

84 mΩ P-Channel MOSFET in SC-70-6

Features

- 1.8V to 5.5V input voltage range
- Low on-resistance P-channel MOSFET
 - 70 mΩ at $V_{GS} = 4.5V$ (typ.)
 - 2A continuous current
- VGS pull-up resistor (MIC94053)
- SC-70-6 package
- $-40^{\circ}C$ to $+150^{\circ}C$ junction temperature range

Applications

- Load switch in portable applications:
 - Cellular phones
 - PDAs
 - MP3 players
 - Notebook PCs
 - Barcode scanners

General Description

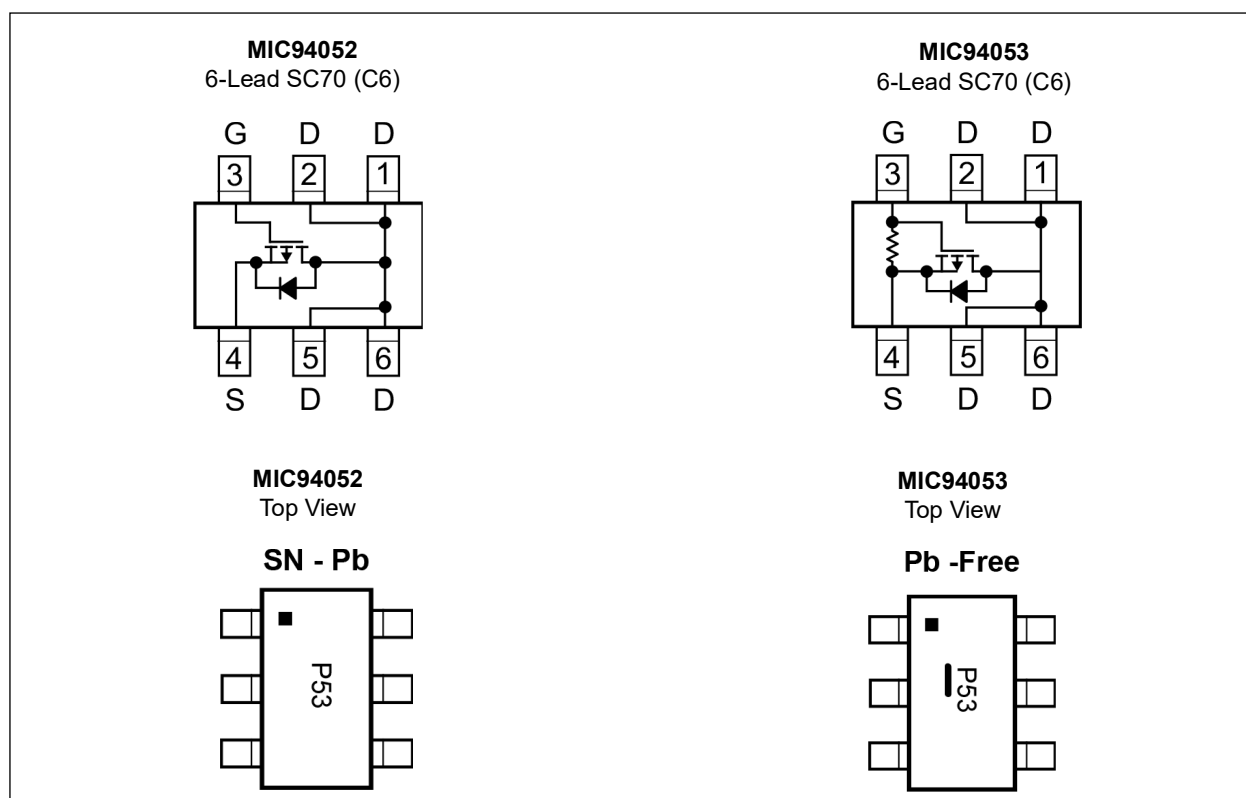
The MIC94052 and MIC94053 are low on-resistance, 84 mΩ_(MAX) P-channel MOSFETs. They are housed in an SC-70-6 package.

Designed for high-side switch applications where space is critical, the MIC94052/3 exhibit a typical on-resistance of 70 mΩ at 4.5V gate-to-source voltage. The devices operate down to 1.8V gate-to-source voltage. Their operating voltage range makes the MIC94052/3 ideal for lithium-ion applications as well as other sub-5V load switch applications.

The MIC94053 is an option that includes an internal gate pull-up resistor. The pull-up resistor ensures that the P-channel MOSFET is OFF until actively pulled down. Integrating the pull-up resistor saves valuable board space and reduces component placement cost.

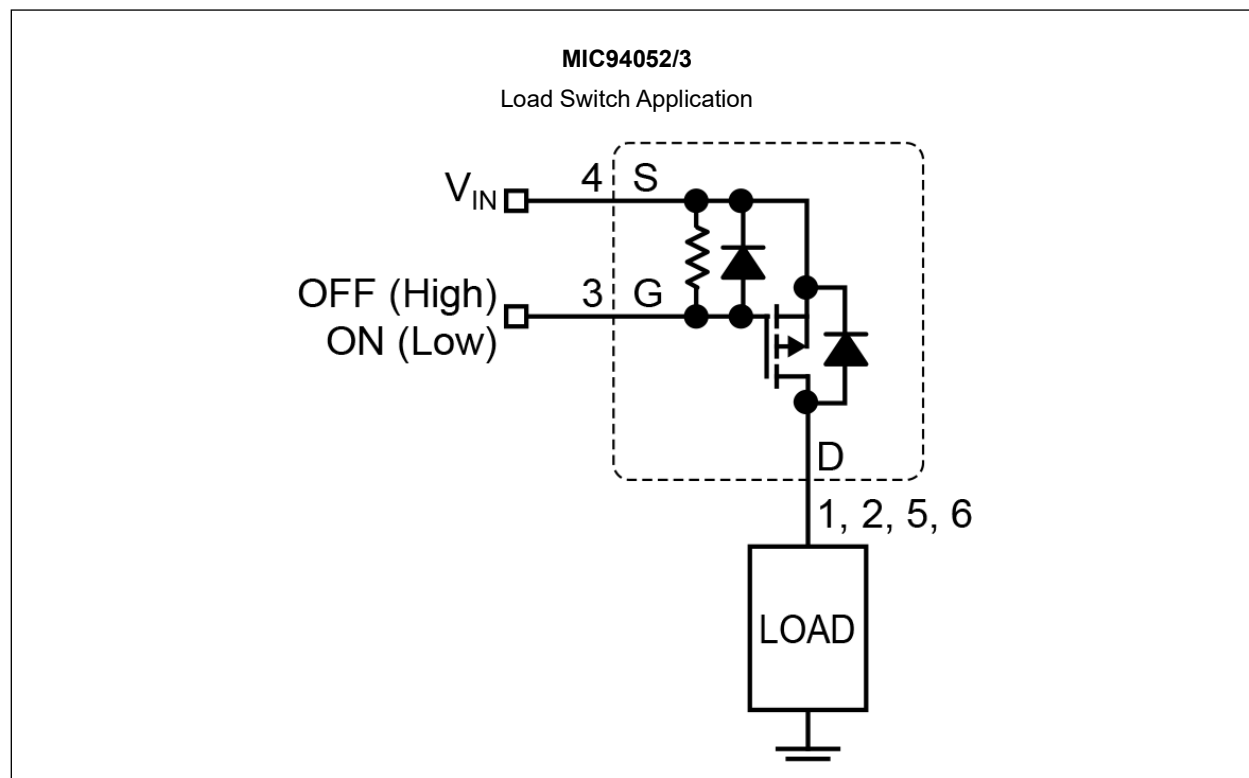
The MIC94052/3 have a junction temperature range of $-40^{\circ}C$ to $+150^{\circ}C$.

Package Types



MIC94052/3

Typical Application Circuits



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

| | |
|---|--------|
| Drain-Source Voltage (V_{DS}) | –6V |
| Gate-Source Voltage (V_{GS}) | –6V |
| Continuous Drain Current (I_D) Note 1 | |
| $T_A = 25^\circ\text{C}$ | ±2A |
| $T_A = 85^\circ\text{C}$ | ±1.4A |
| Pulsed Drain Current (I_{DP}) Note 1 | ±6A |
| Continuous Diode Current (I_S) Note 2 | –50mA |
| Power Dissipation Note 1 | |
| 6-Lead SC-70 ($T_A = 85^\circ\text{C}$) | 270 mW |
| ESD Rating Note 3 | |

Operating Ratings ‡

| | |
|--|-----------------|
| Input Voltage Range (V_{IN}) | 1.8V to 5.5V |
| Junction Temperature Range (T_J) | –40°C to +150°C |
| Package Thermal Impedance Note 1 | |
| θ_{JA} SC-70-6 lead | 240°C/W |

† **Notice:** $T_A = 25^\circ\text{C}$ unless otherwise noted. Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of its operating ratings.

‡ **Notice:** This device is not guaranteed to operate beyond its specified operating rating.

Note 1: Mounted on 1 square-inch pad of 2 oz. copper.

2: Body diode current conduction is not recommended.

3: IC devices are inherently ESD sensitive. Handling precautions required.

ELECTRICAL CHARACTERISTICS

| $T_A = 25^\circ\text{C}$, unless otherwise specified. Bold values indicate $-40^\circ\text{C} \leq T_J \leq +150^\circ\text{C}$. | | | | | | |
|---|--------------|------|------|-----------|---------------|--|
| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
| Static | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | –0.5 | — | –1.2 | V | $V_{DS} = V_{GS}$, $I_D = -250\ \mu\text{A}$ |
| Gate Body Leakage (MIC94052 only) | I_{GSS} | — | — | 100 | nA | $V_{DS} = 0\text{V}$, $V_{GS} = -5.5\text{V}$ |
| Gate-Source Resistance (MIC94053 only) | R_{GS} | 250 | 400 | 550 | k Ω | $V_{DS} = 0\text{V}$, $V_{GS} = -5.5\text{V}$ |
| Zero Gate Voltage Drain Current | I_{DSS} | — | — | –1 | μA | $V_{DS} = -5.5\text{V}$, $V_{GS} = 0\text{V}$ |
| | | — | — | –5 | | $T_J = +85^\circ\text{C}$ |
| Drain-Source On-Resistance (Note 3) | $R_{DS(ON)}$ | — | 70 | 84 | m Ω | $V_{GS} = -4.5\text{V}$, $I_{DS} = -100\ \text{mA}$ |
| | | — | 76 | 110 | | $V_{GS} = -3.6\text{V}$, $I_{DS} = -100\ \text{mA}$ |
| | | — | 92 | 130 | | $V_{GS} = -2.5\text{V}$, $I_{DS} = -100\ \text{mA}$ |
| | | — | 125 | 180 | | $V_{GS} = -1.8\text{V}$, $I_{DS} = -100\ \text{mA}$ |

Note 1: Pulse test; pulse width = 300 μs , duty cycle = 2%.

2: Guaranteed by design.

3: Ensure that all drain pins are connected together to optimize $R_{DS(ON)}$ performance.

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ELECTRICAL CHARACTERISTICS (CONTINUED)

| $T_A = 25^{\circ}\text{C}$, unless otherwise specified. Bold values indicate $-40^{\circ}\text{C} \leq T_J \leq +150^{\circ}\text{C}$. | | | | | | |
|---|---------------------|------|------|------|-------|---|
| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
| Dynamic (Note 2) | | | | | | |
| Turn-on Delay Time | $t_{d(\text{on})}$ | — | 15 | — | ns | $V_{DD} = -5\text{V}$, $I_D = -0.5\text{A}$, $V_{GS} = -4.5\text{V}$, $R_{GEN} = 50\Omega$ |
| Turn-on Rise Time | t_r | — | 15 | — | | |
| Turn-off Delay Time | $t_{d(\text{off})}$ | — | 60 | — | | |
| Turn-off Fall Time | t_f | — | 20 | — | | |

- Note 1:** Pulse test; pulse width = 300 μs , duty cycle = 2%.
- 2:** Guaranteed by design.
- 3:** Ensure that all drain pins are connected together to optimize $R_{DS(\text{ON})}$ performance.

TEMPERATURE SPECIFICATIONS

| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
|--------------------------------------|---------------|------|------|------|----------------------|------------|
| Operating Junction Temperature Range | T_J | -40 | — | +150 | $^{\circ}\text{C}$ | — |
| Ambient Storage Temperature Range | T_S | -55 | — | +150 | $^{\circ}\text{C}$ | — |
| Thermal Resistance (6-Lead SC70) | θ_{JA} | — | 240 | — | $^{\circ}\text{C/W}$ | Note 1 |

- Note 1:** Mounted on 1 square-inch pad of 2 oz. copper.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

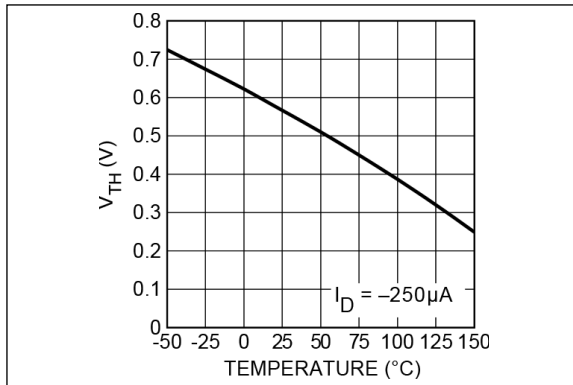


FIGURE 2-1: V_{TH} Variance vs. Temperature.

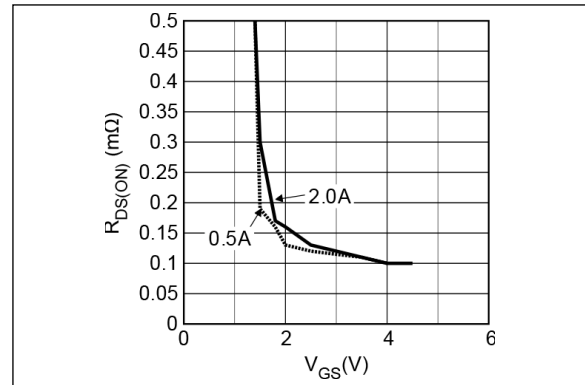


FIGURE 2-4: On-Resistance vs. V_{GS} .

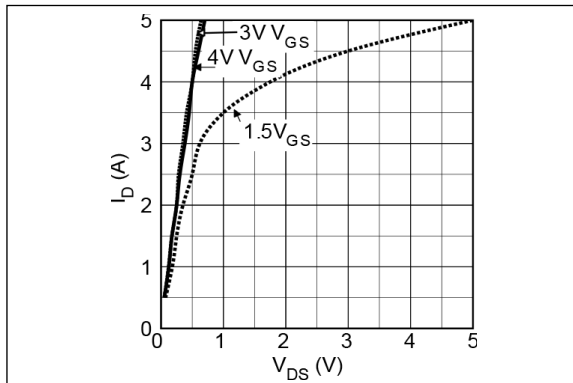


FIGURE 2-2: V_{DS} vs. I_D .

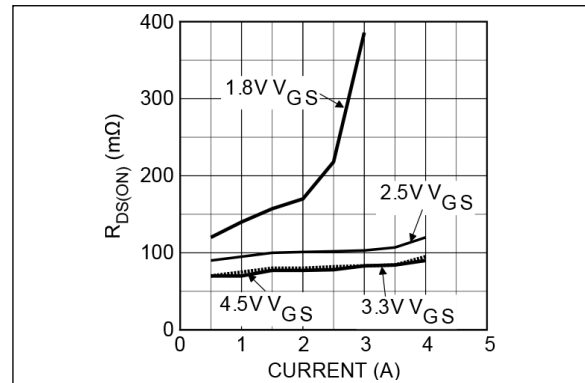


FIGURE 2-5: On-Resistance vs. I_D .

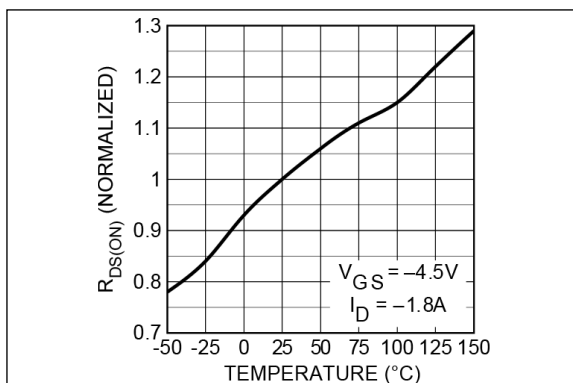


FIGURE 2-3: $R_{DS(ON)}$ Variance vs. Temperature.

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3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 3-1](#).

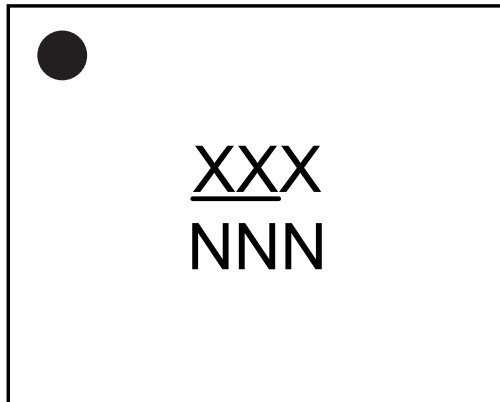
TABLE 3-1: PIN FUNCTION TABLE

| Pin Number (UDFN) | Pin Name | Description |
|----------------------|----------|---|
| 1, 2, 5, 6 | D | Drain. Ensure that all drain pins are connected together to optimize RDS(ON) performance. |
| 3 | G | Gate. |
| 4 | S | Source. |

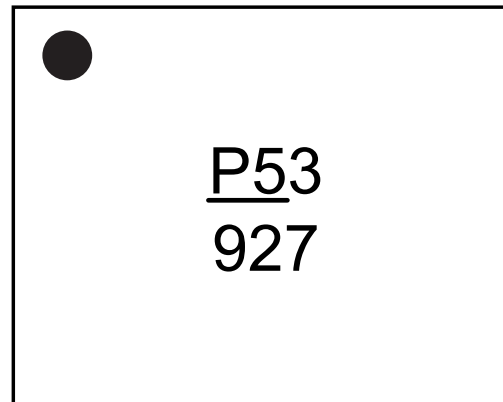
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

6-Lead SC70



Example



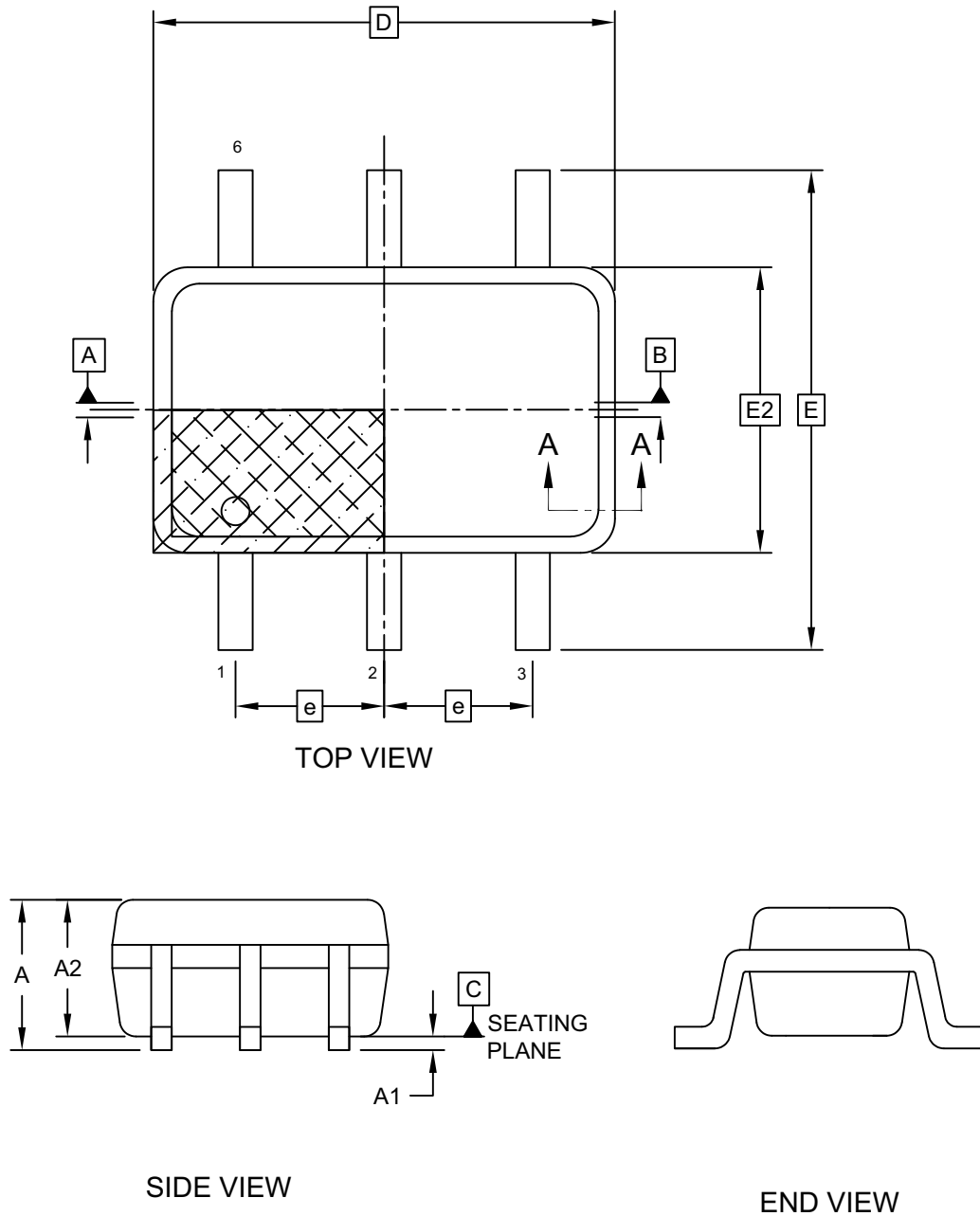
| | | |
|----------------|--|--|
| Legend: | XX...X | Product code or customer-specific information |
| | Y | Year code (last digit of calendar year) |
| | YY | Year code (last 2 digits of calendar year) |
| | WW | Week code (week of January 1 is week '01') |
| | NNN | Alphanumeric traceability code |
| | (e3) | Pb-free JEDEC® designator for Matte Tin (Sn) |
| | * | This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package. |
| | •, ▲, ▼ | Pin one index is identified by a dot, delta up, or delta down (triangle mark). |
| 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 customer-specific information. Package may or may not include the corporate logo. | |
| | Underbar (_) and/or Overbar (¯) symbol may not be to scale. | |

Note: If the full seven-character YYWWNNN code cannot fit on the package, the following truncated codes are used based on the available marking space: 6 Characters = YWWNNN; 5 Characters = WWNNN; 4 Characters = WNNN; 3 Characters = NNN; 2 Characters = NN; 1 Character = N.

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6-Lead 2.0 mm × 1.25 mm SC70 [D4A] Package Outline and Recommended Land Pattern

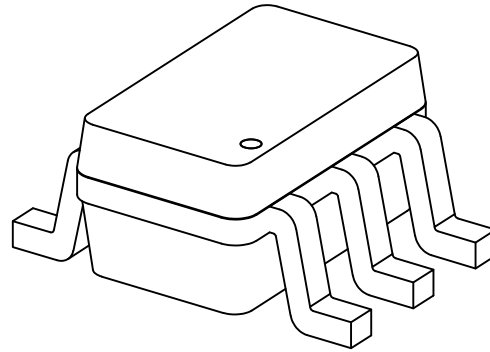
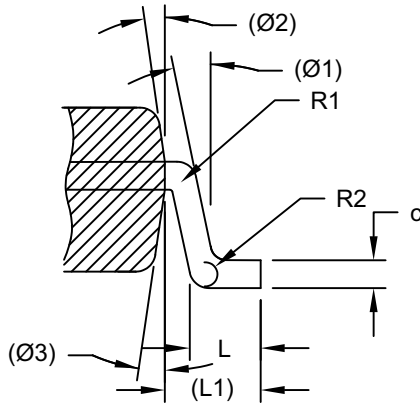
Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-1133 Rev A Sheet 1 of 2

6-Lead 2.0 mm × 1.25 mm SC70 [D4A] Package Outline and Recommended Land Pattern

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



SECTION A-A

| | | Units | MILLIMETERS | | |
|--------------------------|----|-------|-------------|-----|------|
| Dimension Limits | | | MIN | NOM | MAX |
| Number of Terminals | N | | 6 | | |
| Pitch | e | | 0.65 BSC | | |
| Overall Height | A | - | - | - | 1.10 |
| Standoff | A1 | | 0.00 | - | 0.10 |
| Molded Package Thickness | A2 | | 0.80 | - | 1.00 |
| Overall Length | D | | 2.00 BSC | | |
| Overall Width | E | | 2.10 BSC | | |
| Molded Package Width | E2 | | 1.25 BSC | | |
| Terminal Width | b | | 0.15 | - | 0.30 |
| Terminal Thickness | c | | 0.08 | - | 0.25 |
| Terminal Length | L | | 0.21 | - | 0.46 |
| Footprint | L1 | | 0.55 REF | | |
| Lead Bend Radius | R1 | | 0.02 | - | 0.08 |
| Lead Bend Radius | R2 | | 0.08 | - | 0.20 |
| Lead Angle | Ø1 | | 12° REF | | |
| Mold Draft Angle | Ø2 | | 8° REF | | |
| Mold Draft Angle | Ø3 | | 8° REF | | |

Notes:

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Dimensioning and tolerancing per ASME Y14.5M
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

APPENDIX A: REVISION HISTORY

Revision A (December 2023)

- Converted Micrel document MIC94052/3 to Microchip data sheet DS20006847A.
- Minor text changes throughout.

MIC94052/3

NOTES:

PRODUCT IDENTIFICATION SYSTEM

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

| <u>Part Number</u> | <u>X</u> | <u>XX</u> | <u>-XX</u> | Examples: |
|---|----------------------|-----------|------------|---|
| Device | Junction Temp. Range | Package | Media Type | |
| Device: MIC94052/3: 84 mΩ P-Channel MOSFET in SC-70-6 Junction Temperature Range: Y = -40°C to +125°C Package: C6 = 6-Lead SC70 Media Type: TR = 3000/Reel | | | | a) MIC94052YC6-TR: MIC94052, -40°C to +125°C Temperature Range, 6-Lead SC70, 3000/Reel b) MIC94053YC6-TR: MIC94053, -40°C to +125°C Temperature Range, 6-Lead SC70, 3000/Reel |
| | | | | Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option. |

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