Transition to Saw QFN

White Paper

Revision 3

CYPRESS SEMICONDUCTOR

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INTRODUCTION

The QFN (Quad Flat pack No lead) package is a near Chip Scale Package (CSP) related to the plastic Quad Flat package. As the name states, the QFN is lead-less, which means the leadframe does not extend beyond the package body. Because of its exposed die attach paddle, which serves as an effective thermal pad, the QFN package is considered a thermally enhanced package. The QFN is referred to by various names in the industry, including MLF (Micro Lead-Frame package), LPCC (Leadless Plastic Chip Carrier), and VQFN (Very thin profile Quad Flat pack No lead). Cypress has adopted the QFN exposed pad package design rules defined in JEDEC specification MO-220.

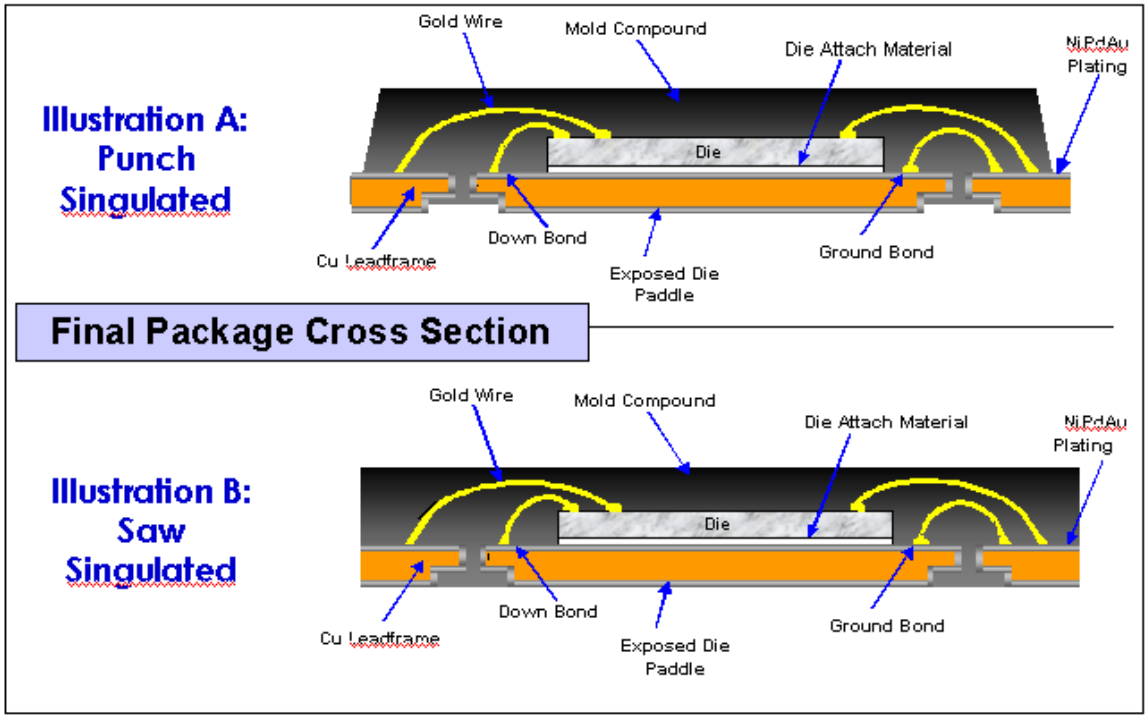
Currently, the QFN package is singulated using either a punch or saw technique. This document compares the two singulation techniques. Cypress introduced the punched QFN package in 2003. Consistent with industry trends, Cypress is now transitioning from the punched to the sawn QFN package.

QFN PACKAGE DESIGN

Cross Section

A typical QFN cross section, shown in Figure 1, illustrates a leadframe based, plastic encapsulated chip scale package in single mold cavity format (punch) and molded array format (saw) with wire bonding technology. The die is attached, with epoxy, to the die pad and the opposing side of the pad is exposed on the base of the package.

Figure 1. Punch and Saw QFN Package Cross Section



Source: Amkor Technology

Package Dimensions

Package design has taken into account the requirement for external dimensions to be identical for both Punch and Saw packages of the same pin count and thickness, to enable easy customer migration from Punch to Saw.

Table 1. QFN Package Dimensions

PIN COUNT	TYPE	Package Length	Package Width	Package Thickness	Lead Pitch	Lead Length	Lead Width	Exposed pad Size
24 Thin	PUNCH	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SAW	4.00 ± 0.10mm	4.00 ± 0.10mm	0.55 ± 0.05 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	2.65X2.65
32 Thick	PUNCH	5.00 ± 0.10mm	5.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.5X3.5
	SAW	5.00 ± 0.10mm	5.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.5X3.5
32 Thin	PUNCH	5.00 ± 0.10mm	5.00 ± 0.10mm	0.55 ± 0.05 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	1.3x2.7[Note1]
	SAW	5.00 ± 0.10mm	5.00 ± 0.10mm	0.55 ± 0.05 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.5x3.5[Note1]
40	PUNCH	6.00 ± 0.10mm	6.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.0x3.1
		6.00 ± 0.10mm	6.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.5x3.5
		6.00 ± 0.10mm	6.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	4.09x4.09
	SAW	6.00 ± 0.10mm	6.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.0x3.1
		6.00 ± 0.10mm	6.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.5X3.5
		6.00 ± 0.10mm	6.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	4.09x4.09
48	PUNCH	7.00 ± 0.10mm	7.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	5.1x5.1
		7.00 ± 0.10mm	7.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.85x4.6
		7.00 ± 0.10mm	7.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	4.5x4.5
	SAW	7.00 ± 0.10mm	7.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	5.1x5.1
		7.00 ± 0.10mm	7.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	3.85x4.6
		7.00 ± 0.10mm	7.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	4.5x4.5

PIN COUNT	TYPE	Package Length	Package Width	Package Thickness	Lead Pitch	Lead Length	Lead Width	Exposed pad Size
56	PUNCH	8.00 ± 0.10mm	8.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	4.5x5.2
		8.00 ± 0.10mm	8.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	6.1X6.1
	SAW	8.00 ± 0.10mm	8.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	4.5x5.2
		8.00 ± 0.10mm	8.00 ± 0.10mm	0.90 ± 0.10 mm	0.50 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	6.1X6.1
68	PUNCH	8.00 ± 0.10mm	8.00 ± 0.10mm	0.90 ± 0.10 mm	0.40 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	5.7X5.7
		8.00 ± 0.10mm	8.00 ± 0.10mm	0.90 ± 0.10 mm	0.40 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	6.28x6.28
	SAW	8.00 ± 0.10mm	8.00 ± 0.10mm	0.90 ± 0.10 mm	0.40 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	5.7X5.7
		8.00 ± 0.10mm	8.00 ± 0.10mm	0.90 ± 0.10 mm	0.40 mm	0.40 ± 0.10 mm	0.23 ± 0.05 mm	6.28x6.28

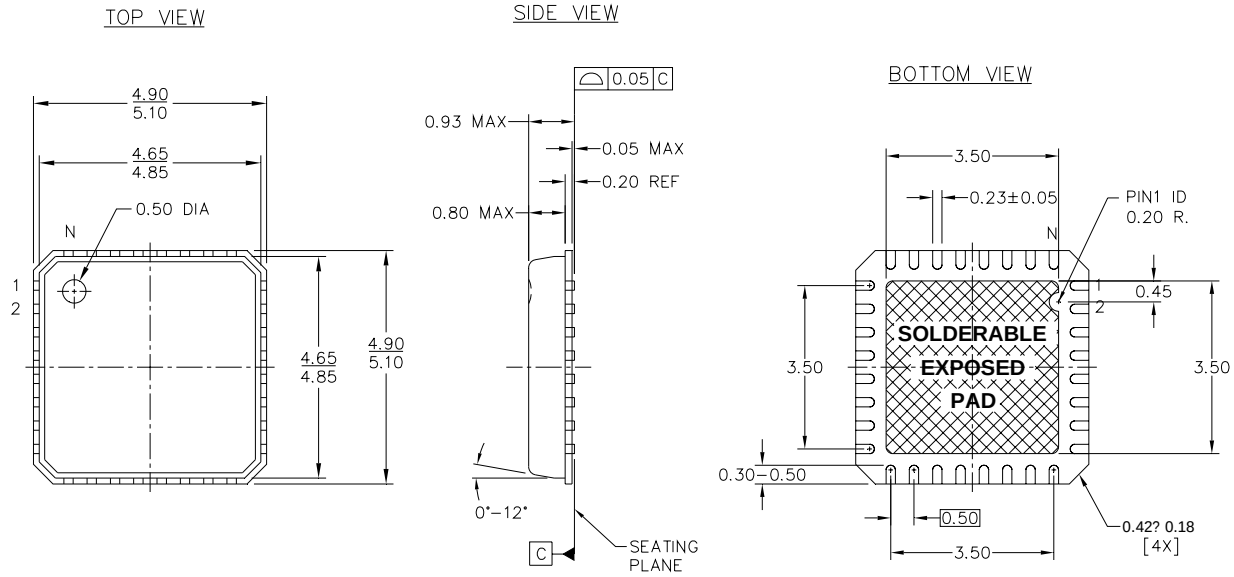
Note 1: No current plan to migrate to saw QFN with small EPAD size.

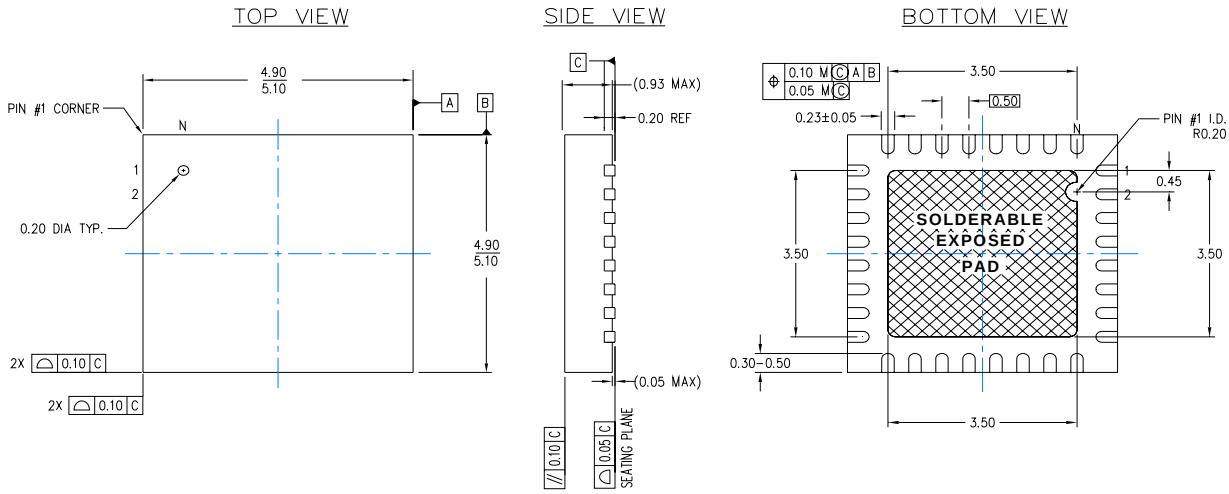
Package Outline

Examples of QFN Saw and Punch package outline drawings (POD) are documented in Figure 2.

The PC board foot-prints for both packages are identical. The upper body outlines differ, with the Punch QFN displaying a trapezoidal outline and the Saw QFN displaying a parallelepiped outline.

Figure 2. 32 QFN SAW & PUNCH POD



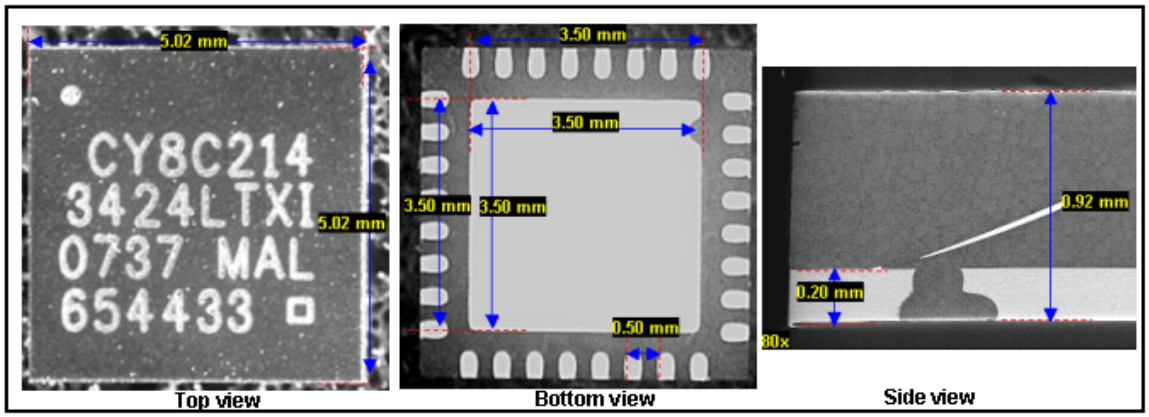


SAW QFN CONSTRUCTION ANALYSIS

Cypress's internal qualification process requires completion of a package construction analysis.

The following figures provide a sample of the dimensional analysis collected on qualification lots for the Saw 32 QFN 5x5x0.9mm package.

Figure 3. Saw 32QFN Package Dimensions



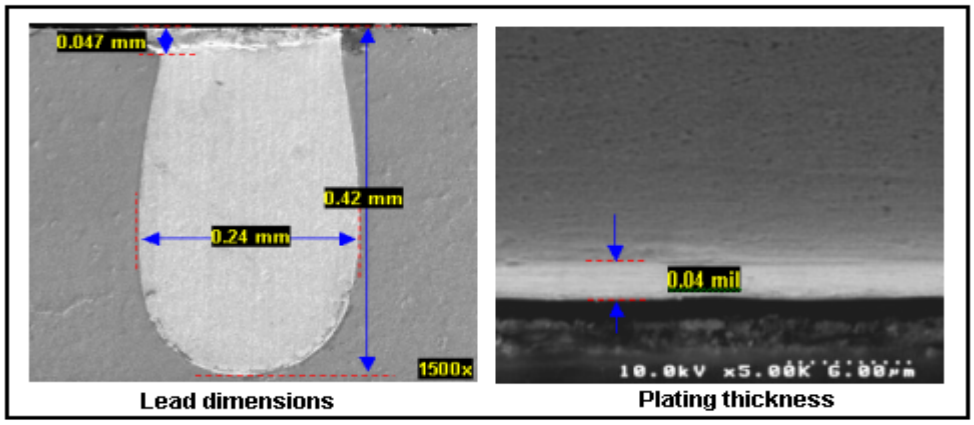
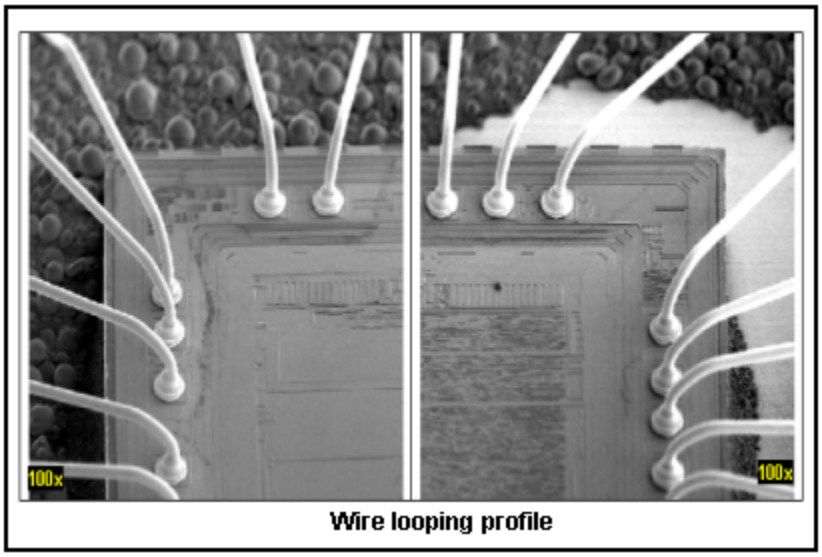
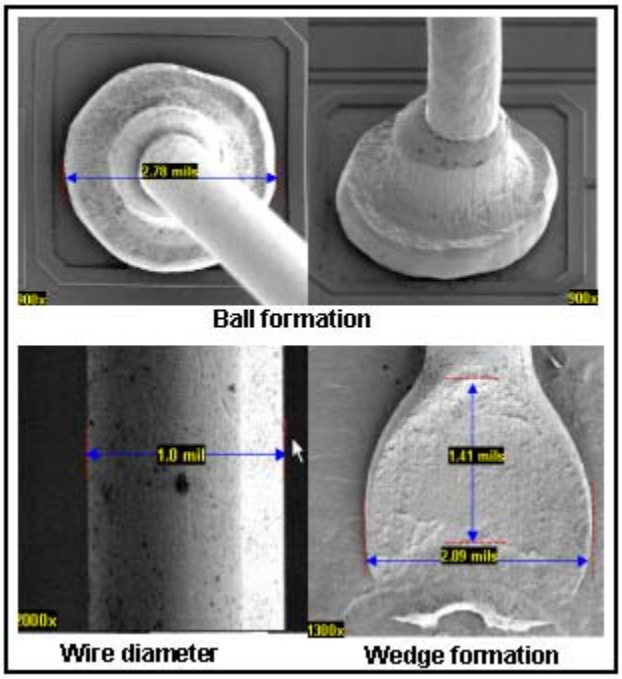
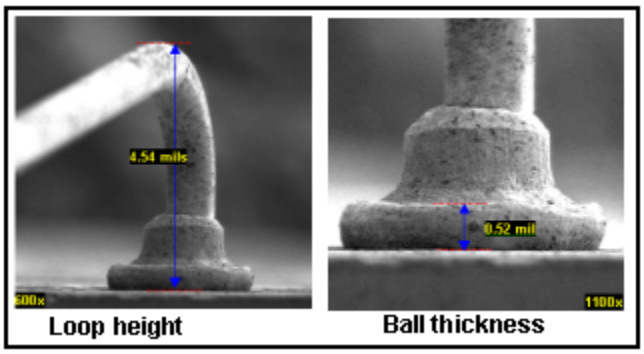


Figure 4. Saw 32QFN Wire Bond Control



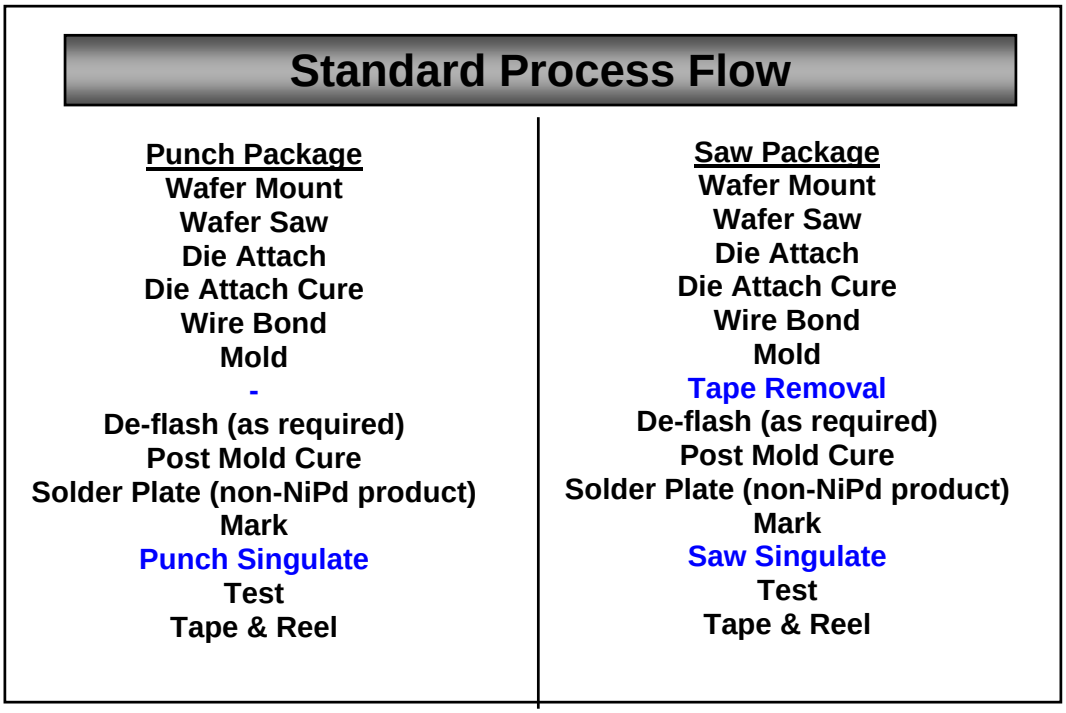




PROCESS FLOW

Besides the singulation step, the only other difference between the Saw QFN process flow and the Punch QFN process flow is the “Tape Removal” step. With saw QFN technology, lead-frame strips include a protective tape, which prevents molding compound bleeding onto the lead and e-pad surfaces. This tape must be removed after mold.

Figure 5. Standard QFN Process Flow



QUALIFICATION PROCESS

The QFN package qualification is similar to any other package qualification process. Qualification includes a thorough process review, package construction analysis, manufacturability testing and reliability testing.

The estimated cycle time for completion of the qualification process is eight weeks. The table below defines the series of qualification tests required per Cypress’s qualification specification, 25-00112.

Process and site audits are conducted prior to qualification launch. Follow-up audits are performed quarterly for the first year following qualification, and annually thereafter.

Table 2. QFN Package Qualification Tests

Test #	Stress or Data	Sample Size per Test Vehicle (TV)	New Package Technology		
			TV1	TV2	TV3
1	Physical Dimensions	30	X	X	X
3	Solderability	3	X	X	X
4	Internal Visual	5	X	X	X
12	Temperature Cycle	77	X	X	X
13	Thermal Shock	77	X		
22E	EFR	77	X	X	
22L	LFR	77	X	X	
23	HAST	77	X	X	
24	PCT	77	X	X	X
26	X-ray	15	X	X	X
29	Die Shear	30	X		
30	Ball Shear	10	X		
32	Final Visual Inspection	15	X		
43	Pre/Post Acoustics	15	X	X	X
46	High Temp. Storage	77	X		
78	Assembly Bond Pull	10	X		
109	Glue Adhesion	1	X	X	X
123p	Dye Penetration Test	15	X	X	X
124	Construction Analysis	1	X		

INDUSTRY BENCHMARK ON PUNCH VERSUS SAW SINGULATION

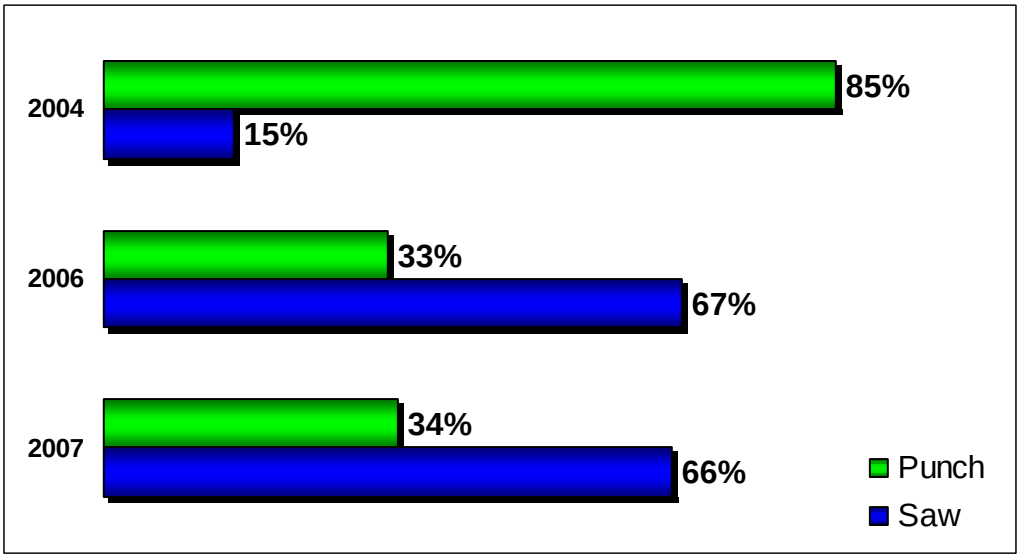
In 2004, when Cypress introduced QFN, 85% of the QFN assembly volume in the industry used the punch singulation technique.

However, in recent years, the industry has moved away from punch singulation to saw singulation.

In 2006, 67% of all QFN volume was produced using saw singulation, only 33% using punch.

Data collected 2007 to date exhibits a similar trend.

Figure 5. Volume Percentage comparison of Saw & Punch Singulation technique for 2004-2007



The accelerated adoption of saw singulation is the result of its improved manufacturability and reliability when processing smaller packages.

CUSTOMER BOARD ASSEMBLY

Package outline dimensions and footprint are the same for these two types of QFN packages. Due to the slight difference in body shape, minor adjustments at the board assembly insertion process and auto inspection step may be required.
