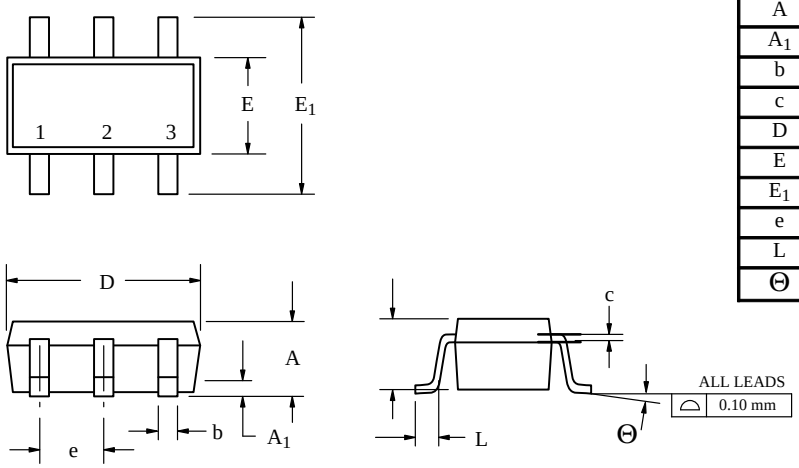
TSOP-6—The Next Step for LITTLE FOOT®

Cellular telephones, notebook computers, and other portable electronic systems are becoming smaller with each new generation of products. The new TSOP-6 LITTLE FOOT family anticipates this evolution. Its small size allows the placement of a MOSFET in spaces that have become too small for any other surface-mount power MOSFET package.

With a power rating of 2 W, on-resistance as low as 0.065 Ω, and current ratings of up to 4.2 A, the new LITTLE FOOT TSOP-6 (Figure 1) is a true power package, providing the kind of performance, on an even smaller scale, that designers have come to expect from LITTLE FOOT.



Dim	Millimeters		Inches	
	Min	Max	Min	Max
A	–	1.10	–	0.043
A_1	0.01	0.10	0.0004	0.004
b	0.25	0.50	0.010	0.020
c	0.10	0.26	0.004	0.010
D	2.90	3.10	0.114	0.122
E	1.30	1.70	0.051	0.067
E_1	2.75 BSC		0.108 BSC	
e	1.00 BSC		0.039 BSC	
L	0.20	0.60	0.008	0.024
Θ	0°	8°	0°	8°

Figure 1. TSOP-6 Outline Drawing

Not only is the TSOP-6 small, it's also a JEDEC registered package: with the same footprint as the SC-59, but with a lower profile and higher power rating (up to 2 W). As further assurance that the TSOP-6 will be established as the industry standard for low-voltage applications with limited circuit board space, these devices are being second-sourced by Motorola Semiconductors. For these TSOP-6 devices, Siliconix and Motorola have agreed on compatible pin-outs, power ratings, and package outlines and dimensions.

A New Branch Of A Great Family

When Siliconix created the first true surface-mount power MOSFETs with its SO-8 LITTLE FOOT family, two innovations were involved: a lower on-resistance power MOSFET technology and modifications to the standard, surface-mount SOIC package. The lower on-resistance MOSFET reduced the power dissipation per unit of current, while the innovative packing provided a path for heat to escape, allowing high currents to be switched in a package that is much smaller and easier to assemble.

The introduction of LITTLE FOOT MOSFETs in the SO-8 inevitably raised the expectations of the market as regards surface-mounted power MOSFETs, resulting in a demand for devices with greater capabilities in even smaller packages. In 1994, Siliconix halved the size of the smallest available power MOSFET package with the introduction of the LITTLE FOOT TSSOP-8.

With the introduction of LITTLE FOOT devices in the TSOP-6, Siliconix is answering the demand of the market for smaller size and greater capabilities with even smaller devices that can provide the current handling available until now only in the TSSOP-8, SO-8, and other larger packages.

The Footprint

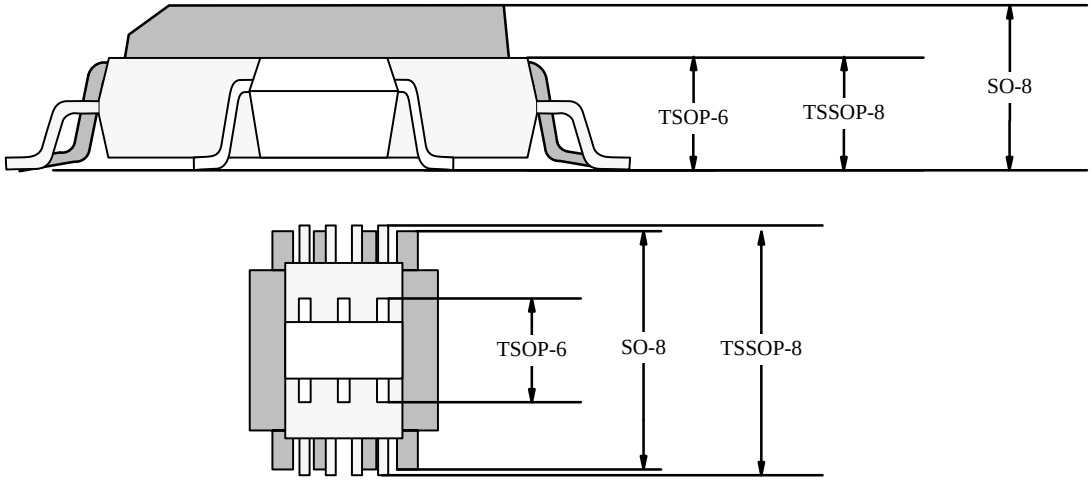


Figure 2. LITTLE FOOT® Family Package Evolution

The TSOP-6 is a 6-leaded, 1-mm thick package with a total height of 1.1 mm. The package and leads occupy an area of 2.75 × 3.10 mm. To put this in perspective, Figure 2 gives a visual comparison by overlaying the package outlines of the TSOP-6, the TSSOP-8 and the SO-8 packages. The TSOP-6 measures 2.75 mm in width, including the leads, less than half as wide as the SO-8. Table 1 gives a comparison of the dimensions of these packages.

Table 1. Comparison of Dimensions

Dim	TSOP-6				TSSOP-8				SOIC-8			
	Millimeters		Inches		Millimeters		Inches		Millimeters		Inches	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Height	–	1.10	–	0.043	1.05	1.20	0.041	0.047	1.35	1.75	0.053	0.069
Lead Width	0.25	0.50	0.010	0.020	0.25	0.30	0.010	0.012	0.35	0.45	0.014	0.018
Package Length	2.90	3.10	0.114	0.122	2.90	3.10	0.114	0.122	4.69	5.00	0.185	0.196
Package Width	1.30	1.70	0.051	0.067	4.30	4.50	0.170	0.177	3.50	4.05	0.140	0.160
Width of Foot Print	2.75 BSC		0.108 BSC		6.20	6.60	0.244	0.260	5.70	6.30	0.224	0.248
Lead Pitch	1.00 BSC		0.039 BSC		0.65 BSC		0.025 BSC		1.27 BSC		0.050 BSC	

Thermal Capabilities

The same copper lead frame innovations introduced in the SO-8 LITTLE FOOT have been used in the TSOP-6 LITTLE FOOT to dissipate heat. The TSOP-6 lead frame is shown in Figure 3. As in the SO-8 and TSSOP-8 packages, the thermal path runs from the die, through the die attach, into the copper lead frame, and out the drain leads (Figure 4). The drain leads account for the largest portion of the thermal impedance due to the small cross sectional area of the leads. The small size of the package helps to keep the length of the drain leads short. The short lead length, in combination with the use of four drain leads, keeps the thermal impedance low for this size package.

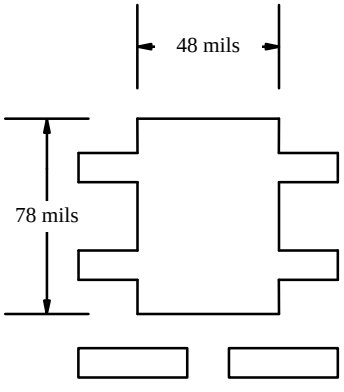


Figure 3. TSOP-6 Leadframe

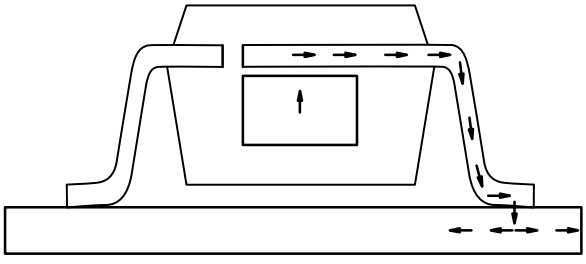


Figure 4. Thermal Path

The thermal rating as provided on data sheets for surface-mount MOSFETs is measured with the part mounted on a one-inch square piece of 0.062-inch thick FR4 PC board. This choice of test board is neither a “worst-case” or “best-case” layout. It represents a compromise between single-layer and multilayer boards, with more copper on its single side than the average single-layer construction. Thus, it can serve as an approximation of multilayer boards with center power planes and far less surface copper.

The junction is heated by a known amount of power for a known amount of time. The junction temperature is measured immediately after heating using the temperature coefficient of the forward voltage of the internal diode. This procedure is repeated from a time of 5 ms out to several hundred seconds. This series of measurements and measurement of the ambient temperature provides Rθja, the single pulse power curve, and provides the data required to generate the transient thermal impedance curves from junction to ambient.

Two Versions: 0.5 W and 2 W

Each TSOP-6 LITTLE FOOT device is available in two versions with different thermal ratings. The rating is dependent on the lead frame material used. The parts with the “V” suffix are built with a copper leadframe which gives the best thermal performance. The parts with the “X” suffix have an Alloy 42 leadframe. Although the “X” series devices are rated with the same electrical resistance as the “V” series devices, they are specified at a reduced current level to compensate for their increased thermal impedance.*

The first thermal performance parameter that is normally seen is Rθja. This parameter gives a means of comparing the package capability before the PC board starts to have a significant effect. For the TSOP-6, the board is considered to dominate after 5 seconds. Rθja for the TSOP-6 is 62.5°C/W for the “V” parts and 90°C/W for the “X” parts. The “V” parts, which have the copper lead frame compare very favorably with 50°C/W for the single-die SO-8, 62.5°C/W for the dual-die SO-8.

A comparison of the single-pulse power curves (Figure 5) reveals the difference in the thermal mass of the TSOP-6 and the SO-8 die and lead frames and therefore in ability of these two packages to handle surge currents. The single-pulse power curve shows the amount of power it takes for a single pulse of fixed duration to raise the junction temperature from room temperature to 150°C. If extended below 10 ms, the curves would become asymptotic and converge, reflecting the limitations of the die alone. The opposite end of the curve reflects the limitations of the PC board upon which the device is mounted. The difference in thermal mass shows up in between. The reduced thermal mass of the TSOP-6 results in a significant but reduced capability in pulse duration, amounting to less than 5 seconds. It should be noted that the TSOP-6 can dissipate a 30-W pulse of 10-ms duration.

*Samples of “V”-series devices are available now. Samples of “X”-series devices will be available in November 1996. Please contact us then at 1 800-554-5565 (1 408 567-8220 outside the U.S. and Canada) to receive data sheets for these devices.

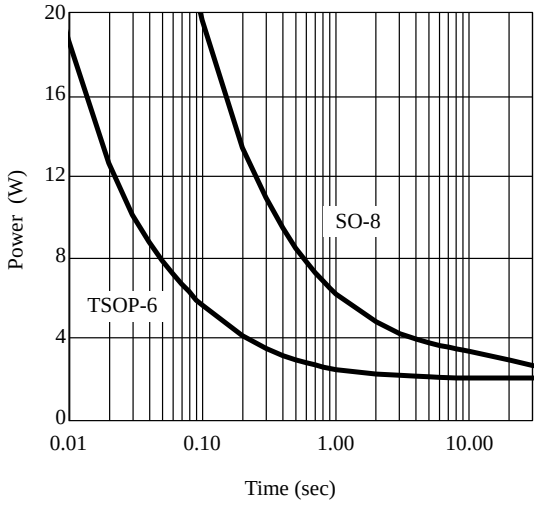


Figure 5. Single Pulse Power

The combination of very low on-resistance power MOSFET technology, and a thermally efficient copper leadframe in the new LITTLE FOOT TSOP-6 package creates a new standard for performance per footprint. For applications requiring very low on-resistance, at less current, the Alloy 42-leadframes offer manufacturing advantages that make them even more economical.