

N-Channel and P-Channel Enhancement-Mode MOSFET Pair

Features

- Integrated Gate-to-source Resistor
- Integrated Gate-to-source Zener Diode
- Low Threshold
- Low On-resistance
- Low Input Capacitance
- Fast Switching Speeds
- Free from Secondary Breakdown
- Low Input and Output Leakage
- Independent Electrically Isolated N-channel and P-channel

Applications

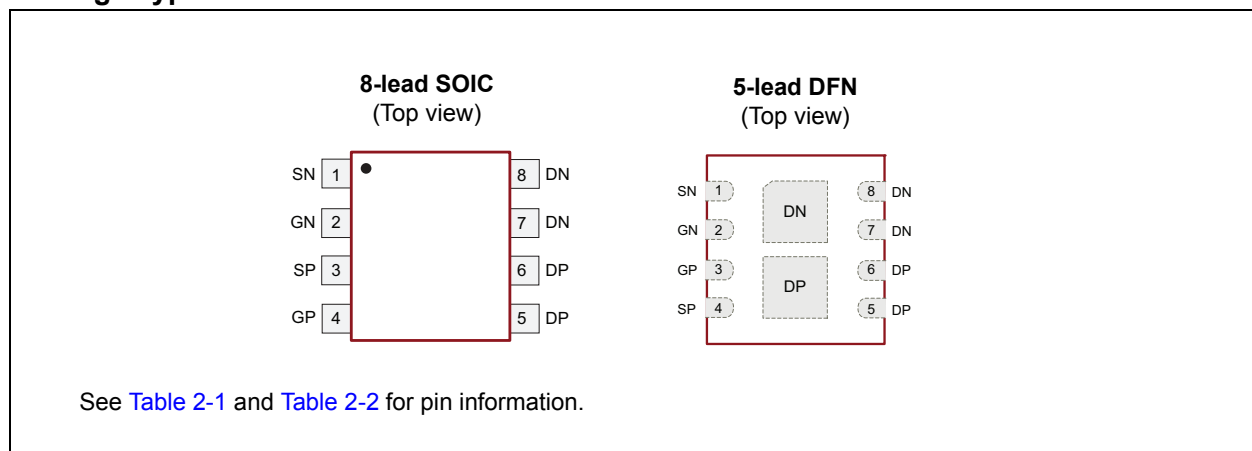
- High-voltage Pulsers
- Amplifiers
- Buffers
- Piezoelectric Transducer Drivers
- General Purpose Line Drivers
- Logic-level Interfaces

General Description

The TC6320 consists of high-voltage, low-threshold N-channel and P-channel MOSFETs in 8-lead SOIC and DFN packages. Both MOSFETs have integrated gate-to-source resistors and gate-to-source Zener diode clamps which are desired for high-voltage pulser applications. It is a complimentary, high-speed, high-voltage, gate-clamped N-channel and P-channel MOSFET pair, which utilizes an advanced vertical DMOS structure and a well-proven silicon gate manufacturing process. This combination produces a device with the power handling capabilities of bipolar transistors and with the high input impedance and positive temperature coefficient inherent in MOS devices. Characteristic of all MOS structures, this device is free from thermal runaway and thermally induced secondary breakdown.

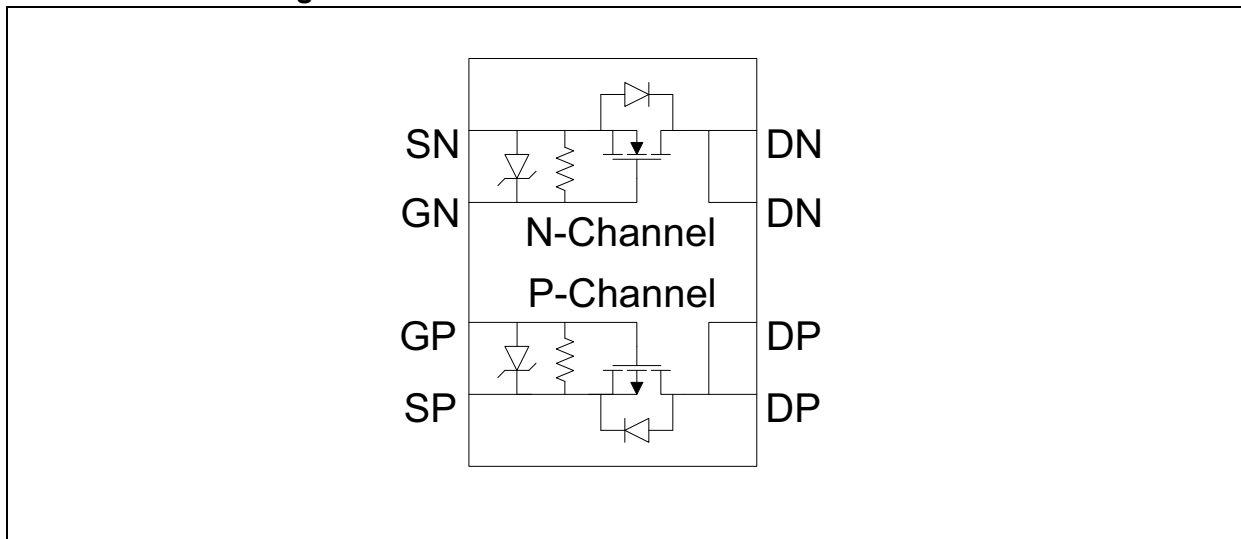
Microchip's vertical DMOS FETs are ideally suited to a wide range of switching and amplifying applications where very low threshold voltage, high breakdown voltage, high input impedance, low input capacitance and fast switching speeds are desired.

Package Types

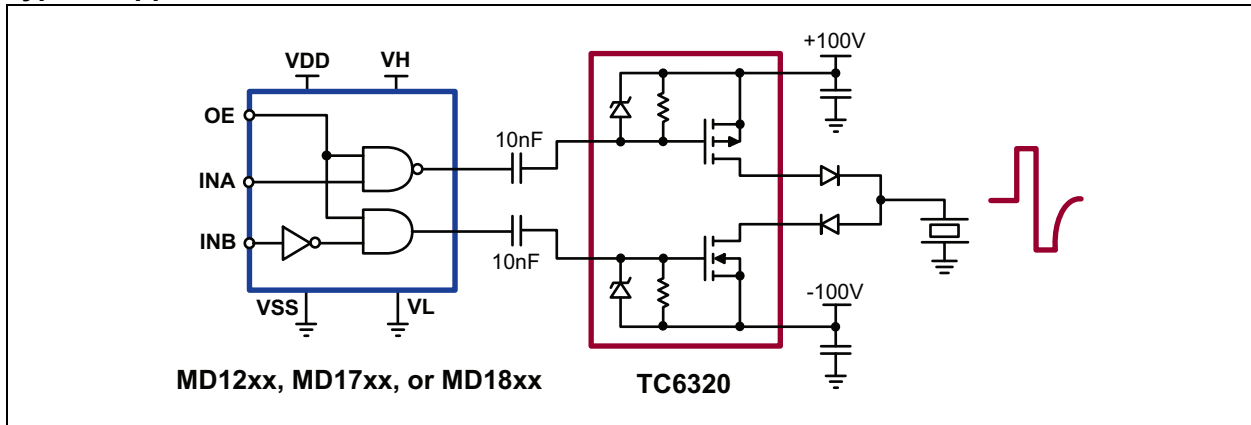


TC6320

Functional Block Diagram



Typical Application Circuit



TC6320

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

| | |
|--|-----------------|
| Drain-to-source Voltage | BV_{DSS} |
| Drain-to-gate Voltage | BV_{DGS} |
| Operating Ambient Temperature, T_A | -55°C to +150°C |
| Storage Temperature, T_S | -55°C to +150°C |

† **Notice:** Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

N-CHANNEL ELECTRICAL CHARACTERISTICS

| Electrical Specifications: $T_A = T_J = 25^\circ\text{C}$ unless otherwise specified. | | | | | | |
|---|---------------------|------|------|------|---------------|--|
| Parameter | Sym. | Min. | Typ. | Max. | Unit | Conditions |
| DC PARAMETER (Note 1 unless otherwise specified) | | | | | | |
| Drain-to-source Breakdown Voltage | BV_{DSS} | 200 | — | — | V | $V_{GS} = 0\text{V}, I_D = 2\text{ mA}$ |
| Gate Threshold Voltage | $V_{GS(th)}$ | 1 | — | 2 | V | $V_{GS} = V_{DS}, I_D = 1\text{ mA}$ |
| Change in $V_{GS(th)}$ with Temperature | $\Delta V_{GS(th)}$ | — | — | -4.5 | mV/°C | $V_{GS} = V_{DS}, I_D = 1\text{ mA}$ (Note 2) |
| Gate-to-source Shunt Resistor | R_{GS} | 10 | — | 50 | kΩ | $I_{GS} = 100\text{ }\mu\text{A}$ |
| Gate-to-Source Zener Voltage | V_{ZGS} | 13.2 | — | 25 | V | $I_{GS} = 2\text{ mA}$ |
| Zero-gate Voltage Drain Current | I_{DSS} | — | — | 10 | μA | $V_{DS} = \text{Maximum rating}, V_{GS} = 0\text{V}$ |
| | | — | — | 1 | mA | $V_{DS} = 0.8\text{ Maximum rating}, V_{GS} = 0\text{V}, T_A = 125^\circ\text{C}$ (Note 2) |
| On-state Drain Current | $I_{D(ON)}$ | 1 | — | — | A | $V_{GS} = 4.5\text{V}, V_{DS} = 25\text{V}$ |
| | | 2 | — | — | | $V_{GS} = 10\text{V}, V_{DS} = 25\text{V}$ |
| Static Drain-to-source On-state Resistance | $R_{DS(ON)}$ | — | — | 8 | Ω | $V_{GS} = 4.5\text{V}, I_D = 150\text{ mA}$ |
| | | — | — | 7 | | $V_{GS} = 10\text{V}, I_D = 1\text{ A}$ |
| Change in $R_{DS(ON)}$ with Temperature | $\Delta R_{DS(ON)}$ | — | — | 1 | %/°C | $V_{GS} = 4.5\text{V}, I_D = 150\text{ mA}$ (Note 2) |
| AC PARAMETER (Note 2) | | | | | | |
| Forward Transconductance | G_{FS} | 400 | — | — | mmho | $V_{DS} = 25\text{V}, I_D = 500\text{ mA}$ |
| Input Capacitance | C_{ISS} | — | — | 110 | pF | $V_{GS} = 0\text{V}, V_{DS} = 25\text{V}, f = 1\text{ MHz}$ |
| Common Source Output Capacitance | C_{OSS} | — | — | 60 | pF | |
| Reverse Transfer Capacitance | C_{RSS} | — | — | 23 | pF | |
| Turn-on Delay Time | $t_{d(ON)}$ | — | — | 10 | ns | $V_{DD} = 25\text{V}, I_D = 1\text{ A}, R_{GEN} = 25\Omega$ |
| Rise Time | t_r | — | — | 15 | ns | |
| Turn-off Delay Time | $t_{d(OFF)}$ | — | — | 20 | ns | |
| Fall Time | t_f | — | — | 15 | ns | |
| DIODE PARAMETER | | | | | | |
| Diode Forward Voltage Drop | V_{SD} | — | — | 1.8 | V | $V_{GS} = 0\text{V}, I_{SD} = 500\text{ mA}$ (Note 1) |
| Reverse Recovery Time | t_{rr} | — | 300 | — | ns | $V_{GS} = 0\text{V}, I_{SD} = 500\text{ mA}$ (Note 2) |

Note 1: All DC parameters are 100% tested at 25°C unless otherwise stated. Pulse test: 300 μs pulse, 2% duty cycle.

2: Specification is obtained by characterization and is not 100% tested.

P-CHANNEL ELECTRICAL CHARACTERISTICS

| Electrical Specifications: $T_A = T_J = 25^\circ\text{C}$ unless otherwise specified. | | | | | | |
|---|---------------------|------|------|------|---------------|--|
| Parameter | Sym. | Min. | Typ. | Max. | Unit | Conditions |
| DC PARAMETER (Note 1 unless otherwise specified) | | | | | | |
| Drain-to-source Breakdown Voltage | BV_{DSS} | -200 | — | — | V | $V_{GS} = 0\text{V}, I_D = -2\text{ mA}$ |
| Gate Threshold Voltage | $V_{GS(th)}$ | -1 | — | -2.4 | V | $V_{GS} = V_{DS}, I_D = -1\text{ mA}$ |
| Change in $V_{GS(th)}$ with Temperature | $\Delta V_{GS(th)}$ | — | — | 4.5 | mV/°C | $V_{GS} = V_{DS}, I_D = -1\text{ mA}$ (Note 2) |
| Gate-to-source Shunt Resistor | R_{GS} | 10 | — | 50 | k Ω | $I_{GS} = 100\text{ }\mu\text{A}$ |
| Gate-to-Source Zener Voltage | V_{ZGS} | 13.2 | — | 25 | V | $I_{GS} = -2\text{ mA}$ |
| Zero-gate Voltage Drain Current | I_{DSS} | — | — | -10 | μA | $V_{DS} = \text{Maximum rating}, V_{GS} = 0\text{V}$ |
| | | — | — | -1 | mA | $V_{DS} = 0.8\text{ Maximum rating}, V_{GS} = 0\text{V}, T_A = 125^\circ\text{C}$ (Note 2) |
| On-state Drain Current | $I_{D(ON)}$ | -1 | — | — | A | $V_{GS} = -4.5\text{V}, V_{DS} = -25\text{V}$ |
| | | -2 | — | — | | $V_{GS} = -10\text{V}, V_{DS} = -25\text{V}$ |
| Static Drain-to-source On-state Resistance | $R_{DS(ON)}$ | — | — | 10 | Ω | $V_{GS} = -4.5\text{V}, I_D = -150\text{ mA}$ |
| | | — | — | 8 | | $V_{GS} = -10\text{V}, I_D = -1\text{A}$ |
| Change in $R_{DS(ON)}$ with Temperature | $\Delta R_{DS(ON)}$ | — | — | 1 | %/°C | $V_{GS} = -10\text{V}, I_D = -200\text{ mA}$ (Note 2) |
| AC PARAMETER (Note 2) | | | | | | |
| Forward Transconductance | G_{FS} | 400 | — | — | mmho | $V_{DS} = -25\text{V}, I_D = -500\text{ mA}$ |
| Input Capacitance | C_{ISS} | — | — | 200 | pF | $V_{GS} = 0\text{V}, V_{DS} = -25\text{V}, f = 1\text{ MHz}$ |
| Common Source Output Capacitance | C_{OSS} | — | — | 55 | pF | |
| Reverse Transfer Capacitance | C_{RSS} | — | — | 30 | pF | |
| Turn-on Delay Time | $t_{d(ON)}$ | — | — | 10 | ns | $V_{DD} = -25\text{V}, I_D = -1\text{A}, R_{GEN} = 25\Omega$ |
| Rise Time | t_r | — | — | 15 | ns | |
| Turn-off Delay Time | $t_{d(OFF)}$ | — | — | 20 | ns | |
| Fall Time | t_f | — | — | 15 | ns | |
| DIODE PARAMETER | | | | | | |
| Diode Forward Voltage Drop | V_{SD} | — | — | -1.8 | V | $V_{GS} = 0\text{V}, I_{SD} = -500\text{ mA}$ (Note 1) |
| Reverse Recovery Time | t_{rr} | — | 300 | — | ns | $V_{GS} = 0\text{V}, I_{SD} = -500\text{ mA}$ (Note 2) |

Note 1: All DC parameters are 100% tested at 25°C unless otherwise stated. Pulse test: 300 μs pulse, 2% duty cycle.

2: Specification is obtained by characterization and is not 100% tested.

TEMPERATURE SPECIFICATIONS

| Electrical Characteristics: Unless otherwise specified, for all specifications $T_A = T_J = +25^\circ\text{C}$. | | | | | | |
|--|---------------|---------------------|------|------|------|------------|
| Parameter | Sym. | Min. | Typ. | Max. | Unit | Conditions |
| TEMPERATURE RANGE | | | | | | |
| Operating Ambient Temperature | T_A | -55°C | — | +150 | °C | |
| Storage Temperature | T_S | -55°C | — | +150 | °C | |
| PACKAGE THERMAL RESISTANCE | | | | | | |
| 8-lead DFN | θ_{JA} | — | 44 | — | °C/W | Note 1 |
| 8-lead SOIC | θ_{JA} | — | 101 | — | °C/W | Note 1 |

Note 1: 1 oz., four-layer, 3" x 4" PCB

TC6320

2.0 PIN DESCRIPTION

Table 2-1 and Table 2-2 show the description of pins in TC6320 8-lead DFN and 8-lead SOIC, respectively. Refer to [Package Types](#) for the location of pins.

TABLE 2-1: 8-LEAD DFN PIN FUNCTION TABLE

| Pin Number | Pin Name | Description |
|------------|----------|------------------|
| 1 | SN | Source N-channel |
| 2 | GN | Gate N-channel |
| 3 | GP | Gate P-channel |
| 4 | SP | Source P-channel |
| 5 | DP | Drain P-channel |
| 6 | DP | Drain P-channel |
| 7 | DN | Drain N-channel |
| 8 | DN | Drain N-channel |

TABLE 2-2: 8-LEAD SOIC FUNCTION TABLE

| Pin Number | Pin Name | Description |
|------------|----------|------------------|
| 1 | SN | Source N-channel |
| 2 | GN | Gate N-channel |
| 3 | SP | Source P-channel |
| 4 | GP | Gate P-channel |
| 5 | DP | Drain P-channel |
| 6 | DP | Drain P-channel |
| 7 | DN | Drain N-channel |
| 8 | DN | Drain N-channel |

3.0 FUNCTIONAL DESCRIPTION

Figure 3-1 and Figure 3-2 illustrate the switching waveforms and test circuits for TC6320.

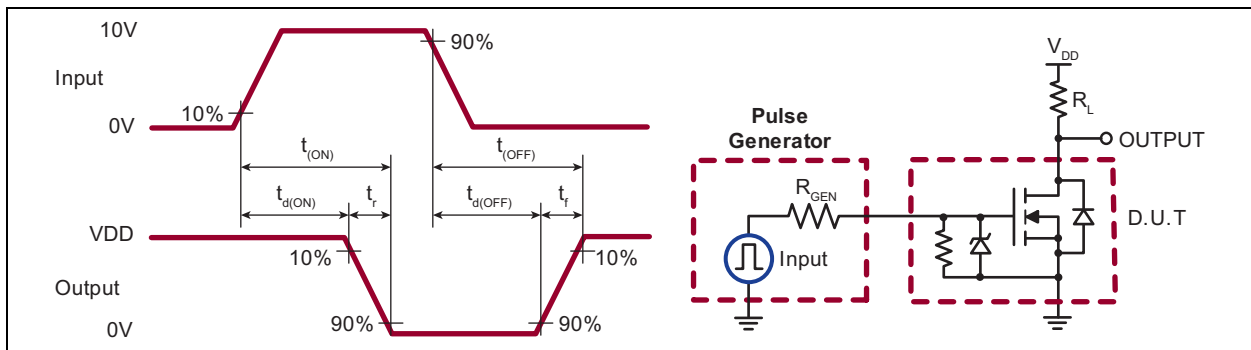


FIGURE 3-1: N-Channel Switching Waveforms and Test Circuit.

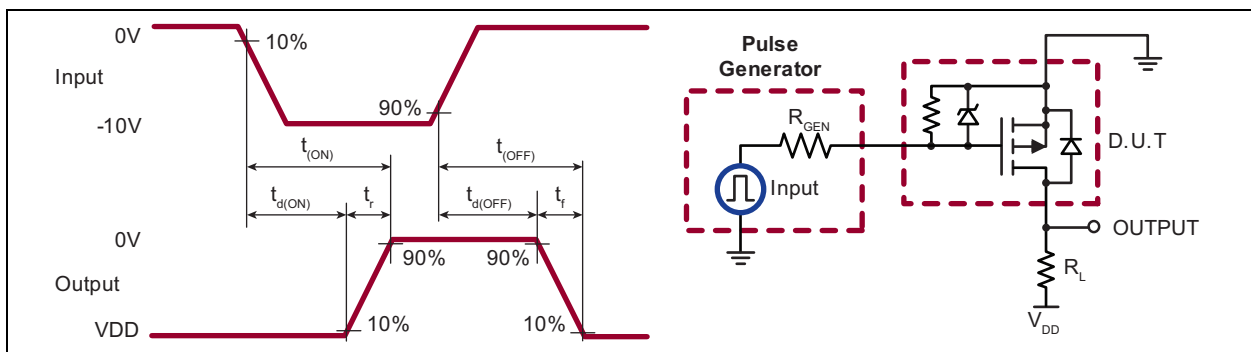


FIGURE 3-2: P-Channel Switching Waveforms and Test Circuit.

PRODUCT SUMMARY

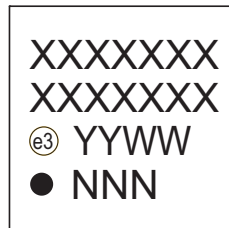
| BV_{DSS}/BV_{DGS} (V) | | $R_{DS(ON)}$ (Maximum) (Ω) | |
|----------------------------|-----------|---|-----------|
| N-Channel | P-Channel | N-Channel | P-Channel |
| 200 | -200 | 7 | 8 |

TC6320

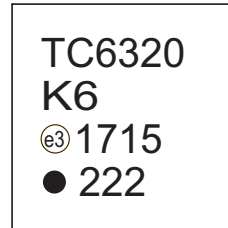
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

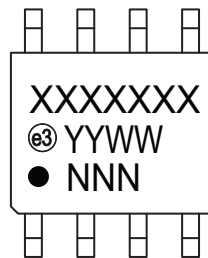
8-lead DFN



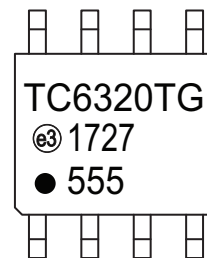
Example



8-lead SOIC



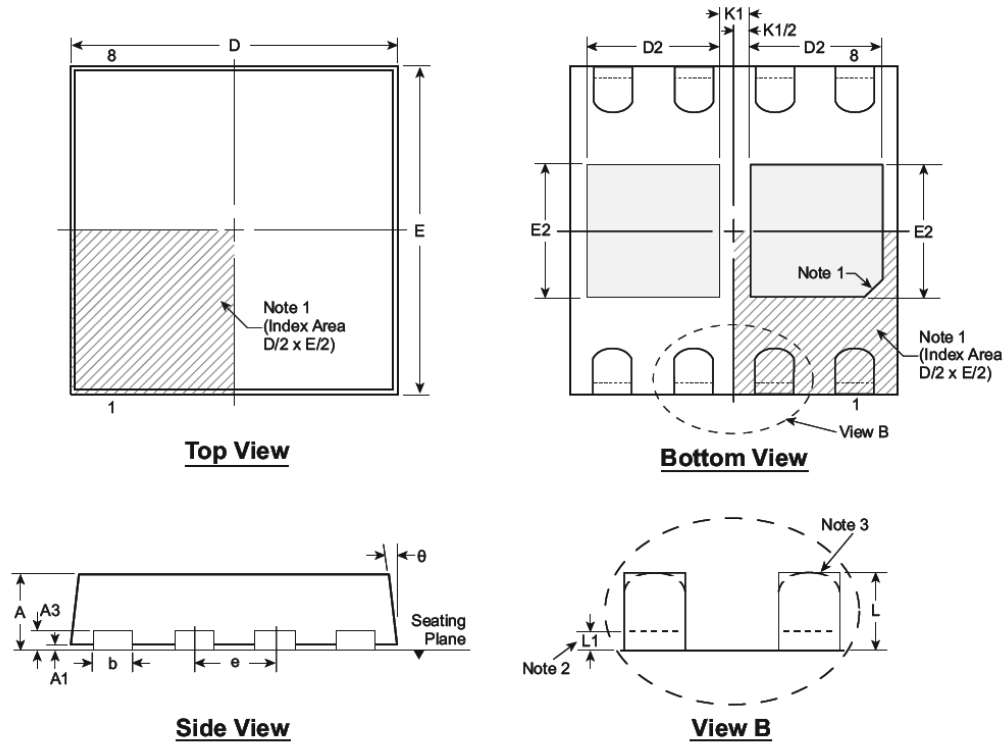
Example



| | | |
|----------------|--|--|
| Legend: | XX...X | Product Code or Customer-specific information |
| | Y | Year code (last digit of calendar year) |
| | YY | Year code (last 2 digits of calendar year) |
| | WW | Week code (week of January 1 is week '01') |
| | NNN | Alphanumeric traceability code |
| | Ⓔ3 | Pb-free JEDEC [®] designator for Matte Tin (Sn) |
| | * | This package is Pb-free. The Pb-free JEDEC designator (Ⓔ3) can be found on the outer packaging for this package. |
| Note: | In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo. | |

8-Lead DFN Package Outline (K6)

4.00x4.00mm body, 1.00mm height (max), 1.00mm pitch (dual pad)



Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

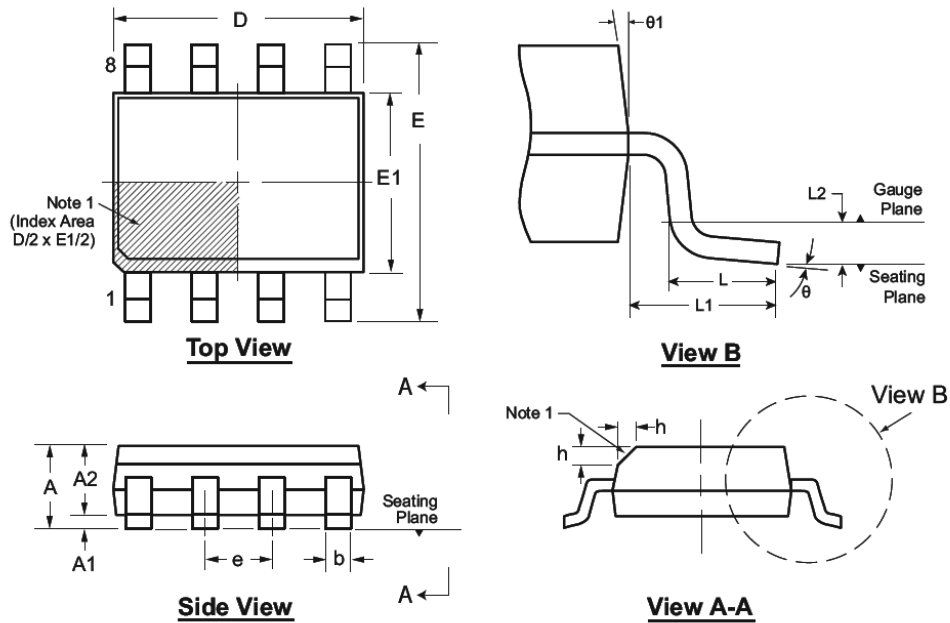
Notes:

1. A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.
2. Depending on the method of manufacturing, a maximum of 0.15mm pullback (L1) may be present.
3. The inner tip of the lead may be either rounded or square.

| Symbol | A | A1 | A3 | b | D | D2 | E | E2 | e | K1 | L | L1 | θ | |
|----------------|-----|------|------|----------|------|------|------|------|------|----------|----------|------|----------|-----|
| Dimension (mm) | MIN | 0.80 | 0.00 | 0.20 REF | 0.25 | 3.90 | 1.35 | 3.90 | 1.35 | 1.00 BSC | 0.50 REF | 0.40 | 0.00 | 0° |
| | NOM | 0.90 | - | | 0.30 | 4.00 | 1.45 | 4.00 | 1.45 | | | 0.50 | - | - |
| | MAX | 1.00 | 0.05 | | 0.35 | 4.10 | 1.55 | 4.10 | 1.55 | | | 0.60 | 0.15 | 14° |

Drawings not to scale

8-Lead SOIC (Narrow Body) Package Outline (LG/TG) 4.90x3.90mm body, 1.75mm height (max), 1.27mm pitch



Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Note:

1. This chamfer feature is optional. A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier, an embedded metal marker, or a printed indicator.

| Symbol | A | A1 | A2 | b | D | E | E1 | e | h | L | L1 | L2 | θ | $\theta 1$ | | | |
|----------------|-----|-------|------|-------|------|-------|-------|-------|-------------|------|------|-------------|----------|------------|----|----|---|
| Dimension (mm) | MIN | 1.35* | 0.10 | 1.25 | 0.31 | 4.80* | 5.80* | 3.80* | 1.27 BSC | 0.25 | 0.40 | 1.04 REF | 0.25 | BSC | 0° | 5° | |
| | NOM | - | - | - | - | 4.90 | 6.00 | 3.90 | | - | - | | - | - | - | - | - |
| | MAX | 1.75 | 0.25 | 1.65* | 0.51 | 5.00* | 6.20* | 4.00* | | 0.50 | 1.27 | | 8° | 15° | | | |

JEDEC Registration MS-012, Variation AA, Issue E, Sept. 2005.

* This dimension is not specified in the JEDEC drawing.

Drawings are not to scale.

APPENDIX A: REVISION HISTORY

Revision A (October 2017)

- Converted Supertex Doc# DSFP-TC6320 to Microchip DS20005697A
- Changed the package marking format
- Changed the quantity of the 8-lead DFN K6 package from 3000/Reel to 3300/Reel
- Changed the quantity of the 8-lead SOIC TG package from 2000/Reel to 3300/Reel
- Made minor text changes throughout the document

TC6320

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

| <u>PART NO.</u> | <u>XX</u> | - | <u>X</u> | - | <u>X</u> |
|-----------------|-----------------|---|--|---|------------|
| Device | Package Options | | Environmental | | Media Type |
| Device: | TC6320 | = | N-Channel and P-Channel Enhancement-Mode MOSFET Pair | | |
| Packages: | K6 | = | 8-lead (4x4) VDFN | | |
| | TG | = | 8-lead SOIC | | |
| Environmental: | G | = | Lead (Pb)-free/RoHS-compliant Package | | |
| Media Type: | (blank) | = | 3300/Reel for a K6 Package | | |
| | | = | 3300/Reel for a TG Package | | |

Examples:

a) TC6320K6-G: N-Channel and P-Channel Enhancement-Mode MOSFET Pair, 8-lead (4x4) VDFN, 3300/Reel

b) TC6320TG-G: N-Channel and P-Channel Enhancement-Mode MOSFET Pair, 8-lead SOIC, 3300/Reel

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