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# Automotive P-Channel 30 V (D-S) 175 °C MOSFET

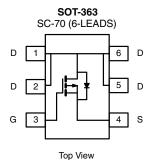
| PRODUCT SUMMARY                                  |        |  |  |  |
|--------------------------------------------------|--------|--|--|--|
| V <sub>DS</sub> (V)                              | - 30   |  |  |  |
| $R_{DS(on)}(\Omega)$ at $V_{GS} = -10 \text{ V}$ | 0.175  |  |  |  |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS}$ = - 4.5 V  | 0.300  |  |  |  |
| I <sub>D</sub> (A)                               | - 3    |  |  |  |
| Configuration                                    | Single |  |  |  |

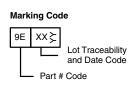
#### **FEATURES**

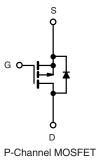
- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET® Power MOSFET
- AEC-Q101 Qualified<sup>c</sup>
- 100 % Rq and UIS Tested
- Compliant to RoHS Directive 2002/95/EC











| ORDERING INFORMATION            |                 |  |
|---------------------------------|-----------------|--|
| Package                         | SC-70           |  |
| Lead (Pb)-free and Halogen-free | SQ1431EH-T1-GE3 |  |

| <b>ABSOLUTE MAXIMUM RATINGS</b> (T <sub>C</sub> = 25 °C, unless otherwise noted) |                         |                                   |               |     |  |
|----------------------------------------------------------------------------------|-------------------------|-----------------------------------|---------------|-----|--|
| PARAMETER                                                                        | SYMBOL                  | LIMIT                             | UNIT          |     |  |
| Drain-Source Voltage                                                             |                         | $V_{DS}$                          | - 30          | V   |  |
| Gate-Source Voltage                                                              | V <sub>GS</sub>         | ± 20                              | V             |     |  |
| Continuous Drain Current                                                         | T <sub>C</sub> = 25 °C  | 1                                 | - 3           |     |  |
| Continuous Drain Current                                                         | T <sub>C</sub> = 125 °C | I <sub>D</sub>                    | - 1.8         |     |  |
| Continuous Source Current (Diode Conduct                                         | I <sub>S</sub>          | - 3.7                             | Α             |     |  |
| Pulsed Drain Current <sup>a</sup>                                                |                         | I <sub>DM</sub>                   | - 12          |     |  |
| Single Pulse Avalanche Current                                                   | . 0.4                   | I <sub>AS</sub>                   | - 6           |     |  |
| Single Pulse Avalanche Energy                                                    | L = 0.1 mH              | E <sub>AS</sub>                   | 1.8           | mJ  |  |
|                                                                                  | T <sub>C</sub> = 25 °C  |                                   | 3             | 14/ |  |
| Maximum Power Dissipation <sup>a</sup>                                           | T <sub>C</sub> = 125 °C | $P_{D}$                           | 1             | W   |  |
| Operating Junction and Storage Temperatur                                        | re Range                | T <sub>J</sub> , T <sub>sta</sub> | - 55 to + 175 | °C  |  |

| THERMAL RESISTANCE RATINGS |                        |            |       |       |  |
|----------------------------|------------------------|------------|-------|-------|--|
| PARAMETER                  |                        | SYMBOL     | LIMIT | UNIT  |  |
| Junction-to-Ambient        | PCB Mount <sup>b</sup> | $R_{thJA}$ | 130   | °C/W  |  |
| Junction-to-Foot (Drain)   |                        | $R_{thJF}$ | 50    | C/ VV |  |

#### Notes

- a. Pulse test; pulse width  $\leq$  300  $\mu$ s, duty cycle  $\leq$  2 %.
- b. When mounted on 1" square PCB (FR-4 material).
- c. Parametric verification ongoing.



| PARAMETER                                     | SYMBOL                  | TEST CONDITIONS                                                                                     |                                                   | MIN. | TYP.   | MAX.  | UNIT |
|-----------------------------------------------|-------------------------|-----------------------------------------------------------------------------------------------------|---------------------------------------------------|------|--------|-------|------|
| Static                                        |                         |                                                                                                     |                                                   |      |        |       |      |
| Drain-Source Breakdown Voltage                | V <sub>DS</sub>         | V <sub>GS</sub> =                                                                                   | $V_{GS} = 0 \text{ V}, I_{D} = -250 \mu\text{A}$  |      | -      | -     | V    |
| Gate-Source Threshold Voltage                 | V <sub>GS(th)</sub>     | V <sub>DS</sub> =                                                                                   | V <sub>GS</sub> , I <sub>D</sub> = - 250 μA       | - 1  | - 1.5  | - 2   | V    |
| Gate-Source Leakage                           | I <sub>GSS</sub>        | V <sub>DS</sub> =                                                                                   | $0 \text{ V}, \text{ V}_{GS} = \pm 20 \text{ V}$  | -    | -      | ± 100 | nA   |
|                                               |                         | $V_{GS} = 0 V$                                                                                      | V <sub>DS</sub> = - 30 V                          | -    | -      | - 1   |      |
| Zero Gate Voltage Drain Current               | I <sub>DSS</sub>        | $V_{GS} = 0 V$                                                                                      | V <sub>DS</sub> = - 30 V, T <sub>J</sub> = 125 °C | -    | -      | - 50  | μΑ   |
|                                               |                         | $V_{GS} = 0 V$                                                                                      | V <sub>DS</sub> = - 30 V, T <sub>J</sub> = 175 °C | -    | -      | - 150 |      |
| On-State Drain Current <sup>a</sup>           | I <sub>D(on)</sub>      | V <sub>GS</sub> = - 10 V                                                                            | V <sub>DS</sub> ≤ - 5 V                           | - 5  | -      | -     | Α    |
|                                               |                         | V <sub>GS</sub> = - 10 V                                                                            | I <sub>D</sub> = - 2 A                            | -    | 0.125  | 0.175 |      |
| Drain Course On State Decistores              | R <sub>DS(on)</sub>     | V <sub>GS</sub> = - 10 V                                                                            | I <sub>D</sub> = - 2 A, T <sub>J</sub> = 125 °C   | -    | -      | 0.252 |      |
| Drain-Source On-State Resistance <sup>a</sup> |                         | V <sub>GS</sub> = - 10 V                                                                            | I <sub>D</sub> = - 2 A, T <sub>J</sub> = 175 °C   | -    | -      | 0.294 | Ω    |
|                                               |                         | V <sub>GS</sub> = - 4.5 V                                                                           | I <sub>D</sub> = - 1.6 A                          | -    | 0.230  | 0.300 |      |
| Forward Transconductanceb                     | 9 <sub>fs</sub>         | V <sub>DS</sub> = - 10 V, I <sub>D</sub> = - 2 A                                                    |                                                   | -    | 3      | -     | S    |
| Dynamic <sup>b</sup>                          |                         |                                                                                                     |                                                   |      |        |       |      |
| Input Capacitance                             | C <sub>iss</sub>        |                                                                                                     |                                                   | -    | 164    | 205   |      |
| Output Capacitance                            | C <sub>oss</sub>        | $V_{GS} = 0 V$                                                                                      | V <sub>DS</sub> = - 25 V, f = 1 MHz               | -    | 44     | 55    | pF   |
| Reverse Transfer Capacitance                  | C <sub>rss</sub>        |                                                                                                     |                                                   | -    | 28     | 35    |      |
| Total Gate Charge <sup>c</sup>                | Qg                      |                                                                                                     |                                                   | -    | 4.2    | 6.5   |      |
| Gate-Source Charge <sup>c</sup>               | Q <sub>gs</sub>         | V <sub>GS</sub> = - 4.5 V                                                                           | $V_{DS} = -15 \text{ V}, I_{D} = -2.2 \text{ A}$  | -    | 0.7    | -     | nC   |
| Gate-Drain Charge <sup>c</sup>                | Q <sub>gd</sub>         | 1                                                                                                   |                                                   | -    | 1      | -     | 1    |
| Gate Resistance                               | R <sub>g</sub>          | f = 1 MHz                                                                                           |                                                   | 6.5  | 12.5   | 18.5  | Ω    |
| Turn-On Delay Time <sup>c</sup>               | t <sub>d(on)</sub>      |                                                                                                     |                                                   | -    | 5      | 8     |      |
| Rise Time <sup>c</sup>                        | t <sub>r</sub>          | $V_{DD}$ = - 15 V, $R_L$ = 15 $\Omega$<br>$I_D \cong$ - 1 A, $V_{GEN}$ = - 10 V, $R_g$ = 1 $\Omega$ |                                                   | -    | 8      | 12    |      |
| Turn-Off Delay Time <sup>c</sup>              | t <sub>d(off)</sub>     |                                                                                                     |                                                   | -    | 11     | 17    | ns   |
| Fall Time <sup>c</sup>                        | t <sub>f</sub>          |                                                                                                     |                                                   | -    | 8      | 12    |      |
| Source-Drain Diode Ratings and Chara          | cteristics <sup>b</sup> |                                                                                                     |                                                   |      |        |       |      |
| Pulsed Current <sup>a</sup>                   | I <sub>SM</sub>         |                                                                                                     |                                                   | -    | -      | - 12  | Α    |
| Forward Voltage                               | V <sub>SD</sub>         | l                                                                                                   | 1.2 A, V <sub>GS</sub> = 0 V                      | _    | - 0.85 | - 1.2 | V    |

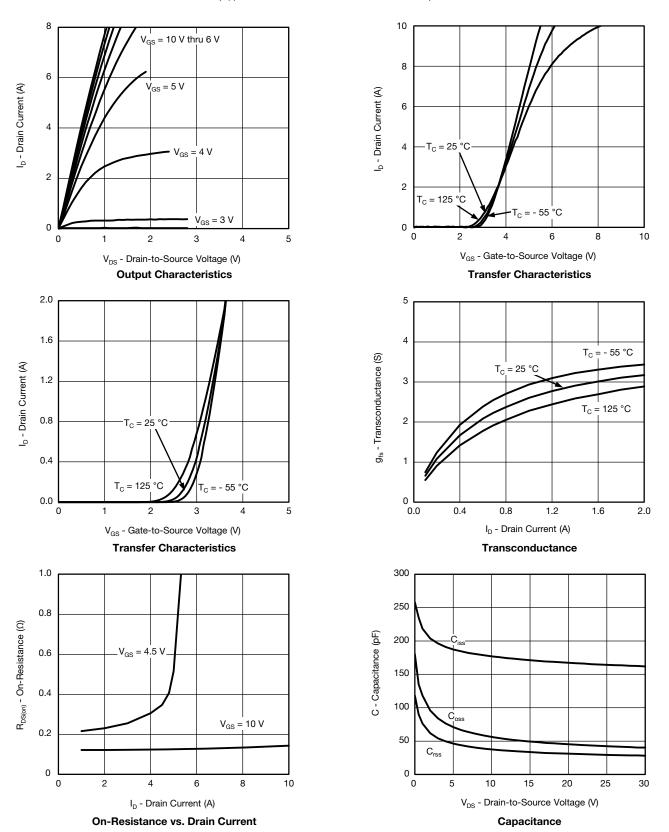
### Notes

- a. Pulse test; pulse width  $\leq 300~\mu s,~duty~cycle \leq 2~\%.$
- b. Guaranteed by design, not subject to production testing.
- c. Independent of operating temperature.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

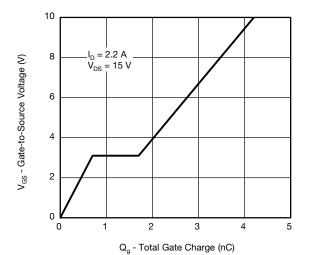


# **TYPICAL CHARACTERISTICS** (T<sub>A</sub> = 25 °C, unless otherwise noted)

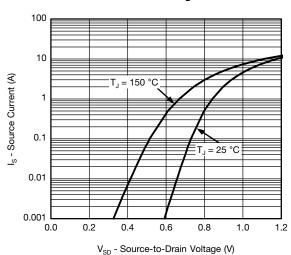




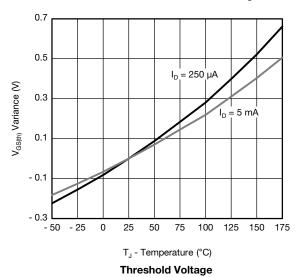
# **TYPICAL CHARACTERISTICS** (T<sub>A</sub> = 25 °C, unless otherwise noted)

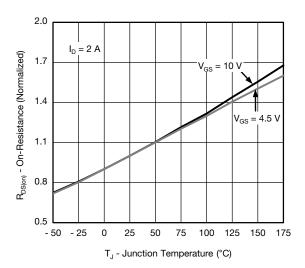


#### **Gate Charge**

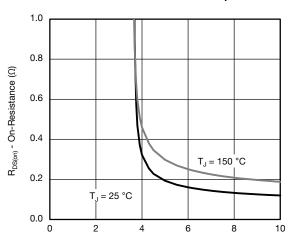


#### **Source Drain Diode Forward Voltage**



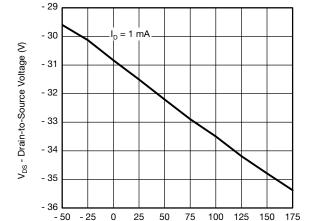


#### On-Resistance vs. Junction Temperature



V<sub>GS</sub> - Gate-to-Source Voltage (V)

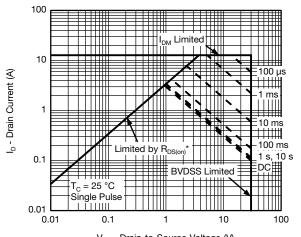
On-Resistance vs. Gate-to-Source Voltage



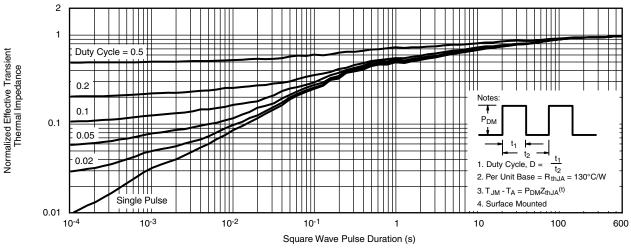
 $\label{eq:TJ-Junction} T_{J} \text{ - Junction Temperature (°C)}$  Drain Source Breakdown vs. Junction Temperature



# **THERMAL RATINGS** ( $T_A = 25$ °C, unless otherwise noted)

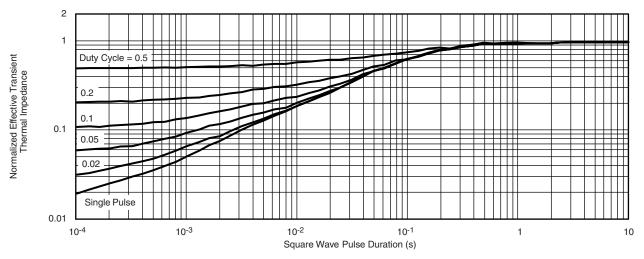


$$\begin{split} &V_{DS}\text{ - Drain-to-Source Voltage (V)}\\ ^*V_{GS}>&\min \text{mum }V_{GS}\text{ at which }R_{DS(on)}\text{ is specified}\\ &\textbf{Safe Operating Area} \end{split}$$



Normalized Thermal Transient Impedance, Junction-to-Ambient

# **THERMAL RATINGS** (T<sub>A</sub> = 25 °C, unless otherwise noted)



#### Normalized Thermal Transient Impedance, Junction-to-Foot

#### Note

- The characteristics shown in the two graphs
- Normalized Transient Thermal Impedance Junction-to-Ambient (25 °C)
- Normalized Transient Thermal Impedance Junction-to-Foot (25 °C)

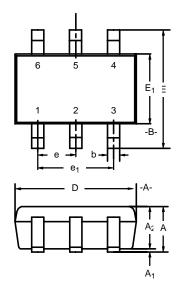
are given for general guidelines only to enable the user to get a "ball park" indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions.

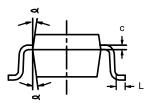
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# SC-70: 6-LEADS





|                | MILLIMETERS |         |      | I     | NCHE     | S     |
|----------------|-------------|---------|------|-------|----------|-------|
| Dim            | Min         | Nom     | Max  | Min   | Nom      | Max   |
| Α              | 0.90        | _       | 1.10 | 0.035 | _        | 0.043 |
| A <sub>1</sub> | -           | _       | 0.10 | -     | _        | 0.004 |
| A <sub>2</sub> | 0.80        | _       | 1.00 | 0.031 | _        | 0.039 |
| b              | 0.15        | _       | 0.30 | 0.006 | _        | 0.012 |
| С              | 0.10        | -       | 0.25 | 0.004 | -        | 0.010 |
| D              | 1.80        | 2.00    | 2.20 | 0.071 | 0.079    | 0.087 |
| Ε              | 1.80        | 2.10    | 2.40 | 0.071 | 0.083    | 0.094 |
| E <sub>1</sub> | 1.15        | 1.25    | 1.35 | 0.045 | 0.049    | 0.053 |
| е              |             | 0.65BSC |      |       | 0.026BSC | ;     |
| e <sub>1</sub> | 1.20        | 1.30    | 1.40 | 0.047 | 0.051    | 0.055 |
| L              | 0.10        | 0.20    | 0.30 | 0.004 | 0.008    | 0.012 |
| کے             | 7°Nom       |         |      |       | 7°Nom    |       |

DWG: 5550





# Single-Channel LITTLE FOOT® SC-70 6-Pin MOSFET Copper Leadframe Version Recommended Pad Pattern and Thermal Performance

#### INTRODUCTION

The new single 6-pin SC-70 package with a copper leadframe enables improved on-resistance values and enhanced thermal performance as compared to the existing 3-pin and 6-pin packages with Alloy 42 leadframes. These devices are intended for small to medium load applications where a miniaturized package is required. Devices in this package come in a range of on-resistance values, in n-channel and p-channel versions. This technical note discusses pin-outs, package outlines, pad patterns, evaluation board layout, and thermal performance for the single-channel version.

#### **BASIC PAD PATTERNS**

See Application Note 826, Recommended Minimum Pad Patterns With Outline Drawing Access for Vishay Siliconix MOSFETs, (http://www.vishay.com/doc?72286) for the basic pad layout and dimensions. These pad patterns are sufficient for the low to medium power applications for which this package is intended. Increasing the drain pad pattern yields a reduction in thermal resistance and is a preferred footprint. The availability of four drain leads rather than the traditional single drain lead allows a better thermal path from the package to the PCB and external environment.

#### **PIN-OUT**

Figure 1 shows the pin-out description and Pin 1 identification. The pin-out of this device allows the use of four pins as drain leads, which helps to reduce on-resistance and junction-to-ambient thermal resistance.

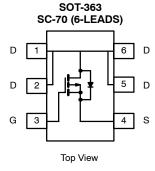


FIGURE 1.

For package dimensions see outline drawing SC-70 (6-Leads) (http://www.vishay.com/doc?71154)

#### **EVALUATION BOARDS — SINGLE SC70-6**

The evaluation board (EVB) measures 0.6 inches by 0.5 inches. The copper pad traces are the same as in Figure 2. The board allows examination from the outer pins to 6-pin DIP connections, permitting test sockets to be used in evaluation testing. See Figure 3.

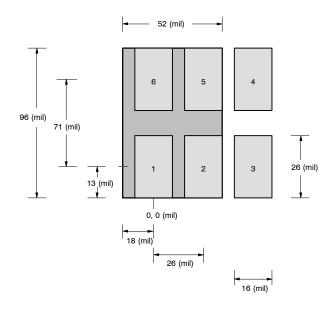
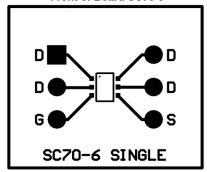


FIGURE 2. SC-70 (6 leads) Single

The thermal performance of the single 6-pin SC-70 has been measured on the EVB, comparing both the copper and Alloy 42 leadframes. This test was first conducted on the traditional Alloy 42 leadframe and was then repeated using the 1-inch<sup>2</sup> PCB with dual-side copper coating.



Front of Board SC70-6



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Back of Board SC70-6

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FIGURE 3.

#### THERMAL PERFORMANCE

#### **Junction-to-Foot Thermal Resistance** (Package Performance)

The junction to foot thermal resistance is a useful method of comparing different packages thermal performance.

A helpful way of presenting the thermal performance of the 6-Pin SC-70 copper leadframe device is to compare it to the traditional Alloy 42 version.

Thermal performance for the 6-pin SC-70 measured as junction-to-foot thermal resistance, where the "foot" is the drain lead of the device at the bottom where it meets the PCB. The junction-to-foot thermal resistance is typically 40°C/W in the copper leadframe and 163°C/W in the Alloy 42 leadframe - a four-fold improvement. This improved performance is obtained by the enhanced thermal conductivity of copper over Alloy 42.

#### **Power Dissipation**

The typical  $R\theta_{JA}$  for the single 6-pin SC-70 with copper leadframe is 103°C/W steady-state, compared with 212°C/W for the Alloy 42 version. The figures are based on the 1-inch<sup>2</sup> FR4 test board. The following example shows how the thermal resistance impacts power dissipation for the two different leadframes at varying ambient temperatures.

| ALLOY 42 LEADFRAME                                          |                                                             |  |  |  |
|-------------------------------------------------------------|-------------------------------------------------------------|--|--|--|
| Room Ambient 25 °C                                          | Elevated Ambient 60 °C                                      |  |  |  |
| $P_D = \frac{T_{J(max)} - T_A}{R\theta_{JA}}$               | $P_D = \frac{T_{J(max)} - T_A}{R\theta_{JA}}$               |  |  |  |
| $P_{D} = \frac{150^{\circ}C - 25^{\circ}C}{212^{\circ}C/W}$ | $P_{D} = \frac{150^{\circ}C - 25^{\circ}C}{212^{\circ}C/W}$ |  |  |  |
| $P_D = 590 \text{ mW}$                                      | $P_D = 425 \text{ mW}$                                      |  |  |  |

| COOPER LEADFRAME                                                                                              |                                                                                                               |  |  |  |
|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--|--|--|
| Room Ambient 25 °C                                                                                            | Elevated Ambient 60 °C                                                                                        |  |  |  |
| $P_{D} = \frac{T_{J(max)} - T_{A}}{R\theta_{JA}}$ $P_{D} = \frac{150^{\circ}C - 25^{\circ}C}{124^{\circ}C/W}$ | $P_{D} = \frac{T_{J(max)} - T_{A}}{R\theta_{JA}}$ $P_{D} = \frac{150^{\circ}C - 60^{\circ}C}{124^{\circ}C/W}$ |  |  |  |
| $P_{D} = 1.01 \text{ W}$                                                                                      | P <sub>D</sub> = 726 mW                                                                                       |  |  |  |

As can be seen from the calculations above, the compact 6-pin SC-70 copper leadframe LITTLE FOOT power MOSFET can handle up to 1 W under the stated conditions.

#### **Testing**

To further aid comparison of copper and Alloy 42 leadframes, Figure 5 illustrates single-channel 6-pin SC-70 thermal performance on two different board sizes and two different pad patterns. The measured steady-state values of  $R\theta_{\text{JA}}$  for the two leadframes are as follows:

| LITTLE FOOT 6-PIN SC-70                                                                          |           |           |  |  |  |
|--------------------------------------------------------------------------------------------------|-----------|-----------|--|--|--|
|                                                                                                  | Alloy 42  | Copper    |  |  |  |
| 1) Minimum recommended pad pattern on the EVB board V (see Figure 3.                             | 329.7°C/W | 208.5°C/W |  |  |  |
| <ol> <li>Industry standard 1-inch<sup>2</sup> PCB with<br/>maximum copper both sides.</li> </ol> | 211.8°C/W | 103.5°C/W |  |  |  |

The results indicate that designers can reduce thermal resistance ( $R\theta_{1\Delta}$ ) by 36% simply by using the copper leadframe device rather than the Alloy 42 version. In this example, a 121°C/W reduction was achieved without an increase in board area. If increasing in board size is feasible, a further 105°C/W reduction could be obtained by utilizing a 1-inch<sup>2</sup> square PCB area.

The copper leadframe versions have the following suffix:

Single: Si14xxEDH Dual: Si19xxEDH Complementary: Si15xxEDH

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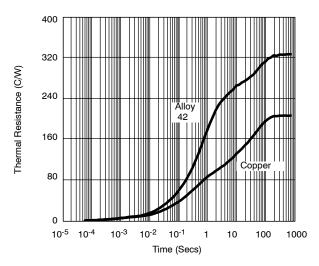


FIGURE 4. Leadframe Comparison on EVB

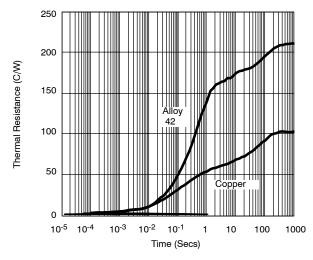
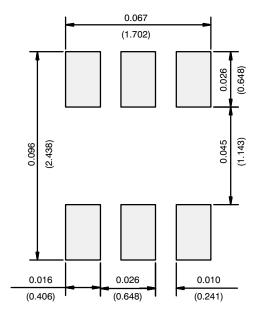


FIGURE 5. Leadframe Comparison on Alloy 42 1-inch<sup>2</sup> PCB



### **RECOMMENDED MINIMUM PADS FOR SC-70: 6-Lead**



Recommended Minimum Pads Dimensions in Inches/(mm)

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# **ПОСТАВКА** ЭЛЕКТРОННЫХ КОМПОНЕНТОВ

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001 Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

# Данный компонент на территории Российской Федерации Вы можете приобрести в компании MosChip.

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

## http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

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