | -71.7 |
| 3000 | 0.616 | 150 | 2.132 | 54.8 | 0.103 | 45.2 | 0.304 | -78.5 |
| 3500 | 0.645 | 142 | 1.935 | 47.0 | 0.118 | 45.5 | 0.289 | -86.5 |
| 4000 | 0.675 | 132 | 1.782 | 38.5 | 0.130 | 45.7 | 0.281 | -96.6 |
| 4500 | 0.705 | 124 | 1.631 | 29.6 | 0.143 | 45.5 | 0.292 | -105.5 |
| 5000 | 0.749 | 115 | 1.538 | 22.0 | 0.159 | 44.5 | 0.281 | -114.1 |
| 5500 | 0.791 | 106 | 1.445 | 14.4 | 0.176 | 43.6 | 0.283 | -125.7 |
| 6000 | 0.832 | 96 | 1.395 | 6.1 | 0.188 | 42.3 | 0.306 | -135.0 |

MP4T64535, $V_{CE} = 8$ Volts, $I_C = 10$ mA

| Frequency (MHz) | S_{11E} | | S_{21E} | | S_{12E} | | S_{22E} | |
|-----------------|-----------|-------|-----------|-------|-----------|-------|-----------|--------|
| | Mag. | Angle | Mag. | Angle | Mag. | Angle | Mag. | Angle |
| 500 | 0.562 | -128 | 10.477 | 111.9 | 0.044 | 44.5 | 0.515 | -46.2 |
| 1000 | 0.564 | -161 | 5.845 | 92.1 | 0.056 | 44.0 | 0.358 | -53.8 |
| 1500 | 0.575 | 176 | 4.088 | 80.5 | 0.068 | 46.5 | 0.313 | -57.2 |
| 2000 | 0.592 | 166 | 3.185 | 70.9 | 0.080 | 49.0 | 0.276 | -62.3 |
| 2500 | 0.601 | 156 | 2.638 | 62.0 | 0.092 | 49.7 | 0.268 | -71.7 |
| 3000 | 0.618 | 148 | 2.266 | 54.5 | 0.105 | 50.1 | 0.272 | -78.3 |
| 3500 | 0.648 | 139 | 2.053 | 46.9 | 0.122 | 49.4 | 0.259 | -87.0 |
| 4000 | 0.677 | 130 | 1.892 | 38.6 | 0.136 | 48.7 | 0.253 | -96.9 |
| 4500 | 0.706 | 122 | 1.734 | 29.8 | 0.150 | 47.9 | 0.264 | -106.0 |
| 5000 | 0.749 | 113 | 1.634 | 22.3 | 0.167 | 46.1 | 0.257 | -115.1 |
| 5500 | 0.790 | 104 | 1.532 | 14.8 | 0.184 | 44.4 | 0.259 | -126.3 |
| 6000 | 0.831 | 95 | 1.482 | 6.4 | 0.196 | 42.6 | 0.278 | -136.0 |

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Typical Scattering Parameters in the Micro-X Package (Cont'd)

MP4T64535, $V_{CE} = 8$ Volts, $I_C = 20$ mA

| Frequency (MHz) | S _{11E} | | S _{21E} | | S _{12E} | | S _{22E} | |
|--------------------|------------------|-------|------------------|-------|------------------|-------|------------------|--------|
| | Mag. | Angle | Mag. | Angle | Mag. | Angle | Mag. | Angle |
| 500 | 0.536 | -154 | 11.788 | 104.0 | 0.033 | 49.8 | 0.390 | -46.8 |
| 1000 | 0.565 | -177 | 6.309 | 87.5 | 0.046 | 55.7 | 0.284 | -53.2 |
| 1500 | 0.579 | 170 | 4.350 | 77.0 | 0.062 | 57.7 | 0.270 | -54.6 |
| 2000 | 0.592 | 160 | 3.368 | 68.6 | 0.077 | 59.3 | 0.237 | -57.5 |
| 2500 | 0.612 | 151 | 2.798 | 60.1 | 0.093 | 58.0 | 0.226 | -70.0 |
| 3000 | 0.630 | 142 | 2.390 | 52.6 | 0.108 | 56.5 | 0.243 | -77.2 |
| 3500 | 0.660 | 134 | 2.156 | 45.4 | 0.126 | 54.4 | 0.231 | -84.4 |
| 4000 | 0.691 | 125 | 1.984 | 37.2 | 0.141 | 52.6 | 0.223 | -95.8 |
| 4500 | 0.719 | 117 | 1.809 | 28.4 | 0.155 | 50.9 | 0.240 | -105.2 |
| 5000 | 0.760 | 109 | 1.697 | 21.3 | 0.173 | 48.5 | 0.229 | -112.6 |
| 5500 | 0.803 | 101 | 1.594 | 13.8 | 0.192 | 46.0 | 0.229 | -112.3 |
| 6000 | 0.844 | 92 | 1.540 | 6.0 | 0.210 | 44.2 | 0.258 | -136.2 |

Typical Scattering Parameters in the SOT-23 Package

MP4T64533, $V_{CE} = 8$ Volts, $I_C = 7$ mA

| Frequency (MHz) | S _{11E} | | S _{21E} | | S _{12E} | | S _{22E} | |
|--------------------|------------------|-------|------------------|-------|------------------|-------|------------------|-------|
| | Mag. | Angle | Mag. | Angle | Mag. | Angle | Mag. | Angle |
| 500 | 0.421 | -95 | 7.378 | 126.4 | 0.062 | 77.9 | 0.519 | -36.3 |
| 1000 | 0.257 | -149 | 4.384 | 118.9 | 0.100 | 97.9 | 0.402 | -36.9 |
| 1500 | 0.232 | -176 | 3.082 | 123.3 | 0.140 | 116.2 | 0.368 | -39.6 |
| 2000 | 0.238 | 157 | 2.408 | 129.2 | 0.183 | 130.9 | 0.354 | -44.7 |
| 2500 | 0.256 | 140 | 2.005 | 136.3 | 0.224 | 145.7 | 0.346 | -51.6 |
| 3000 | 0.279 | 126 | 1.734 | 143.2 | 0.274 | 160.8 | 0.339 | -58.8 |
| 3500 | 0.310 | 116 | 1.498 | 153.3 | 0.308 | 172.0 | 0.331 | -68.5 |
| 4000 | 0.338 | 106 | 1.367 | 163.5 | 0.350 | 173.6 | 0.320 | -80.1 |
| 4500 | 0.359 | 97 | 1.284 | 173.8 | 0.402 | 161.0 | 0.327 | -90.6 |

MP4T64533, $V_{CE} = 8$ Volts, $I_C = 10$ mA

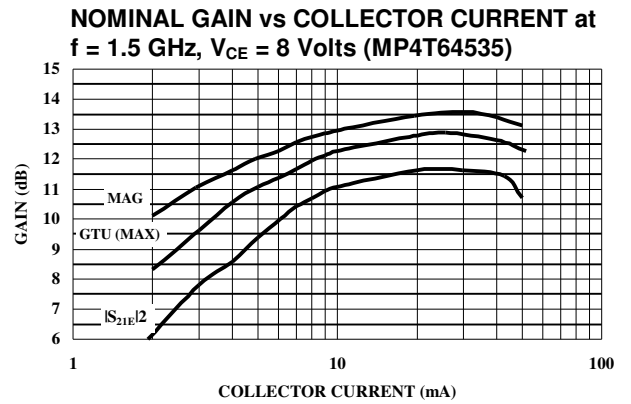
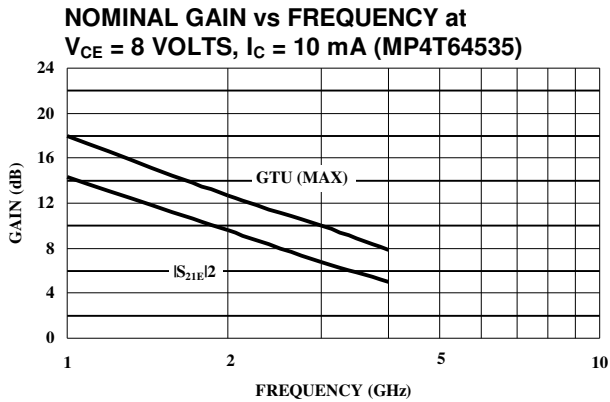
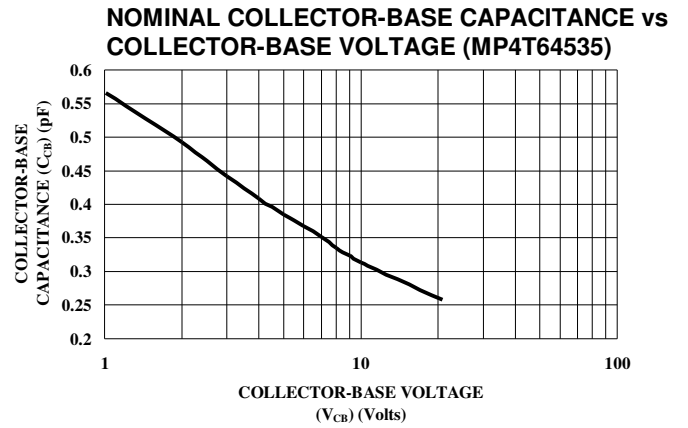
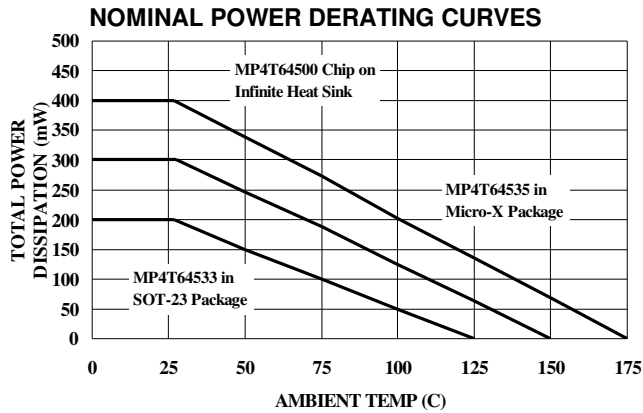
| Frequency (MHz) | S _{11E} | | S _{21E} | | S _{12E} | | S _{22E} | |
|--------------------|------------------|-------|------------------|-------|------------------|-------|------------------|-------|
| | Mag. | Angle | Mag. | Angle | Mag. | Angle | Mag. | Angle |
| 500 | 0.299 | -116 | 8.385 | 119.4 | 0.057 | 82.1 | 0.451 | -33.9 |
| 1000 | 0.216 | -161 | 4.558 | 116.9 | 0.099 | 102.3 | 0.354 | -33.2 |
| 1500 | 0.215 | 172 | 3.185 | 122.7 | 0.142 | 119.5 | 0.332 | -37.7 |
| 2000 | 0.230 | 151 | 2.487 | 129.0 | 0.188 | 132.9 | 0.332 | -44.0 |
| 2500 | 0.247 | 134 | 2.064 | 136.4 | 0.230 | 146.9 | 0.332 | -50.1 |
| 3000 | 0.267 | 123 | 1.783 | 143.8 | 0.281 | 161.5 | 0.322 | -56.1 |
| 3500 | 0.299 | 114 | 1.548 | 153.9 | 0.315 | 172.5 | 0.310 | -66.4 |
| 4000 | 0.328 | 104 | 1.410 | 164.0 | 0.357 | 173.6 | 0.299 | -79.2 |
| 4500 | 0.352 | 96 | 1.320 | 174.5 | 0.408 | 161.3 | 0.310 | -90.1 |

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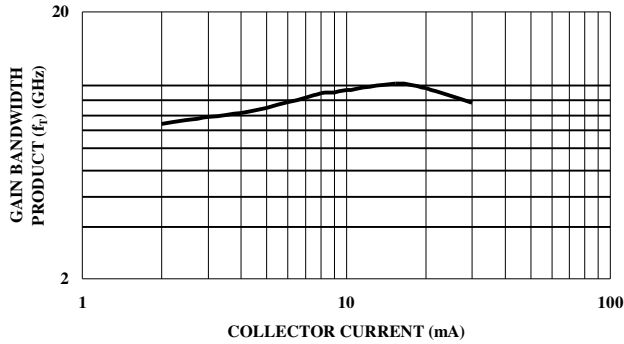
MP4T645 Series
Typical Performance Curves



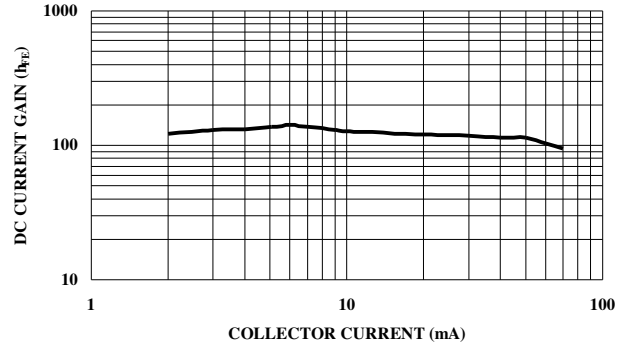
Specification Subject to Change Without Notice

Typical Performance Curves (Cont'd)

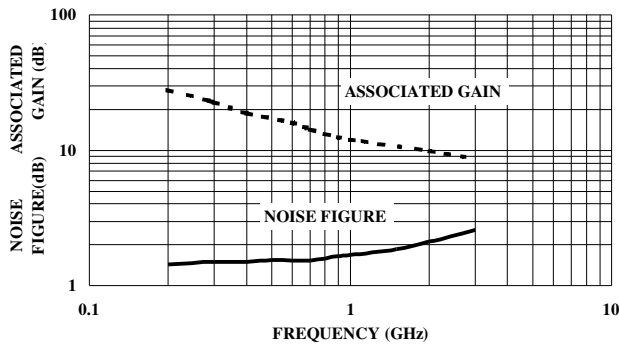
NOMINAL GAIN BANDWIDTH PRODUCT vs COLLECTOR CURRENT (MP4T64535)



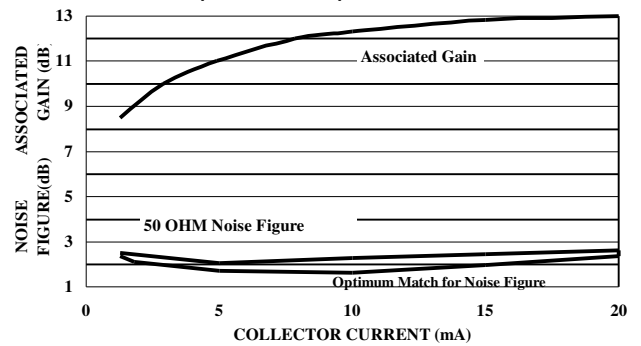
NOMINAL DC CURRENT GAIN vs COLLECTOR CURRENT at $V_{CE} = 8$ VOLTS (MP4T64535)



NOMINAL NOISE FIGURE and ASSOCIATED GAIN vs FREQUENCY at $V_{CE} = 8$ VOLTS, COLLECTOR CURRENT = 7 mA (MP4T64535)



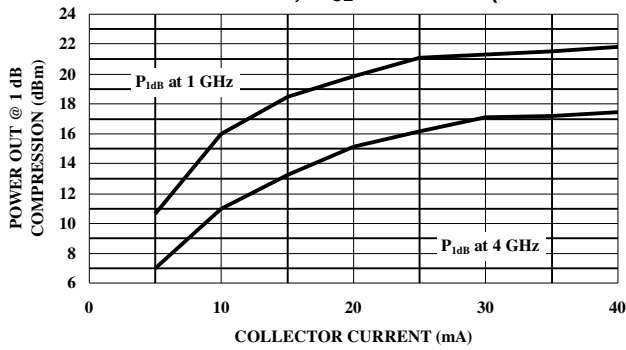
NOMINAL NOISE FIGURE and ASSOCIATED GAIN vs COLLECTOR CURRENT at $f = 1$ GHz and $V_{CE} = 8$ VOLTS (MP4T64535)



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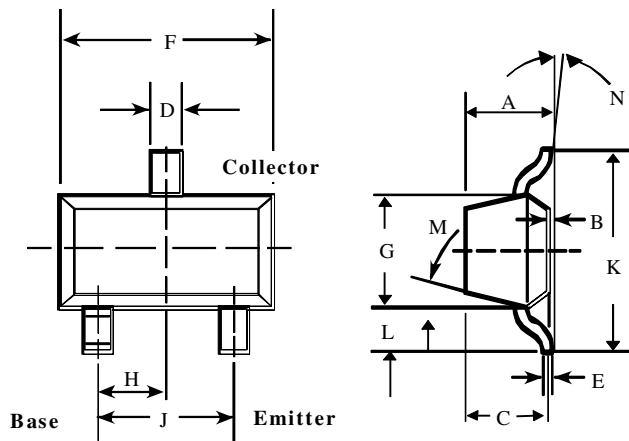
Typical Performance Curves (Cont'd)

NOMINAL OUTPUT POWER at the 1dB COMPRESSION POINT vs COLLECTOR CURRENT at $f = 1$ and 4 GHz, $V_{CE} = 8$ VOLTS (MP4T64535)



Case Styles

MP4T64533
SOT-23



MP4T64533

| DIM. | INCHES | | MILLIMETERS | |
|------|---------------|-------|--------------|------|
| | MIN. | MAX. | MIN. | MAX. |
| A | — | 0.044 | — | 1.12 |
| B | — | 0.004 | — | 0.10 |
| C | — | 0.040 | — | 1.00 |
| D | 0.013 | 0.020 | 0.35 | 0.50 |
| E | 0.003 | 0.006 | 0.08 | 0.15 |
| F | 0.110 | 0.119 | 2.80 | 3.00 |
| G | 0.047 | 0.056 | 1.20 | 1.40 |
| H | 0.037 typical | | 0.95 typical | |
| J | 0.075 typical | | 1.90 typical | |
| K | — | 0.103 | — | 2.60 |
| L | — | 0.024 | — | 0.60 |

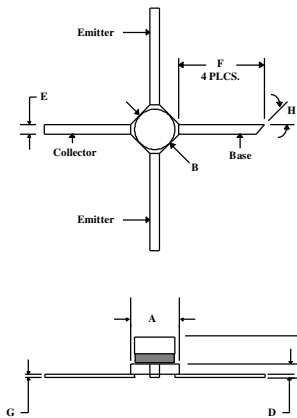
| DIM. | GRADIENT |
|------|-----------------------|
| M | 10° max. ¹ |
| N | 2° ... 30° |

NOTE:
1. Applicable on all sides

Specification Subject to Change Without Notice

Case Styles (Cont'd)

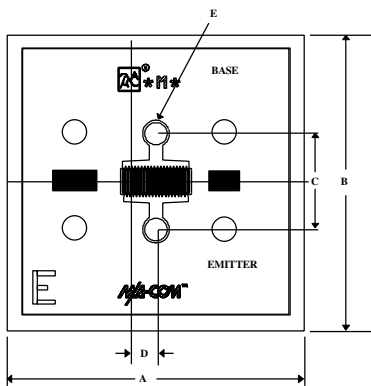
MP4T64535 Micro-X



MP4T64535

| DIM. | INCHES | | MILLIMETERS | |
|------|--------|-------|-------------|------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.092 | 0.108 | 2.34 | 2.74 |
| B | 0.079 | 0.087 | 2.01 | 2.21 |
| C | — | 0.070 | — | 1.78 |
| D | 0.019 | 0.025 | 0.48 | 0.64 |
| E | 0.018 | 0.022 | 0.46 | 0.56 |
| F | 0.150 | — | 3.81 | — |
| G | 0.003 | 0.006 | 0.08 | 0.15 |
| H | 45° | | 45° | |

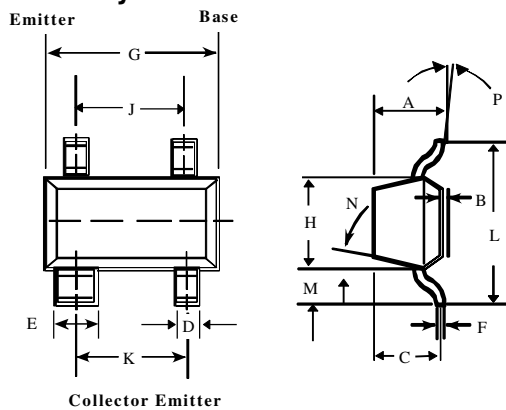
MP4T64500
Case Style 00 (Chip)



MP4T64500

| DIM. | INCHES | MILLIMETERS |
|--------------------|--------|-------------|
| A | 0.013 | 0.325 |
| B | 0.013 | 0.325 |
| C | 0.004 | 0.110 |
| D | 0.0005 | 0.013 |
| E (Dia.) | 0.0012 | 0.030 |
| F (chip thickness) | 0.0045 | 0.114 |

MP4T64539
Case Style SOT-143



MP4T64539

| DIM. | INCHES | | MILLIMETERS | |
|------|---------------|-------|--------------|------|
| | MIN. | MAX. | MIN. | MAX. |
| A | — | 0.044 | — | 1.10 |
| B | — | 0.004 | — | 0.10 |
| C | — | 0.040 | — | 1.00 |
| D | 0.013 | 0.020 | 0.35 | 0.50 |
| E | 0.030 | 0.035 | 0.75 | 0.90 |
| F | 0.003 | 0.006 | 0.08 | 0.15 |
| G | 0.110 | 0.119 | 2.80 | 3.00 |
| H | 0.047 | 0.056 | 1.20 | 1.40 |
| J | 0.075 typical | | 1.90 typical | |
| K | 0.040 typical | | 1.70 typical | |
| L | — | 0.103 | — | 2.60 |
| M | — | 0.024 | — | 0.60 |

| DIM. | GRADIENT |
|------|-----------------------|
| N | 10° max. ¹ |
| P | 2° . . . 30° |

NOTE:
1. Applicable on all sides

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