

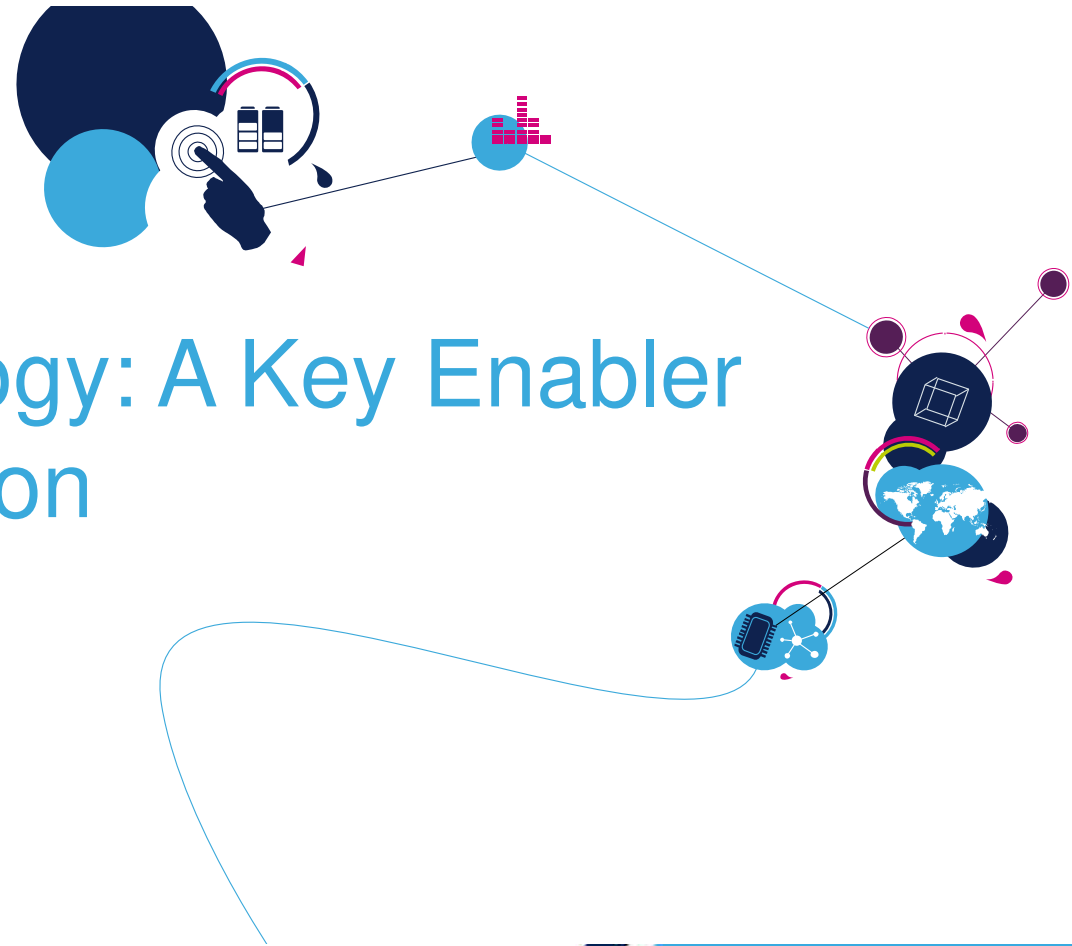
ST IPAD™ Technology: A Key Enabler For IoT Miniaturization

Michael Felato



Technology Tour 2019

Toronto, Canada | May 29



Agenda 2

- ESD Protection for High Speed Applications
- Common Mode & EMI Filters
- RF Integrated Passive Devices
- Target Applications & Product Examples
- Benefits vs Competition
- Q&A

Where is ESD Protection Needed?

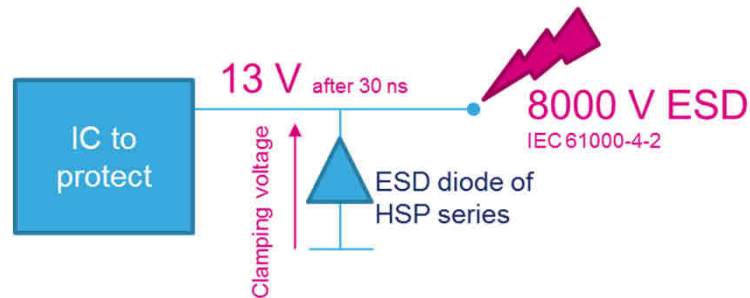
3



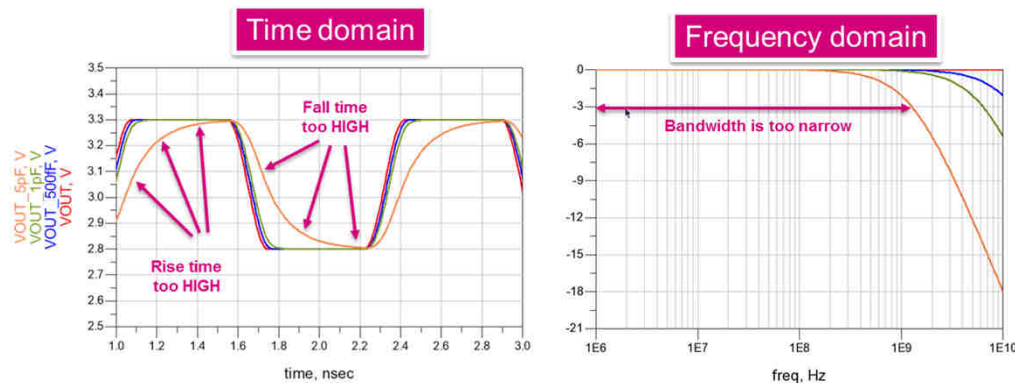
What is Important for ESD Protection?

4

- Clamping Voltage



- Parasitic ESD Capacitance



ESD Selection Criteria

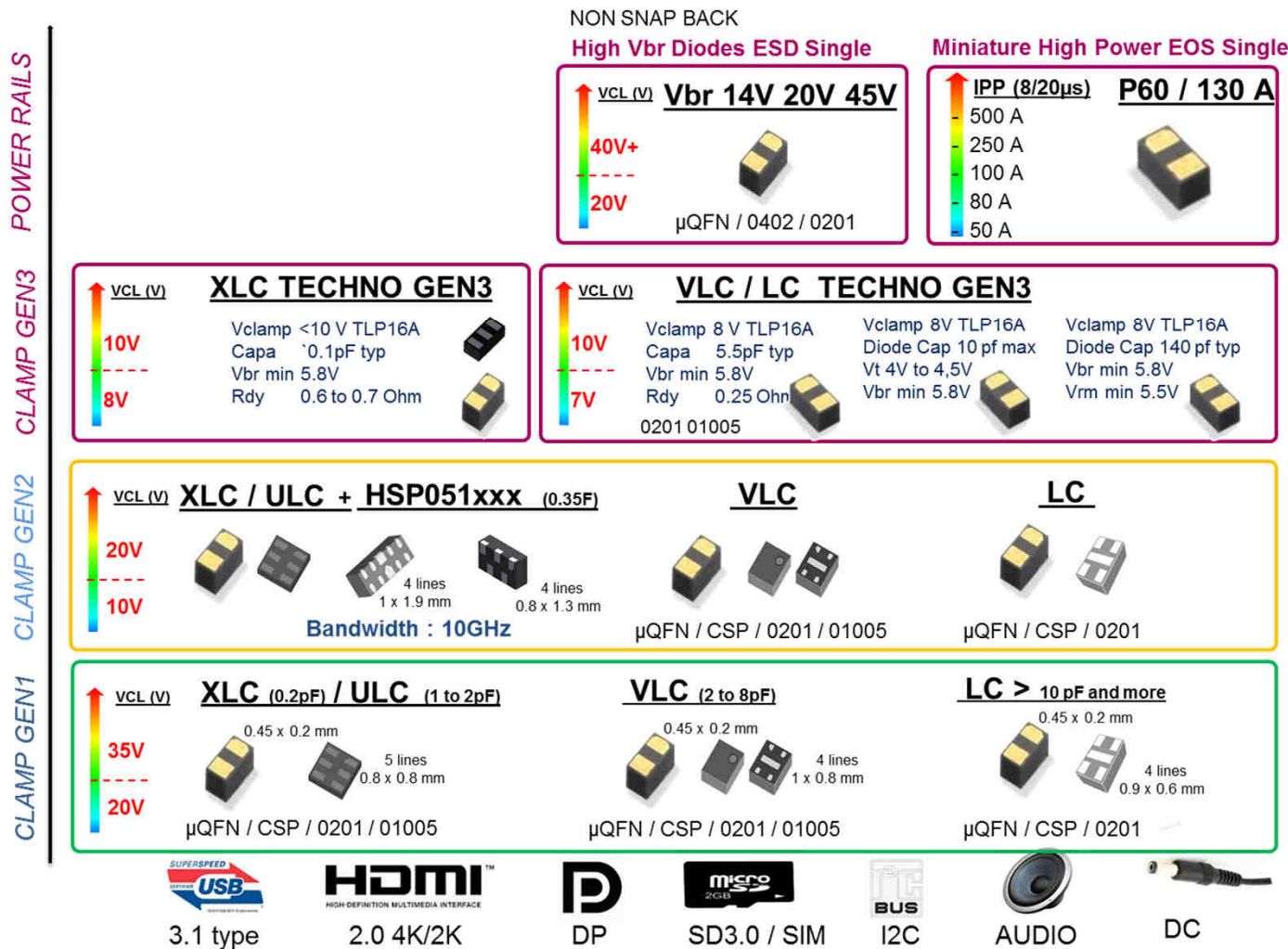
5

- **V_{BR} Breakdown voltage** higher than operating signal
Above this voltage, the ESD protection devices will enter Clamping mode
- **f_c Cut-off frequency** higher than high-speed signal bandwidth defined by the rise time value
- **$C_{I/O \text{ to GND}}$ Low parasitic capacitance** (a consequence of high bandwidth) minimizing the impact on transmission line impedance
- **R_d Dynamic resistance & V_{CL} Clamping voltage** to keep the protected IC safe

Example of HSP051-4M10

Symbol	Test conditions		Min.	Typ.	Max.	Unit
V_{BR}	$I_R = 1 \text{ mA}$		4.5	5.8		V
I_{RM}	$V_{RM} = 3.6 \text{ V}$			10	100	nA
V_{CL}	$I_{PP} = 1 \text{ A}$, 8/20 μs				10	V
V_{CL}	IEC 61000-4-2, +8 kV contact ($I_{PP} = 16 \text{ A}$), measured at 30 ns			13		V
R_d	Dynamic resistance, pulse duration 100 ns	I/O to GND		0.48		Ω
		GND to I/O		0.96		
$C_{I/O - I/O}$	$V_{I/O} = 0 \text{ V}$, F = 200 MHz to 9 GHz			0.2	0.3	pF
$C_{I/O - GND}$	$V_{I/O} = 0 \text{ V}$	F = 200 MHz to 2.5 GHz		0.4	0.55	pF
		F = 2.5 GHz to 9 GHz		0.35	0.45	pF
f_C	-3dB			10		GHz
Z_{diff}	Time domain reflectometry: $t_r = 200 \text{ ps}$ (10 - 90%), $Z_0 = 100 \Omega$		85	100	115	Ω

ESD Protection Lineup 6



Latest ESD Protection products

7

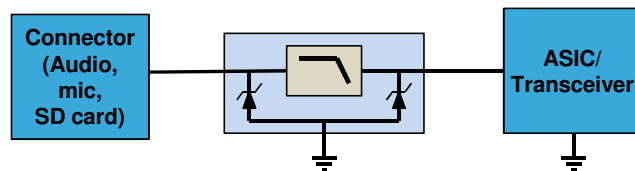
Part number	Description	Uni/Bidirectional	Vrwm	Vtrig (min)	Vcl for TLP 16A	Cline	Package	Status
ESDL031-1BU2	Single line	Bidirectional	<4V		6.35V	10pF typ	0.6 x 0.3mm	Development
ESDZV5-1BF4	Single line	Bidirectional	<4V		7V	6pF typ	0.6 x 0.3mm	MP
ESDZV5-1BV2	Single line	Bidirectional	<4V		7V	5pF typ	0.45 x 0.25mm	MP
HSP053-4M5	4-line	Unidirectional	5V	-	16V	0.15pF typ	1.3 x 0.8mm	MP
ESDZV5H-1BU2	Single line	Bidirectional	5.5V		10V	4pF	0.6 x 0.3mm	MP
ESDZV5HS-1BF4	Single line	Bidirectional	<6.5V	10V	10.5V	4pF	0.6 x 0.3mm	MP
ESDZV141-1BF5	Single line	Bidirectional	<14V	18V	26V	1.5pF typ	0.45 x 0.25mm	Sampling
ESDZV18-1BF4	Single line	Bidirectional	<17V		23V	3pF typ	0.6 x 0.3mm	MP
ESDAXLC18-1BF4	Single line	Bidirectional	<19V	-	37V	0.45pF typ	0.6 x 0.3mm	MP
ESDALC20-1BF4	Single line	Bidirectional	<20V	-	37V	10.5pF typ	0.6 x 0.3mm	MP
ESDAULC45-1BF4	Single line	Bidirectional	40V	-	100V	1pF typ	0.6 x 0.3mm	MP

Common Mode and EMI Filters

8

EMIF series

ElectroMagnetic Interference Filter



Application:

- Audio: microphone, headset, speaker
- Display and camera (parallel interface)
- Keypad and data lines
- SIM card / SD card

Function:

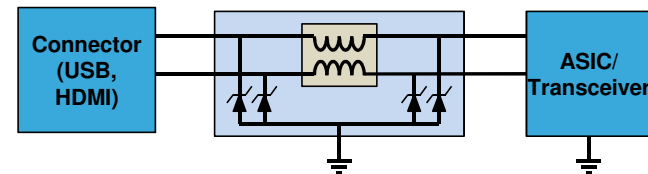
- Rejection of EMI from WiFi/cellular signals on I/O lines
- ESD Protection on I/O lines

Package:

- single line or multi lines
- plastic package/QFN or CSP flipchip.

ECMF series

ESD protected Common Mode Filter



Application / function :

- USB
- HDMI
- MIPI D-PHY, M-PHY
- MHL

Function:

- Rejection of Common mode noise from WiFi/cellular signals on differential I/O lines
- ESD Protection on I/O lines

Package:

- single line or multi lines
- plastic package/QFN or CSP flipchip.



ESD and Common Mode Filters for USB Type C

9

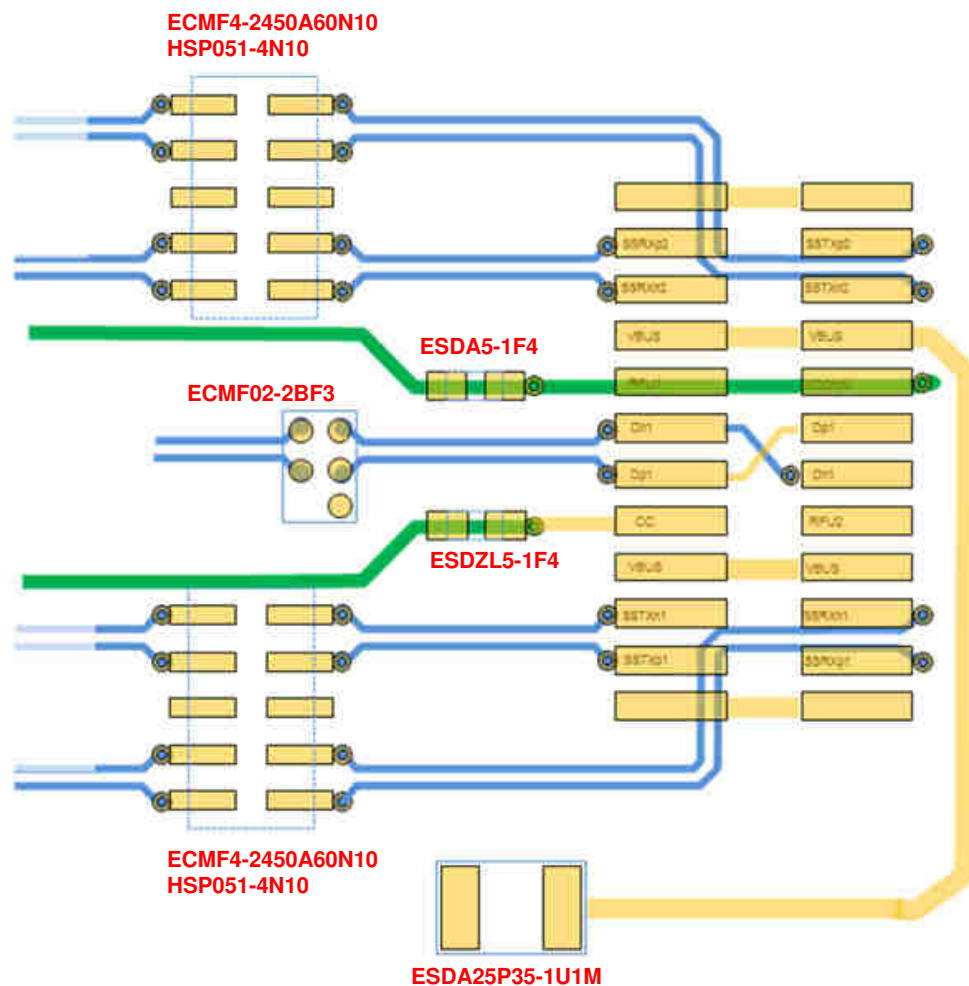
P/N	APPLICATION	COMMON MODE REJECTION		COMMENT
ECMF4-20A42N10	- Smartphone - Tablet	 GPS	-23 dB	Large bandwidth of 5GHz
		 	-25 dB	
ECMF4-2450A60N10	- Tablet - Streaming Stick	 	-40dB	Deep rejection of -40dB at 2.4Ghz
		 	-35dB	
	- Tablet - Streaming Stick	 5Ghz	-25dB	- Complete solution to filter both Wifi frequencies 400µm pitch
			-35 dB	
ECMF02-2HSMX6	- Smartphone - STB / Sticks - Game Console	 	-20 dB	- Complete solution to filter from 0.7Ghz to 5 GHz 500µm pitch package size compatible with consumer applications
		 5Ghz	-20 dB	
			-20 dB from 0.7GHz to 2.4GHz	
			-35 dB	
ECMF04-4HSWM10	- STB / Sticks - Game Console	 	-25dB	- Large bandwidth of 4.2 GHz 500µm pitch package size compatible with consumer applications
			-35 dB	



Typical BOM

ESD and Common Mode Filters for USB Type C

10



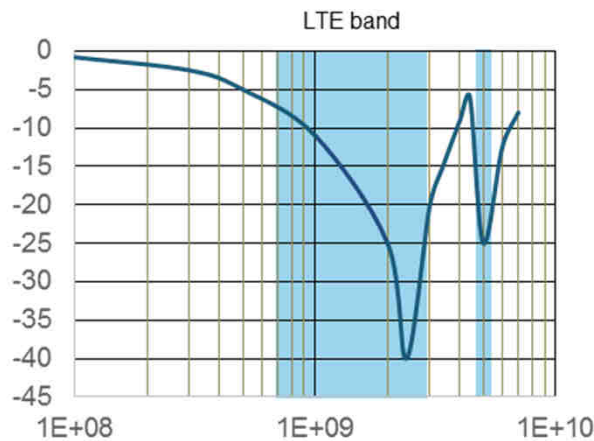


ESD and Common Mode Filters

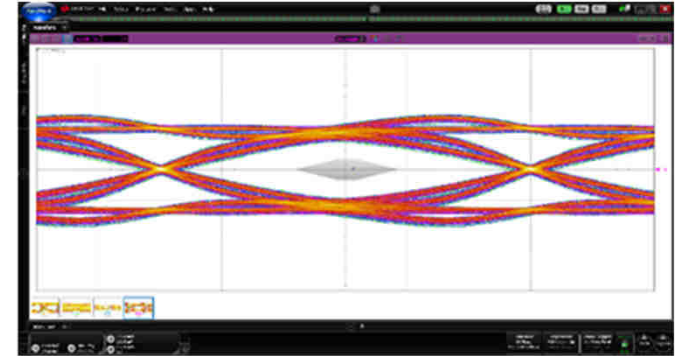
for USB Type C

11

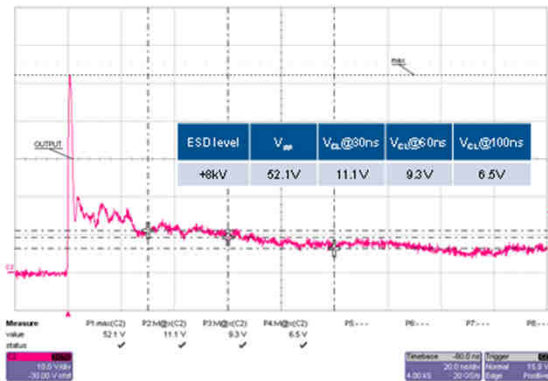
Scc21



USB3.1
10Gbps



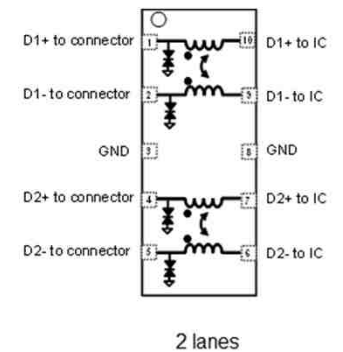
8kV ESD
response



QFN 10L



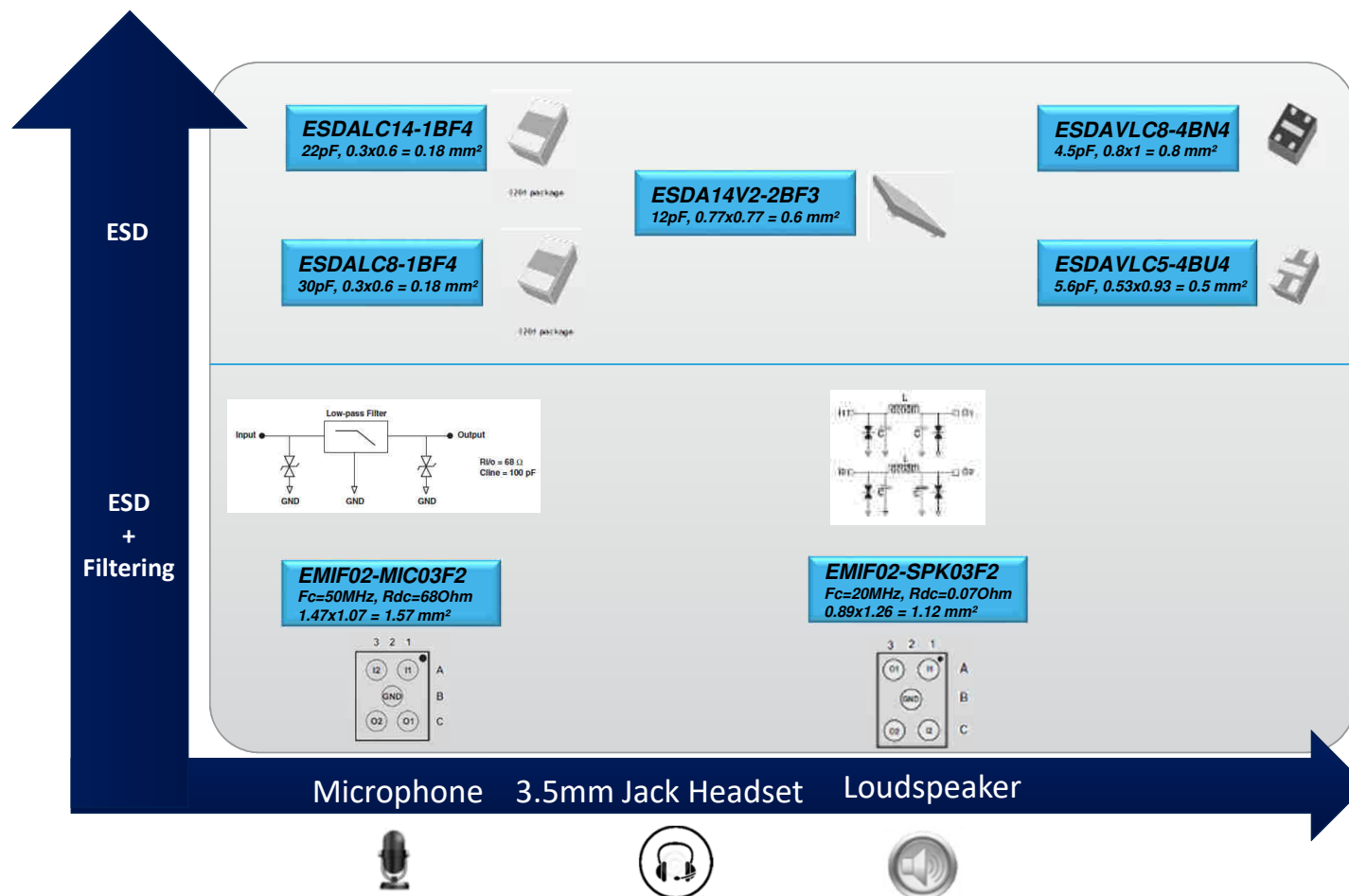
2.2mm x 1.35mm



EMI Filters

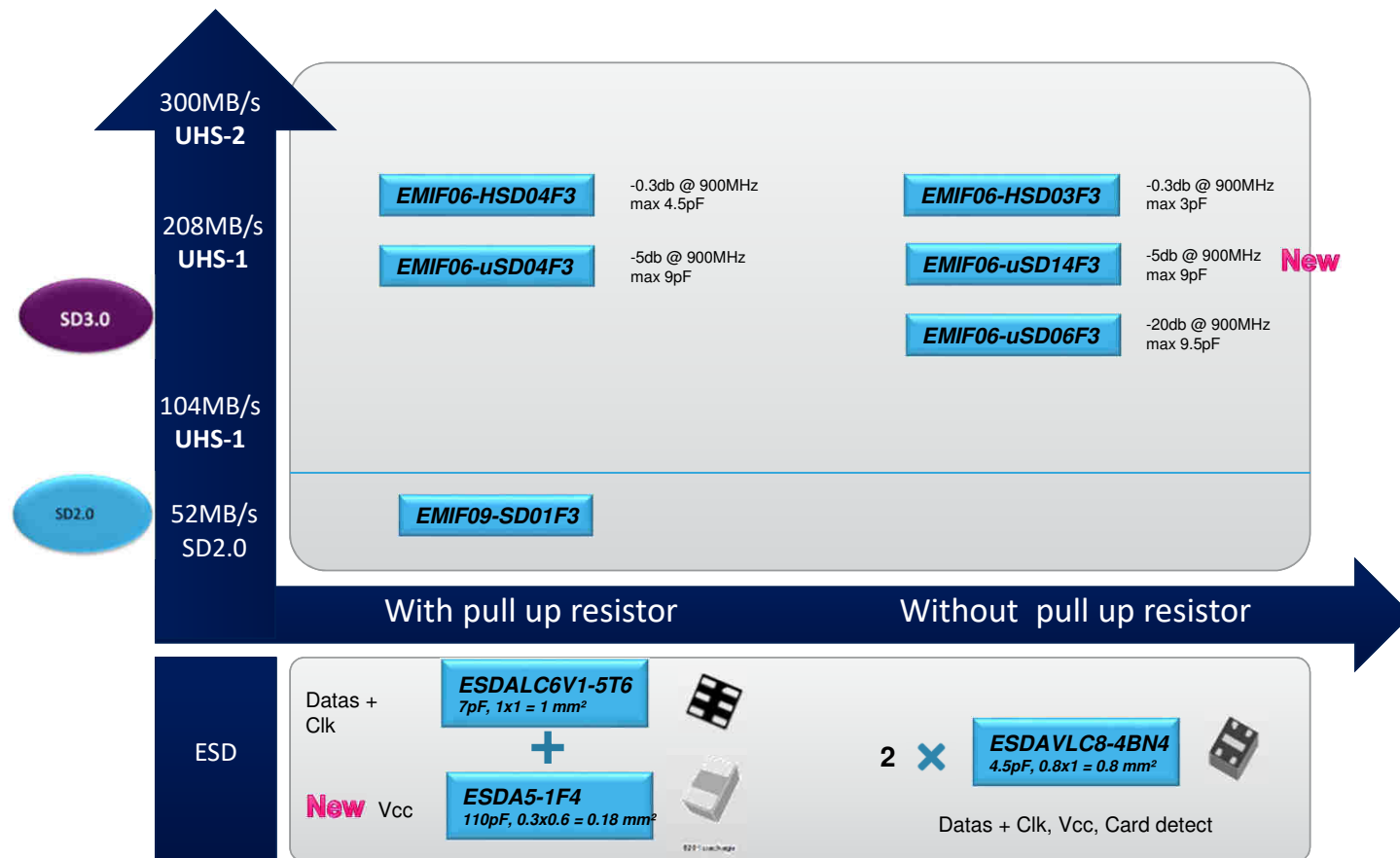
Audio

12



EMI Filters uSD card

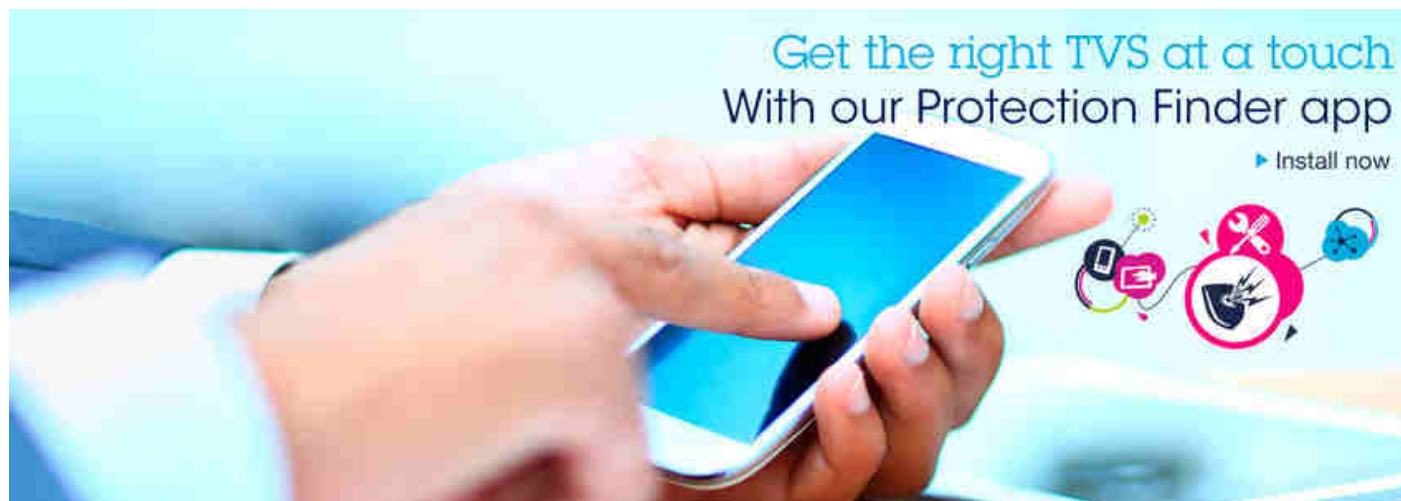
13





ST Protection Finder

14



豌豆荚
Wandoujia

SnapPea



下载 APK 文件





ST Protection Finder in 4 touches

15

1
OPEN
application

2
SELECT
parameter

3
CHOOSE
product

4
GET
datasheet

ST Protection Finder (1.0.1 ML off)

PART NUMBER SEARCH

ESD Protection
(IEC61000-4-2)

TVS clamping diodes
(10/1000 μ s and 8/20 μ s)

Current-Limiting Termination
for Programmable Logic Controller

MY FAVORITES

ST Parametric Search

ESD Protection
(IEC61000-4-2)

Stand off Voltage

100 mV to 36 V

100 mV 36 V

Breakdown voltage

700 mV to 39 V

700 mV 39 V

Line Capacitance I/O-GND

300 fF to 350 pF

300 fF 350 pF

Number of protected Line

ST 20/30 Product

DVIULC6-4SC6Y Active

ESD Protection

V_{RM} Typ	V_{BR} Min	C_{LINE} Typ
5 V	6 V	0.85 pF

Nb of Line 4 Directionality UNI-DIRECTIONAL

Package SOT23-6L

EMIF02-02OABRY Active

ESD Protection

V_{RM} Typ	V_{BR} Min	C_{LINE} Typ
3 V	6 V	1.2 pF

Nb of Line 2 Directionality BI-DIRECTIONAL

Package QFN-6L WF

EMIF02-02OABRY

Active

ESD Protection

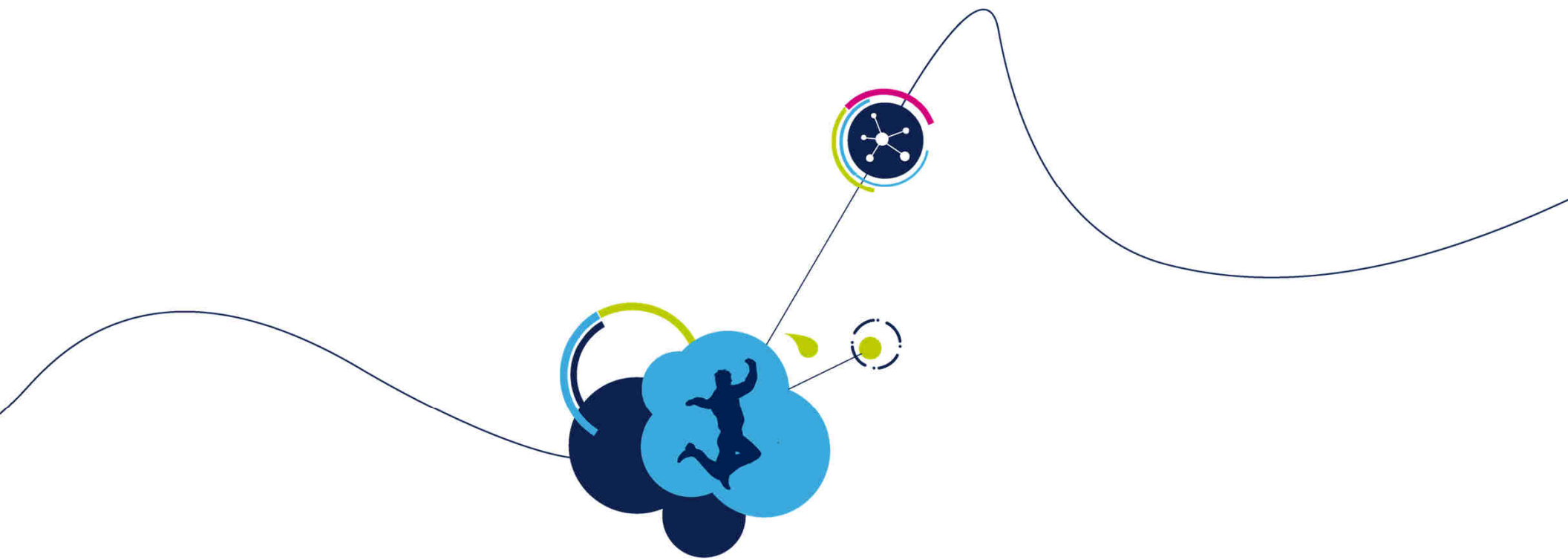
Key Features

- Attenuation profile compliant with BroadR Reach™ requirements from -40 °C to 125 °C
- Return loss (S_{dd11}) at 60 MHz
 - 20 dB
- Components matching
 - 1% (between line 1 and 2)
- Package
 - Dimensions: 3.0 x 3.0 mm
 - Pitch: 1.1 μ m
 - Wettable flank QFN
- AEC-Q101 compliant

Technical Documentation

Data Sheet

Description	Version	Size
Data Sheet	1.0	1115 KB

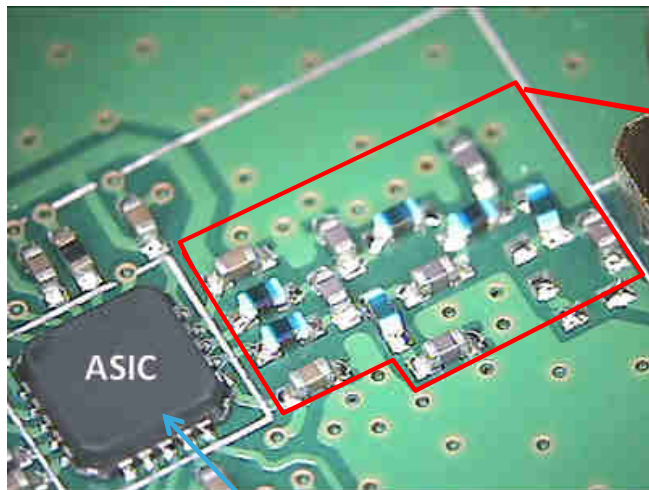


RF Integrated Passive Devices

What is IPD?

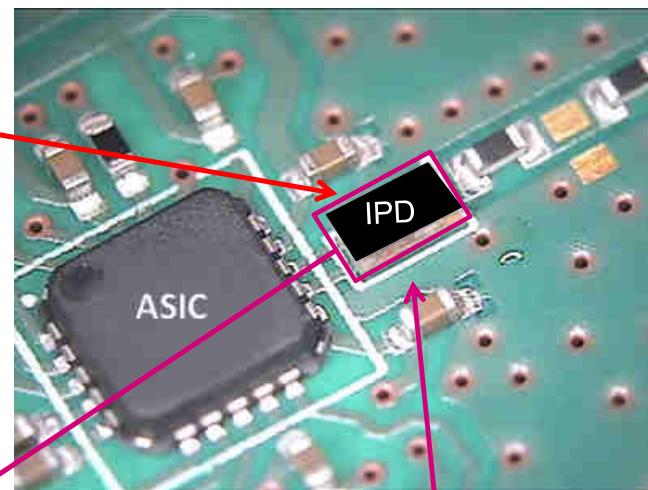
18

THIS IS NOT IPD



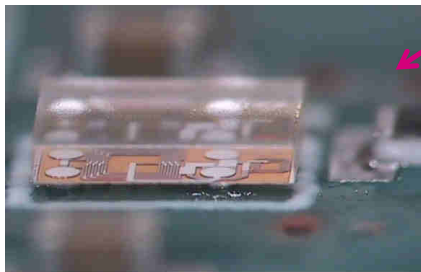
Application Specific Integrated Circuits

THIS IS IPD



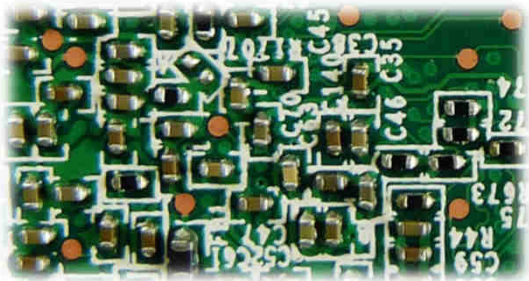
RF Integrated Passive Devices

- Design **simplification**
- **Performance** optimization
- System **integration**
- **Reliability** improvement
- BOM **reduction**
- Successful **development** story



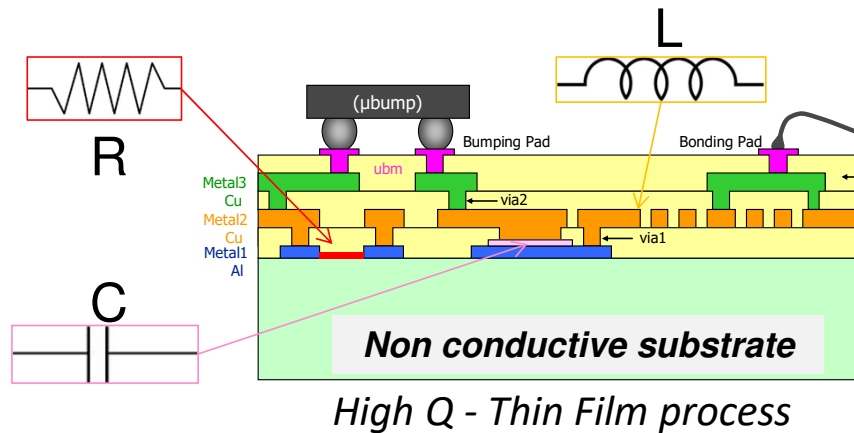
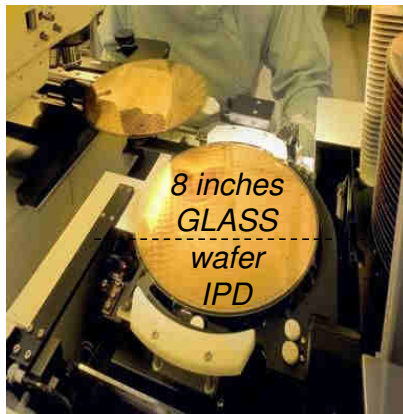
IPD Technology

19



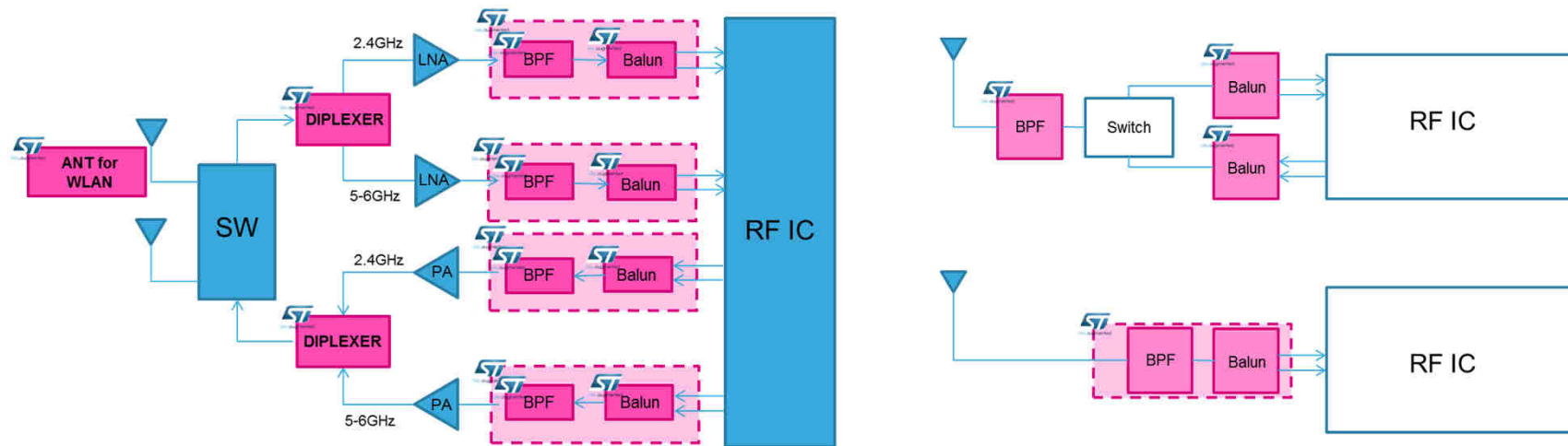
Size $\div 10$ @ lower cost

IPD for RF



Integrate multiple RF functions on a single die

IPD for Wireless Connectivity 20

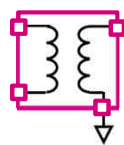


WHAT WE DO

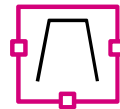
ANTENNA



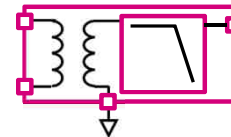
BALUN



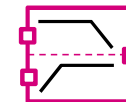
FILTER



BALUN+FILTER



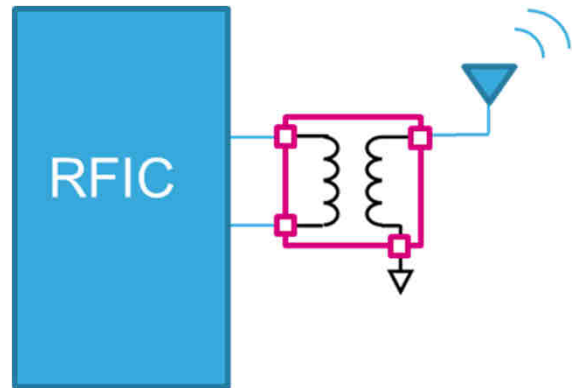
DIPLEXER





Why Use a Balun?

21



- Baluns transform an differential input to a single ended output and vice versa
- Typically between RF Transceiver and antenna
- Required at the output of most Bluetooth and SubG transceivers
- ST balun with integrated filter
- Baluns help to
 - improve RF signal integrity
 - provide optimal output power
 - improve overall battery life
- Some SoC solutions may not require external Balun

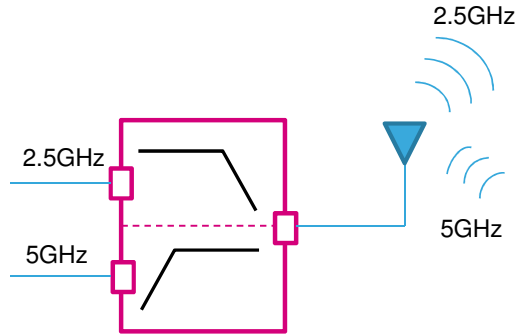
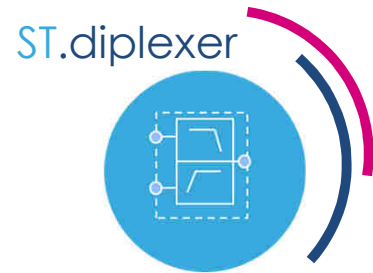


Balun of ST ICs

22

RF IC supplier	RF IC	Matched Balun	Frequency (MHz)	Integrated filter	Size	Package
STMicroelectronics 	SPIRIT 1	BALF-SPI-01D3	868-915	Yes	1.4mm x 2.0 mm	WLCSP
	SPIRIT 1	BALF-SPI-02D3	433	Yes	1.4mm x 2.0 mm	WLCSP
	S2-LP NEW !	BALF-SPI2-01D3	868-915	Yes	2.1mm x 1.55 mm	WLCSP
	S2-LP	BALF-SPI2-02D3(**)	433	Yes	2.1mm x 1.55 mm	WLCSP
	STLC2690	BALF-2690-02D3	2400	Yes	1.64 mm x 0.94 mm	WLCSP
	BLUENRG BLUENRG-MS BLUENRG-1 BLUENRG-2 NEW !	BALF-NRG-01D3 (<i>NRND</i>) BALF-NRG-02D3 BALF-NRG-02Q6Y BALF-NRG-02J5	2400	Yes	1.4 mm x 0.85 mm	WLCSP

RF IC supplier	Matched Balun	Frequency (MHz)	Integrated filter	Size	Package
Atmel	BAL-WILC10-01D3	2400	No	0.95mm x 0.95mm	WLCSP
	BALF-ATM-01E3	2400	Yes	2.00 mm x 1.25 mm	WLCSP
Texas Instrument	BAL-CC1101-01D3	868-915	No	2.0mm x 1.0mm	WLCSP
	BALF-112X-01D3	868-915	Yes	1.95mm x 1.87mm	WLCSP
	BALF-112X-02D3	433	Yes	1.95mm x 1.87mm	WLCSP
	BAL-CC25-01D3	2400	No	0.9mm x 0.9mm	WLCSP
	BALF-CC25-02D3	2400	Yes	0.9mm x 0.9mm	WLCSP
	BALF-CC26-05D3	2400	Yes	0.9mm x 0.9mm	WLCSP
Nordic Semi	BAL-NRF01D3	2400	Yes	1.5mm x 1.0mm	WLCSP
	BALF-NRF01J5(*)	2400	Yes	1.4mm x 0.85mm (height < 350µm)	Thin WLCSP
	BAL-NRF02D3	2400	Yes	1.4mm x 0.9mm	WLCSP
	BALF-NRF01E3	2400	Yes	1.5mm x 1.0mm	LGA
	BALF-NRF01D3	2400	Yes	1.5mm x 1.0mm	WLCSP



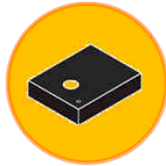
Why Use a Diplexer?

23

- Diplexer used to split RF signal into two frequencies
- Combination of two filters
- Typical Applications:
 - System supports WiFi 2.5/5GHz + BLE
 - System supports WiFi 2.5/5GHz
 - System supports GPS/GLONASS + BLE or WiFi
 - Systems supporting multiple cellular bands
- ST Diplexers can integrate additional filtering for specific band rejection
- Becomes a triplexer when there is need to separate one signal to 3 freq

WLAN 2G/5G Diplexer

24



DIP2450-01D3

1 LOW INSERTION LOSS

▶ BELOW 0.5dB

2 ISOLATION

▶ 15dB Out of Band Rejection / Isolation between Bands

3 HARMONICS FILTERING

▶ 15dB attenuation @ 2nd & 3rd harmonics

4 ESD PROTECTION

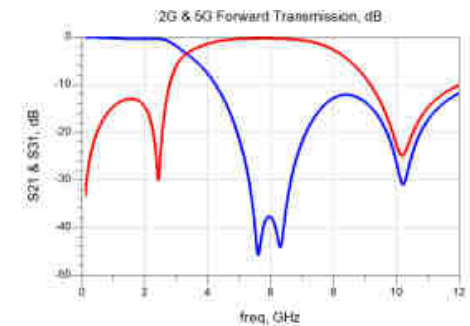
▶ Integrated ESD protection – 15kV

5 SMALL

▶ Smaller footprint than LTCC equivalent

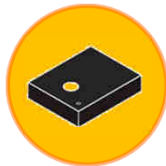


1.1 x 1.25 mm²



5GHz Band Pass Filter

25



BPF50-03D3

1 LOW INSERTION LOSS

▶ ~ 1.0 dB

2 REJECTION on cellular bands

▶ >35dB Rejection [700 - 2699] MHz

3 HARMONICS FILTERING

▶ >25dB Rejection [10000-12000] MHz

4 ESD PROTECTION

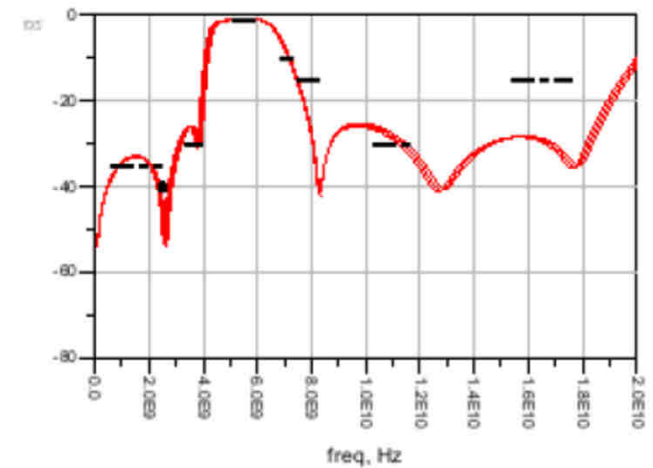
▶ Integrated ESD protection – 2kV

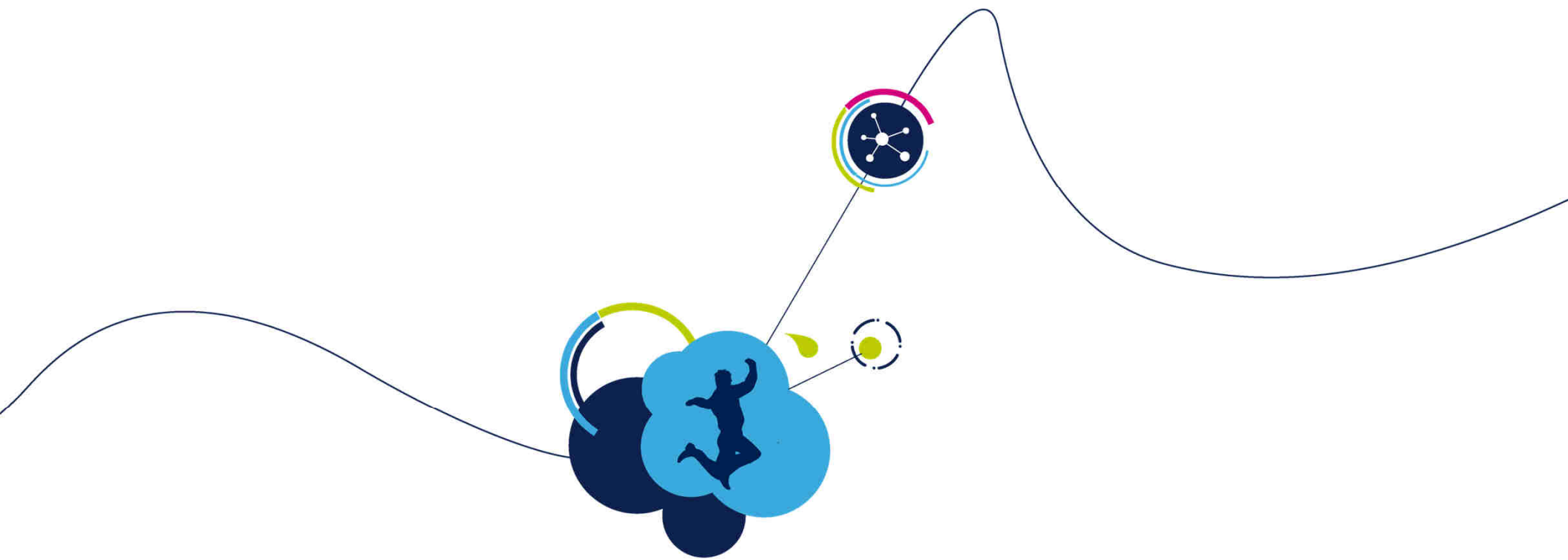
5 SMALL

▶ Smaller footprint than LTCC equivalent
0.95x0.90mm



0.95 x 0.90mm²





Benefits of RF Integrated Passives

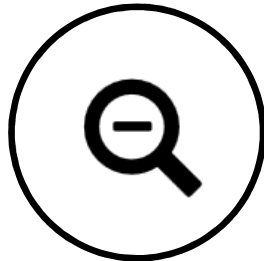
Benefits of RF Integrated Passives

Criteria			
Performance	Excellent	Excellent	Good
BOM & Cost	Excellent	Excellent	Good
Robustness to drop	Excellent	Medium	Good
Size	Excellent	Good	Bad
Implementation simplification	Excellent	Excellent	Complex
Flexibility	Good	Good	Excellent
Temperature variation	Excellent	Good	Bad
Embedding capability	Excellent	Medium	Good

**COMPETITIVE
SCORE**

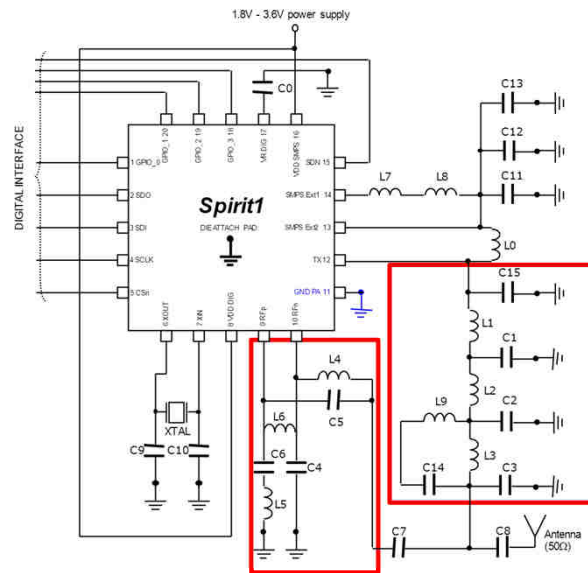


SMALLER

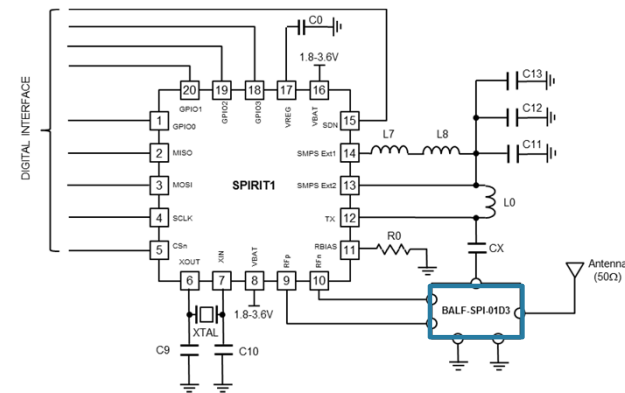
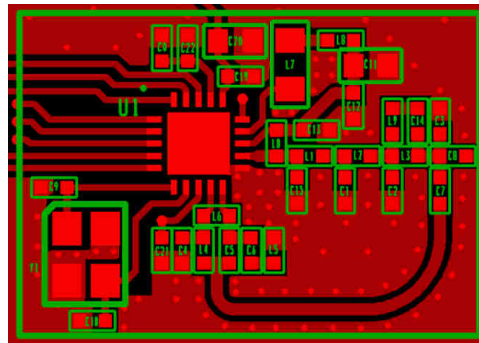


Benefits of RF Integrated Passives

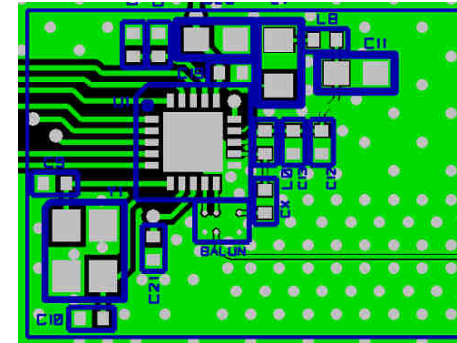
28



37 mm²



2.8 mm²



15 x smaller

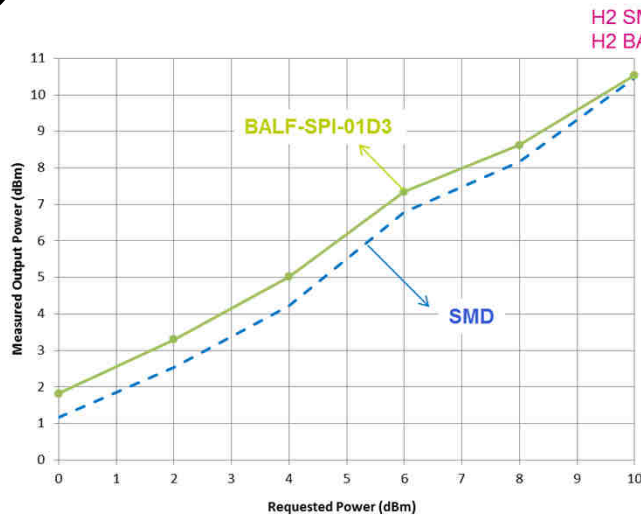
Benefits of RF Integrated Passives

29

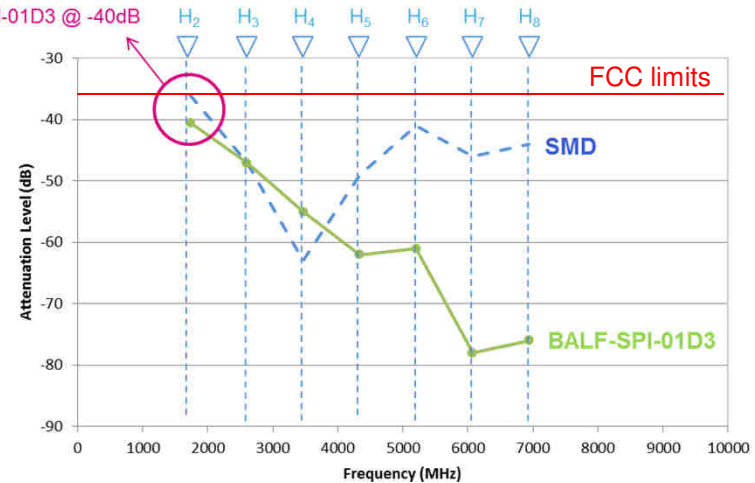
BETTER PERFORMANCE



BETTER PERFORMANCES on HARMONICS & Pout



+1dBm power



+4dB H2 filtering

- ESD Protection & Filter products targeting USB Type C, HDMI, SD card, Audio etc.
- RF Integrated Passive Devices (RF IPD) targeting wireless connectivity applications
- RF IPD Product-line: Baluns, Filters, Diplexers etc.
- Clear benefits over competition: Smaller, Better Performance, Better cost optimization

For Further Information

29

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