Pb-Free, RoHS Compliance at Cypress

White Paper

Revision 2

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Introduction

This paper addresses the compliance status of Cypress Semiconductor to the global directives on Restriction of the use of certain Hazardous Substances (RoHS) requirements.

The European Union (EU) initiated the RoHS directive, 2002/95/EC, in 2003 for implementation by July 1, 2006, hereafter referred to as EU RoHS. EU RoHS limited the amounts of six hazardous substances in electrical and electronic equipment. The China government promulgated the RoHS directive on February 28, 2006 for implementation on March 1, 2007, hereafter referred to as China RoHS. Similarly China RoHS restricted the same use EU RoHS substances at the same maximum concentration limits. Besides EU RoHS and China RoHS, California has issued the California legislation banning the four metals in the EU/China RoHS.

Cypress Semiconductor products comply with the above RoHS directives. As other global RoHS like directives evolve, Cypress will update its operating procedures where applicable.

Cypress Compliance Summary

Cypress is committed to provide environmentally safe products and meets the requirements of the above RoHS directives. Even before the release of the EU RoHS directive in 2003, Cypress has proactively begun converting to RoHS compliant products using NiPdAu plated lead-frames since 2002.

Cypress Pb-Free/RoHS policy is: "**Cypress Semiconductor Standard Products are Pb-Free**". Consequently, Non Pb-Free products will be handled as non-standard, and will be phased out after Product Change Notifications (PCN's) are issued for the applicable products. Working continually in concert with our customers and suppliers, more than 90% of the unit shipments in Q207 to date are RoHS compliant products. The remaining less than 10% of non-compliant products shipped were per customer orders and were not due to Cypress supply limitations.

Cypress has chosen the most widely accepted industry RoHS solutions. For lead-frame products, the primary finish plating is Nickel-Palladium-Gold (NiPdAu) in line with iNEMI's (International Electronics Manufacturing Initiatives) recommendation, reference "iNEMI Recommendations for Lead-Free Finishes", dated 12-1-2006. NiPdAu lead-frame products are packaged in Cypress internal manufacturing in Cypress Philippines and by Cypress subcontractor suppliers. Where NiPdAu is not available at the subcontractors, matte tin is employed. To mitigate tin whisker growth, matte tin finish is annealed for 1 hour at 150º C and the minimum plating thickness is increased to 400 micro-inches or 10 microns. Both NiPdAu and matte tin finishes are forward and backward compatible. For BGA, the Pb-Free/RoHS solution is SnAgCu (SAC) solder composition. However, SAC solder is not backward compatible. To address the requirement for soldering Pb-Free BGA at a lower temperature, Cypress Semiconductor has co-worked with the customers and EMS contract manufacturers to develop a lower temperature soldering profile solution. This method was aligned with the iNEMI recommendation for soldering Pb-Free BGA with SnPb paste at a lower temperature than Pb-Free paste.

Cypress Semiconductor Pb-Free Policy

"Cypress standard products are Pb-Free." Products containing Pb are considered as defects and will be phased out in concert with customers and handled via the Product Change Notification process.

Pb-Free, RoHS Defined

The EU and China RoHS directives restrict the use of the following six substances to the respective maximum concentration values (MCV):

Cadmium (Cd)	100 PPM
Hexavalent Chromium (Cr^{+6})	1000 PPM
Lead (Pb)	1000 PPM
Mercury (Hg)	1000 PPM
Polybrominated biphenyls (PBB)	1000 PPM
Polybrominated biphenyl ethers (PBDE)	1000 PPM

RoHS 6 or RoHS compliant products are defined as products containing less than the applicable MCV for the six substances in the homogenous materials or packing materials. Board assembly reflow temperature conditions are not defined.

RoHS 5 or RoHS non-compliant products are defined as products containing Pb but do not contain the other five substances in the homogenous materials. Board assembly follows the SnPb eutectic solder paste profile.

Pb-Free products are RoHS 6 compliant and can withstand the Pb-Free board assembly temperature requirements based on JEDEC standard, J-STD-020C. Both conditions must be satisfied to be considered Pb-Free.

Non Pb-Free products are either not RoHS 6 compliant and/or cannot withstand the above Pb-Free board assembly temperature conditions. Therefore, this may be a RoHS 5 or 6 product that will not withstand the Pb-Free reflow conditions.

Green compliant products are Pb-Free and RoHS 6 compliant and in addition, do not contain halides, antimony and other EIA/EICTA/JEITA Joint Industry Guide (JIG) controlled substances beyond the threshold limits.

Compliance Solutions – Lead-Frame Products

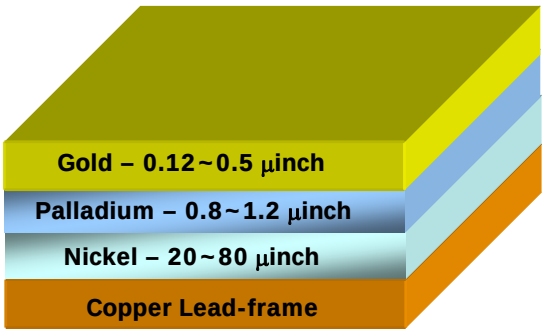
Cypress has selected the most widely accepted industry Pb-Free, RoHS solutions for both lead-frame and BGA products.

Plating Finish

(A) NiPdAu

NiPdAu lead finish (see figure 1) is the primary solution for Pb-Free, RoHS 6 products and the predominant Pb-Free lead-frame volume at Cypress. NiPdAu is the most preferred finish recommended by iNEMI in the paper on "iNEMI Recommendations on Lead-Free Finish", version 4, published on 12-01-06. There is no tin whisker failure to be concerned about with this finish. In addition, NiPdAu is both forward compatible with Pb-Free solder paste and backward compatible with SnPb paste. NiPdAu is a proven technology, used by leading semiconductor manufacturers for over 12 years. Cypress products with NiPdAu finish are supplied mostly by Cypress internal manufacturing while some products are supplied by subcontractors.

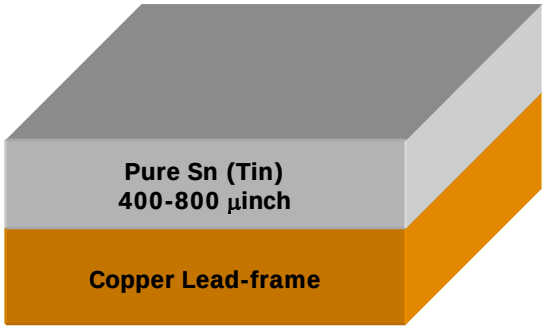
Figure 1 – NiPdAu Finish



(B) Matte Tin Finish

Matte tin finish (see figure 2) is the second choice at Cypress where NiPdAu finish is not available. Matte tin is also the second preference in the iNEMI recommended list of Pb-Free finishes. Although matte tin is the second order of choice, it is the predominant volume in the industry. At Cypress, this finish is available only at the subcontractors supplying to Cypress and is not available in Cypress internal factory. Matte tin finish is both backward compatible and forward compatible.

Figure 2 – Matte Tin Finish



Backward and Forward Compatibility

NiPdAu and matte tin finishes are both backward compatible with SnPb eutectic solder paste and forward compatible with Pb-Free (SnAgCu) solder paste. Cypress Pb-Free qualifications passed solderability tests at 215º C with eutectic solder and 240 ºC with Pb-Free solder. For lead-frame products, the solder paste system rules as the amount of solder on the plated terminals are minute relative to the paste amount. Cypress recommends using solder reflow profile with minimum solder joint temperature of 205º-220º C for eutectic solder paste and minimum solder joint temperature of 235-245º C for Pb-Free solder paste (see Table 1). It is recommended that the solder paste manufacturer be contacted for exact solder profile requirements and the process validated by the user. In addition, the maximum package peak temperature (PPT) range of 245-260º C for Pb-Free products or 225-240C for the Non Pb-Free products must not be exceeded for the applicable package dimensions, reference Appendix A on JEDEC Moisture/Reflow Sensitivity standard, J-STD-020C.

Table 1 – Reflow profile for Pb-Free Lead-Frame Products

Solder Paste	SnPb Paste	SnAgCu Paste
Liquidus (^{0} C)	179-183	217-225
Minimum Solder Joint Temperature (^{0} C)	205-220	235-245
Maximum Peak Package Temperature (^{0} C)	245-260	245-260

Tin Whiskers

Tin whisker is a reliability concern for matte tin finish products. To mitigate the growth of tin whisker, Cypress has implemented two important requirements for all products that are matte tin plated. First, an annealing step is required after the tin plate process. This 150º C, 1-hour bake, reduces the inter-metallic stresses created in the plating process. The reduction in stress has the effect of reducing the potential for whisker growth. Second, the thickness of the matte tin plating is controlled to a minimum of 400 micro-inches (10 microns). The thick plating also reduces the potential for whisker growth. Cypress and the subcontractors tested the products to JEDEC standards (JESD22-A121 and JESD201). The tests performed are as follows:

Ambient storage	30^{o}C / 60% RH, 4000 Hours
Humidity storage	60^{o}C / 87% RH, 4000 Hours
Temperature cycle	- 55^o / 85^o C, 1500 Cycles

For more details, please refer to the white paper on tin whiskers (please see your sales support for a copy).

Compliance Solutions - BGA Products

Pb-Free BGA products use SnAgCu solder spheres. Pb-Free BGA's are forward compatible with Pb-Free (SnAgCu) solder paste but not backward compatible with SnPb paste. As the amount of solder in the paste is small relative to the amount in the solder balls, the Pb-Free solder balls rule the reflow system in this case unlike the Pb-Free lead-frame products. Therefore the minimum solder joint reflow profile recommended for Pb-Free BGA with Pb-Free solder paste is 235-245 º C (see Table 2). It is recommended that the solder paste manufacturer be contacted for the exact solder profile requirements and the process validated by the user. In addition, the maximum package peak temperature (PPT) range of 245-260º C for Pb-Free products or 225-240º C for the Non Pb-Free products must not be exceeded for the applicable package dimensions, reference Appendix A on JEDEC Moisture/Reflow Sensitivity standard, J-STD-020C.

In situations where the users need to reflow Pb-Free components using eutectic paste or have a mixture of Pb-Free components and Pb containing components for board assembly, a lower reflow temperature may be applied using eutectic paste. This has been addressed by iNEMI and also several papers have been presented by the user group in the IPC. The recommended minimum solder joint profile for such board assembly using eutectic solder paste is a reflow profile ranging from 225-230º C depending on several factors such as pitch and size of solder balls, paste volume, component dimensions, etc… Please refer to the iNEMI study and IPC presentations on this topic for details. However, the reliability project of this optimized lower reflow temperature has not been completed by iNEMI. Note that the maximum package temperature per JEDEC standard, J-STD-020C, must not be exceeded per the applicable package due to moisture sensitivity.

Table 2 – Reflow Profile for Pb-Free BGA Products

Solder Paste	SnPb Paste	SnAgCu Paste
Liquidus (^{0}C)	179-183	217-225
Minimum Solder Joint Temperature (^{0}C)	225-230	235-245
Maximum Peak Package Temperature (^{0}C)	245-260	245-260

Compliance Quality Systems

Cypress products are monitored to ensure that the banned substances are not above the allowable rates. Cypress monitors homogenous materials, packing materials and packaged devices. Testing is performed by suppliers and third party laboratories certified by Cypress. Cypress manufacturing facilities and qualified subcontractors have established Environmental Management Systems that are ISO 14001, ISO 9001 and TS 16949 certified. Lastly, Cypress is a Sony "Green Partner" since 2003, after passing an extended audit for environmental management systems.

Cypress provides material content disclosure reports and compliance certifications for our products in Cypress standard formats. In addition, Cypress supports iNEMI / IPC-1752 certification and content declaration format if this is the format required by the customers.

Product Availability

Cypress Pb-Free, RoHS policy is: “Cypress Semiconductor Standard products are Pb-Free”.

Consequently, Non Pb-Free products will be handled as non-standard, and will be phased out. Cypress will continue to work with the customers and continue to support the requirements where business conditions justify. Final decisions to terminate will be determined based on business opportunities for each Marketing Part Number. PCN’s will be advised for End of Life (EOL) and last time buy order as the EOL is determined for the applicable products.

Product Identification and Labeling

Cypress differentiates Pb-Free, RoHS compliant products from non-compliant products via distinct marketing part numbers. Pb-Free, RoHS 6 compliant products are identified with a suffix letter “X” in the marketing part numbers. In addition, each component is marked with the marketing part number. Non Pb-Free or RoHS 5 products do not have the letter “X” in the marketing part numbers. A sample is as follows:

Pb-Free, RoHS 6 Marketing Part	= CY7C199C-15VXC
Non Pb-Free, RoHS 5 Marketing Part	= CY7C199C-15VC

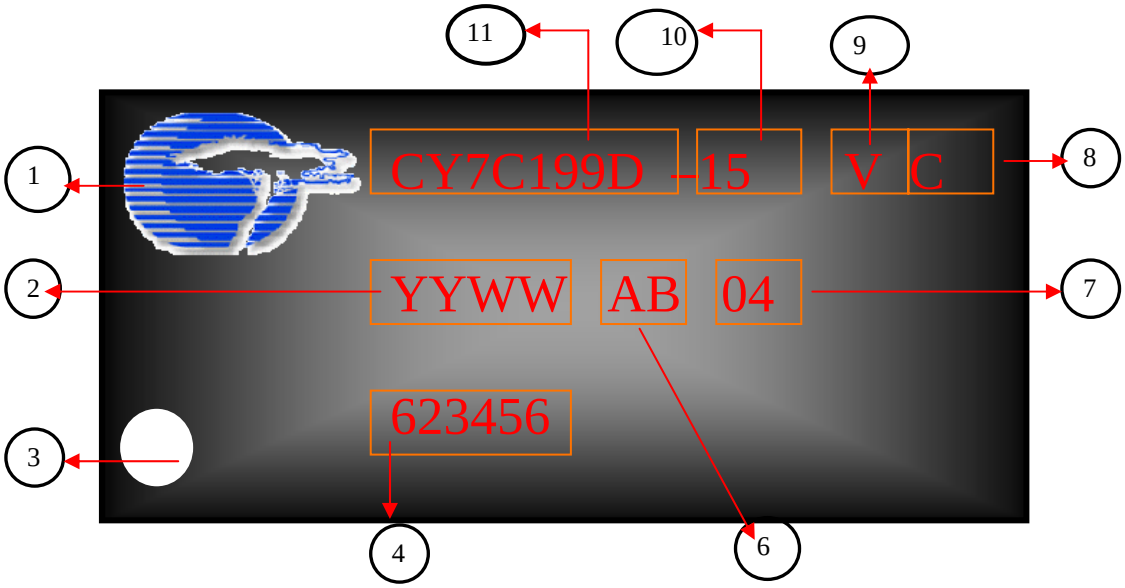
Additional examples are in Appendix B. Two examples of the final marking on the package, Non Pb-Free or RoHS 5 and Pb-Free or RoHS 6 products, are provided in the next page.

PRODUCT LABEL FORMAT EXAMPLES

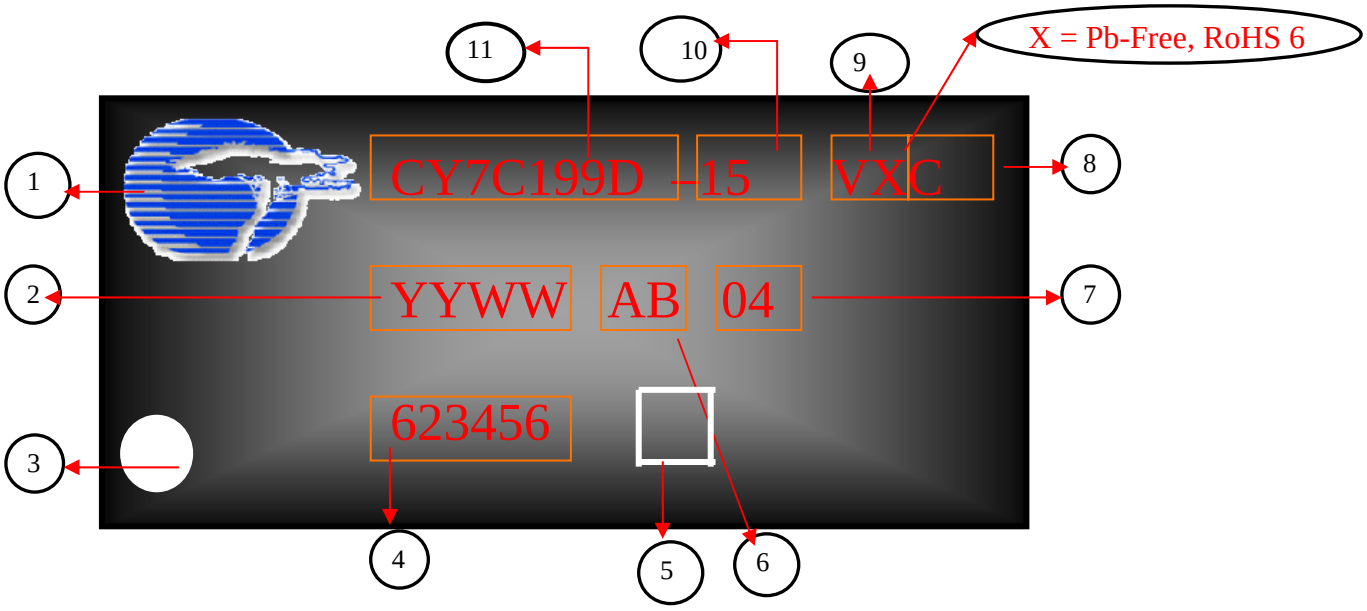
Legend:

1 – Cypress logo
2 – Date code
3 – Pin1 identification
4 – Lot number
5 – Zero Pb termination designator
6 – Die Revision
7 – Fab Location
8 – Grade
9 – Package Code
10- Speed
11- Marketing Part Number

Non Pb-Free, RoHS 5 Product Mark



Pb-Free, RoHS 6 Product Mark



LABELS ON PACKAGING MATERIALS

The packaging materials are currently labeled with the Pb-Free logo. The China RoHS logos for Pb-Free and Non Pb-Free products are added, starting work week 32 in 2007. Figure 1 shows the Pb-Free label for EU and China RoHS. Figure 2 shows the label for products containing Lead (Pb). The number "50" in the Non Pb-Free logo signifies the number of years of Environmental Friendly Use Period (EFUP). During the transition period, there may be some packaging labels still reflecting only the Pb-Free logo.

Figure 1 - Pb-Free Label on Protective Bag/Reel/Tray

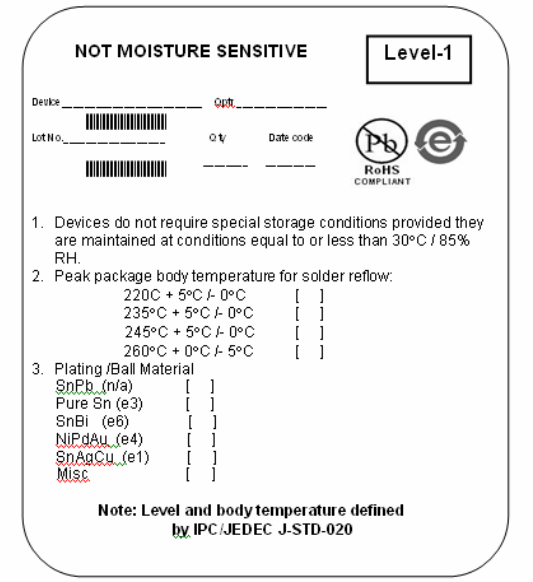
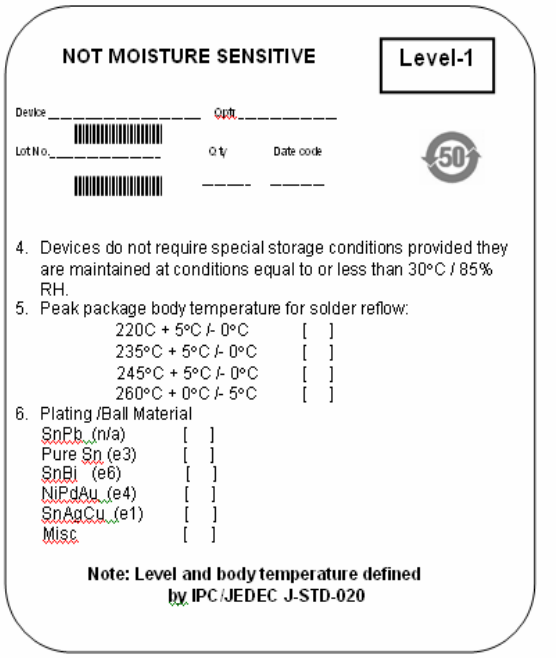


Figure 2 - Non Pb-Free Label on Protective Bag/Reel/Tray



Chinese certificate of material declaration is provided for every shipment to China, starting work week 32 in 2007

有毒有害物质名称及含量的标识格式

CHINA RoHS – Table of Hazardous Substances and Concentration

部件名称 Part Number	有毒有害物质或元素 Hazardous Substances' Name					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{6+})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
……	……	……	……	……	……	……

o：表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/Txxxx-xxxx标准规定的限量要求以下。
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/Txxxx-xxxx标准规定的限量要求。
（企业可在此处，根据实际情况对上表中打"×"的技术原因进行进一步说明。）

o : indicate hazardous substance concentration lower than MCV
×: indicate hazardous substance concentration higher than MCV
(company can explain technical reason to mark "×")

APPENDIX A – JEDEC STANDARD, J-STD-020C

Table 4-1 SnPb Eutectic Process – Package Peak Reflow Temperatures

Package Thickness	Volume mm^3 <350	Volume mm^3 ≥ 350
<2.5 mm	240 +0/-5 °C	225 +0/-5°C
≥ 2.5 mm	225 +0/-5°C	225 +0/-5°C

Table 4-2 Pb-free Process – Package Classification Reflow Temperatures

Package Thickness	Volume mm^3 <350	Volume mm^3 350 - 2000	Volume mm^3 >2000
<1.6 mm	260 +0 °C *	260 +0 °C *	260 +0 °C *
1.6 mm - 2.5 mm	260 +0 °C *	250 +0 °C *	245 +0 °C *
≥2.5 mm	250 +0 °C *	245 +0 °C *	245 +0 °C *

Table 5-2 Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average Ramp-Up Rate (Ts_{max} to Tp)	3 °C/second max.	3° C/second max.
Preheat – Temperature Min (Ts_{min}) – Temperature Max (Ts_{max}) – Time (ts_{min} to ts_{max})	 100 °C 150 °C 60-120 seconds	 150 °C 200 °C 60-180 seconds
Time maintained above: – Temperature (T_L) – Time (t_L)	 183 °C 60-150 seconds	 217 °C 60-150 seconds
Peak/Classification Temperature (Tp)	See Table 4.1	See Table 4.2
Time within 5 °C of actual Peak Temperature (tp)	10-30 seconds	20-40 seconds
Ramp-Down Rate	6 °C/second max.	6 °C/second max.
Time 25 °C to Peak Temperature	6 minutes max.	8 minutes max.

Note 1: All temperatures refer to topside of the package, measured on the package body surface.

APPENDIX B – MARKETING PART NUMBERS

	Non-Standard, Non Pb-Free Marketing Part Number	Standard, Pb-Free Marketing Part Number
SRAM	CY7C199C-15VC	CY7C199C-15VXC
	CY7C1011CV33-15BVCT	CY7C1011CV33-15BVXCT
	CY7C1019CV33-15ZCT	CY7C1019CV33-15ZXCT
	CY7C1024AV33-10BGCT	CY7C1024AV33-10BGXCT
	CY62158CV33LL-70BAIT	CY62158CV33LL-70BAXIT
	CYM1841BPM-45C	CYM1841BPMX-45C
DATACOM	CY7C0451V18-133BBI	CY7C0451V18-133BBXI
	CY7C056V-12AC	CY7C056V-12AXC
	CY7C4292V-15ASI	CY7C4292V-15ASXI
	CY7C441-14JC	CY7C441-14JXC
CLOCKS	IMIB9949CAT	CYB9949CAXT
	CY7B9950AC	CY7B9950AXC
	CY2DP818ZI-2T	CY2DP818ZXI-2T
USB	CY7C63001A-PC	CY7C63001A-PXC
	CY7C64113-PVC	CY7C64113-PVXC
	CY7C65640-LFC	CY7C65640-LFXC
	SL811S	CY811SX
	AN2131QC	CY2131QXC
	CY7C65113-SCT	CY7C65113-SXCT
PSOC	CY8C27643-24PVIT	CY8C2643-24PVXIT
	CY8C27643-24LFI	CY8C2643-24LFXI
	CY8C26443-24SIT	CY8C26443-24SXIT
	CY8C26643-24AI	CY8C26643-24AXI