AN18.15

PCB Design Guidelines for QFN and DQFN Packages

| Author: | Wayne Little |
| | Microchip Technology Inc. |

INTRODUCTION

This application note provides information on general Printed Circuit Board (PCB) layout considerations for Microchip products using QFN and DQFN packages. It is written for user's who are familiar with PCB design, including signal integrity and thermal management implementation concepts.

The goal of this document is to provide implementation information that is specific to designing PCBs using QFN and DQFN packages. Microchip suggests that all implementations be confirmed with the user's PCB fabricator and PCBA assembler.

Successful implementation of QFN and DQFN packages requires special consideration for PCB layout and solder paste stencil production. This application note describes these important considerations.

PCB LAYOUT GUIDELINES

The guidelines presented are applicable to Microchip QFN and DQFN packaged devices and supersede previous notes.

The following recommendations for optimizing the use of QFN and DQFN packages are suggestions based on Microchip's experience and knowledge and may be accepted or rejected. Microchip does not guarantee any design. The user is ultimately responsible for determining the suitability of their own design.

QFN style packages (see Figure 1) are physically robust, thermally efficient, and occupy much less PCB space than equivalent QFP packages. They generally have superior lead inductance characteristics. They also present some particular design constraints.
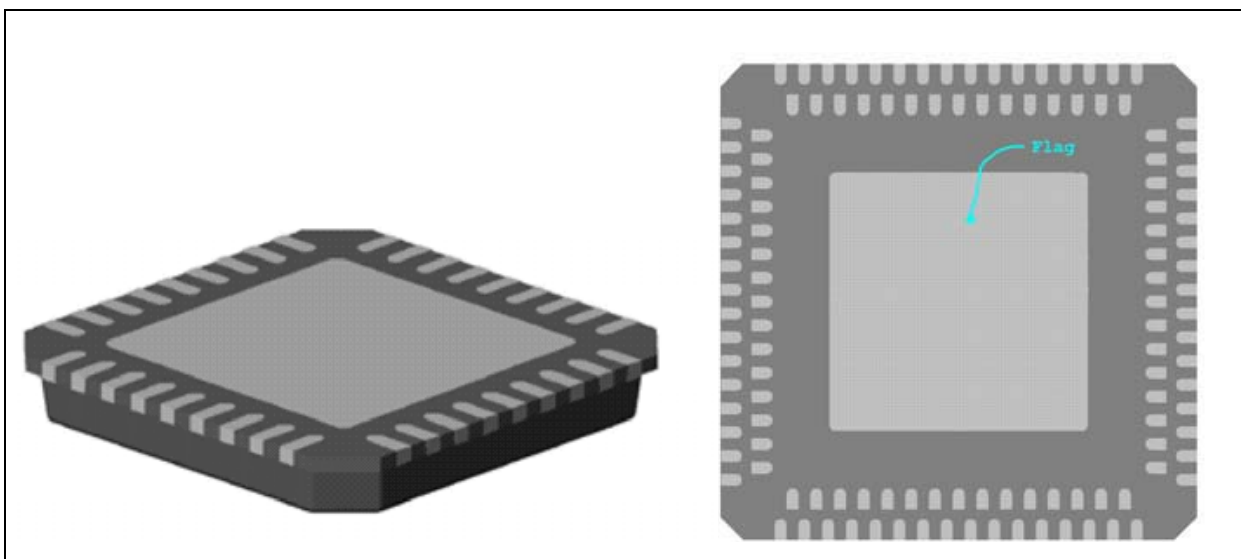

FIGURE 1:   *QFN and DQFN Packages.*

As shown in Figure 1, QFN packages generally have a row (QFN) or two (DQFN) of perimeter pads around a larger central pad ("flag" or "Epad") encapsulated in a plastic body. These packages are surface-mounted to the target system PCB by a solder reflow process. This is standard for all Microchip QFN and DQFN packages.

The perimeter pads are typically used for signal assignment, while the flag use is two-fold; as the primary thermal conduction path to remove package heat, and for device ground.

Many of the Microchip QFN devices use this flag as the primary – or ONLY – connection to ground (V_{SS}), as well as a thermal conduction path.

During soldering the QFN device will float too high if too much solder paste is deposited under the device. This may not allow the perimeter pads to reach the PCB, causing "opens". Also, the QFN will sink too low if too little solder paste is under the flag. This can cause the pads to "squeeze-out" solder, causing "shorts" between adjacent pads.

To address these issues, constraints are imposed for the use of these packages.

Flag Vias

Use as many vias as can practically fit within the flag. For example, this number should be at least eight vias for 36-pin devices and at least 16 vias for 6x6 mm flags. For best results, use vias with a finished hole size (FHS) of 0.28 mm to 0.5 mm.

THERMAL PERFORMANCE

The more vias placed within the flag, the better thermal conduction to the internal ground planes, if any, and to thermal radiation and conduction floods or features on the opposite side of the PCB.

SIGNAL LOOP AREA

The more vias placed within the flag and near its edges, the shorter the loop area to the internal device circuitry. This will reduce the signal return lengths.
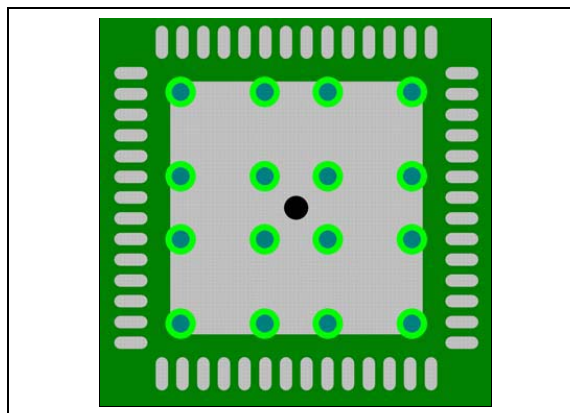

FIGURE 2: *Example Via Placement for a QFN Flag.*

Solder Stencil Considerations

Use a solder paste stencil pattern for the flag composed of several small solder paste openings in the stencil (paste) data for the flag rather than a single, large opening. These four to nine openings should cover 70%-80% of the flag dimension area. This will better meter paste deposition and improve the solderability of the flag.

Consider the size, quantity, position, and type (tented, plugged, open, etc.) of vias used within the flag to determine their effect on the amount of solder paste that may be wicked away from the pad by the vias during soldering. Make appropriate adjustments to the stencil openings and via positions.
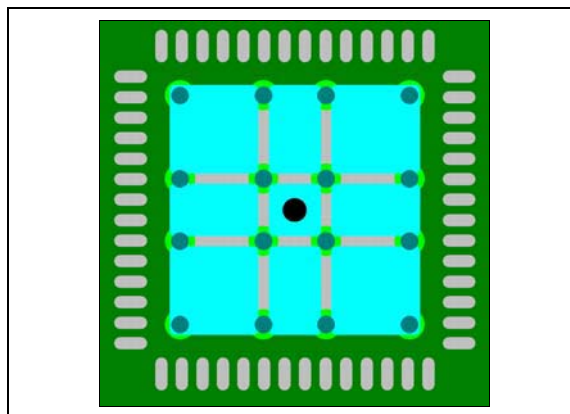

FIGURE 3: *Example of Solder Paste Stencil Pattern.*

Routing Hazards

QFN PACKAGES

Avoid routing between the flag and the pads of a QFN device, as shown in Figure 4 below.
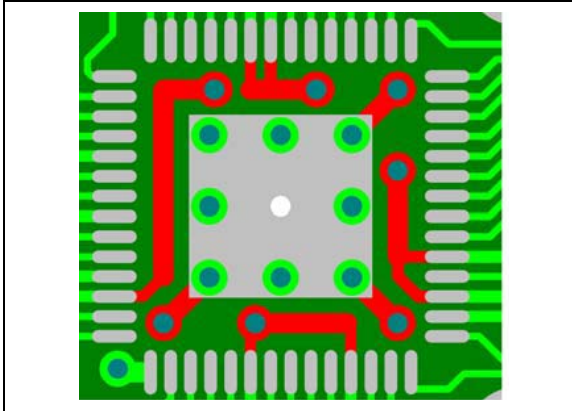

FIGURE 4: *Incorrect Routing Underneath QFN Package.*

Routing and vias between the flag and the pads can easily be shorted to either the flag or to the pads because of the physical dynamics of the solder under the device. Shorts can occur to traces and, especially to vias, even if they are covered by solder mask. This is because the trace edges (crowns), via pad edges, and especially via hole edges can be exposed, particularly after thermal cycling during soldering processes.

Via tenting (capping) and via plugging can reduce the occurrences of these effects, but it is less expensive and more beneficial to avoid putting traces or vias under the device in the first place.

DQFN PACKAGES

Take special care when routing between the flag and the pads of a DQFN device.

FIGURE 5: *Example Routing of Traces and Vias for DQFN Package.*

It is usually desirable to breakout the inner pads of a DQFN to the inside and drop vias to escape the part. Per the discussion above, this can cause shorts under the device, but the DQFN devices have a larger gap between the pads and the flag, making this problem less likely.

Via tenting (capping) and via plugging can reduce the likelihood of shorts.

Place any vias in the region between the flag and the pads carefully to allow proper ground (V_{SS}) connection paths to the flag vias. These ground (V_{SS}) paths must support the device needs and signal return path needs.

Make sure to carefully control the solder paste stencil as well.

AN18.15

NOTES:

QUALITY MANAGEMENT SYSTEM

CERTIFIED BY DNV

═ ISO/TS 16949 ═

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/
support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2943-5100
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Hangzhou
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880- 3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Pforzheim
Tel: 49-7231-424750

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

03/25/14