



May 1996

## NDM3000

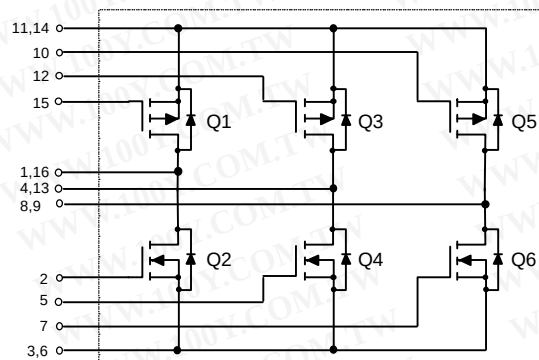
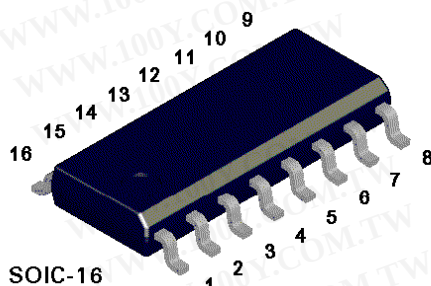
### 3 Phase Brushless Motor Driver

#### General Description

The NDM3000 three phase brushless motor driver consists of three N-Channel and P-Channel MOSFETs in a half bridge configuration. These devices are produced using Fairchild's proprietary, high cell density DMOS technology. This very high density process is tailored to minimize on-state resistance which reduces power loss, provide superior switching performance, and withstand high energy pulses in the avalanche and commutation modes. These devices are particularly suited for low voltage 3 phase motor driver such as disk drive spindle motor control and other half bridge applications.

#### Features

- $\pm 3.0A$ ,  $\pm 30V$ , 2.5W
- High density cell design for extremely low  $R_{DS(ON)}$
- High power and current handling capability.
- Industry standard SOIC-16 surface mount package.



#### Absolute Maximum Ratings $T_A = 25^\circ C$ unless otherwise noted

| Symbol         | Parameter                                                                  | NDM3000    | Units      |
|----------------|----------------------------------------------------------------------------|------------|------------|
| $V_{DSS}$      | Drain-Source Voltage (All Types)                                           | $\pm 30$   | V          |
| $V_{GSS}$      | Gate-Source Voltage (All Types)                                            | $\pm 20$   | V          |
| $I_D$          | Drain Current Q1+Q4 or Q1+Q6 or Q3+Q2 - Continuous Q3+Q6 or Q5+Q2 or Q5+Q4 | $\pm 3.0$  | A          |
|                | - Pulsed (Note 1a & 2)                                                     | $\pm 10$   |            |
| $P_D$          | Total Power Dissipation (Note 1a)                                          | 2.5        | W          |
|                | Q1+Q4 or Q1+Q6 or Q3+Q2 or (Note 1b)                                       | 1.6        |            |
|                | Q3+Q6 or Q5+Q2 or Q5+Q4 (Note 1c)                                          | 1.4        |            |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                    | -55 to 150 | $^\circ C$ |

| THERMAL CHARACTERISTICS                                                   |                                                                                                               |                                                                                        |            |      |       |      |       |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------|------|-------|------|-------|
| R <sub>θJA</sub>                                                          | Thermal Resistance, Junction-to-Ambient<br>Q1+Q4 or Q1+Q6 or Q3+Q2 or<br>Q3+Q6 or Q5+Q2 or Q5+Q4<br>(Note 1a) | 50                                                                                     |            |      |       |      | °C/W  |
| R <sub>θJC</sub>                                                          | Thermal Resistance, Junction-to-Case<br>Q1+Q4 or Q1+Q6 or Q3+Q2 or<br>Q3+Q6 or Q5+Q2 or Q5+Q4<br>(Note 1)     | 20                                                                                     |            |      |       |      | °C/W  |
| Electrical Characteristics (T <sub>A</sub> = 25°C unless otherwise noted) |                                                                                                               |                                                                                        |            |      |       |      |       |
| Symbol                                                                    | Parameter                                                                                                     | Conditions                                                                             | Type       | Min  | Typ   | Max  | Units |
| OFF CHARACTERISTICS                                                       |                                                                                                               |                                                                                        |            |      |       |      |       |
| BV <sub>DSS</sub>                                                         | Drain-Source Breakdown Voltage                                                                                | V <sub>GS</sub> = 0 V, I <sub>D</sub> = ± 250 μA                                       | All        | ±30  |       |      | V     |
| I <sub>DSS</sub>                                                          | Zero Gate Voltage Drain Current                                                                               | V <sub>DS</sub> = ±20 V, V <sub>GS</sub> = 0 V<br>T <sub>J</sub> = 55°C                | All        |      |       | ±1   | μA    |
| I <sub>GSS</sub>                                                          | Gate - Body Leakage, Forward                                                                                  | V <sub>GS</sub> = ±20 V, V <sub>DS</sub> = 0 V                                         | All        |      |       | ±100 | nA    |
| ON CHARACTERISTICS (Note 3)                                               |                                                                                                               |                                                                                        |            |      |       |      |       |
| V <sub>GS(th)</sub>                                                       | Gate Threshold Voltage                                                                                        | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μA<br>T <sub>J</sub> = 125°C | Q1, Q3, Q5 | -1   | -1.6  | -3   | V     |
|                                                                           |                                                                                                               | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA<br>T <sub>J</sub> = 125°C  | Q2, Q4, Q6 | -0.7 | -1.25 | -2.2 |       |
|                                                                           |                                                                                                               |                                                                                        |            | 1    | 1.7   | 3    |       |
|                                                                           |                                                                                                               |                                                                                        |            | 0.7  | 1.2   | 2.2  |       |
| R <sub>DS(on)</sub>                                                       | Static Drain-Source On-Resistance                                                                             | V <sub>GS</sub> = -10 V, I <sub>D</sub> = -3.0 A<br>T <sub>J</sub> = 125°C             | Q1, Q3, Q5 |      | 0.125 | 0.16 | Ω     |
|                                                                           |                                                                                                               | V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -1.0 A                                      |            |      | 0.18  | 0.29 |       |
|                                                                           |                                                                                                               | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 3.0 A<br>T <sub>J</sub> = 125°C               | Q2, Q4, Q6 |      | 0.16  | 0.25 |       |
|                                                                           |                                                                                                               | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 1.0 A                                        |            |      | 0.07  | 0.09 |       |
|                                                                           |                                                                                                               |                                                                                        |            |      | 0.1   | 0.16 |       |
|                                                                           |                                                                                                               |                                                                                        |            |      | 0.09  | 0.13 |       |
| I <sub>D(on)</sub>                                                        | On-State Drain Current                                                                                        | V <sub>GS</sub> = -10 V, V <sub>DS</sub> = -5 V                                        | Q1, Q3, Q5 | -10  |       |      | A     |
|                                                                           |                                                                                                               | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 5 V                                          | Q2, Q4, Q6 | 10   |       |      |       |
| DYNAMIC CHARACTERISTICS                                                   |                                                                                                               |                                                                                        |            |      |       |      |       |
| C <sub>iss</sub>                                                          | Input Capacitance                                                                                             | Q1, Q3, Q5<br>V <sub>DS</sub> = -10 V, V <sub>GS</sub> = 0 V,<br>f = 1.0 MHz           | Q1, Q3, Q5 |      | 375   |      | pF    |
|                                                                           |                                                                                                               |                                                                                        | Q2, Q4, Q6 |      | 360   |      |       |
| C <sub>oss</sub>                                                          | Output Capacitance                                                                                            | Q2, Q4, Q6<br>V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 0 V,<br>f = 1.0 MHz            | Q1, Q3, Q5 |      | 245   |      | pF    |
|                                                                           |                                                                                                               |                                                                                        | Q2, Q4, Q6 |      | 260   |      |       |
| C <sub>rss</sub>                                                          | Reverse Transfer Capacitance                                                                                  |                                                                                        | Q1, Q3, Q5 |      | 130   |      | pF    |
|                                                                           |                                                                                                               |                                                                                        | Q2, Q4, Q6 |      | 105   |      |       |

# Electrical Characteristics (T<sub>A</sub> = 25°C unless otherwise noted)

| Symbol                                    | Parameter             | Conditions                                                                                                        | Type       | Min | Typ | Max | Units |
|-------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------|------------|-----|-----|-----|-------|
| <b>SWITCHING CHARACTERISTICS</b> (Note 3) |                       |                                                                                                                   |            |     |     |     |       |
| t <sub>D(on)</sub>                        | Turn - On Delay Time  | Q1, Q3, Q5<br>V <sub>DD</sub> = -15 V, I <sub>D</sub> = -1 A,<br>V <sub>GEN</sub> = -10 V, R <sub>GEN</sub> = 6 Ω | Q1, Q3, Q5 |     | 10  | 40  | ns    |
| t <sub>r</sub>                            | Turn - On Rise Time   |                                                                                                                   | Q2, Q4, Q6 |     | 9   | 40  |       |
|                                           |                       |                                                                                                                   | Q1, Q3, Q5 |     | 13  | 40  | ns    |
|                                           |                       |                                                                                                                   | Q2, Q4, Q6 |     | 21  | 40  |       |
| t <sub>D(off)</sub>                       | Turn - Off Delay Time | Q2, Q4, Q6<br>V <sub>DD</sub> = 15 V, I <sub>D</sub> = 1 A,<br>V <sub>GEN</sub> = 10 V, R <sub>GEN</sub> = 6 Ω    | Q1, Q3, Q5 |     | 21  | 90  | ns    |
|                                           |                       |                                                                                                                   | Q2, Q4, Q6 |     | 21  | 90  |       |
| t <sub>f</sub>                            | Turn - Off Fall Time  |                                                                                                                   | Q1, Q3, Q5 |     | 5   | 50  | ns    |
|                                           |                       |                                                                                                                   | Q2, Q4, Q6 |     | 8   | 50  |       |
| Q <sub>g</sub>                            | Total Gate Charge     | Q1, Q3, Q5<br>V <sub>DS</sub> = -10 V,<br>I <sub>D</sub> = -3.0 A, V <sub>GS</sub> = -10 V                        | Q1, Q3, Q5 |     | 10  | 25  | nC    |
|                                           |                       |                                                                                                                   | Q2, Q4, Q6 |     | 9.5 | 25  |       |
| Q <sub>gs</sub>                           | Gate-Source Charge    |                                                                                                                   | Q1, Q3, Q5 |     | 1.6 |     | nC    |
|                                           |                       | Q2, Q4, Q6<br>V <sub>DS</sub> = 10 V,<br>I <sub>D</sub> = 3.0 A, V <sub>GS</sub> = 10 V                           | Q2, Q4, Q6 |     | 1.5 |     |       |
| Q <sub>gd</sub>                           | Gate-Drain Charge     |                                                                                                                   | Q1, Q3, Q5 |     | 3   |     | nC    |
|                                           |                       |                                                                                                                   | Q2, Q4, Q6 |     | 2.5 |     |       |

## DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

|                 |                                                       |                                                                                   |            |  |  |      |      |    |
|-----------------|-------------------------------------------------------|-----------------------------------------------------------------------------------|------------|--|--|------|------|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current |                                                                                   | Q1, Q3, Q5 |  |  | -1.2 | A    |    |
|                 |                                                       |                                                                                   | Q2, Q4, Q6 |  |  | 1.2  |      |    |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = -3.0 A (Note 3)                           | Q1, Q3, Q5 |  |  | -0.8 | -1.3 | V  |
|                 |                                                       | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 3.0 A (Note 3)                            | Q2, Q4, Q6 |  |  | 0.8  | 1.3  |    |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>F</sub> = ±3.0 A,<br>dI <sub>F</sub> /dt = 100 A/μs | All        |  |  |      | 100  | ns |

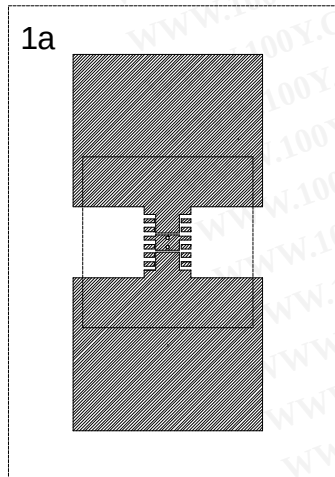
Notes:

- R<sub>θJA</sub> 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<sub>θJC</sub> is guaranteed by design while R<sub>θCA</sub> is determined by the user's board design.

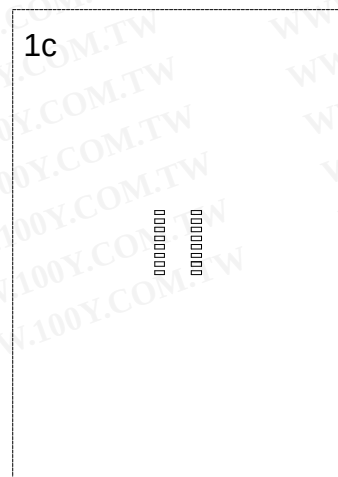
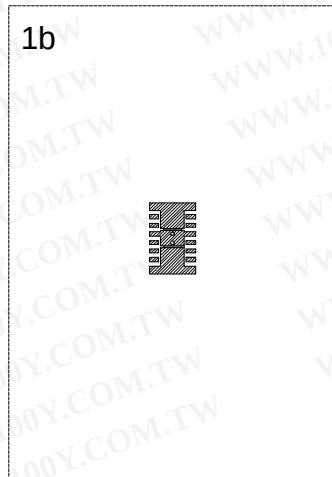
$$P_D(t) = \frac{T_F T_A}{R_{θJ} A(t)} = \frac{T_F T_A}{R_{θJ} + R_{θCA}(t)} = I_D^2(t) \times R_{DS(on)} @ T_J$$

Typical R<sub>θJA</sub> using the board layouts shown below on 4.5"x5" FR-4 PCB in a still air environment:

- 50°C/W when mounted on a 1 in<sup>2</sup> pad of 2oz copper.
- 80°C/W when mounted on a 0.027 in<sup>2</sup> pad of 2oz copper.
- 90°C/W when mounted on a 0.0028 in<sup>2</sup> pad of 2oz copper.



Scale 1 : 1 on letter size paper



- Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2.0%.

## Typical Electrical Characteristics

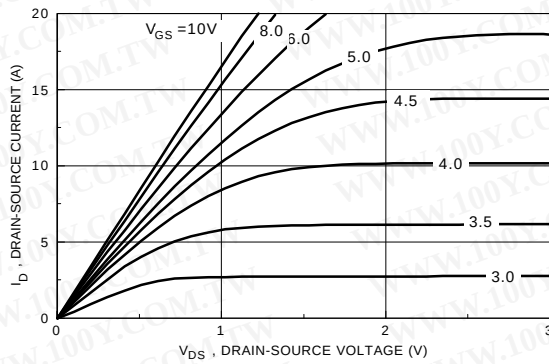


Figure 1. N-Channel On-Region Characteristic.

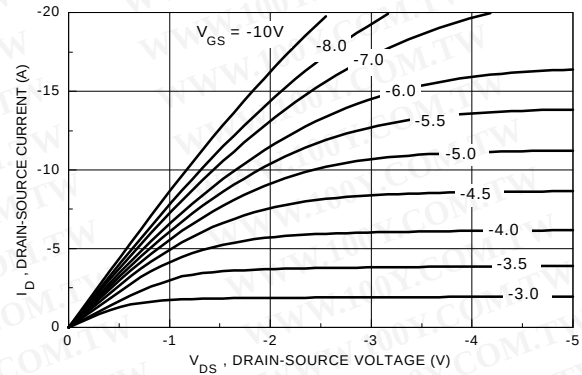


Figure 2. P-Channel On-Region Characteristics.

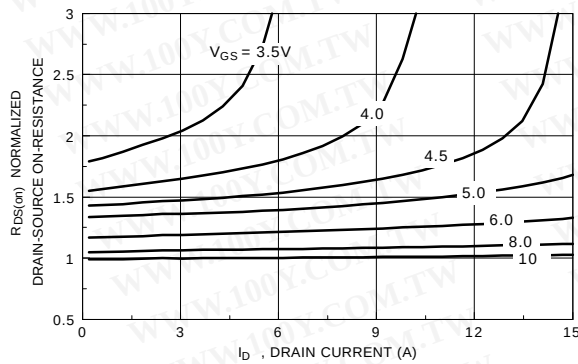


Figure 3. N-Channel On-Resistance Variation with Gate Voltage and Drain Current.

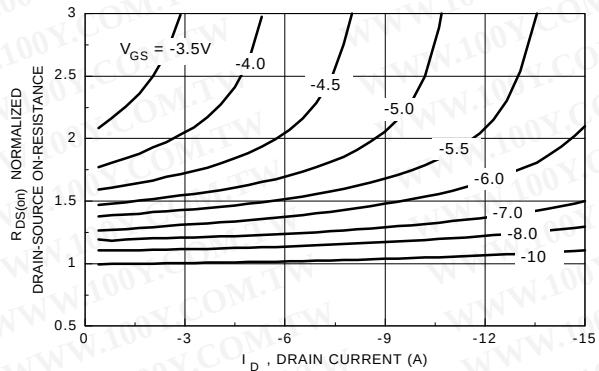


Figure 4. P-Channel On-Resistance Variation with Gate Voltage and Drain Current.

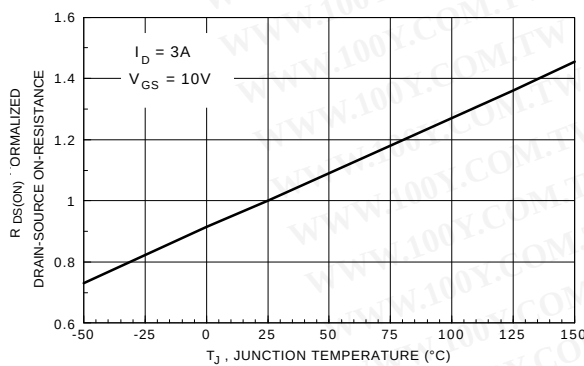


Figure 5. N-Channel On-Resistance Variation with Temperature.

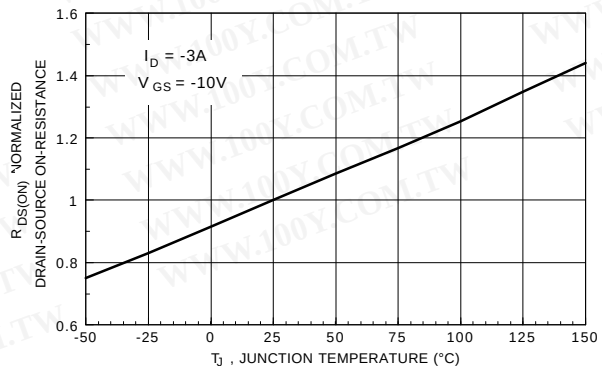


Figure 6. P-Channel On-Resistance Variation with Temperature.



## Typical Electrical Characteristics

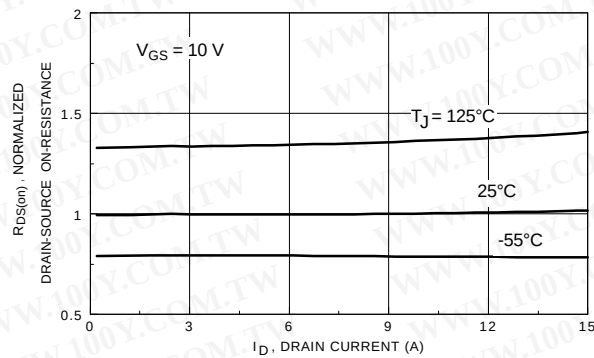


Figure 7. N-Channel On-Resistance Variation with Drain Current and Temperature.

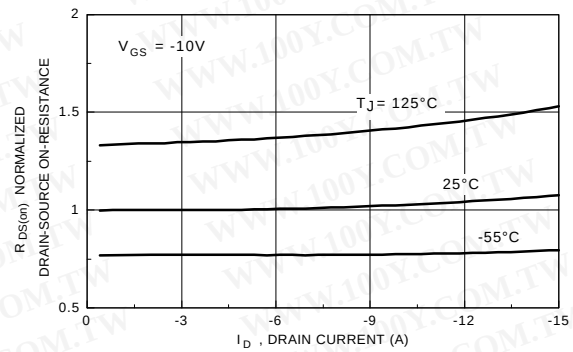


Figure 8. P-Channel On-Resistance Variation with Drain Current and Temperature.

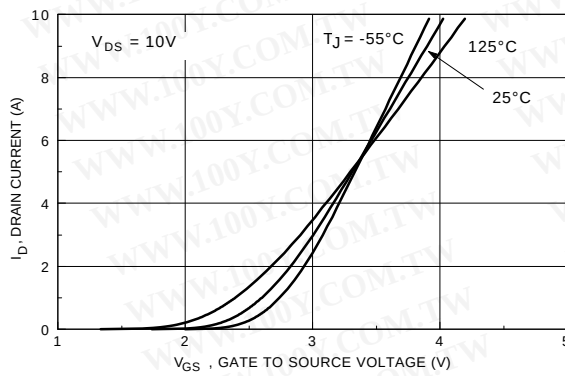


Figure 9. N-Channel Transfer Characteristics.

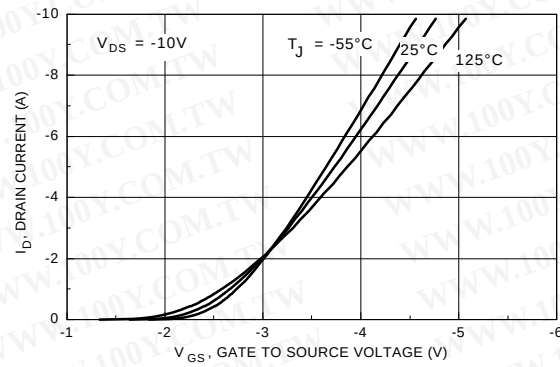


Figure 10. P-Channel Transfer Characteristics.

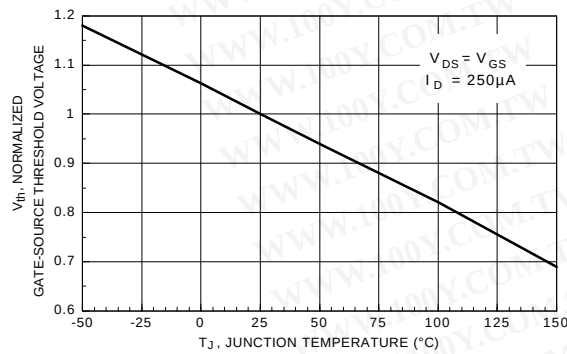


Figure 11. N-Channel Gate Threshold Variation with Temperature.

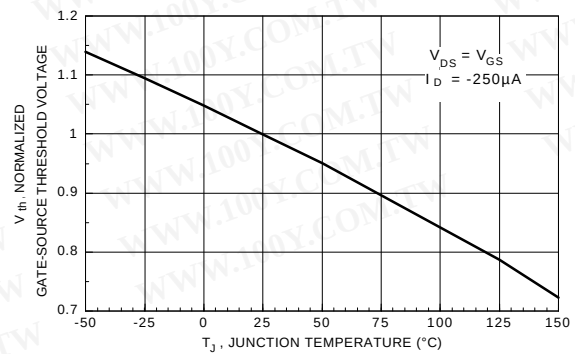


Figure 12. P-Channel Gate Threshold Variation with Temperature.

## Typical Electrical Characteristics

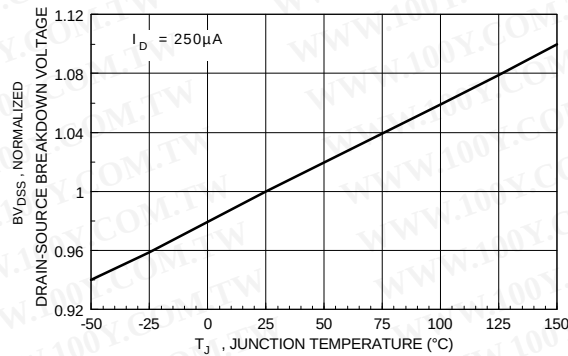


Figure 13. N-Channel Breakdown Voltage Variation with Temperature.

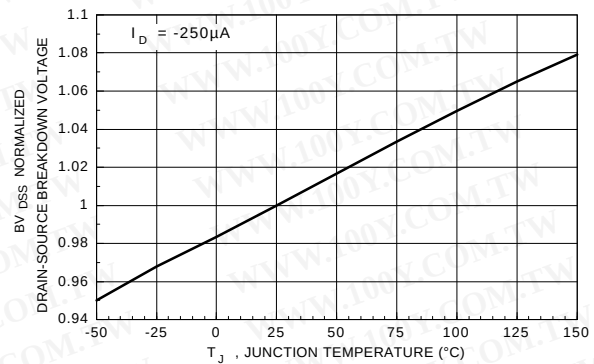


Figure 14. P-Channel Breakdown Voltage Variation with Temperature.

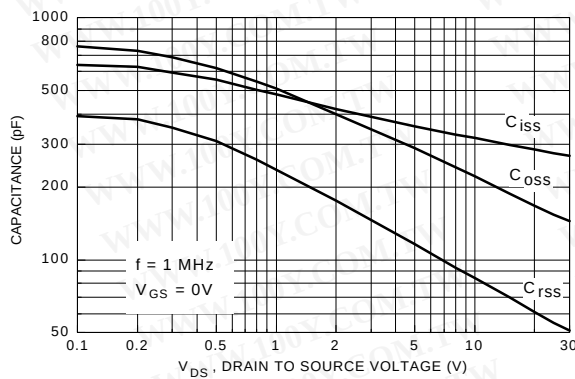


Figure 15. N-Channel Capacitance Characteristics.

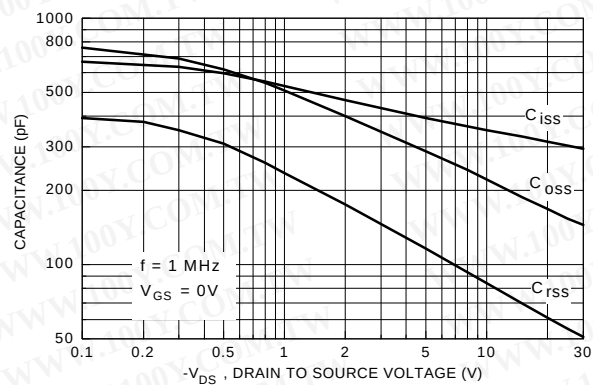


Figure 16. P-Channel Capacitance Characteristics.

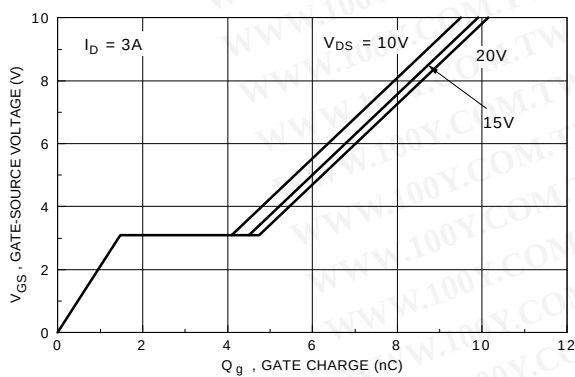


Figure 17. N-Channel Gate Charge Characteristics.

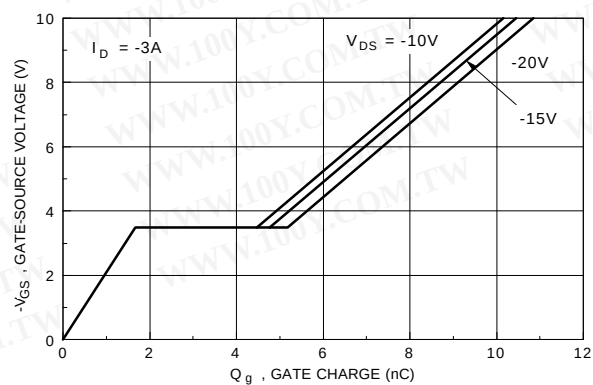


Figure 18. P-Channel Gate Charge Characteristics.

## Typical Electrical Characteristics

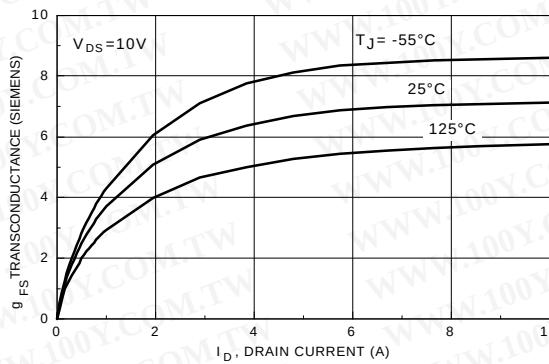


Figure 19. N-Channel Transconductance Variation with Drain Current and Temperature.

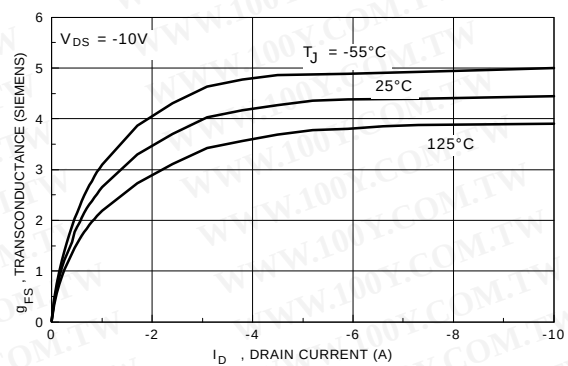


Figure 20. P-Channel Transconductance Variation with Drain Current and Temperature.

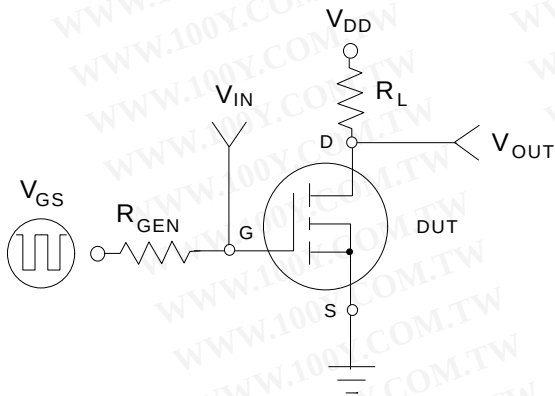


Figure 21. N or P-Channel Switching Test Circuit.

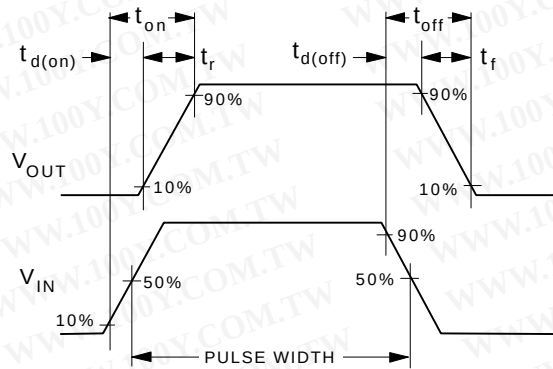


Figure 22. N or P-Channel Switching Waveforms.

## Typical Thermal and Electrical Characteristics

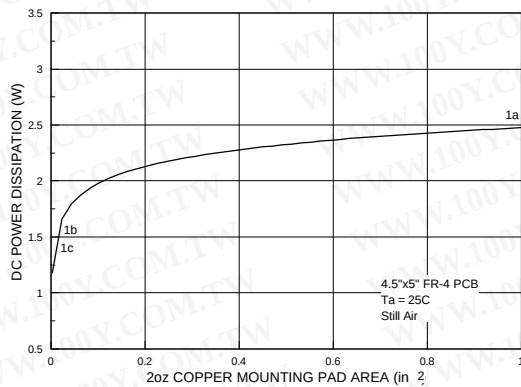


Figure 23. SOIC-16 3 Leadframe Device DC Power Dissipation versus Copper Mounting Pad Area

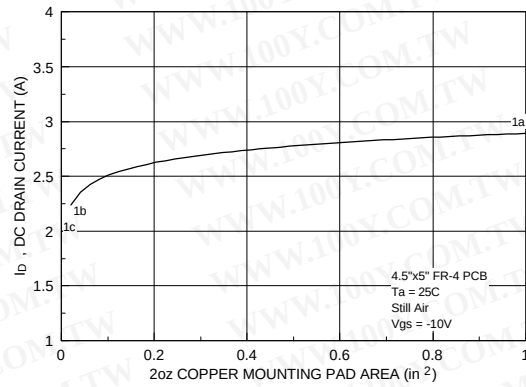


Figure 24. P-Ch DC Drain Current Capability versus Copper Mounting Pad Area.

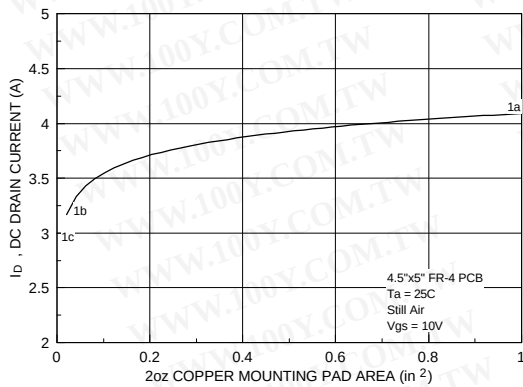


Figure 25. N-Ch DC Drain Current Capability versus Copper Mounting Pad Area.

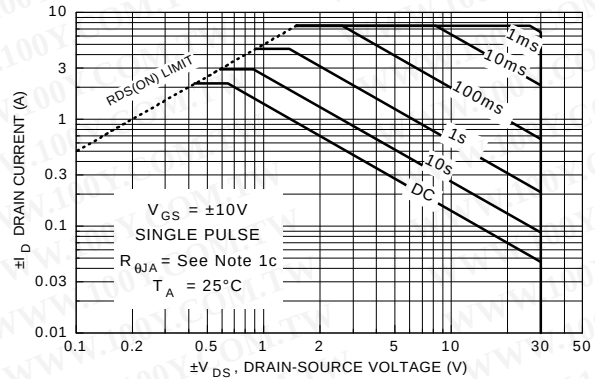


Figure 26. P-Ch Typical Safe Operating Area

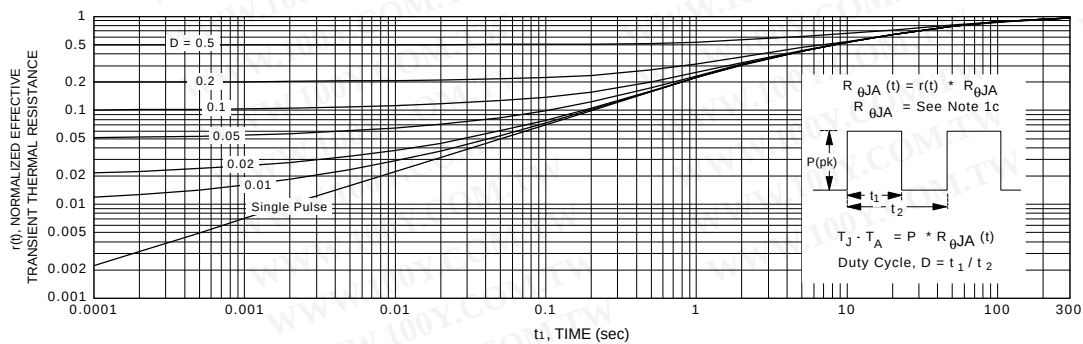


Figure 27. Transient Thermal Response Curve.

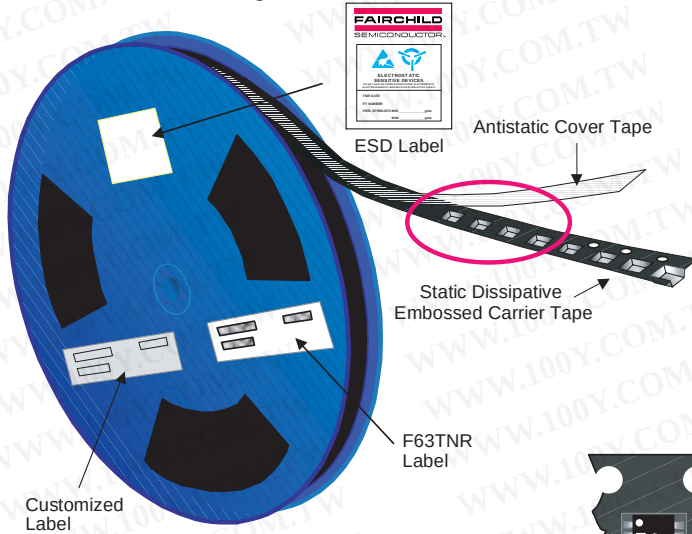
Note: Thermal characterization performed using the conditions described in note 1c. Transient thermal response will change depending on the circuit board design.



## SOIC-16 Tape and Reel Data and Package Dimensions

**FAIRCHILD**  
 SEMICONDUCTOR™

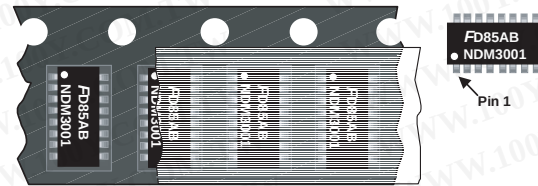
### SOIC(16lds) Packaging Configuration: Figure 1.0



#### Packaging Description:

SOIC-16 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 2,500 units per 13" or 330cm diameter reel. The reels are dark blue in color and is made of polystyrene plastic (anti-static coated). This and some other options are further described in the Packaging Information table.

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

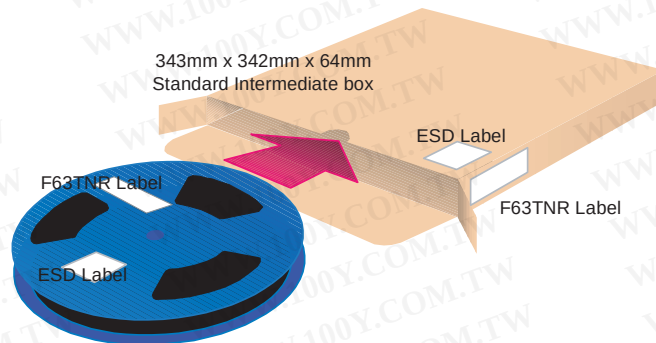


#### SOIC-16 Unit Orientation

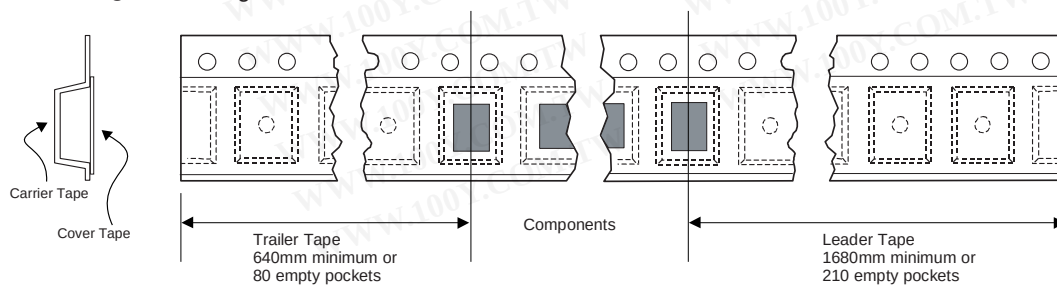
| SOIC (16lds) Packaging Information |                         |            |
|------------------------------------|-------------------------|------------|
| Packaging Option                   | Standard (no flow code) | L86Z       |
| Packaging type                     | TNR                     | Rail/Tube  |
| Qty per Reel/Tube/Bag              | 2,500                   | 45         |
| Reel Size                          | 13" Dia                 | -          |
| Box Dimension (mm)                 | 343x64x343              | 530x130x83 |
| Max qty per Box                    | 5,000                   | 13,500     |
| Weight per unit (gm)               | 0.1437                  | 0.1437     |
| Weight per Reel (kg)               | 0.7735                  | -          |
| Note/Comments                      |                         |            |

#### F63TNR Label sample

|                  |           |
|------------------|-----------|
| LOT: CBVK741B019 | QTY: 2500 |
| FSID: NDM3000    | SPEC:     |
| D/C1: D9842      | QTY1:     |
| D/C2:            | QTY2:     |
| SPEC REV: CPN:   | N/F: F    |
|                  | (F63TNR)3 |

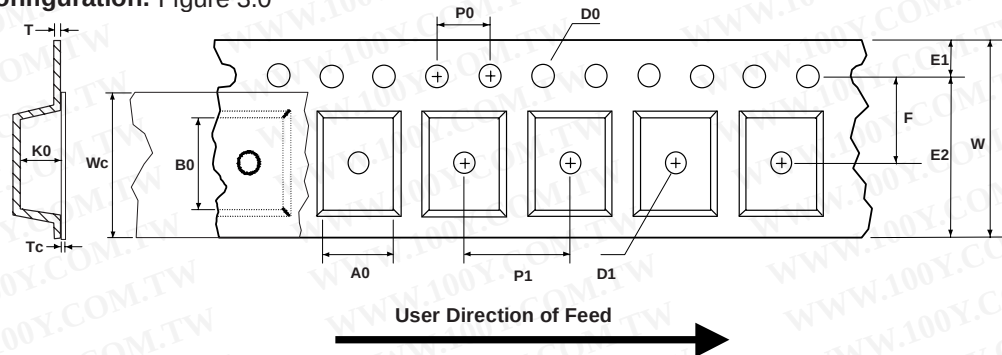


### SOIC(16lds) Tape Leader and Trailer Configuration: Figure 2.0



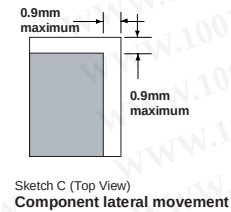
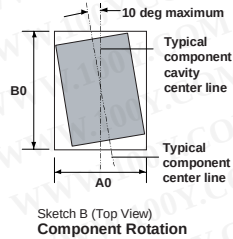
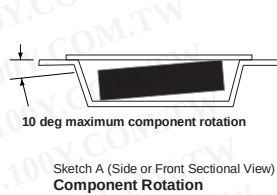
## SOIC-16 Tape and Reel Data and Package Dimensions, continued

### SOIC(16lds) Embossed Carrier Tape Configuration: Figure 3.0

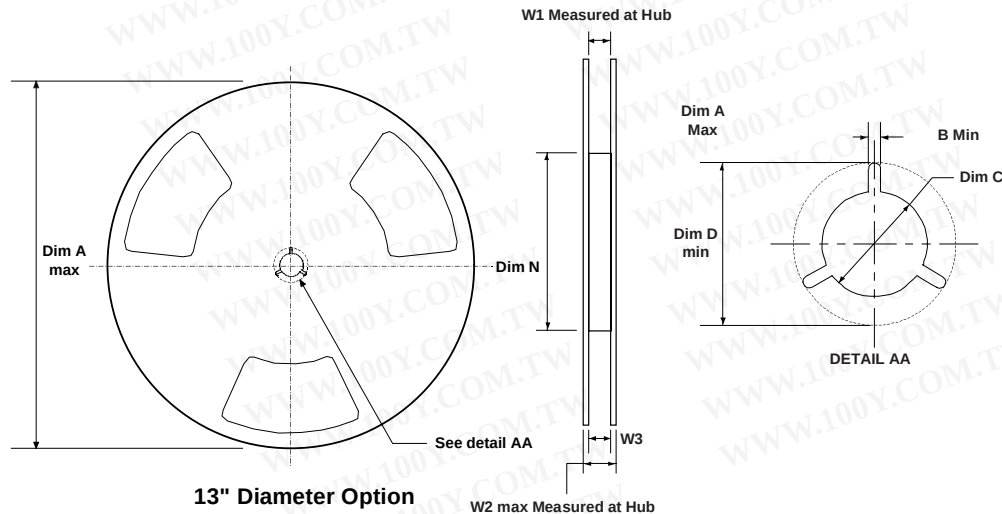


| Dimensions are in millimeter |                 |                  |                |                 |                 |                 |              |                 |               |               |                 |                   |                |                 |
|------------------------------|-----------------|------------------|----------------|-----------------|-----------------|-----------------|--------------|-----------------|---------------|---------------|-----------------|-------------------|----------------|-----------------|
| Pkg type                     | A0              | B0               | W              | D0              | D1              | E1              | E2           | F               | P1            | P0            | K0              | T                 | Wc             | Tc              |
| SOIC(16lds)<br>(16mm)        | 6.60<br>+/-0.30 | 10.35<br>+/-0.25 | 16.0<br>+/-0.3 | 1.55<br>+/-0.05 | 1.60<br>+/-0.10 | 1.75<br>+/-0.10 | 14.25<br>min | 7.50<br>+/-0.05 | 8.0<br>+/-0.1 | 4.0<br>+/-0.1 | 2.40<br>+/-0.40 | 0.450<br>+/-0.150 | 13.0<br>+/-0.3 | 0.06<br>+/-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).



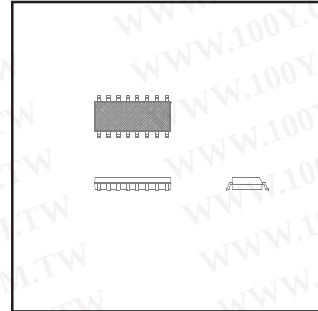
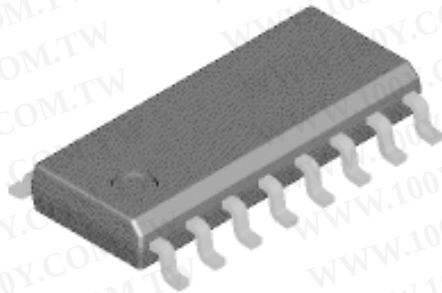
### SOIC(16lds) Reel Configuration: Figure 4.0



| 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)             |
| 16mm                                     | 13" Dia     | 13.00<br>330 | 0.059<br>1.5 | 512 +0.020/-0.008<br>13 +0.5/-0.2 | 0.795<br>20.2 | 4.00<br>100 | 0.646 +0.078/-0.000<br>16.4 +2/0 | 0.882<br>22.4 | 0.626 - 0.764<br>15.9 - 19.4 |

# SOIC-16 Tape and Reel Data and Package Dimensions, continued

## SOIC-16 (FS PKG Code S3)

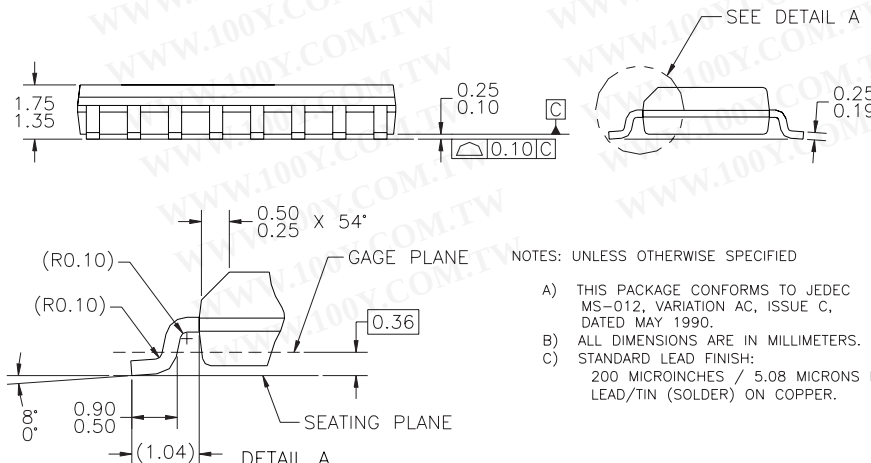
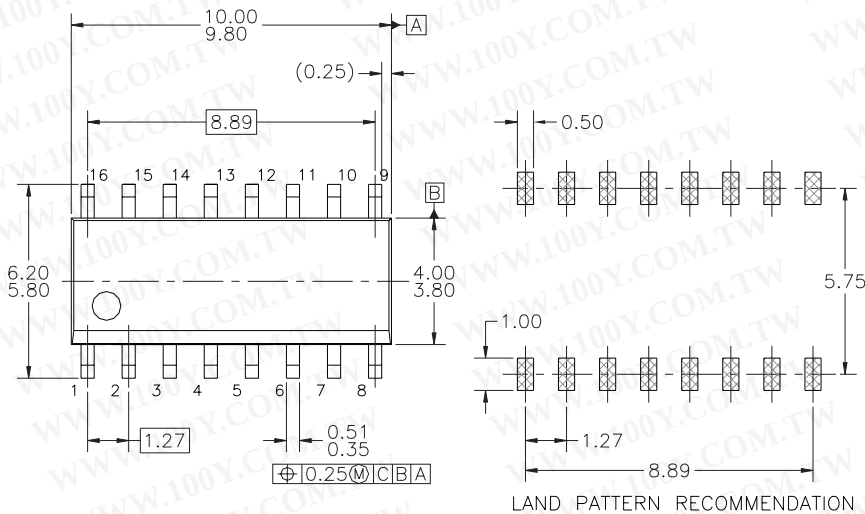


1:1

Scale 1:1 on letter size paper

Dimensions shown below are in:  
inches [millimeters]

Part Weight per unit (gram): 0.1437



NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE CONFORMS TO JEDEC MS-012, VARIATION AC, ISSUE C, DATED MAY 1990.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) STANDARD LEAD FINISH:  
200 MICROINCHES / 5.08 MICRONS MIN.  
LEAD/TIN (SOLDER) ON COPPER.

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| FACT™                | QFET™         |            |
| FACT Quiet Series™   | QS™           |            |
| FAST®                | Quiet Series™ |            |
| FASTr™               | SuperSOT™-3   |            |
| GTO™                 | SuperSOT™-6   |            |
| HiSeC™               | SuperSOT™-8   |            |

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