FAIRCHILD SEMICONDUCTOR™

October 2001

# FDC6401N

## Dual N-Channel 2.5V Specified PowerTrench® MOSFET

### General Description

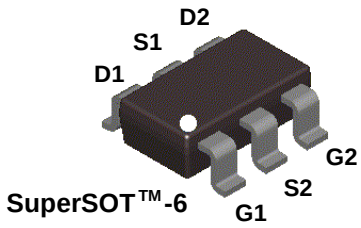
This Dual N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low $R_{DS(ON)}$ and fast switching speed.

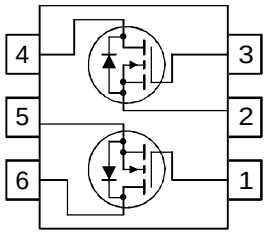
### Applications

- DC/DC converter
- Battery Protection
- Power Management

### Features

- 3.0 A, 20 V. $R_{DS(ON)}$ = 70 mΩ @ $V_{GS}$ = 4.5 V
  $R_{DS(ON)}$ = 95 mΩ @ $V_{GS}$ = 2.5 V
- Low gate charge (3.3 nC)
- High performance trench technology for extremely low $R_{DS(ON)}$
- High power and current handling capability




## Absolute Maximum Ratings $T_A$=25°C unless otherwise noted

| Symbol | Parameter | | Ratings | Units |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | | 20 | V |
| $V_{GSS}$ | Gate-Source Voltage | | ±12 | V |
| $I_D$ | Drain Current – Continuous | (Note 1a) | 3.0 | A |
| | – Pulsed | | 12 | |
| $P_D$ | Power Dissipation for Single Operation | (Note 1a) | 0.96 | W |
| | | (Note 1b) | 0.9 | |
| | | (Note 1c) | 0.7 | |
| $T_J$, $T_{STG}$ | Operating and Storage Junction Temperature Range | | –55 to +150 | °C |

## Thermal Characteristics

| | | | | |
|---|---|---|---|---|
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | (Note 1a) | 130 | °C/W |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | (Note 1) | 60 | °C/W |

## Package Marking and Ordering Information

| Device Marking | Device | Reel Size | Tape width | Quantity |
|---|---|---|---|---|
| .401 | FDC6401N | 7” | 8mm | 3000 units |

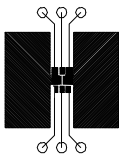
## Electrical Characteristics

$T_A$ = 25°C unless otherwise noted

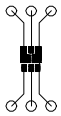
| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain–Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 250 µA | 20 | | | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250 µA, Referenced to 25°C | | 13 | | mV/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 16 V, $V_{GS}$ = 0 V | | | 1 | µA |
| $I_{GSSF}$ | Gate–Body Leakage, Forward | $V_{GS}$ = 12 V, $V_{DS}$ = 0 V | | | –100 | nA |
| $I_{GSSR}$ | Gate–Body Leakage, Reverse | $V_{GS}$ = –12 V $V_{DS}$ = 0 V | | | 100 | nA |
| **On Characteristics** (Note 2) | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 0.5 | 0.9 | 1.5 | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D$ = 250 µA, Referenced to 25°C | | –3 | | mV/°C |
| $R_{DS(on)}$ | Static Drain–Source On–Resistance | $V_{GS}$ = 4.5 V, $I_D$ = 3.0 A<br>$V_{GS}$ = 2.5 V, $I_D$ = 2.5 A<br>$V_{GS}$ = 4.5 V, $I_D$ = 3.0 A,$T_J$=125°C | | 50<br>66<br>71 | 70<br>95<br>106 | mΩ |
| $I_{D(on)}$ | On–State Drain Current | $V_{GS}$ = 4.5 V, $V_{DS}$ = 5 V | 12 | | | A |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 5V, $I_D$ = 3.0 A | | 10 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 10 V, $V_{GS}$ = 0 V, f = 1.0 MHz | | 324 | | pF |
| $C_{oss}$ | Output Capacitance | | | 82 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 42 | | pF |
| **Switching Characteristics** (Note 2) | | | | | | |
| $t_{d(on)}$ | Turn–On Delay Time | $V_{DD}$ = 10 V, $I_D$ = 1 A, $V_{GS}$ = 4.5 V, $R_{GEN}$ = 6 Ω | | 5 | 10 | ns |
| $t_r$ | Turn–On Rise Time | | | 7 | 14 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time | | | 13 | 23 | ns |
| $t_f$ | Turn–Off Fall Time | | | 1.6 | 3 | ns |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = 10 V, $I_D$ = 3.0 A, $V_{GS}$ = 4.5 V | | 3.3 | 4.6 | nC |
| $Q_{gs}$ | Gate–Source Charge | | | 0.95 | | nC |
| $Q_{gd}$ | Gate–Drain Charge | | | 0.7 | | nC |
| **Drain–Source Diode Characteristics and Maximum Ratings** | | | | | | |
| $I_S$ | Maximum Continuous Drain–Source Diode Forward Current | | | | 0.8 | A |
| $V_{SD}$ | Drain–Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 0.8 A (Note 2) | | 0.7 | 1.2 | V |

**Notes:**

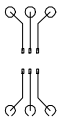
**1.** $R_{\theta JA}$ is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. $R_{\theta JC}$ is guaranteed by design while $R_{\theta CA}$ is determined by the user's board design.



a) 130 °C/W when mounted on a 0.125 $in^2$ pad of 2 oz. copper.



b) 140 °C/W when mounted on a .004 $in^2$ pad of 2 oz copper



c) 180 C°/W when mounted on a minimum pad.

Scale 1 : 1 on letter size paper

**2.** Pulse Test: Pulse Width < 300µs, Duty Cycle < 2.0%

## Typical Characteristics

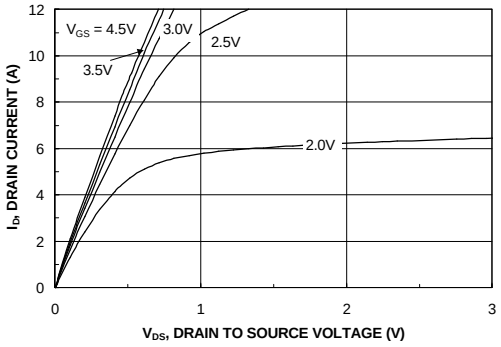



**Figure 1. On-Region Characteristics.**

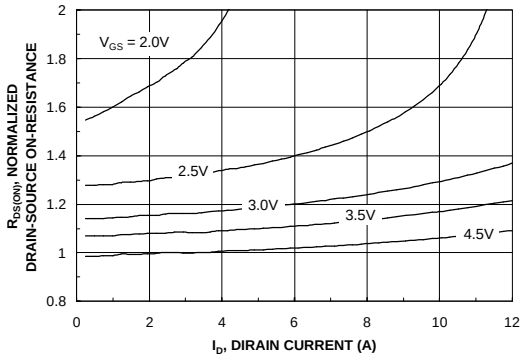



**Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.**

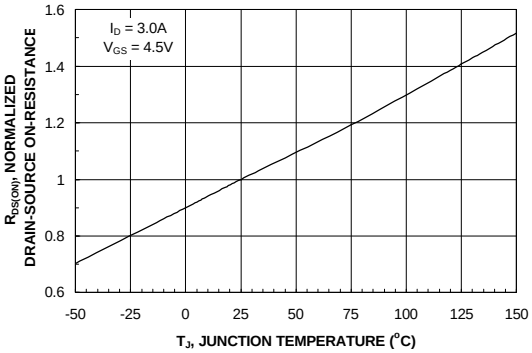



**Figure 3. On-Resistance Variation with Temperature.**

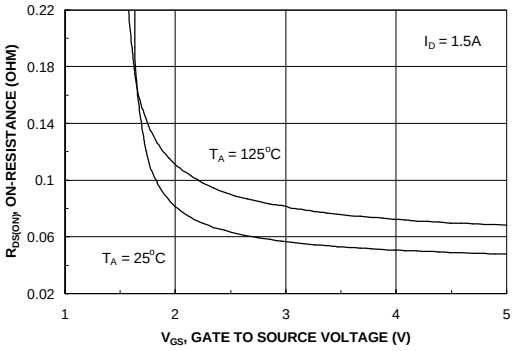



**Figure 4. On-Resistance Variation with Gate-to-Source Voltage.**

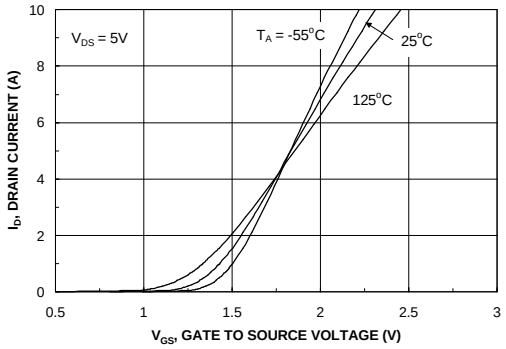



**Figure 5. Transfer Characteristics.**

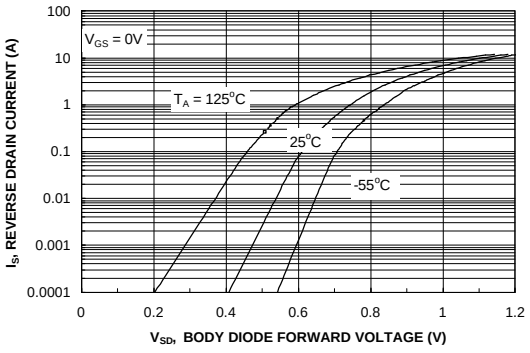



**Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.**

## Typical Characteristics

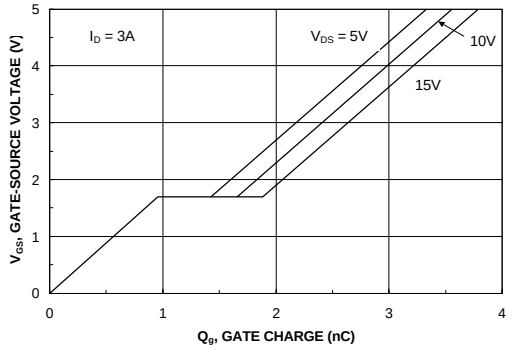



**Figure 7. Gate Charge Characteristics.**

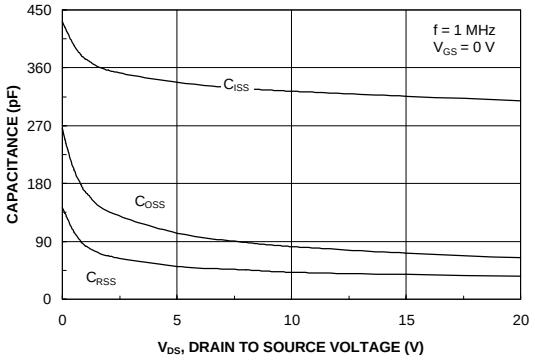



**Figure 8. Capacitance Characteristics.**

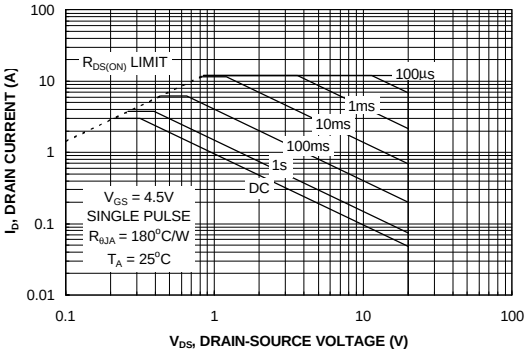



**Figure 9. Maximum Safe Operating Area.**

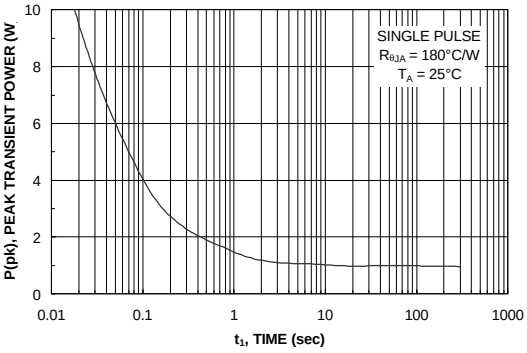



**Figure 10. Single Pulse Maximum Power Dissipation.**

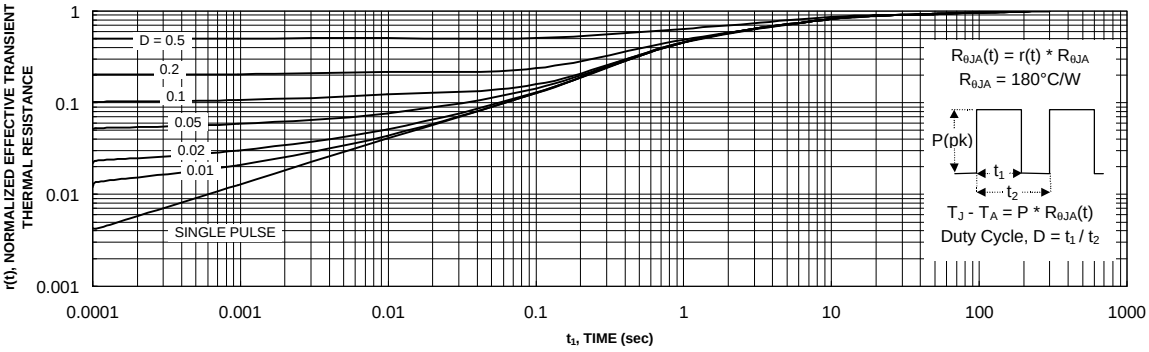


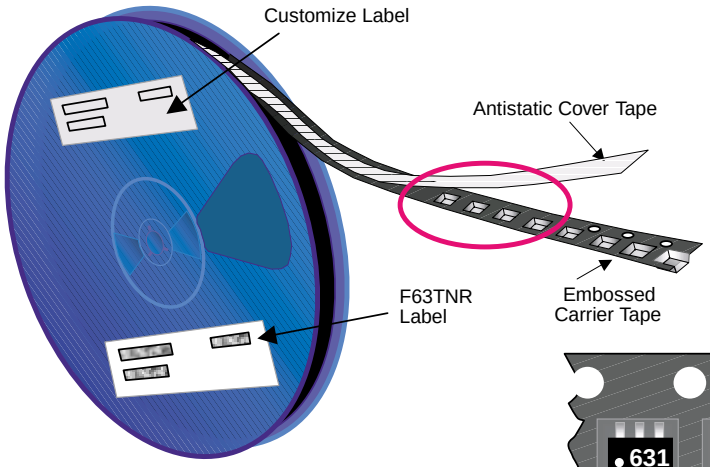

**Figure 11. Transient Thermal Response Curve.**

**Thermal characterization performed using the conditions described in Note 1c.**
**Transient thermal response will change depending on the circuit board design.**

# SuperSOT™-6 Tape and Reel Data

FAIRCHILD SEMICONDUCTOR®

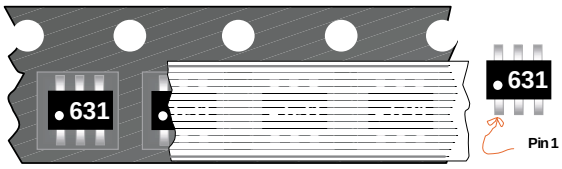
## SSOT-6 Packaging Configuration: Figure 1.0




**Packaging Description:**

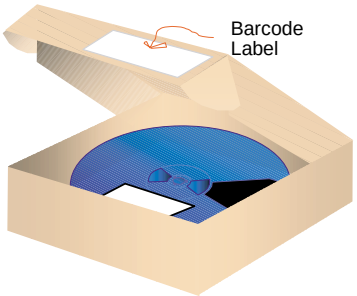
SSOT-6 parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 3,000 units per 7" or 177cm diameter reel. The reels are dark blue in color and is made of polystyrene plastic (anti-static coated). Other option comes in 10,000 units per 13" or 330cm diameter reel. This and some other options are described in the Packaging Information table.

These full reels are individually barcode labeled and placed inside a pizza box (illustrated in figure 1.0) made of recyclable corrugated brown paper with a Fairchild logo printing. One pizza box contains five reels maximum. And these pizza boxes are placed inside a barcode labeled shipping box which comes in different sizes depending on the number of parts shipped.

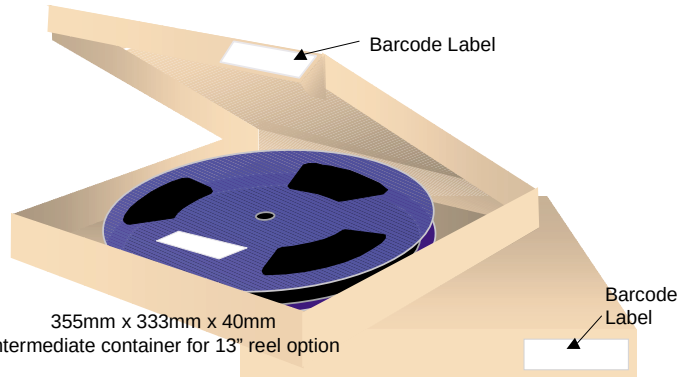



**SSOT-6 Unit Orientation**

| SSOT-6 Packaging Information | | |
|---|---|---|
| Packaging Option | Standard (no flow code) | D87Z |
| Packaging type | TNR | TNR |
| Qty per Reel/Tube/Bag | 3,000 | 10,000 |
| Reel Size | 7" Dia | 13" |
| Box Dimension (mm) | 193x183x80 | 355x333x40 |
| Max qty per Box | 15,000 | 30,000 |
| Weight per unit(gm) | 0.0158 | 0.0158 |
| Weight per Reel (kg) | 0.1440 | 0.4700 |
| Note/Comments | | |




193mm x 183mm x 80mm
Pizza Box for Standard Option

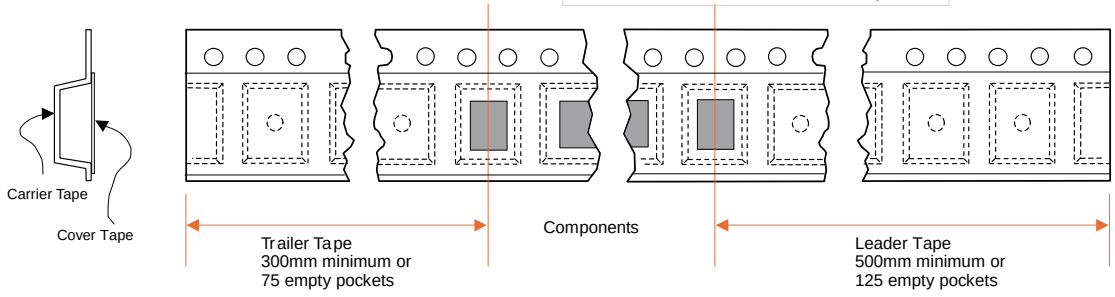



355mm x 333mm x 40mm
Intermediate container for 13" reel option

Barcode Label sample

LOT: CBVK741B019 QTY: 3000
FSID: FDC633N SPEC:
D/C1: D9842AB QTY1: SPEC REV:
D/C2: QTY2: CPN:
FAIRCHILD SEMICONDUCTOR CORPORATION (F63T

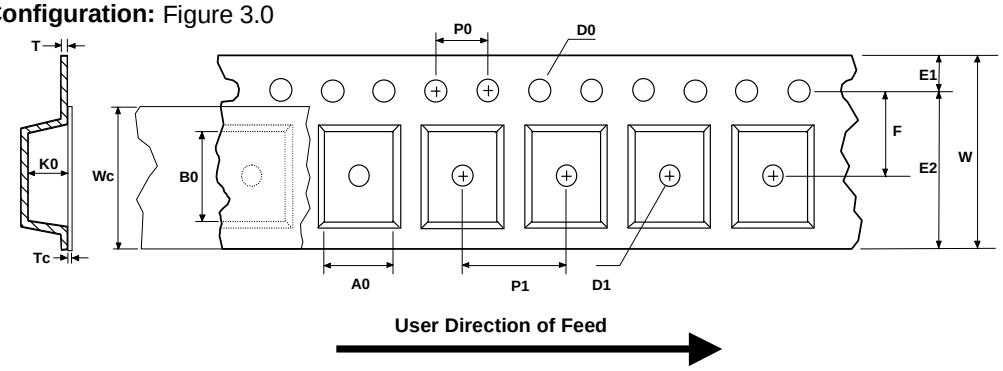
## SSOT-6 Tape Leader and Trailer Configuration: Figure 2.0



# SuperSOT™-6 Tape and Reel Data, continued

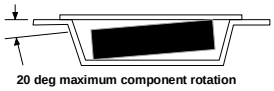
## SSOT-6 Embossed Carrier Tape

**Configuration:** Figure 3.0

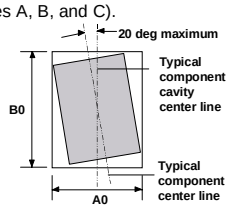



| Dimensions are in millimeter | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pkg type** | **A0** | **B0** | **W** | **D0** | **D1** | **E1** | **E2** | **F** | **P1** | **P0** | **K0** | **T** | **Wc** | **Tc** |
| **SSOT-6** (8mm) | 3.23 +/-0.10 | 3.18 +/-0.10 | 8.0 +/-0.3 | 1.55 +/-0.05 | 1.125 +/-0.125 | 1.75 +/-0.10 | 6.25 min | 3.50 +/-0.05 | 4.0 +/-0.1 | 4.0 +/-0.1 | 1.37 +/-0.10 | 0.255 +/-0.150 | 5.2 +/-0.3 | 0.06 +/-0.02 |

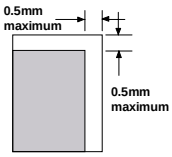
Notes: A0, B0, and K0 dimensions are determined with respect to the EIA/Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).




Sketch A (Side or Front Sectional View)
**Component Rotation**

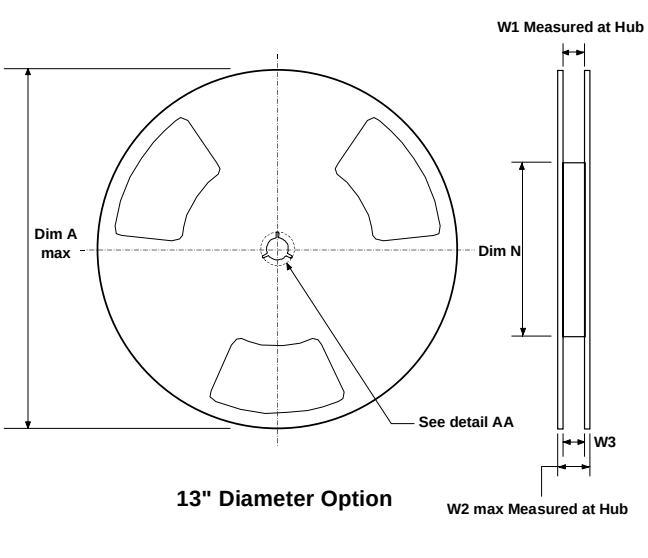



Sketch B (Top View)
**Component Rotation**




Sketch C (Top View)
**Component lateral movement**

## SSOT-6 Reel Configuration: Figure 4.0

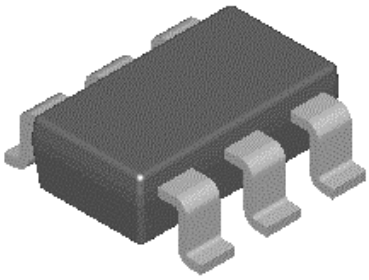


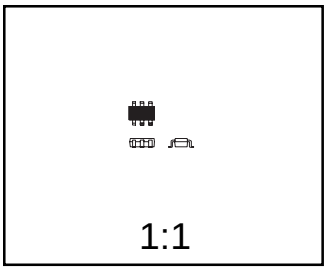

| Dimensions are in inches and millimeters | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Tape Size** | **Reel Option** | **Dim A** | **Dim B** | **Dim C** | **Dim D** | **Dim N** | **Dim W1** | **Dim W2** | **Dim W3 (LSL-USL)** |
| 8mm | 7" Dia | 7.00 177.8 | 0.059 1.5 | 512 +0.020/-0.008 13 +0.5/-0.2 | 0.795 20.2 | 2.165 55 | 0.331 +0.059/-0.000 8.4 +1.5/0 | 0.567 14.4 | 0.311 – 0.429 7.9 – 10.9 |
| 8mm | 13" Dia | 13.00 330 | 0.059 1.5 | 512 +0.020/-0.008 13 +0.5/-0.2 | 0.795 20.2 | 4.00 100 | 0.331 +0.059/-0.000 8.4 +1.5/0 | 0.567 14.4 | 0.311 – 0.429 7.9 – 10.9 |

## SuperSOT™-6 Package Dimensions

FAIRCHILD SEMICONDUCTOR™

# SuperSOT™-6 (FS PKG Code 31, 33)

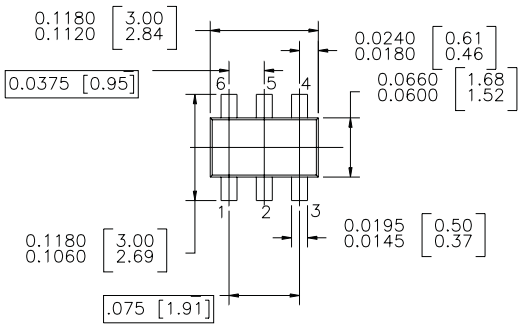


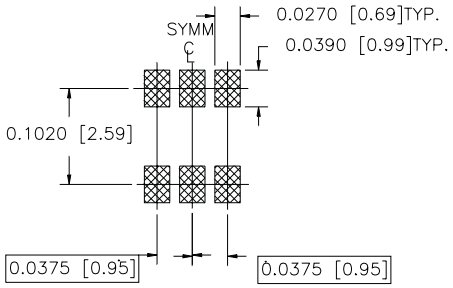



Scale 1:1 on letter size paper

Dimensions shown below are in:
inches [millimeters]

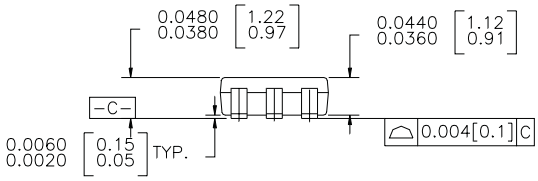
Part Weight per unit (gram): 0.0158

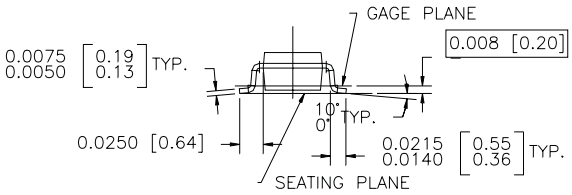



LAND PATTERN RECOMMENDATION

CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS




NOTES : UNLESS OTHERWISE SPECIFIED

1.0 STANDARD LEAD FINISH : 150 MICROINCHES 93.81 MICROMETERS)
MINIMUM TIN / LEAD (SOLDER) ON COPPER.

2.0 NO JEDEC REGISTRATION AS OF JULY 1996

SUPER SOT 6 LEADS

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| Bottomless™ | FASTr™ | OPTOPLANAR™ | STAR*POWER™ | |
| CoolFET™ | FRFET™ | PACMAN™ | Stealth™ | |
| *CROSSVOLT*™ | GlobalOptoisolator™ | POP™ | SuperSOT™-3 | |
| DenseTrench™ | GTO™ | Power247™ | SuperSOT™-6 | |
| DOME™ | HiSeC™ | PowerTrench® | SuperSOT™-8 | |
| EcoSPARK™ | ISOPLANAR™ | QFET™ | SyncFET™ | |
| $E^2$CMOS™ | LittleFET™ | QS™ | TinyLogic™ | |
| EnSigna™ | MicroFET™ | QT Optoelectronics™ | TruTranslation™ | |
| FACT™ | MicroPak™ | Quiet Series™ | UHC™ | |
| FACT Quiet Series™ | MICROWIRE™ | SILENT SWITCHER® | UltraFET® | |

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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

| Datasheet Identification | Product Status | Definition |
|---|---|---|
| Advance Information | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. |
| Preliminary | First Production | This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
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