

Integrated Discretes

Interface conditioning and interface protection
in mobile appliances

Rev. 8.1 — 9 March 2011

Brochure

Document information

Info	Content
Keywords	Integrated Discretes, EMI filter, ESD protection, chip scale package (CSP), level shifting, memory card, SD memory card, MMC, T-flash, audio, microphone, LCD interface, HDMI, DVI, USB,
Abstract	This document presents a short, compressed overview about NXP Semiconductors Integrated Discretes device family typical used in mobile appliances such as: • cellular phones • smart phones • tablets / slates • portable media players (PMP) • Mobile Internet Devices (MID)



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1. Summary

The Cellular handset industry is facing two very different challenges; first, to compete in the low-end market for high volume limited feature mobile phone models, and second, in the mid to high end market where features are one of the key elements in brand marketing.

1.1 Low end mobile phone handsets

For the low end, reduction of cost is of the highest importance. Integration is of major benefit, in both reduction in size of the overall phone, and also in reducing the component count and thereby the total cost of the phone.

The continuing trend towards miniaturization combined with the drive for more product features makes integrating components into electronic devices increasingly difficult. This is further compounded by requirements to limit EMI/RFI interference and also to provide high level ESD protection.

An obvious solution to space constrained applications is to integrate multiple components into a single package; NXP Semiconductor Integrated Discretes use thin film on silicon techniques to combine active and passive components into monolithic silicon solutions. These devices range from simple ESD protection arrays to complex audio interfaces incorporating many functions. The use of Chip Scale packaging maximizes the space utilization; space savings of up to 95 % are achievable compared to equivalent discrete solutions. Products in CSP packages can be placed on the PCB with normal high speed placement equipment. The CSP package has been designed to meet all reliability tests without the need for underfill.



Fig 1. PCB area comparison of different package type for a 10-channel filter

A further benefit of the combination of thin film integration and Chip Scale packing is the improvement in filter performance. Devices using this combination and a multi layer board provide the maximum broadband attenuation of unwanted frequencies.

1.2 Mid and high end handsets

Whilst cost remains an important metric for any phone model the introduction of value added services require high and mid range phones to pack increased electronics into the same case sizes as preceding models. Here miniaturization plus performance are the leading requirements. The performance improvements of Integrated Discretes are of added benefit to a layout that has had to be optimized to fit into a limited space at the expense of filtering.

2. Introduction

NXP Integrated Discretes has developed solutions for use in many areas of cellular phone design focusing on the following key application areas:

1. ESD protection
2. EMI/RFI filtering
3. Termination
4. Low ohmic/over voltage tolerant analog switches
5. Level shifters

By the use of Integrated Discretes all of these applications can be fulfilled with just one single piece of silicon. The following sections will highlight the main features that are integrated into Integrated Discretes products

2.1 ESD protection

There are several system level tests required for phone certification; one of these is IEC61000-4-2 for Electrostatic Discharge protection.

Level 4 of this specification is one of the most stringent and requires the device to withstand contact discharges of at least 8 kV or, if contact discharge cannot be applied air discharges of 15 kV.

These discharges generate very high instantaneous currents that require specially designed devices to withstand these surges. The peak current for IEC61000-4-2 at 8 kV is between 27 and 33 amps.

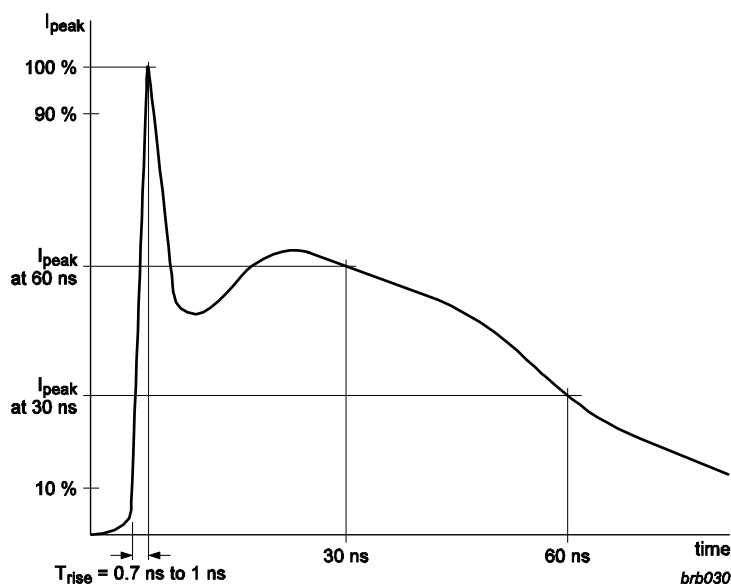


Fig 2. ESD-pulse according the IEC61000-4-2 standard, $I = f(t)$

2.2 EMI/RFI Filtering

An important area for any certification of electronic appliances is the amount of unwanted radiation coming from e.g. the phone and accessories connected to it. This is particularly important for the oscillator frequency output and its harmonics. This also has relevance for the audio circuits where the induced voltages can cause audible interference if not filtered sufficiently. The values quoted in this report represent typical figures when the devices are used as recommended in the datasheet. Please refer to the individual datasheet for full information.

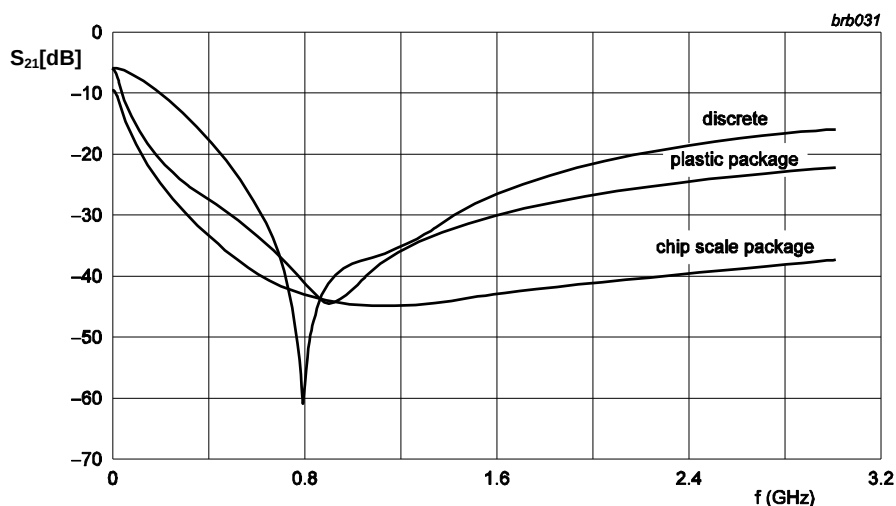


Fig 3. Filter performance comparison between a discrete, a plastic and a CSP packaged EMI filter

The Chip Scale Package, as well as the NXP leadless plastic package provide an excellent filter performance over a broad frequency range up to a few GHz. This outstanding performance is achieved by minimizing the lead inductance of the ground connection. Due to this, all relevant frequencies for mobile phones from 800 MHz up to 2.4 GHz can be filtered with one EMI filter and an ESD protection device.

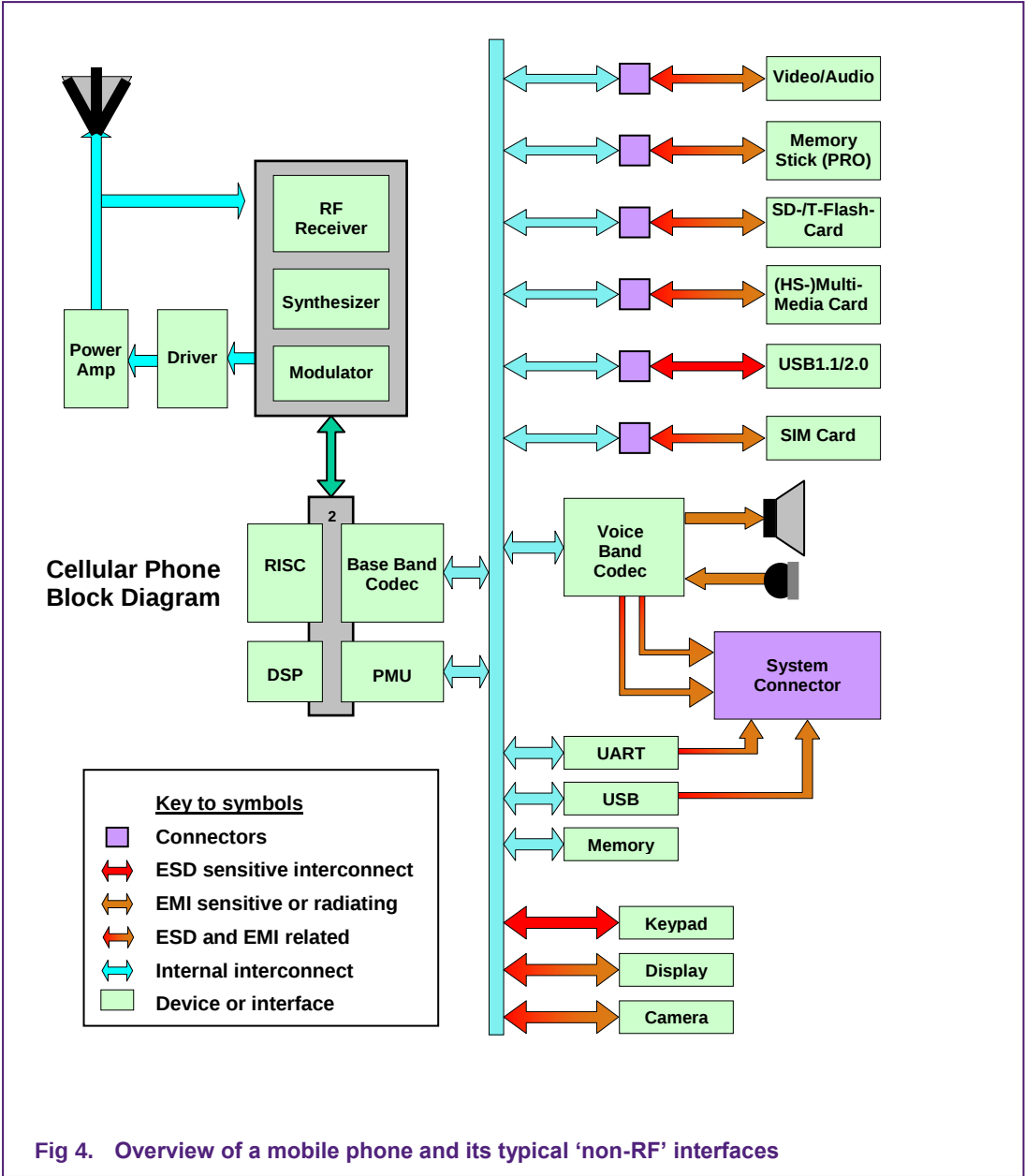
2.3 Termination

In addition to providing the above functions the filter components may also be used for impedance matching between the baseband controller and external devices such as USB appliances. Further components may also be integrated to provide bias voltages.

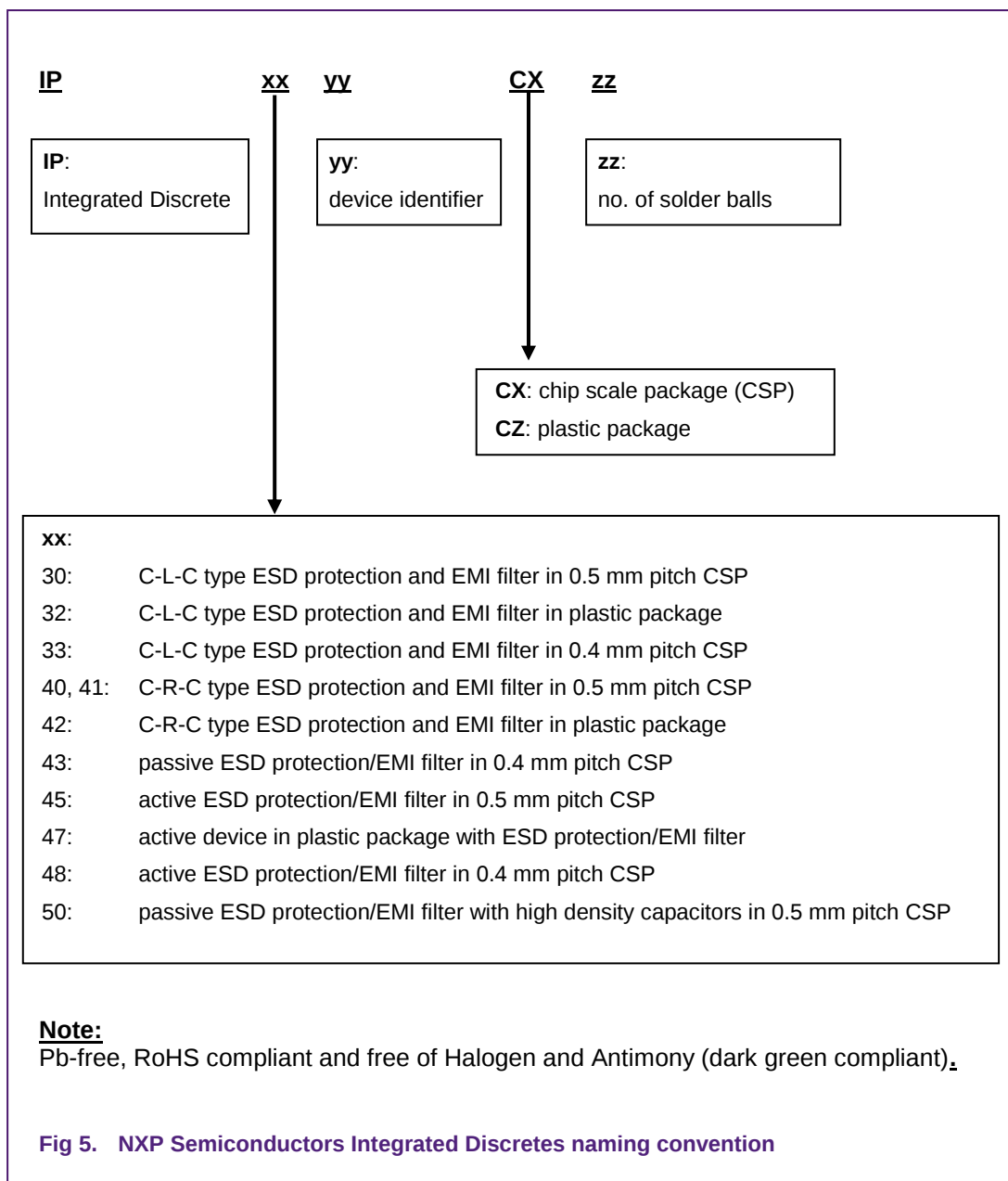
Based on the above features the ideal applications for Integrated Discretes are interfaces between the baseband processing and external devices or connectors.

3. Application Areas Overview

Here is a typical block diagram of a mobile phone. Some of these blocks are present in every handset, like the microphone, others are only present in the mid and high tier models. The areas indicated in red are potential interfaces that can benefit from today's Integrated Discretes products; these areas are described in more detail below. Most of these interfaces are, but not exclusively, close to the base band or the power management unit (PMU) or their interfaces respectively.



4. Integrated Discretes naming convention



5. Overview of available Integrated Discretes

ESD protection and EMI filter circuits

The following tables list a selection of Integrated Discretes (IDs), ESD protection devices and EMI filters with integrated ESD protection functionality described in this document.

Table 1 and Table 2 list devices to be used with different types of memory cards, such as SIM-, MMC-, SD-Cards or the Memory Stick PRO. USB related EMI filter/ESD protection devices are shown in Table 3 and Table 4.

A reference for HDMI interface devices is given in Table 5.

A selection of audio interface devices is listed in Table 6 which does not mean, that these devices are used exclusively for this purpose. They can be found in many varied application areas and various appliances in the communications, computer and consumer markets.

Table 7 to Table 9 provide a summary of different multi-channel, multi-purpose EMI filter/ESD protection devices, ranging from 1 to 10-channels in CSP and/or plastic package.

General protection diode arrays in Wafer-Level CSP are listed in Table 10, while the plastic packaged devices – especially low capacitance devices - are shown in Table 11. The lowest diode capacitance values can be found in this table.

Active devices including high-level ESD-protection according the IEC61000-4-2 standard are summarized in Table 12.

Most devices presented in this document, far exceed the IEC61000-4-2 level 4 requirements of 8 kV contact or 15 kV air discharge.

Typically NXP's Integrated Discretes ESD-protection and EMI-filter devices in WLCSP (Wafer Level Chip Scale Package) are qualified using 1000 pulses of $\pm 15\text{kV}$ contact discharges according the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges).

Table 1. Memory Card EMI-filter, ESD-protection and biasing for: SIM-, MMC-, SD-Cards, T-Flash or Memory Stick PRO in CSP

Type name	Channel small signal equivalents		Digital interface clock speed ^[1]	Remark
Chip Scale Package	R _{channel}	C _{channel}		Devices are typically tested with 1000 pulses of ±15 kV contact discharges according the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges)
IP4064CX8	47 Ω, 100 Ω	<20 pF	~ 20 MHz	SIM-Card EMI-filter and ESD protection. Foot print compatible to IP4044CX8, 0.5 mm pitch
IP4364CX8	47 Ω, 100 Ω	<20 pF	~ 20 MHz	SIM-Card EMI- filter and ESD protection in 0.4 mm pitch, similar to IP4064CX8
IP4366CX8	47 Ω, 100 Ω	<12 pF	~ 20 MHz	SIM-Card EMI- filter and ESD protection in 0.4 mm pitch, footprint compatible to IP4364CX8
IP4365CX11	47 Ω, 100 Ω	<12 pF	~ 20 MHz	SIM-Card EMI- filter and ESD protection with 3 additional single diodes fur USB and VSIM in 0.4 mm pitch
IP4051CX11	47 Ω +pull-up	25 pF	> 26MHz	MMC- interface ESD protection, EMI filter device with integrated pull-up resistors, 0.5mm pitch
IP4060CX16	50 Ω +pull-up	18 pF	> 26MHz	MMC-High-Speed Mode compatible ESD protection, EMI filter with integrated pull-up resistors, 0.5mm pitch
IP4052CX20	40 Ω +pull-up	18 pF	> 52 MHz	SD-/T-Flash card interface ESD protection, EMI filter device with integrated pull-up resistors in 0.5 mm pitch
IP4351CX11	47 Ω +pull-up	25 pF	> 26MHz	MMC- interface ESD protection, EMI filter device with integrated pull-up resistors, 0.4 mm pitch
IP4350CX24	15 Ω +pull-up	8.8 pF	> 52 MHz	SD-/T-Flash card interface ESD protection, EMI filter device with integrated pull-up resistors in 0.4 mm pitch to be used with IP4852CX24 or without IP4852CX24 if no level-shifting is required, identical footprints
IP4352CX24	40 Ω +pull-up	18 pF		
IP4853CX24	40 Ω +pull-up	18 pF	> 52 MHz	Active SD-/T-Flash card interface level-shifter (1.8 V (core) ↔ 2.9 V (card)) in 0.4 mm pitch with a Power Supply Unit (V _{battery} to 2.9 V SD-Card supply), integrated EMI filter and ESD protection up to ±15 kV contact discharge. This device is an integration of IP4352CX24 and IP4853CX24 plus a PSU.

¹ Using a 50 Ω source and ~ 20 pF load impedance

Table 2. Memory Card EMI-filter, ESD-protection an biasing for: SIM-, MMC-, SD-Cards, T-Flash or Memory Stick PRO in plastic package

Type name	Channel small signal equivalents		Digital interface clock speed ^[2]	Remark
Plastic package	R _{channel}	C _{channel}		
IP4252CZ8-4 IP4252CZ12-6 IP4252CZ16-8	40 Ω	12 pF	> 52 MHz	4-,6- ,8- channel SD-/T-Flash card interface ESD protection, EMI filter device in 0.4 mm pitch plastic package
IP4264CZ8-20	47 Ω, 100 Ω	20 pF	> 20 MHz	SIM-Card EMI-filter and ESD protection in a 0.4 mm pitch plastic package
IP4264CZ8-40		40 pF	> 12MHz	

² Using a 50 Ω source and ~ 20 pF load impedance

Table 3. USB1.1 and USB 2.0 Interface EMI filter/ESD protection devices in CSP

Type name	Channel small signal equivalents		USB Speed compliance	Remark
Chip Scale Package	R _{channel}	C _{channel}	Devices are typically tested with 1000 pulses of ± 15 kV contact discharges according to the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges)	
IP4056CX8	33 Ω , 1.3 k Ω	35 pF	Full-Speed	USB1.1 interface compliant EMI filter, ESD protection and termination device, 0.5 mm pitch CSP
IP4057CX10	33 Ω , 1.3 k Ω	30 pF	Full-Speed	USB1.1 interface compliant EMI filter, ESD protection and termination device, 0.5 mm pitch CSP
IP4058CX8	33 Ω , 1.5 k Ω	35 pF	Full-Speed	USB1.1 interface compliant EMI filter, ESD protection and termination device, 0.5 mm pitch CSP
IP4158CX8	17 Ω , 1.5 k Ω	35 pF	Full-Speed	USB1.1 interface compliant EMI filter, ESD protection and termination device, 0.5 mm pitch CSP
IP4065CX11	33 Ω , 1.3 k Ω	27 pF	Full-Speed	USB1.1 interface compliant EMI filter, ESD protection and termination device, 0.5 mm pitch CSP
IP4368CX9	33 Ω , 1.5 k Ω , 18.5 k Ω	17 pF	Full-Speed	USB1.1 interface compliant EMI filter, ESD protection and termination device, 0.4 mm pitch CSP
IP4078CX6	33 Ω	35 pF	Full-Speed	USB1.1 interface compliant EMI filter, ESD protection and termination device, 0.5 mm pitch CSP
IP4059CX5	-	3 pF	High-Speed	USB2.0 High-Speed compliant ESD protection, 0.5 mm pitch CSP
IP4358CX6	-	1.3 pF	High-Speed	USB2.0 dual differential channel High-Speed compliant ESD protection in 0.4 mm pitch CSP
IP4359CX4	-	1.5 pF	High-Speed	USB2.0 High-Speed compliant ESD protection in 0.4 mm pitch CSP

Table 4. USB1.1 and USB 2.0 Interface EMI filter/ESD protection devices in plastic package

Type name	Channel capacitance	USB Speed compliance	Remark
Plastic package			
IP4220CZ6	1 pF	High-Speed	USB2.0 High-Speed compliant ESD protection in plastic package, SC-74, SOT457
IP4221CZ6-S	1 pF	High-Speed	USB2.0 High-Speed compliant ESD protection in plastic package, MO-252, SOT886
IP4221CZ6-XS	1 pF	High-Speed	USB2.0 High-Speed compliant ESD protection in plastic package, SOT891
PRTR5V0U4Y	1 pF	High-Speed	USB2.0 High-Speed compliant ESD protection in plastic package, SC-88, SOT363
PRTR5V0U4D	1 pF	High-Speed	USB2.0 High-Speed compliant ESD protection in plastic package, SC-74, SOT457

Table 5. HDMI Interface ESD protection and conditioning devices

Type name	Channel small signal equivalents	Remark
Chip Scale Package	R_{channel}	C_{channel}
These devices are typically tested with 1000 pulses of ± 15 kV contact discharges according the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges)		
IP4309CX9	-	1,3 pF
IP4310CX8	1.75 k Ω , 100 k Ω	20 p F
IP4282CZ6	-	0.7 pF
IP4283CZ10	-	0.6 pF
IP4284CZ10	-	0.5 pF
IP4285CZ9	-	0.6 pF
IP4791CZ12	Control channel level shifter and ESD-protection device	

Table 6. Audio path EMI Filter and ESD protection devices

Type name	Channel small signal equivalents			Loudspeaker		Microphone		Integrated biasing resistors
	R _{channel}	L _{channel}	C _{channel}	≤ 8 Ω	≥8 Ω	Single-Ended	Differential	
IP3047CX6	0.25 Ω	3 nH	280 pF	x	x		x	-
IP3048CX5	0.25 Ω	3 nH	280 pF	x	x		X	-
IP4047CX6	0.95 Ω		2x 140 pF	X				-
IP4048CX5	10 Ω		2x 100 pF		X			-
IP4049CX5	68 Ω		2x 47 pF				X	-
IP4055CX6	470 Ω		35 pF			X	X	-
IP4355CX6	470 Ω		<20 pF			X	X	-
IP5002CX8	2.2 kΩ, 4.4 kΩ		3 nF +1 nF			X		-

Table 7. C-L-C based multi-channel EMI filter and ESD protection devices 2-, 4-, 6-, 7-, 8-, 10-channels in 0.5 and 0.4 mm pitch, CSP

Type name	Channel small signal equivalents			-3 dB frequency ^[3]	Remark
Chip Scale Package	R _{channel}	(L _{channel})	C _{channel}	Devices are typically tested with 1000 pulses of ±15 kV contact discharges according the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges)	
IP3053CX5 IP3053CX10 IP3053CX15 IP3053CX20	^[4] 100 Ω	35 nH	47 pF	150 MHz	2-, 4-, 6-, 8-channel C-L-C-type EMI filter and ESD protection, 0.5 mm pitch, footprint compatible with IP3088CXyy
IP3088CX5 IP3088CX10 IP3088CX15 IP3088CX20	^[4] 18 Ω	40 nH	65 pF	175 MHz	2-, 4-, 6-, 8-channel C-L-C-type EMI filter and ESD protection, 0.5 mm pitch footprint compatible with IP3053Cxyy
IP3348CX5 IP3348CX10 IP3348CX15 IP3348CX20	^[4] 10 Ω	15 nH	30 pF	350 MHz	2-, 4-, 6-, 8-channel C-L-C-type EMI filter and ESD protection, 0.4 mm pitch
IP3337CX18	125 Ω	60 nH	25 pF	180 MHz	7-channel C-L-C-type EMI filter and ESD protection, 0.4 mm pitch, Footprint compatible with IP4337CX18
IP3338CX24	125 Ω	60 nH	25 pF	180 MHz	10-channel C-L-C-type EMI filter and ESD protection, 0.4 mm pitch, footprint compatible with IP4338CX24

3. R_{source} = R_{load} = 50 Ω

4. IP3xxxCX5: 2-channel, IP3xxxCX10: 4-channel, IP3xxxCX15: 6-channel, IP3xxxCX20: 8-channel

Table 8. C-R-C based multi-channel EMI filter and ESD protection devices, 1-, 4-, 6-, 7-, 8-, 10-channels in 0.5 mm and 0.4 mm pitch, CSP

Type name	Channel small signal equivalents		-3 dB frequency ³	Remark	
IP4032CX25 IP4033CX25	80 Ω	40 pF	100 MHz	10-channel	CRC-type EMI filter/ESD protection
IP4035CX24	1 k Ω	50 pF	22 MHz	10-channel	CRC-type EMI filter/ESD protection for key-pad interfaces
IP4337CX18	70 Ω	25 pF	240 MHz	7-channel	CRC-type EMI filter/ESD protection, 0.4 mm pitch, footprint compatible with IP3337CX18
IP4338CX24	70 Ω	25 pF	240 MHz	10-channel	CRC-type EMI filter/ESD protection, 0.4 mm pitch footprint compatible with IP3338CX24
IP4040CX25	84 Ω	14 pF	365 MHz	10-channel	CRC-type EMI filter/ESD protection
IP4041CX25	200 Ω	50 pF	105 MHz	10-channel	CRC-type EMI filter/ESD protection
IP4053CX15	100 Ω	60 pF	120 MHz	6-channel	CRC-type EMI filter/ESD protection, footprint compatible with IP4153CX15
IP4153CX15	100 Ω	30 pF	210 MHz	6-channel	CRC-type EMI filter/ESD protection, low capacitance version of IP4053CX15
IP4353CX15	100 Ω	60 pF	120 MHz	6-channel	CRC-type EMI filter/ESD protection, 0.4mm pitch
IP4054CX15	100 Ω	60 pF	85 MHz	4-channel	CRC-type EMI filter/ESD protection + 4 single protection diodes
IP4307CX4	75 Ω	36 pF	155 MHz	1-channel	CRC-type EMI filter/ESD protection with one common ground
IP4088CX20	100 Ω	50 pF	120 MHz	8-channel	CRC-type EMI filter/ESD protection, easy to route

Table 9. C-L-C and C-R-C based multi-channel EMI filter and ESD protection devices, 1-, 2-, 4-, 6- and 8-channels in 0.4 mm pitch plastic package

Type name	Channel small signal equivalents		-3 dB frequency ^[5]	Remark	
Plastic package	R _{channel} (L _{channel})	C _{channel}		Devices are typically tested with 1000 pulses of ±15 kV contact discharges according the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges)	
C-L-C type					
IP3253CZ8-4 IP3253CZ12-6 IP3253CZ16-8	^[6] (18 nH)	43 pF	175 MHz	4, 6, 8 –channel	CLC -type EMI-filter & ESD protection in a plastic package (QFN-type)
IP3254CZ8-4 IP3254CZ12-6 IP3254CZ16-8	^[6] (12 nH)	50 pF	145 MHz	4, 6, 8 –channel	CLC -type EMI-filter & ESD protection in a plastic package (QFN-type)
C-R-C type					
IP4251CZ8-4 IP4251CZ12-6 IP4251CZ16-8	^[6] 100 Ω	15 pF	330 MHz	4, 6, 8 –channel	CRC -type EMI-filter & ESD protection in a plastic package (QFN-type)
IP4252CZ8-4 IP4252CZ12-6 IP4252CZ16-8	^[6] 40 Ω	18 pF	300 MHz	4, 6, 8 –channel	CRC -type EMI-filter & ESD protection in a plastic package (QFN-type)
IP4253CZ8-4 IP4253CZ12-6 IP4253CZ16-8	^[6] 200 Ω	45 pF	110 MHz	4, 6, 8 –channel	CRC -type EMI-filter & ESD protection in a plastic package (QFN-type)
IP4254CZ8-4 IP4254CZ12-6 IP4254CZ16-8	^[6] 100 Ω	45 pF	130 MHz	4, 6, 8 –channel	CRC -type EMI-filter & ESD protection in a plastic package (QFN-type)
IP4256CZ3-M IP4256CZ5-F IP4256CZ6-W	100 Ω	30 pF	200 MHz	1, 2 –channel	CRC -type EMI-filter & ESD protection in SOT883 (M), SOT886 (F) or SOT665 (W)

5. R_{source} = R_{load} = 50 Ω

6. IPx25xCZ8: 4-channel, IPx25xCZ12: 6-channel, IPx25xCZ16: 8-channel version

Type name	Channel small signal equivalents		-3 dB frequency ^[5]	Remark	
C-R-C type family devices					
PEMI2STD	20 Ω to100 Ω	15 pF to 45 pF	depends	2 –channel	CRC-type EMI-filter & ESD protection in SOT665
PEMI1QFN	20 Ω to100 Ω	15 pF to 45 pF	depends	1 –channel	CRC-type EMI-filter & ESD protection in SOT883
PEMI2QFN	20 Ω to100 Ω	15 pF to 45 pF	depends	2 –channel	CRC-type EMI-filter & ESD protection in SOT886
PEMI4QFN	20 Ω to100 Ω	15 pF to 45 pF	depends	4 –channel	CRC-type EMI-filter & ESD protection in HXSON8
PEMI6QFN	20 Ω to100 Ω	15 pF to 45 pF	depends	6 –channel	CRC-type EMI-filter & ESD protection in HXSON12
PEMI8QFN	20 Ω to100 Ω	15 pF to 45 pF	depends	8 –channel	CRC-type EMI-filter & ESD protection in HXSON16

Table 10. General ESD protection diodes in CSP packages

Type name	C _{Channel} 0 V _{DC_bias} (2.5 V _{DC_bias})	No of protection channels	Single diodes	Bi- directional diodes	V _{BR} (min)	Remark
Chip Scale Package			Devices are typically tested with 1000 pulses of ±15 kV contact discharges according the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges)			
IP4042CX5	30 pF (19 pF)	4	X		+5.5	4x single diode with one common ground, footprint compatible with IP4142CX5
IP4142CX5	14 pF (9 pF)	4	X		+5.5	4x single diode with one common ground, footprint compatible with IP4042CX5
IP4043CX5	16 pF	4		X	±14	4x back-to-back diode with one common ground, 0.5 mm pitch CSP
IP4342CX5	48 pF (30 pF)	4	X		+5.5	4x single diode with one common ground in 0.4 mm pitch
IP4343CX5	16 pF	4		X	±14	4x back-to-back diode with one common ground in 0.4 mm pitch
IP4358CX6	1.3 pF	4	X		+6	4x single diode low capacitance ESD-protection in 0.4 mm pitch CSP
IP4309CX9	1.3 pF	8	X		+6	8x single diode low capacitance ESD-protection in 0.4 mm pitch CSP
IP4359CX4	1.3 pF	2	X		+6	2x single diode low capacitance ESD-protection in 0.4 mm pitch CSP
IP4085CX4	240 pF	1	X		+16	Single power diode to protect charger interfaces from wrong polarity, 0.5 mm pitch
IP4385CX4	450 pF	1	X		+7	Single power diode to protect charger interfaces from wrong polarity, 0.4 mm pitch
IP4386CX4	220 pF	1	X		+16	Single power diode to protect charger interfaces from wrong polarity, 0.4 mm pitch
IP4387CX4	260 pF	1	X		+10	Single power diode to protect charger interfaces from wrong polarity, 0.4 mm pitch
IP4389CX4	260 pF	1	X		+16	Melting fuse + single power diode to protect charger interfaces from wrong polarity, 0.4 mm pitch
IP4302CX2	10 pF	1		X	±14	Single back-to-back (bidirectional) diode, size is 0.7 mm x 0.52 mm
IP4303CX4	10 pF	2		X	±14	2x back-to-back diode with one common ground
IP4305CX4	19 pF, 7 pF	1+2	X		±5.5	1x bi-directional diode + 2 Schottky diodes, in one 0.4 mm CSP
IP4306CX2	65 pF	1	Schottky		+22	1x power Schottky diode in 0.4 mm CSP

Table 11. Low capacitance and general ESD protection diodes in plastic packages

Type name	C _{Channel} 0 V _{DC bias} (2.5 V _{DC bias})	No of protection channels	V _{BR} (min)	Remark
Plastic package			Devices are typically tested with 1000 pulses of ±15 kV contact discharges according the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges) unless specified otherwise	
IP4220CZ6	1 pF	4(+1)	+6	4x ultra-low capacitance ESD protection device for USB, Ethernet etc. Leadless SOT363 package
IP4221CZ6-S	1 pF	4(+1)	+6	4x ultra-low capacitance ESD protection device for USB, Ethernet etc. Leadless SOT886 package
IP4221CZ6-XS	1 pF	4(+1)	+6	4x ultra-low capacitance ESD protection device for USB, Ethernet etc. Leadless SOT891 package
IP4282CZ6	0.7 pF	2	+6	2x ultra-low capacitance ESD protection device for HDMI etc. Leadless SOT886 package
IP4283CZ10	0.6 pF	4	+6	4x ultra-low capacitance ESD protection device for HDMI etc. Leadless SOT1165 package
IP4284CZ10	0.5 pF	4	+6	4x ultra-low capacitance ESD protection device for HDMI etc. Leadless SOT1176 package
IP4285CZ9	0.6 pF	4	+6	4x ultra-low capacitance 12 kV ESD protection device for HDMI, USB3 etc. Leadless SOT1178 package
PESD5V0L1BSF	3.5 pF	1	+6	1x low capacitance bidirectional ESD protection device in leadless SOD962 package
PESD5V0S1BSF	12 pF	1	+6	1x bidirectional ESD protection device in leadless SOD962 package
PESD5V0V1BSF	35 pF	1	+6	1x bidirectional ESD protection device in leadless SOD962 package
PRTR5V0U4Y	1 pF	4(+1)	+6	4x ultra-low capacitance ESD protection device for USB, Ethernet etc. in a SOT363 package
PRTR5V0U4D	1 pF	4(+1)	+6	4x ultra-low capacitance ESD protection device for USB, Ethernet etc. in a SOT457 package
PRTR5V0U8S	1 pF	8(+1)	+6	8x ultra-low capacitance ESD protection device for USB, Ethernet etc. in TSSOP10 (SOT552) package

Table 12. Active devices with high-level ESD-protection to IEC61000-4-2

Type name	Integrated active function	remark
IP4791CZ12	Ultra small active level translator and ESD-protection device for HDMI interface control lines (e.g. 1.8 V base band processor to HDMI compliant 5 V level and vice versa)	
IP4826CX12	Several high current / low ohmic switches with automatic voltage detection, driver stages	-
IP4853CX24	Active (micro-)SD-/Trans-Flash card interface level-shifter(1.8 V (core) ↔ 2.9 V (card)) in 0.4 mm pitch with a Power Supply Unit (V_{battery} to 1.8 V SD-Card supply), integrated EMI filter and ESD protection up to ±15 kV contact discharge. This devices is an integration of IP4352CX24 and IP4853CX24 plus a PSU(LDO).	-

6. Application Areas

6.1 External Memory Cards: SIM, SD-Card, T-Flash, MMC etc.

6.1.1 SIM Card Interface

**IP4064CX8, IP4364CX8, IP4365CX11,
IP4366CX8, IP4264CX8-20, IP4264CZ8-40**

These devices provide all the necessary components for EMI-filtering and ESD-protection of the Subscriber Identity Module including the supply rail. IP4365CX11 and IP4264CZ8 offer additional ESD-protection diodes to also protect the USB ports in USIM interfaces. An important feature of the integrated digital lines is the close matching of the resistors and the low capacitance to maintain the rise times within the specified limit and to avoid group delay. ESD protection at the input and output provides a high level of surge limitation due to the two stage ESD protection around the pi-filter structure with ESD protection/clamping diodes at both sides of each data channel. (refer to application note AN10914 on www.nxp.com for more details)

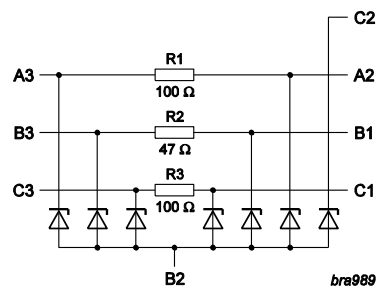


Fig 6. SIM-Card EMI-filter and ESD-protection schematic

	IP4064CX8 IP4364CX8	IP4365CX11	IP4366CX8	IP4264CZ8-20	IP4264CZ8-40
R_{line}	47 Ω, 100 Ω	47 Ω, 100 Ω	47 Ω, 100 Ω	47 Ω, 100 Ω	47 Ω, 100 Ω
C_{line} ($V_{bias}=0$ V)	< 20 pF	10 pF	10 pF	20 pF	40 pF
USB ESD diodes	No	Yes	No	Yes	Yes
Package	0.5/0.4 mm pitch CSP	0.4 mm pitch CSP	0.4 mm pitch CSP	0.4 mm pitch plastic	0.4 mm pitch plastic

6.1.2 IP4051CX11 & IP4351CX11 Multi Media Card Interface

Another external memory device is the Multi Media Card for storage and transfer of downloaded data. The IP4051CX11 (0.5 mm pitch) and the IP4351CX11 (same footprint with reduced package size due to 0.4 mm pitch) have been carefully optimized to achieve the balance between ESD performance and channel capacitance to allow for fast rise-times. The extremely close channel-to-channel matching inherent in wafer level integration provides the optimum performance for this interface. (refer to application note AN10911 on www.nxp.com for more details)

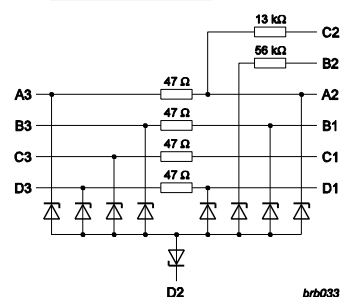


Fig 7. IP40(3)51CX11 schematic and device depicted with solder balls facing up

	IP4051CX11	IP4351CX11
R_{line}	47 Ω	47 Ω
R_{pull}	13k Ω, 56 kΩ	13k Ω, 56 kΩ
$C_{line}(V_{bias}=0$ V)	25 pF	20 pF

6.1.3 IP4052CX20 (micro-)SD-Card & T-Flash Interface

Mechanically similar to the Multi-Media Card, the SD (Secure Digital) or T-Flash Card is also used for data transfer and storage. It offers a fast 4-bit (nibble-wise) data transmission and also a SPI compatible operation mode. While the similarity in size allows for using one slot for both types, the interface looks quite different, so that the SD-/T-Flash Card requires different filters. The line capacitance is lower than the one integrated in IP4051CX11 and all required pull-up resistors for the SD-/T-Flash card are also integrated. (refer to application note AN10911 on www.nxp.com for more details)

	IP4052CX20
R_{line}	40 Ω (pull-up: 1 k Ω , 25 k Ω , 50 k Ω)
C_{line}	18 pF ($V_{DC} = 0$ V, typical)

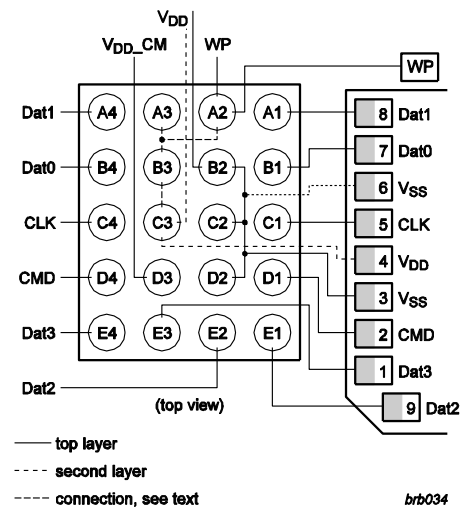


Fig 8. IP4052CX20 application proposal

6.1.4 IP4350CX24 & IP4352CX24 SD-Card, MMC, T-flash Interface

IP4350CX24 and IP4352CX24 are a 0.4 mm pitch devices, similar to the IP4052CX20. They contain 9 channels protected by rail-to-rail diodes at the card holder interface side. IP4350CX24 can also be used with MultiMediaCards. All required pull-up and pull-down resistors are integrated. The device is optimized to be used with the NXP Integrated Discretes SD-Card level shifter IP4852CX25. (refer to application note AN10911 on www.nxp.com for more details)

	IP4350CX24	IP4352CX24
R_{line}	15 Ω	40 Ω
R_{pull}	4.7 k Ω , 50 k Ω	15 k Ω , 50 k Ω
C_{line} ($V_{bias}=0$ V)	< 9 pF	< 20 pF

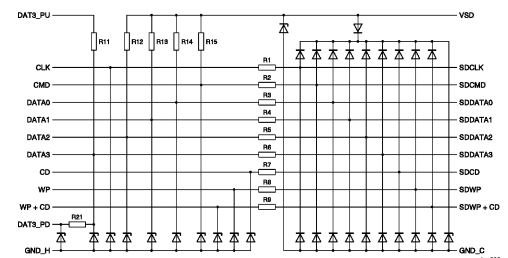


Fig 9. IP4350(2)CX24 schematic drawing

6.1.5 IP4252CZ8-4, IP4252CZ12-6, IP4252CZ16-8 SD-Card, MMC, T-flash Interface

IP4252CZyy devices are C-R-C EMI-filters and ESD protection devices in 4-, 6-, 8- leadless packages with 0.4 mm pitch. (refer to application note AN10911 on www.nxp.com for more details)

	IP4252CZyy
R_{line}	40 Ω
C_{line} ($V_{bias} = 2.5$ V)	12 pF

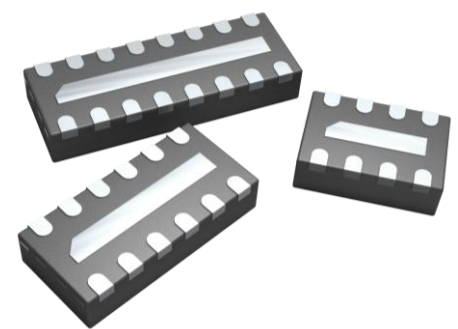


Fig 10. IP4252CZyy leadless packages

6.1.6 IP4853CX24

(micro-)SD-Card / T-Flash active level shifter with PSU (LDO)

The following functions are integrated into these only 2.0 x 2.0 mm² large devices:

- High speed 1.8 V ↔ 2.9 V active level shifter
- EMI-filter
- IEC61000-4-2.level 4 compliant ESD-protection
- Memory-Card supply (2.9 V LDO) from battery
- 2.01 x 2.01 mm² device size

It is optimized for the SD-Card / T-Flash interfaces. In case a low voltage processor has to interface a memory card still requiring voltages of 2.9 V and above, this device contains bidirectional push-pull drivers for clock speeds up to 50-60MHz. The low voltage side can operate in the range of 1.62 V to 1.9 V while the high voltage side works at 2.5 V to 3.5 V.

The device also contains a LDO that delivers 2.9 V for the memory card from a battery voltage of up to 5 V. It is a 0.4 mm pitch device with a package size of just 2.01x2.01 mm².

(refer to application note AN10911 on www.nxp.com for more details)

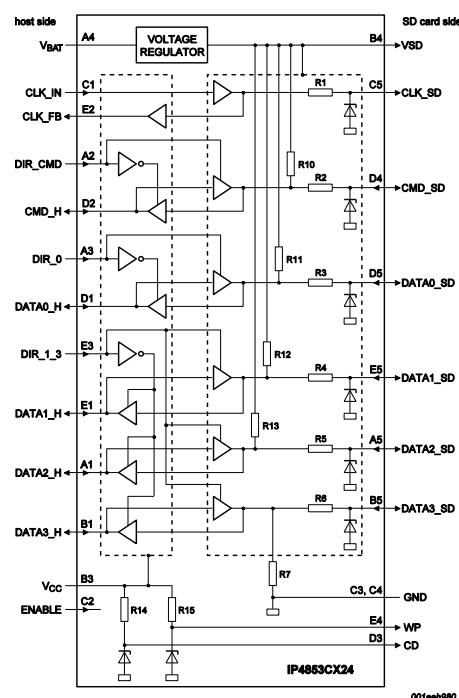


Fig 11. IP4853CX24 schematic

6.2 USB Interfaces

In order to achieve a low line capacitance and meet the capacitance requirements of the USB specification NXP Integrated Discretes has developed a wide range of different protection devices.

6.2.1 USB 1.1 & USB2.0 OTG (at Full Speed)

IP4056CX8, IP4058CX8, IP4158CX8 and IP4078CX6, IP4368CX9

IP4056CX8, IP40(1)58CX8, IP4078CX6 and IP4368CX9 are very small 6-9 ball devices with footprints specifically matching to the USB connector. They are suitable for low speed and full speed data rates as well as for USB OnTheGo (OTG) with external pull down resistor switching.

For transceivers with an increased integrated series resistance on-chip, IP4158CX8 contains lower channel resistor values of 17 Ω only and is pin-compatible with IP4058CX8.

IP4368CX9 also contains two 18.5 k Ω biasing resistors

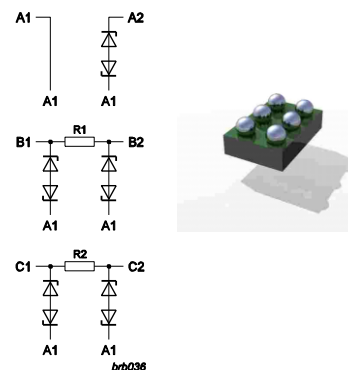


Fig 13. IP4078CX6 Schematic view and device package drawing

	IP4056CX8	IP4058CX8	IP4158CX8	IP4078CX6	IP4368CX9
$R_{D+}, D-$	= 33 Ω	33 Ω	17 Ω	33 Ω	33 Ω
R_{bias}	= 1.3 k Ω	1.5 k Ω	1.5 k Ω	-	1.5 k Ω , 18.5 k Ω
C_{line}^7	= 30 pF	35 pF	35 pF	35 pF	17 pF

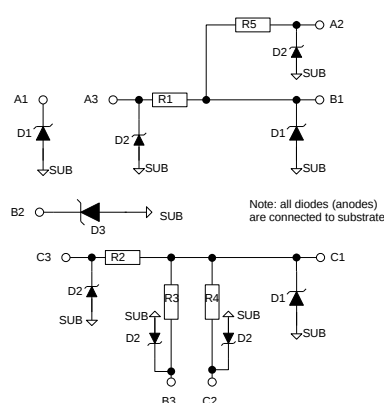


Fig 12. IP4368CX9 Schematic view and

⁷ $V_{DC} = 0 V$

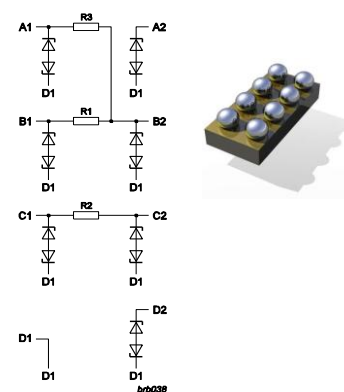


Fig 14. IP4058CX8, IP4158CX8 Schematic view and package drawing

6.2.2 USB2.0 (High Speed, Full Speed & Low Speed)

IP4059CX5, IP4358CX6, IP4359CX4

The most recent development in the field of physical transmission of USB technology is the USB2.0 High Speed (HS) standard. This operation mode requires as low as possible line capacitances, especially for protection devices and allows no series resistors in the data lines. IP4059CX5 and IP4358CX6 can be used to protect the full USB interface including D+, D-, Vbus and ID while IP4359CX4 is optimized aboslutely minimized in area to protect D+, D- only.

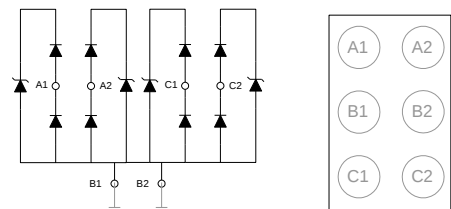


Fig 15. IP4358CX6 Schematic view and package drawing

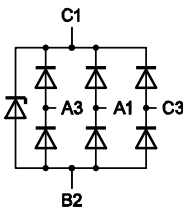


Fig 16. IP4059CX5 Schematic view and package drawing

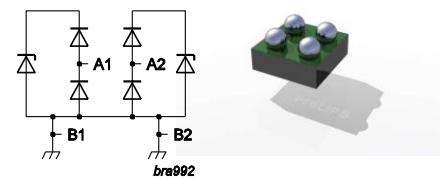


Fig 17. IP4359CX4 Schematic view and package drawing

	IP4059CX5	IP4358CX6	IP4359CX4
C _{line}	= 3 pF	1.3 pF	1.4 pF
no. of channels	= 3	4	2
Pitch	= 0.5 mm	0.4 mm	0.4 mm

IP4220CZ6, PRTR5V0U4D, IP4221CZ6-S, IP4221CZ6-XS, PRTR5V0U4Y

These devices are 4-channel channel low capacitance ESD-protection devices in different plastic packages. All devices sport just 1 pF C_{line}.

Supported packages are SC-74, SOZ886, SC-88 and SOT363 plastic package.

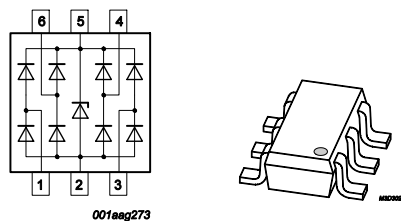


Fig 18. Schematic SC-74 package drawing



Fig 19. SOT886 package

6.3 HDMI interface ESD-protection and conditioning

IP4309CX9, IP4310CX8 ^[8]

These two 0.4 mm pitch CSP devices cover the full HDMI interface with respect to ESD-protection of all pins and biasing of DDC lines and hotplug.

IP4309CX9 contains 4x2 low capacitance ESD-protection diodes while IP4310CX8 is covering the lower speed communication interface.

IP4282CZ6, IP4283CZ10, IP4284CZ10 ^[8]

In case leadless packages are preferred, NXP offers various low capacitance solutions for the TMDS line ESD-protection.

While the IP428xCZ10 packages offer 2 x 2 channel protection, IP4282CZ6 does offer 2 ESD-protection channels. All types support an easy PCB routing using straight line running under the package to avoid problems in TDR measurement results. Therefore, each pin connected to an ESD-protection rail has an opposite pin that is not connected and can be soldered to the same TMDS channel without adding any relevant capacitance.

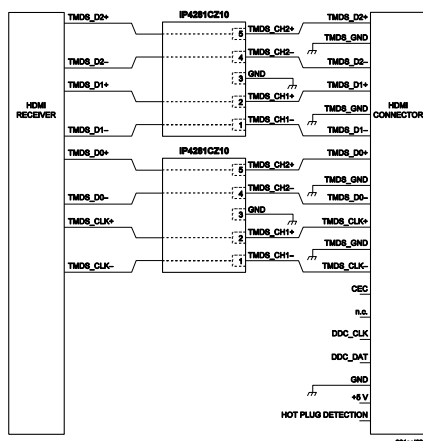


Fig 20. Simplified application schematic for IP428xCZyy based HDMI ESD-protection

⁸ (refer to 'HDMI in mobile' application note under www.nxp.com for more details)

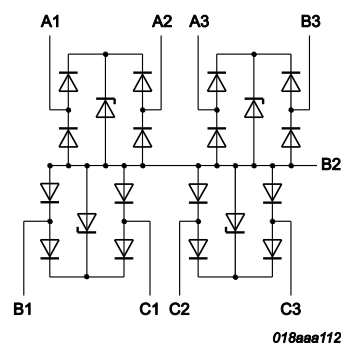


Fig 21. IP4309CX9 schematic view

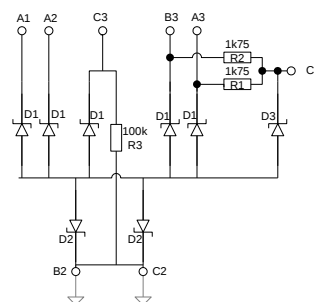


Fig 22. IP4310CX8 schematic view

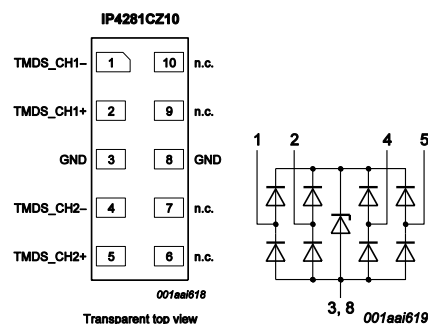


Fig 23. IP428xCZ10 pinning and schematic view

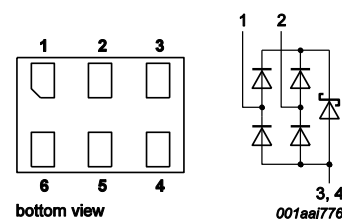


Fig 24. IP4282CZ6 pinning and schematic view

PESD5V0F1BSF

The PESD5V0F1BSF is an ultra small 0201 size ($0.6 \times 0.3 \text{ mm}^2$), 5 V, 8 kV ESD compliant protection diode. Its very low line capacitance of 0.5 pF only makes this device an ideal ESD-protection for HDMI TMDS lines but also for other high speed / data rate signals.

The device height is 0.3 mm only allowing placement of the device also in areas where maximum component height is critical.

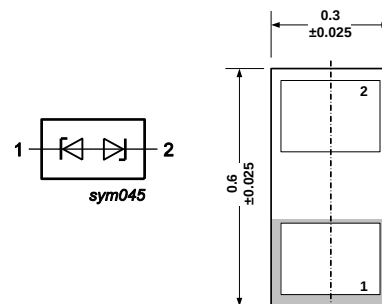


Fig 26. PESD5V0F1BSF schematic symbol and package outline view

IP4791CZ12

IP4791CZ12 is a fully integrated HDMI control line level shifter and ESD protection device for mobile appliances. The device translates host processor signals with amplitudes lower than the required 5 V to HDMI 1.3a and 1.4 compatible 5 V levels and vice versa. Furthermore, all required pull-up and pull-down resistors are integrated as are 8 kV IEC61000-4-2 ESD-protection diodes on all external interface pins. The IP4791CZ12 is available in a $2.1 \times 2.5 \text{ mm}^2$ leadless plastic package with a maximum height of 0.5 mm only.

(refer to 'HDMI in mobile' application note under www.nxp.com for more details)

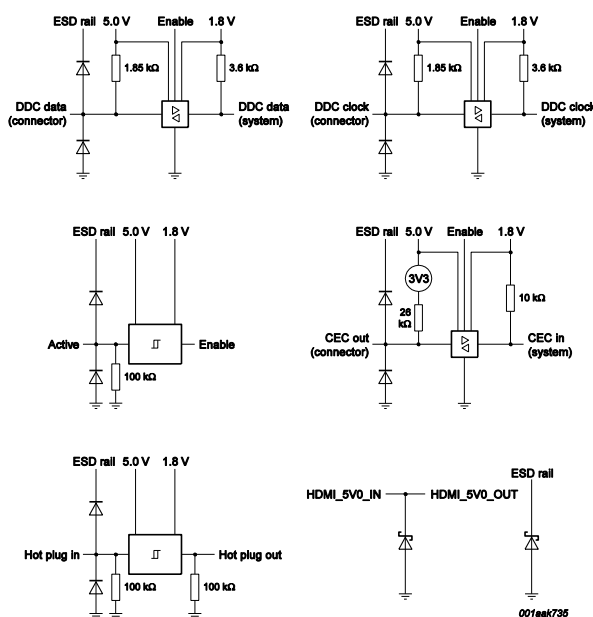


Fig 25. IP4791CZ12 block diagram

6.4 Audio Interfaces

IP3047CX6, IP3048CX5, IP4047CX6, IP4048CX5, IP4049CX5, IP4055CX6

In addition to providing all the normal interface requirements the design of an audio interface has also to consider the following issues:

- Filtering of induced signals from long cables (which act like aerials).
- Demodulation of induced signals by non-linear elements.
- Extra ESD protection because of the positioning of the transducers upstream of the protection element.
- Channel resistance, matching of differential channels
- Biasing

6.4.1 IP3047CX6, IP3048CX5, IP4047CX6

IP3047CX6 and IP3048CX5 are C-L-C type EMI-filters and ESD-protection devices for low-ohmic loudspeakers while IP4047CX6 is a C-R-C device. The small size allows for maximum placement flexibility. The very low series resistance enables applications of the connected loudspeaker for not only voice but also hands-free and ringing functionality. IP4047CX6 is footprint compatible with IP3047CX6.

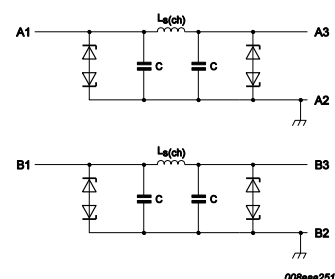


Fig 27. IP3047CX6 Schematic view

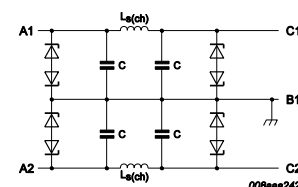


Fig 28. IP3048CX5 Schematic view

	IP3047CX6	IP3048CX5	IP4047CX6
L	= 3 nH	3 nH	-
R	= 0.25 Ω	0.25 Ω	0.95 Ω
C _{line}	= 280 pF (V _{DC} = 0 V)	280 pF (V _{DC} = 0 V)	280 pF (V _{DC} = 0 V)

6.4.2 IP4048CX5 & IP4049CX5

These are two small 5 ball devices used for speaker (IP4048) and microphone (IP4049) applications and provide the entire interface and protection components in the smallest space possible, only 1.38 mm x 0.92 mm. The small size allows for maximum placement flexibility.

	IP4048CX5	IP4049CX5
R	10 Ω	68 Ω
C _{line}	100 pF (V _{DC} = 0 V)	33 pF (V _{DC} = 0 V)

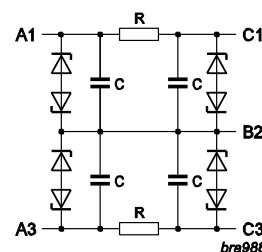


Fig 29. IP4048CX5 & IP4049CX5 Schematic view

6.4.3 IP4055CX6 & IP4355CX6

These devices have been especially developed to provide higher levels of filtering of induced interference in differential microphone channels. The extra ground ball (compared to e.g. IP4049CX5) provides an excellent broadband filtering of up to a minimum of 35 dB in the range 800 MHz- 2.4 GHz. This is particularly useful for CDMA applications where the oscillator multiplex rate falls within the audio band. Alternatively this device is also useful for adding 2 additional data lines to an existing data interface due to the low line capacitance of 35 pF (IP4055CX6) or <20 pF (IP4355CX6).

	IP4055CX6	IP4355CX6
R	470 Ω	470 Ω
C _{line}	35 pF (V _{DC} = 0 V)	< 20 pF (V _{DC} =0 V)

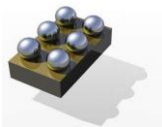
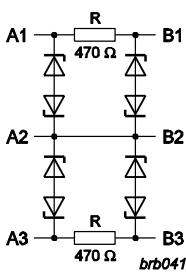


Fig 30. IP4055CX6 & IP4355CX6
Schematic view and depiction of CSP package

7. General Purpose Multi-Channel Interfaces (e.g. Data I/O, LCD)

The typical application areas for these devices are e.g. Data I/Os, LCD-Displays interface or keypad interfaces. Depending on the application area, parameters such as channel resistance and line capacitance are most important. In case where higher clock speeds and very high attenuation of RF-frequencies are required, the NXP C-L-C – coil based EMI-filters and ESD-protections are the devices of choice. Several filters are available in devices with different numbers of channels to enable optimum usage of the PCB area. Nearly all devices withstand ± 15 kV contact ESD-discharges according the IEC61000-4-2 model and above, far exceeding the level 4. CSP packaged products.

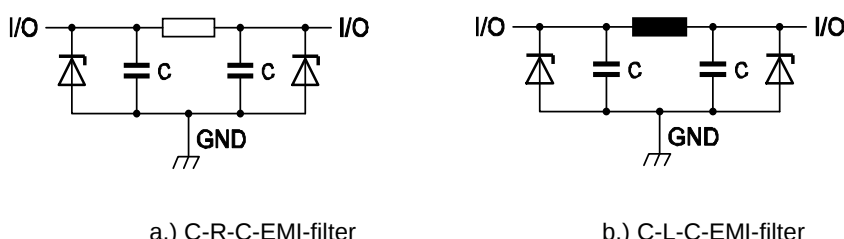


Fig 31. Schematic view of 1 filter channel of a C-R-C (a) and C-L-C (b) based EMI-filter with high-level ESD-protection diodes

Table 13. C-L-C type multi-channel EMI filter and ESD protection devices in CSP

Type name	Channel small signal equivalents			-3dB frequency ^[9] (insertion loss)	Remark
	L_{channel}	R_{channel} (L_{channel})	C_{channel} [10]		
IP3053CXyy ^[11]	35 nH	100 Ω	47 pF	150 MHz	2-, 4-, 6-, 8-channel CLC-type EMI filter/ESD protection, 0.5 mm pitch, same footprint as IP3088CXyy
IP3088CXyy ^[11]	40 nH	18 Ω	65 pF	175 MHz	2-, 4-, 6-, 8-channel CLC-type EMI filter/ESD protection, 0.5 mm pitch, same footprint as IP3053CXyy
IP3348CXyy ^[11]	15 nH	10 Ω	30 pF	350 MHz	2-, 4-, 6-, 8-channel CLC-type EMI filter/ESD protection, 0.4 mm pitch
IP3337CX18	60 nH	125 Ω	25 pF	180 MHz	7-channel CLC-type EMI filter/ESD protection, 0.4 mm pitch, same footprint as IP4337CX18
IP3338CX24	60 nH	125 Ω	25 pF	200 MHz	10-channel CLC-type EMI filter/ESD protection, 0.4 mm pitch, same footprint as IP4338CX24 and IP3328CX24

9. $R_{\text{source}} = R_{\text{load}} = 50 \Omega$

10. Capacitance measured at $V_{\text{DC_bias}} = 0 \text{ V}$

11. IP3xxxCX5: 2-channel, IP3xxxCX10: 4-channel, IP3xxxCX15: 6-channel, IP3xxxCX20: 8-channel

Table 14. C-R-C type multi-channel EMI filter and ESD protection devices in CSP

Type name	Channel small signal equivalents R_{channel} (L_{channel})	C_{channel} [13]	-3dB frequency ^[12] (insertion loss)	Remark
IP4337CX18	70 Ω	25 pF	240 MHz	7-channel CRC -EMI filter/ESD protection, 0.4 mm pitch, same footprint as IP3337CX18
IP4338CX24	70 Ω	25 pF	240 MHz	10-channel CRC -EMI filter/ESD protection, 0.4 mm pitch, same footprint as IP3328CX24 and IP3338CX24
IP4041CX25	200 Ω	50 pF	105 MHz	10-channel CRC -EMI filter/ESD protection device
IP4307CX4	75 Ω	36 pF	155 MHz	1-channel CRC -ESD protection/EMI filter with one common ground
IP4032CX25	80 Ω	40 pF	100 MHz	10-channel CRC -filter, footprint compatible to IP4033CX25
IP4035CX24	1 k Ω	50 pF	22 MHz	10-channel CRC -EMI filter/ESD protection for key pads
IP4040CX25	84 Ω	14 pF	365 MHz	10-channel CRC -EMI filter
IP4053CX15	100 Ω	60 pF	120 MHz	6-channel CRC -EMI filter/ESD protection device
IP4153CX15	100 Ω	30 pF	210 MHz	6-channel CRC -EMI filter/ESD protection, low capacitance version of IP4053CX15
IP4353CX15	100 Ω	45 pF	160 MHz	6-channel CRC -EMI filter/ESD protection, similar to IP4053CX15 and IP5153CX15 but 0.4 mm pitch
IP4054CX15	100 Ω	60 pF	85 MHz	4-channel CRC -EMI filter/ESD protection +4 single protection diodes
IP4088CX20	100 Ω	50 pF	120 MHz	8-channel CRC -EMI filter/ESD protection device

Table 15. Multi-channel EMI filter and ESD protection devices in plastic package

Type name [+]	Channel small signal /equivalents R_{channel} (L_{channel})	C_{channel} ¹⁵	-3dB frequency ^[14] (insertion loss)	Remark
IP3253CZyy	(18 nH)	43 pF	175 MHz	4, 6, 8 -channel CLC -EMI-filter & ESD protection in QFN-type package
IP3254CZyy	(18 nH)	50 pF	145 MHz	4, 6, 8 -channel CLC -EMI-filter & ESD protection in QFN-type package
IP4251CZyy	100 Ω	15 pF	330 MHz	4, 6, 8 -channel CLC -EMI-filter & ESD protection in QFN-type package
IP4252CZyy	40 Ω	18 pF	300 MHz	4, 6, 8 -channel CLC -EMI-filter & ESD protection in QFN-type package
IP4253CZyy	200 Ω	45 pF	110 MHz	4, 6, 8 -channel CLC -EMI-filter & ESD protection in QFN-type package
IP4254CZyy	100 Ω	45 pF	130 MHz	4, 6, 8 -channel CLC -EMI-filter & ESD protection in QFN-type package
PEMI2STD	20 Ω to 100 Ω	15 pF to 45 pF	depends	2 -channel CRC -EMI-filter & ESD protection in a SOT665 package
PEMI1QFN	20 Ω to 100 Ω	15 pF to 45 pF	depends	1-channel CRC -EMI-filter & ESD protection in a SOT883 package
PEMI2QFN	20 Ω to 100 Ω	15 pF to 45 pF	depends	2 -channel CRC -EMI-filter & ESD protection in a SOT886 package
PEMI4QFN	20 Ω to 100 Ω	15 pF to 45 pF	depends	4 -channel CRC -EMI-filter & ESD protection in a SOT665 package
PEMI6QFN	20 Ω to 100 Ω	15 pF to 45 pF	depends	6 -channel CRC -EMI-filter & ESD protection in a SOT665 package
PEMI8QFN	20 Ω to 100 Ω	15 pF to 45 pF	depends	8 -channel CRC -EMI-filter & ESD protection in a SOT665 package

12. $R_{\text{source}} = R_{\text{load}} = 50 \Omega$ 13. Capacitance measured at $V_{\text{DC_bias}} = 0 \text{ V}$ 14. $R_{\text{source}} = R_{\text{load}} = 50 \Omega$ 15. Capacitance measured at $V_{\text{DC_bias}} = 0 \text{ V}$

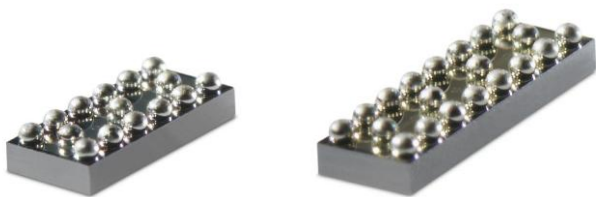


Fig 32. package view of IP3xxxCX15, IP4(0,1,3)53CX15 & IP4054CX15 and IP3xxxCX20 & IP4088CX20

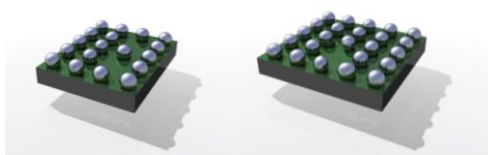


Fig 33. package view of IP4337CX18, IP4338CX24 and IP3337CX18, IP3338CX24

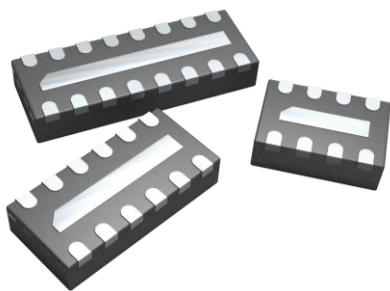


Fig 34. 4-, 6- and 8-channel QFN type plastic package, max height 0.5 mm, IP425xCZyy, PEMI4QFN, PEMI6QFN, PEMI8QFN

7.1 PEMI filter family

The PEMI filter family consists of a matrix of CRC combinations available in 6 different packages with 1, 2, 4, 6 or 8 channels.

The following matrix of 9 different channel capacitances and 5 channel series resistor values is available 6 different plastic packages.

This allows changing the EMI-filter performance in a system at any time during the development process in case the boundary conditions such as driver strength, clock speed, signal shape etc. change unexpected.

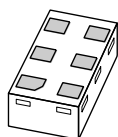
	C _{line}	15	19	23	28	32	36	37	40	41
R _s										
20		Most devices are specified to withstand ESD-discharges up to ±30 kV contact according the IEC61000-4-2 model, far exceeding the specified level 4. Resistor tolerance is < 5% Resistor matching << 1%								
45										
65										
100										
200										

Please refer to Table 15 for package details

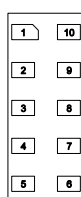
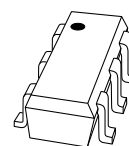
7.2 Multipurpose diodes and diode arrays

To enable customers to protect small interfaces against ESD without specific requirements of EMI filtering, NXP Semiconductors Integrated Discretes offers a variety of “Multi-Purpose Diode Arrays”. These devices offer 2 to 16 integrated ESD protection diodes in different pin count CSPs.

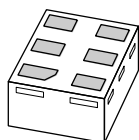
Type name	C_{Channel} 0 V _{DC bias}	No of protection channels	Remark
Plastic package			Devices are typically tested with 1000 pulses of ± 15 kV contact discharges according the IEC61000-4-2 model and far exceed the specified level 4 (8 kV contact discharges)
IP4221CZ6-S	1 pF	4(+1)	4x ultra-low capacitance ESD protection, leadless SOT886 package
IP4221CZ6-XS	1 pF	4(+1)	4x ultra-low capacitance ESD protection, leadless SOT891 package
IP4282CZ6	0.7 pF	2	2x ultra-low capacitance ESD protection, leadless SOT886 package
IP4283CZ10	0.6 pF	4	4x ultra-low capacitance ESD protection, leadless SOT1059 package
IP4284CZ10	0.5 pF	4	4x ultra-low capacitance ESD protection, leadless SOT1059 package
PESD5V0F1BSF	0.5 pF	1	1x ultra low, femto farad-bidirectional ESD protection, leadless SOD962 package
PESD5V0L1BSF	3.5 pF	1	1x low capacitance bidirectional ESD protection in leadless SOD962 package
PESD5V0S1BSF	12 pF	1	1x bidirectional ESD protection in leadless SOD962 package
PESD5V0V1BSF	35 pF	1	1x bidirectional ESD protection in leadless SOD962 package
PRTR5V0U4Y	1 pF	4(+1)	4x ultra-low capacitance ESD protection. in a SOT363 package
PRTR5V0U4D	1 pF	4(+1)	4x ultra-low capacitance ESD protection. in a SOT457 package
PRTR5V0U8S	1 pF	8(+1)	8x ultra-low capacitance ESD protection in TSSOP10 (SOT552) package



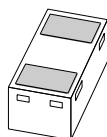
SOT886

SOT1059
bottom view

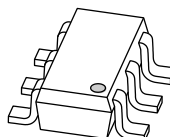
SOT393



SOT891



SOD962



SOT457

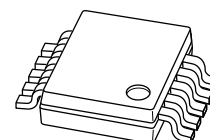
TSSOP10
(SOT552)

Fig 35. Package drawings of multipurpose diodes and diode arrays plastic packages

7.2.1 PESD5V0x1BSF

NXP's smallest state of the art bi-directional ESD-protection diode family PESD5V0x1BSF consists of four different devices offering different line capacitances ranging from 0.5 pF to 35 pF. All with a V_{BR} of 5.0 V.

The ultra small package size of 0.6 x 0.3 mm² (0201 size) combined with 0.3 mm package height make this device ideal for a broad spectrum of interfaces requiring local ESD-protection with a minimum of area consumption.

The minimum

	PESD5V0L1BSF	PESD5V0S1BSF	PESD5V0V1BSF
$C_{line}(V_{DC} = 0 \text{ V})$	3.5 pF	12 pF	35 pF
ESD level, IEC61000-4-2 contact	15 kV	30 kV	30 kV

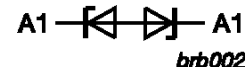


Fig 36. Schematic of PESD5V0x1BSF

7.2.2 IP4302CX2

NXP Semiconductors IP4302CX2 is a very tiny back-to-back diode in a two ball CSP package. When soldered onto standard solder pads on a PCB, the surface tension moves the device to an upright position.

Built using a 0.4 mm pitch, the total device size is 0.7 mm by 0.52 mm only but still provides protection according to the IEC61000-4-2, level 4 standard.

$C_{jo} < 10 \text{ pF}$ ($V_{DC_bias} = 0 \text{ V}$)

$V_{BR} = 14.0 \text{ V}_{min.}$

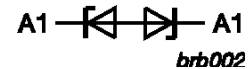


Fig 37. Schematic of IP4302CX2

7.2.3 IP4303CX4

IP4303CX4 is one of the smallest dual back-to-back diode ESD protection Integrated Discrete devices. Built using a 0.4 mm pitch, the total device size is 0.81 mm by 0.81 mm but still provides protection according to the IEC61000-4-2, level 4 standard.

$C_{jo} < 10 \text{ pF}$ ($V_{DC_bias} = 0 \text{ V}$)

$V_{BR} = 14.5 \text{ V}_{typ.}$

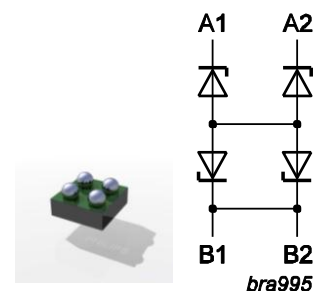


Fig 38. Schematic and CSP package view of IP4303CX4

7.2.4 IP4306CX2

IP4306CX2 is a 2-ball 0.4 mm pitch CSP Schottky power diode. The typical voltage drop at $I_F = 300\text{mA}$ is only 500 mV.

$$C_{jo} = 65 \text{ pF} \quad (V_{DC_bias} = 0 \text{ V})$$

$$V_{BR} = >20 \text{ V}_{typ.}$$



Fig 39. Schematic of IP4306CX2

7.2.5 IP4307CX4

This is a device optimized for analog video signals, where 75Ω ($\pm 5\%$) termination / driver impedance is required. The filter characteristic is designed such, that the maximum insertion loss is $>20 \text{ dB}$ @ 800 MHz and above to filter out unwanted influences from mobile phone frequencies. IP4307CX4 is a 0.4 mm pitch device.

$$C_{Channel} = 36 \text{ pF} \quad (V_{DC_bias} = 0 \text{ V})$$

$$R_{Channel} = 75 \Omega \quad (\pm 5\%)$$

$$V_{BR} = 6 \text{ V} - 10 \text{ V}$$

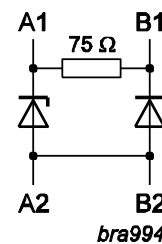
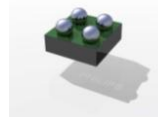


Fig 40. Schematic view of IP4307CX4

7.2.6 IP4042CX5, IP4142CX5, IP4342CX5, IP4043CX5, IP4343CX5

Three general-purpose ESD protection arrays for local protection of devices connected to external interfaces. IP4042CX5 & IP4142CX5 have 4 single diodes in an extremely small package. IP4043CX5 (0.5 mm pitch) and IP4343CX5 (0.4 mm pitch) have 4 pairs of back to back diodes to allow AC- signals through. The back-2-back diode pairs also reduce the capacitance to less than 20 pF.

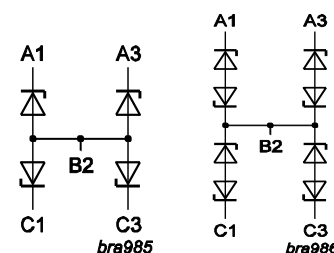


Fig 41. Schematic view of IP40(1)42CX5 & IP4342CX5 & IP40(3)43CX5, IP4343CX5 (right)

	IP4042CX5	IP4142CX5	IP4342CX5	IP4043CX5	IP4343CX5
$V_{BR(typ.)}$	+7.5 V	+6.8 V	+6.8 V	± 16.5 V	± 16.5 V
C_{jo}	< 30 pF	14 pF	14 pF	< 20 pF	< 20 pF
pitch	0.5 mm	0.5 mm	0.5 mm	0.5 mm	0.4 mm

7.2.7 IP4085CX4, IP4385CX4, IP4386CX4, IP4387CX4

IP4085CX4 and IP4385(6,7)CX4 devices are the most robust Integrated Discretes ESD/ TVS diode in a CSP package. Their main purpose is to protect interfaces such as charger interfaces of a PMU from transients and also from wrong polarity connections to the charger interface.

IP4085CX4 offers a surge immunity according IEC61000-4-5 (8/20 μ s) up to 60 A. Its reverse clamping voltage is < 20 V at a current of 1 A.

	V_{BR}	C_{JO}	Pitch [mm]
IP4085CX4	16 V	160 pF	0.5
IP4385CX4	7 V	450 pF	0.4
IP4386CX4	16 V	160 pF	0.4
IP4387CX4	10 V	290 pF	0.4

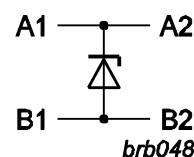


Fig 42. Schematic view of IP4085CX4 & IP4385,6,7CX4

7.2.8 IP4389CX4

The IP4389CX4 is a high performance ESD-protection and TVS diode combined with an additional melting fuse. It is optimized to be used at charger input and battery interface. The diode performance is similar to IP4386CX4 ($V_{BR} = 16$ V, 0.4 mm pitch) with a fuse that allows a 2 A DC current. The fuse melts and burn open at 5 A in less than 100msec.

The maximum series resistance of the fuse and the attached solder balls is less than 50 m Ω .

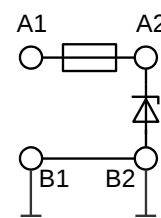


Fig 43. IP4389CX4 schematic view

8. Active Devices

8.1 General

NXP Integrated Discretes offers a wide variety of different integrated active functions. Depending on the customer requirements, such as operating voltage, power consumption requirements and functionality, different technologies can be used.

Available technologies are:

- Bipolar
- CMOS
- High-Voltage CMOS ($U_{BR} < 60\text{ V}$)
- BiMOS

Examples of integrated functional blocks:

- Switches
- Level-Shifters
- Buffer
- Temperature Sensors
- Reference Sources (Voltage and Current)
- Logic
- Voltage and current clamping

In most of the devices built using the technologies listed above, the active functions are combined with passive filters and high-level ESD protection. An ESD protection level compliant to IEC61000-4-2, level 4 standard ($\pm 8\text{ kV}$ contact and $\pm 15\text{ kV}$ air discharge) and above can be reached.

8.2 Examples of active devices

8.2.1 IP4791CZ12

The IP4791CZ12 is designed for mobile HDMI transmitter interface protection and it includes level shifting from a 1.8 V host side to a 5.0 V HDMI specification compliant level for the DDC, CEC, hot plug signal. An additional back drive protection to prevent uncontrolled currents is also integrated. In addition, all signals are protected by high-level ESD diodes. The level shifting function is required to protect the I/Os against over voltages when the transmitter operates at a supply voltage lower than the external devices. All required pull-up and pull-down resistors are integrated.

The IP4791CZ12 is available in a leadless 2.1 x 2.5 x 0.5 mm size plastic package and will also be available in a TSSOP14 package.

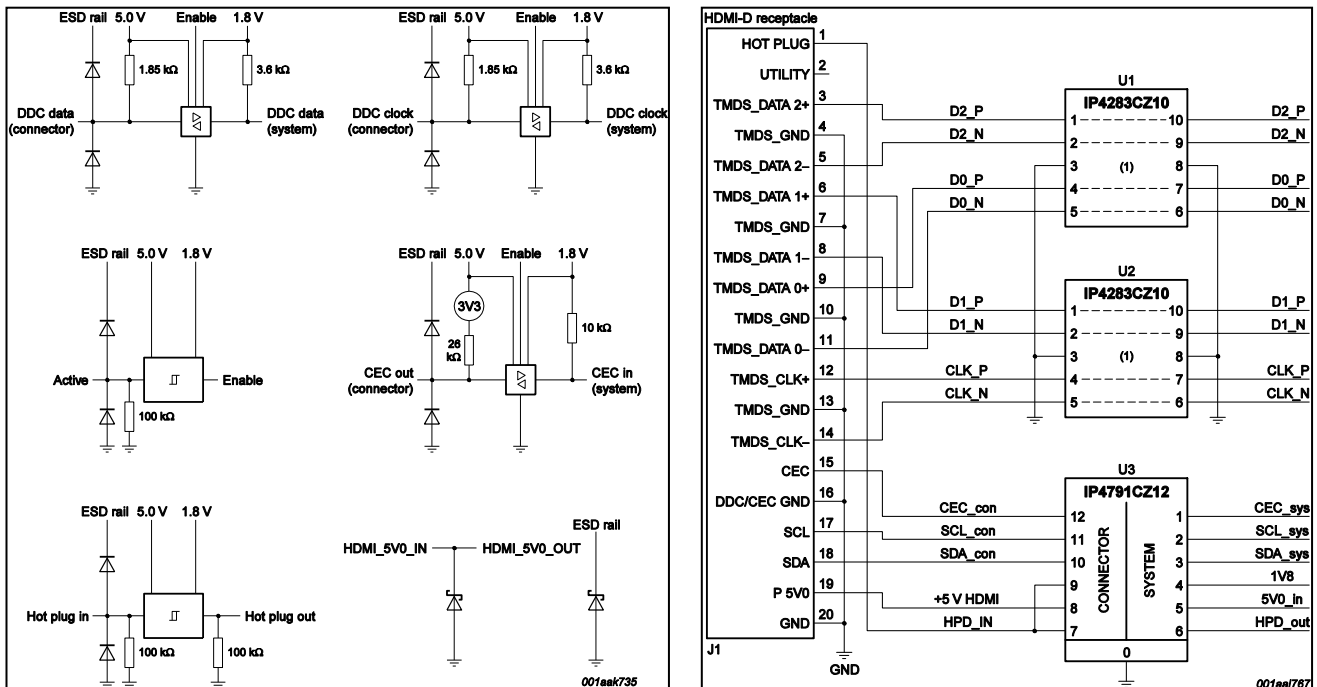


Fig 44. IP4791CZ12 schematic view , showing major building blocks (left) and application schematic including TMDS line ESD-protection (right)

8.2.2 IP4853CX24

IP4853CX24 is a bi-directional high-speed SD-Card (T-Flash) interface that contains a level-shifter, a **Power Supply Unit** (Voltage regulator) delivering the required 2.9 V for the SD-Card and high-level ESD protection and EMI filter in 0.4 mm pitch chip-scale package covering an area of just 4 mm².

The device can handle the SD-Card high-speed requirements, contains a clock feedback channel to support simple read-data synchronization and offers ESD protection up to ± 8 kV contact discharge according the IEC61000-4-2 standard, level 4.

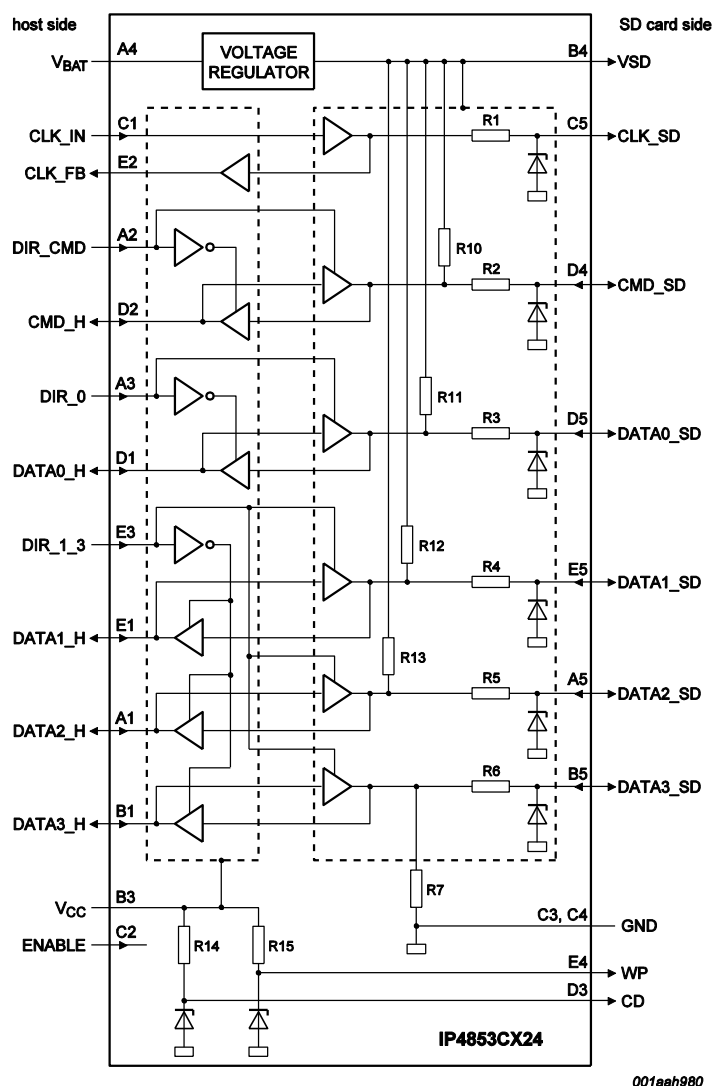


Fig 45. IP4853CX24 schematic view, showing the major building blocks such as drivers, high-level ESD protection, pull-up and filter-resistors

9. Package & Application

Board layout and device placement are very important, especially for EMI filters and ESD protection devices. Data given in this report is based on using a multi layer printed wiring board with ground connections made directly to a ground plane within the PCB using micro vias.

The small footprints of the devices allow them to be placed in the optimum position close to the external connector or device. This provides the maximum filtering of unwanted signals. In devices for specific applications the pinning is chosen to match with the standard connector for that application e.g. SIM card or USB.

9.1 Grounding

For maximum efficiency of filtering and ESD protection the devices should be connected to a ground plane with a micro via. If this is not possible the connection to the ground plane should be as direct as possible to minimize the inductance; the ground should be directly connected to e.g. the USB connector ground. It should not be on a "spur".

9.2 Chip Scale Package

Example of a 5 x 5 *Wafer-Level* Chip Scale Package outline with **0.5 mm** pitch.

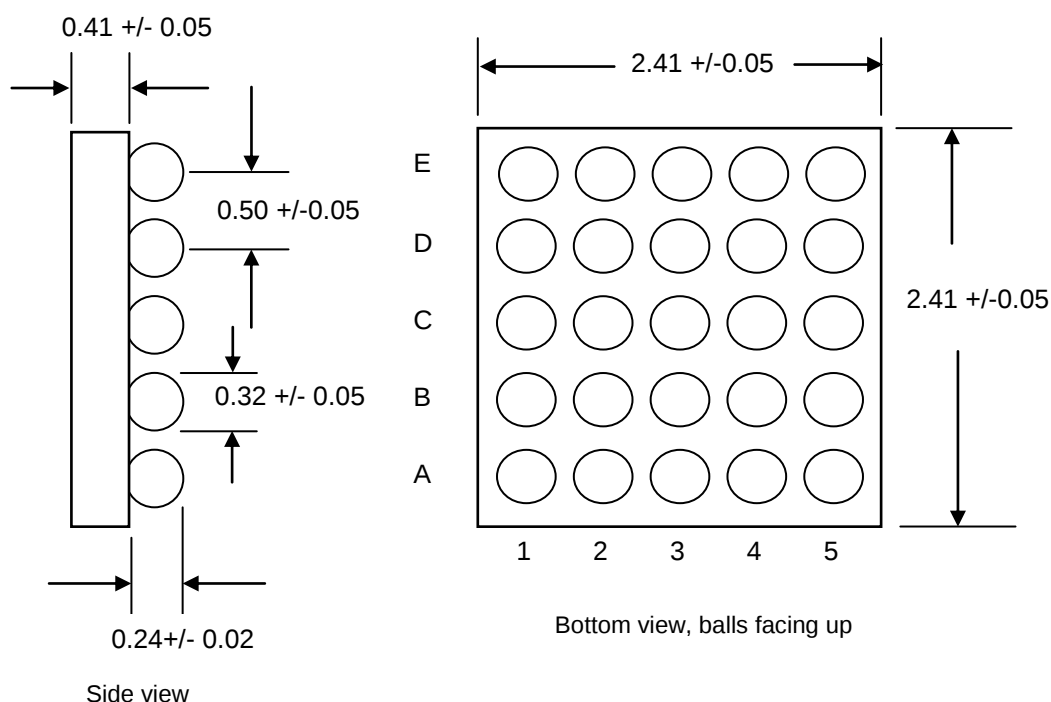


Fig 46. 0.5 mm pitch chip scale package outline

Example of a 5 x 5 *Wafer-Level Chip Scale Package* outline with **0.4 mm** pitch.

New devices sporting 0.4 mm pitch will have a typical height of 0.47 mm (0.5 mm maximum) only.

The former standard height of 0.61 mm typical (0.66 mm maximum) is still used for existing products.

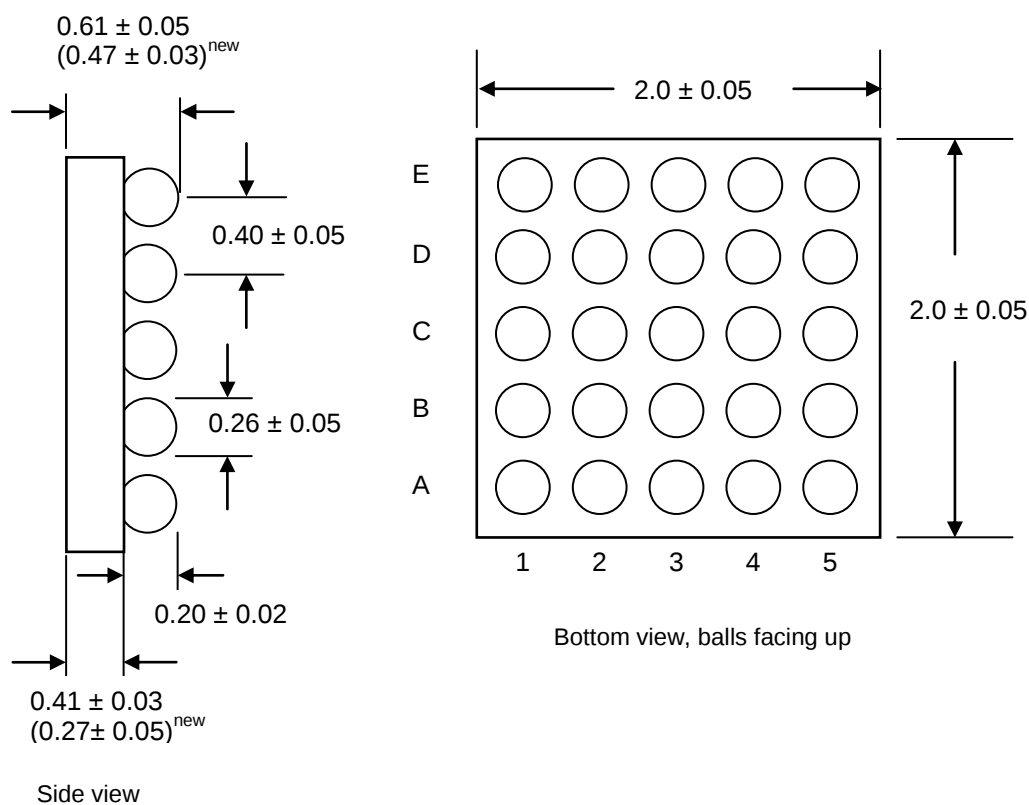


Fig 47. 0.4 mm pitch chip scale package outline

9.2.1 Comparison of *Wafer-Level* CSP with 0.5 mm and 0.4 mm pitch

One possibility to comply with the continuing trend for miniaturization is to reduce the pitch of the solder bumps of the *Wafer-Level* CSP. As long as the integrated components cover less area than given by the size of the footprint, the pitch can be reduced e.g. down to 0.4 mm which reduces the average device size by approximately 20 to 25 %.

A comparison between two electrically identical 10-channel filters, IP4041CX25 and IP4341CX25 is depicted in the drawing below.

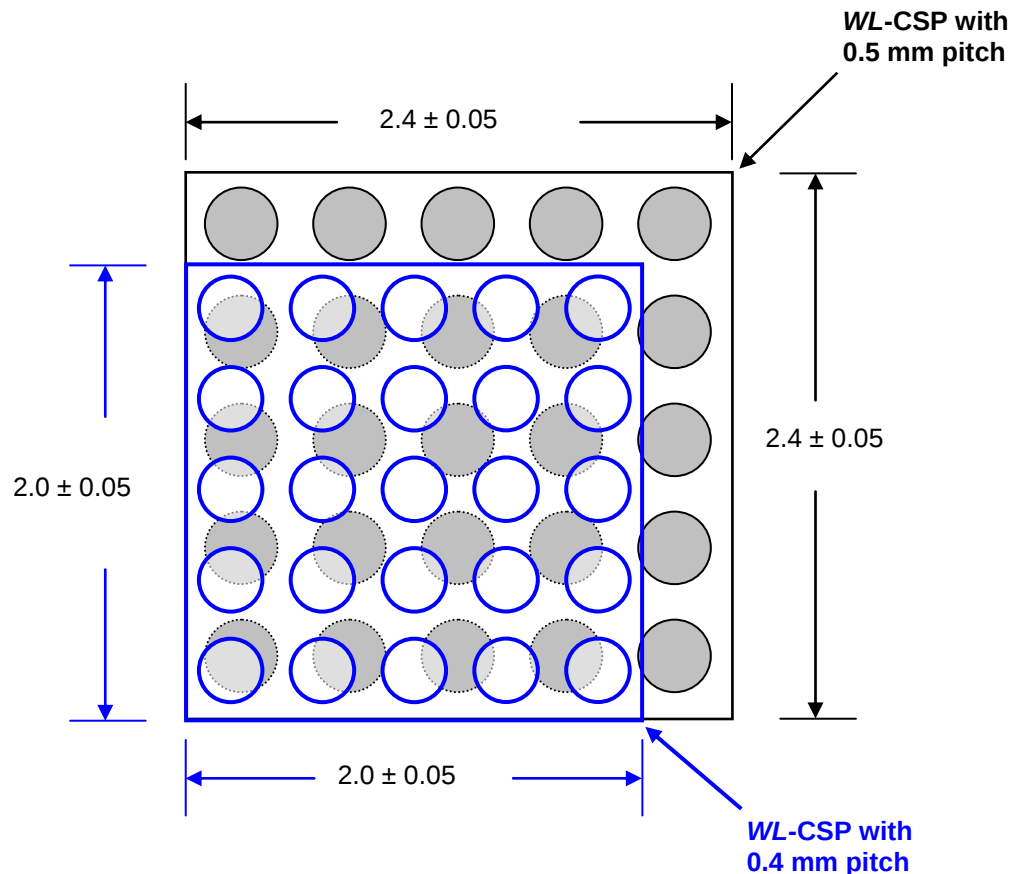


Fig 48. Comparison of a 0.5 mm pitch versus a 0.4 mm pitch chip scale package outline

9.3 Layout Recommendation

- Layout principles for all CSP products in 0.5 mm and 0.4 mm pitch are the same
 - For GND connections, micro vias are placed directly into pads where possible¹⁶ to connect from first layer to second layer
 - Use laser drilled micro vias with a diameter of ~100 μm
 - Cu solder pad (solder lands) diameter 200 μm
 - Place as much as possible additional micro vias for GND connection
 - Devices support straight on bus routing – try to avoid sharp corner in connected traces, especially if these are conducting high-frequency signals (USB2.0, HDMI, DVI etc.)
- Lead free Wafer-Level CSP footprint (reflow soldering) is shown below:

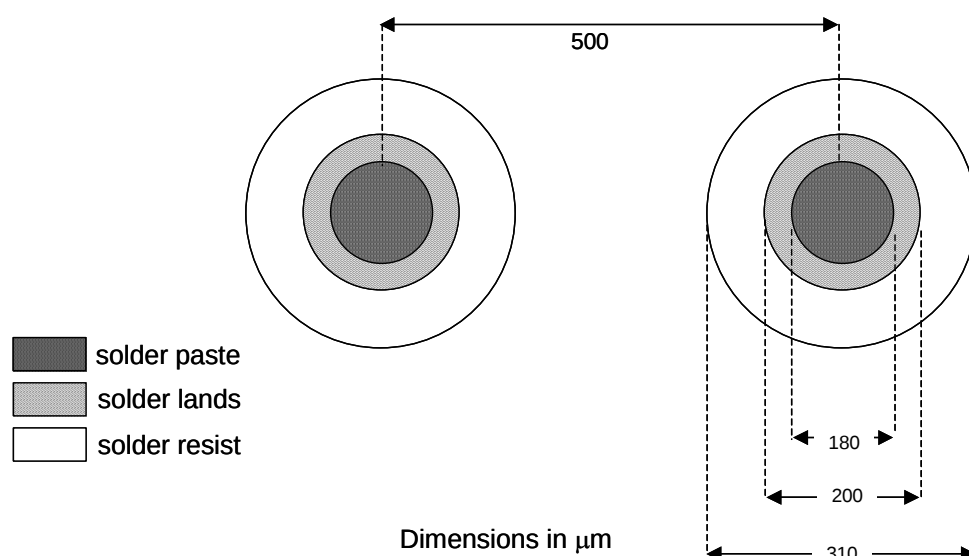


Fig 49. Lead free Wafer-Level CSP footprint (reflow soldering)

9.4 Reliability

Chip Scale packaging has been available for several years. NXP has been supplying these packages since 1998; they have been extensively tested by suppliers and leading customers and by us at our Centre for Manufacturing Technology centre in Eindhoven. These tests have determined the optimum parameters for P.C.B. design, placement and soldering to ensure all applicable reliability tests can be met. It has been proven that all NXP Integrated Discretes devices in *Wafer-Level* CSP up to 6x6 solder balls do not require any under fill. NXP Integrated Discrete products can already be used with lead free soldering processes and most devices are available as lead-content and also as lead-free devices with an identical electrical performance.

¹⁶ If it is not possible to connect the GND layer directly to the device using e.g. micro vias in the pads, try to keep the connecting tracks as short as possible to avoid deterioration of the ESD and/or filter performance

10. Device – application overview table

The table below indicated the major application area for each device shown in this document. Due to their technical parameters, most devices can be used in various other application areas too, even though these are not explicitly stated here.

Underlined device names indicate that data sheets are available on the internet by clicking on the link or under www.nxp.com.
Please contact our sales representatives to receive a copy of non-disclosed data sheets.

Table 16. Device- application overview table

Type name	SD-/MMC-Card	SIM card	USB2.0 USB1.1	Loudspeaker	Microphone	Digital interface (LCD, Camera etc.)	LVDS type interfaces	HDMI	Low speed interfaces (e.g. keypad)	Remark
IP3047CX6				X						
IP3048CX5				X						
IP3053CXyy						X				
IP3088CXyy						X				
IP3253CZyy						X	X			
IP3254CZyy						X	X			
IP3337CX18						X				
IP3338CX24						X				
IP3348CXyy						X				
IP4032CX25 IP4033CX25						X			X	
IP4035CX24									X	
IP4040CX25						X			X	
IP4041CX25						X			X	
IP4042CX5				X	X		X		X	
IP4043CX5				X	X	X	X		X	
IP4047CX6				X						
IP4048CX5				X						
IP4049CX5					X					
IP4051CX11	X									
IP4052CX20	X									
IP4053CX15						X			X	

Type name	SD-/MMC-Card	SIM card	USB2.0 USB1.1	Loudspeaker	Microphone	Digital interface (LCD, Camera etc.)	LVDS type interfaces	HDMI	Low speed interfaces (e.g. keypad)	Remark
IP4054CX15						X			X	
IP4055CX6					X					
IP4056CX8			X							
IP4057CX10			X							
IP4058CX8			X							
IP4059CX5			X							
IP4060CX16	X									
IP4064CX8		X								
IP4065CX11			X							
IP4078CX6			X							
IP4085CX4										Power diode
IP4088CX20						X			X	
IP4142CX5				X	X	X	X		X	
IP4153CX15						X			X	
IP4158CX8			X							
IP4220CZ6	X	X	X			X	X			
IP4221CZ6-S	X	X	X			X	X			
IP4221CZ6-XS	X	X	X			X	X			
IP4251CZyy						X				
IP4252CZyy	X					X				
IP4253CZyy						X			X	
IP4254CZyy						X			X	
IP4256CZyy					X	X			X	
IP4264CZ8-xx		X								
IP4282CZ6	X		X				X	X		
IP4283CZ10	X		X				X	X		
IP4284CZ10	X		X				X	X		

Type name	SD-/MMC-Card	SIM card	USB2.0 USB1.1	Loudspeaker	Microphone	Digital interface (LCD, Camera etc.)	LVDS type interfaces	HDMI	Low speed interfaces (e.g. keypad)	Remark
IP4302CX2	X		X	X	X	X	X		X	
IP4303CX4				X		X	X			
IP4306CX2										Schottky diode
IP4307CX4										CVBS/TV-out
IP4309CX9	X		X			X	X	X		
IP4310CX8								X		
IP4337CX18						X				
IP4338CX24						X				
IP4342CX5				X	X	X	X		X	
IP4343CX5				X	X	X	X		X	
IP4350CX24	X									
IP4351CX11	X									
IP4352CX24	X									
IP4353CX15						X			X	
IP4355CX6					X					
IP4358CX6	X		X							
IP4359CX4			X				X			
IP4363CX10				X	X					
IP4364CX8		X								
IP4365CX11		X	X							
IP4366CX8		X								
IP4368CX9		X	X			X	X			
IP4385CX4										Power diode
IP4386CX4										Power diode
IP4387CX4										Power diode
IP4389CX4										Fuse+Power diode
IP4786CZ12								X		Level shifter

Type name	SD-/MMC-Card	SIM card	USB2.0 USB1.1	Loudspeaker	Microphone	Digital interface (LCD, Camera etc.)	LVDS type interfaces	HDMI	Low speed interfaces (e.g. keypad)	Remark
IP4791CZ12								X		Level shifter
IP4826CX12									X	Active controls
IP4853CX24	X									Levelshifter, LDO, ESD, EMI
IP5002CX8					X					
PESD5V0L1BSF	X	X		X	X	X				
PESD5V0S1BSF		X		X	X	X				
PESD5V0V1BSF	X	X	X	X	X	X				
PRTR5V0U4D	X	X	X			X	X			
PRTR5V0U4Y	X	X	X			X	X			
PEMI2STD	X	X			X	X	X		X	
PEMI1QFN	X	X			X	X	X		X	
PEMI2QFN	X	X			X	X	X		X	
PEMI4QFN	X	X			X	X	X		X	
PEMI6QFN	X				X	X	X		X	
PEMI8QFN	X				X	X	X		X	
PEMI2CSP/RW	X	X			X	X	X		X	
PEMI4CSP/RW	X	X			X	X	X		X	
PEMI6CSP/RW	X				X	X	X		X	
PEMI8CSP/RW	X				X	X	X		X	

Depends on exact R and C value of version

11. Revision history

Revision history

Rev	Date	Description
8.1	20110309	General update
8.0	20100702	General update
7.02	20090921	Minor editorial update
7.01	20090914	Minor editorial update
7.0	20090828	General update
6.1	20081013	Products for USB2.0 added, IP4223CZ6, IP3219
6.0	20080910	New compilation with editorials and new products added
5.6	20070814	Editorial changes, drawings replaced
5.5	20070525	Editorial changes
5.4	20070417	Editorial changes
5.3	20070330	IP4253CZyy and IP4254CZyy added, editorial changes
5.2	20061207	High dense capacitor devices added
5.1	20061127	New compilation with editorials

12. References

12.1 NXP Semiconductors Integrated Discretes:

Please refer to the following online available documents for further details:

- Mobile application guide:
http://www.nxp.com/acrobat_download2/literature/9397/75016882.pdf
- Memory card application note (SD(HC), MMC...):
www.nxp.com/documents/application_note/AN10911.pdf
- SIM card application note:
www.nxp.com/documents/application_note/AN10914.pdf
- Charger interface protection/ USB charging:
www.nxp.com/documents/application_note/AN10910.pdf

Product datasheet that were available at the release date of this document are printed with underline in Table 16.

Please contact your local sales office to obtain access to data sheets that cannot be found on <http://www.nxp.com>

12.2 International Test Standards:

IEC 61000-4-2

MIL-883E Method 3015.7

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