

Make Automatic Optical Inspection Easy Thanks to Packages with Wettable Flanks



David Snook

Designing an automotive application is an extremely complex task that involves several functional areas, which can make the decision-making process difficult when you have conflicting priorities. Package type is one example that has a huge impact on multiple aspects of your design: on the one hand, you have to ensure the device's electrical and thermal performance; on the other hand, you will have concerns about manufacturability, quality control and reliability. When deciding on your power-management integrated circuits (ICs), you may have to choose between leaded small-outline transistor (SOT) packages and unlead quad flat no-lead (QFN) packages. [Figure 1](#) shows an example of each package type.

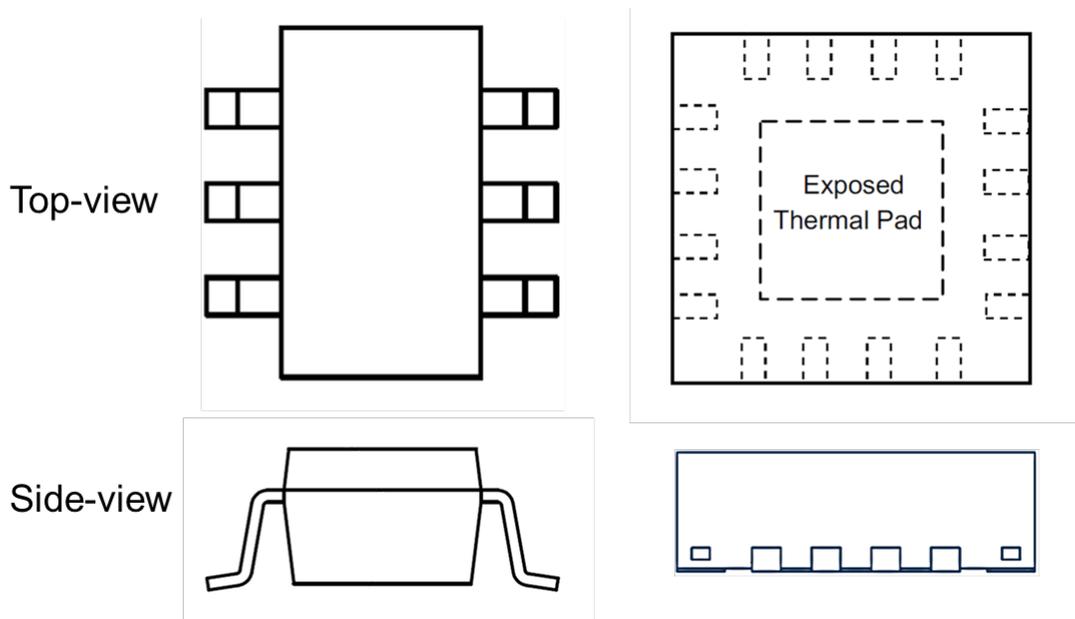


Figure 1. Package Drawings for SOT (Left) and QFN (Right)

SOT packages are simple and easy to use and inspect during manufacturing, thanks to the leads jutting out from the side of the package (more precisely, the mold compound). The additional length of the leads comes at some cost – in electrical performance (increased lead inductance), worsened thermal performance (no exposed thermal pad) and larger solution size.

QFN packages offer smaller size, reduced lead inductance and an exposed thermal pad for improved heat dissipation. Electrical and thermal performance are better than leaded packages, so on this basis alone, QFN would be the best choice.

One challenge for QFN, however, is the inspection of the soldering process during manufacturing. Insufficiently soldered devices result in reduced board-level reliability: if the mechanical link between a device and printed circuit board (PCB) is weak, the link may fail when the PCB is exposed to an abrupt temperature change or subjected to mechanical stress. To avoid this reliability risk and control soldering quality, you need an inspection process in place.

SOT packages are very easy to inspect with an automatic optical inspection (AOI) system because the leads and solder are clearly visible. For QFN packages, setting up an AOI system is trickier, as the leads are located

underneath the package mold compound. To make AOI on QFN packages possible, the solder needs to form side fillets after soldering; otherwise, the AOI system cannot see whether the package is correctly soldered or not. Ensuring that this occurs reliably in a production environment is challenging, which can mean a more expensive X-ray inspection process and increased manufacturing time and costs. [Figure 2](#) shows examples of observed solder wetting with QFN packages: an AOI system would have trouble distinguishing between poor soldering and good soldering in the event of limited side wetting.

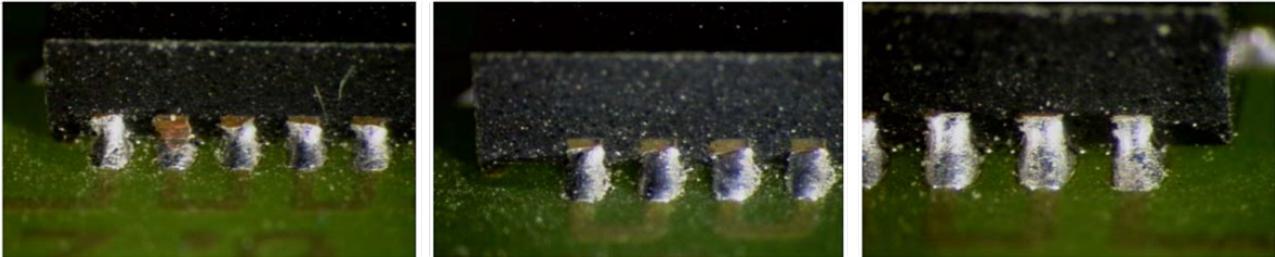


Figure 2. QFN Package Soldering with Limited Side Wetting and Poor Soldering on One Lead (Left); Limited Side Wetting and Good Soldering (Center); Full Side Wetting and Good Soldering (Right)

Adding wettable flanks to help improve side wetting after soldering makes QFN packages easier to inspect with AOI. A wettable flank has a step-cut lead frame and tin (Sn) added on the sidewalls via a replating process. This process allows the side fillet to form more reliably and makes it more visible and easily identifiable with AOI, as shown in [Figure 3](#).

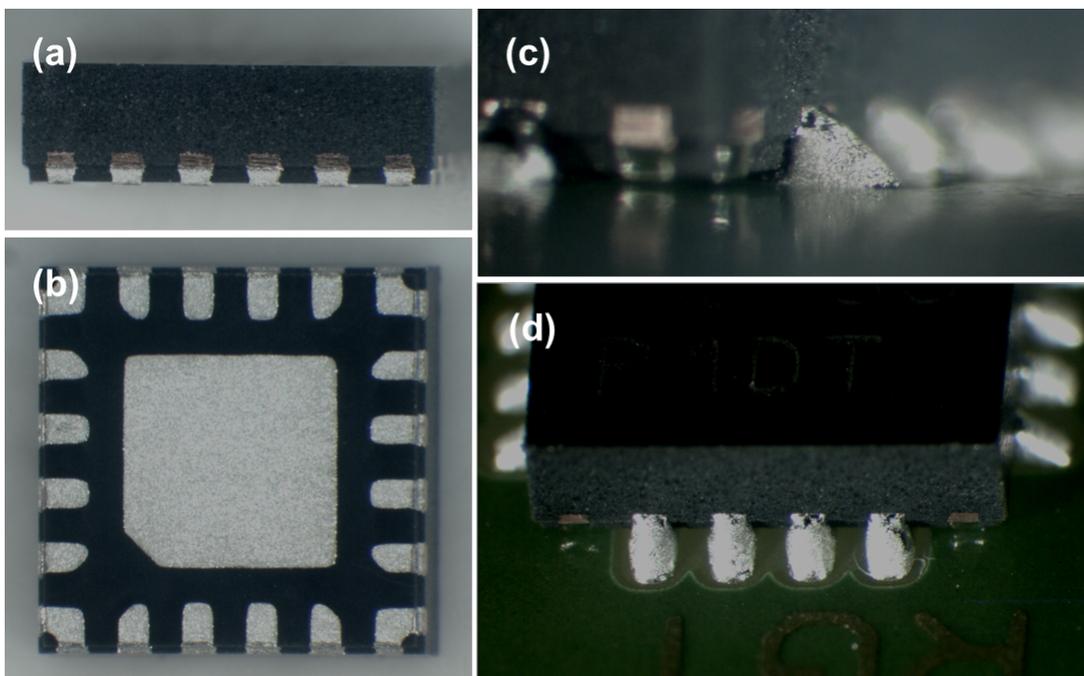


Figure 3. Side (a) and Bottom (b) View of a QFN Package with Wettable Flanks; Side (c) and Top (d) Views of QFN Package Soldering with Wettable Flanks

TI offers a range of Automotive Electronics Council Q100-qualified step-down DC/DC converters in QFN packaging with wettable flanks to help you take advantage of the electrical and thermal benefits that QFN packages offer in your automotive designs. [Figure 4](#) shows how you can find these devices on TI's website by using parametric search and selecting Wettable Flanks Package in the Features tab.

Hide filters Reset 9 matching parts out of 1061 total parts

Part Number	Vin (Min) (V)	Vin (Max) (V)	Vout (Min) (V)	Vout (Max) (V)	Iout (Max) (A)	Type	Regulated Outputs (#)	Switching Frequency (Min) (kHz)	Switching Frequency (Max) (kHz)
<input type="checkbox"/> LM76002 - 3.5V to 60V, 2.5A Synchronous Step-Down Voltage Converter - New	3.5	60	1	57	2.5	Converter	1	300	2200
<input type="checkbox"/> LM76003 - 3.5V to 60V, 3.5A Synchronous Step-Down Voltage Converter - New	3.5	60	1	57	3.5	Converter	1	300	2200
<input type="checkbox"/> TPS62097-Q1 - 2A Automotive Step-Down Converter in 3x3 QFN With Wettable Flanks - New	2.5	6	0.8	6	2	Converter	1		
<input type="checkbox"/> LM73605 - 3.5V to 36V, 5A Synchronous Step-Down Voltage Converter - New	3.5	36	1	34	5	Converter	1	350	2200
<input type="checkbox"/> LM73606 - 3.5V to 36V, 6A Synchronous Step-Down Voltage Converter - New	3.5	36	1	34	6	Converter	1	350	2200
<input type="checkbox"/> LM53635-Q1 - 2.5/3.5A, 36 V Synchronous, 2.1MHz, Automotive Step Down DC-DC Converter	3.5	42	3.2	10	3.5	Converter	1	1850	2350
<input type="checkbox"/> LM53600-Q1 - 3.5V to 36V, 650mA Synchronous 2.1MHz Step-Down Converter for Automotive Applications	3.5	42	3.3	9.9	0.65	Converter	1	1890	2400
<input type="checkbox"/> LM73605-Q1 - Automotive Qualified 3.5V to 36V, 5A Synchronous Step-Down Voltage Converter	3.5	36	1	34	5	Converter	1	350	2200
<input type="checkbox"/> LM73606-Q1 - 3.5V to 36V, 6A Synchronous Step-Down Voltage Converter			1	34	6	Converter	1	350	2200

9 total parts

Figure 4. Filtering Step-down DC/DC Products for Wettable Flanks on TI.com

For example, the [TPS62097-Q1](#) is TI's first 6V step-down converter in a 3mm-by-3mm QFN package with wetttable flanks. Thanks to our wider portfolio, we're making it easier for you to use QFN packages in your design, and you can expect to see more product releases with wetttable flanks for automotive applications in the future.

Additional Resources

- Watch the TI Training video, "[Advanced Auto Packaging](#)," which discusses QFN slotted lead changes.
- Murray Roose explains "[The value of wetttable flank-plated QFN packaging for automotive applications](#)" in this E2E™ Community blog post.
- Check out the application report, "[QFN/SON PCB Attachment](#)."
- Watch a YouTube video about "[Automotive HotRod™ and Wetttable Flanks Packaging Advancements](#)."

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated