Wireless Communication

Application Guide 2023

www.infineon.com/rf

About this application guide

This application guide describes recent trends in wireless communication applications and includes suggestions for designing RF frontends with our latest devices. The following subjects are covered within this guide:

1. Overview of the Infineon Technologies' RF product portfolio
2. RF devices for cellular communication
3. RF devices for Global Navigation Satellite Systems (GNSS), wireless LAN routers
4. RF devices for wearables, wireless broadcasting systems FM radio, SDARs and mobile TVs
5. RF interfaces in wireless communication devices

Infineon Technologies – a leading company in RF and Sensors

Infineon Technologies has more than 60 years of experience in developing RF products for numerous applications. The Radio Frequency & Sensors (RFS) business unit offers solutions for smart phones, mobile devices, cellular infrastructure, sensing, radar & 3D imaging applications. They shape the way we live and work. Please visit the home pages ofs "RF & Wireless Control", "Sensor" or "ESD and Surge Protection" to learn more.

In this application guide, we have summarized the major available application circuits and their performance for the key application area wireless communication. **For your convenience, the Internet product pages and application notes can be reached by simply clicking on any device and application notes marked with ocean color in the tables.**

Table of content

1 Infineon's RF and protection devices for wireless communication systems

Wireless communication devices represent the largest worldwide market in terms of both volume and number of applications on a single platform. For example, wireless communication functions in a smart phone include a cellular modem, Wireless Local Area Network (WLAN), Bluetooth, Global Navigation Satellite System (GNSS), Ultra-Wide Band (UWB), Near-Field Communication (NFC) and entertainment systems such as FM radio.

Infineon addresses requirements for high-performance mobile communication devices and wireless systems by offering RF MMIC LNAs, RF CMOS switches, antenna-tuning devices, RF couplers, RF transistors and diodes. We also offer a comprehensive portfolio for Electro-Static Discharge (ESD)/Electromagnetic Interference (EMI) protection. Figure 1 and Figure 2 illustrate the available product portfolio for a smart phone RF Frontend.

In addition to the above listed components, Infineon also provides XENSIV™ MEMS microphones for mobile devices.

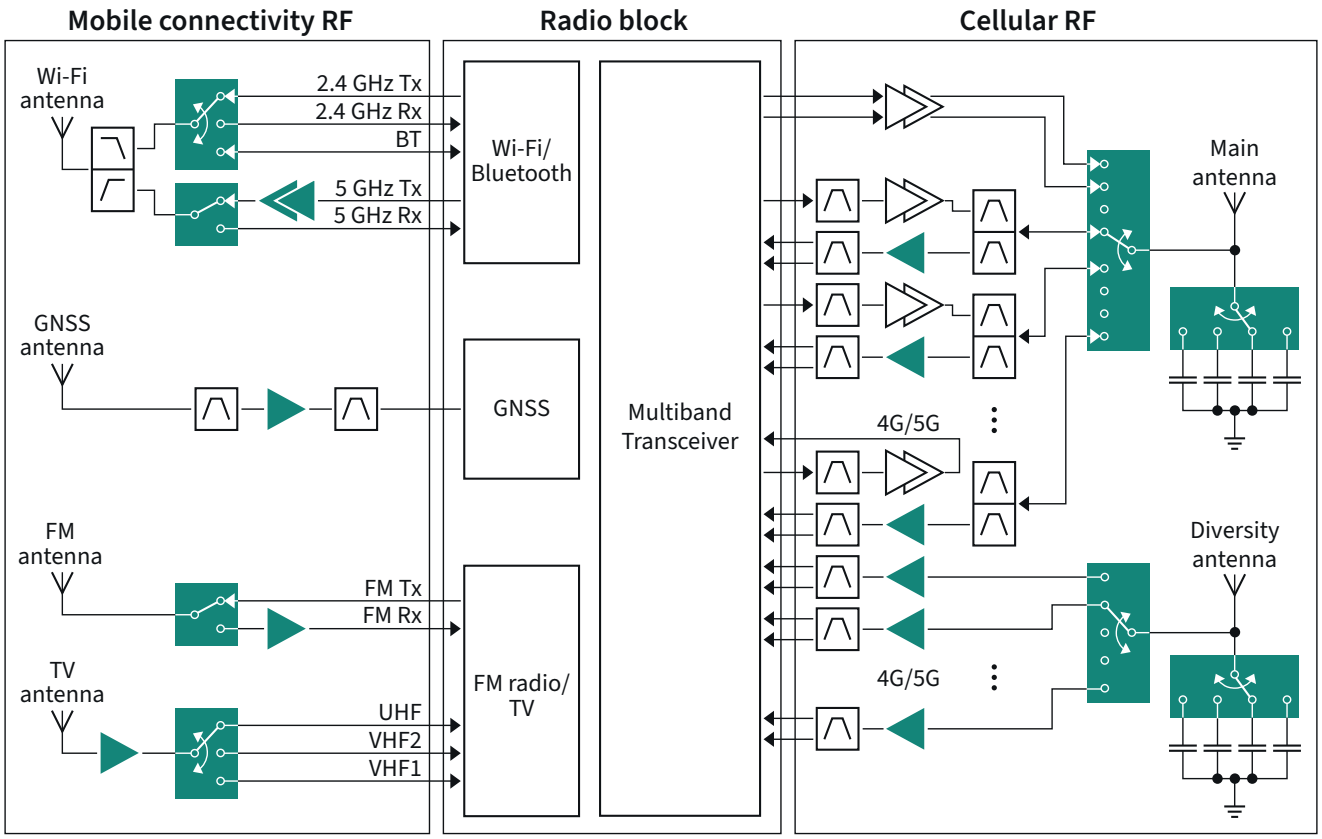


Figure 1 Overview of Infineon's products for a smart phone RF frontend

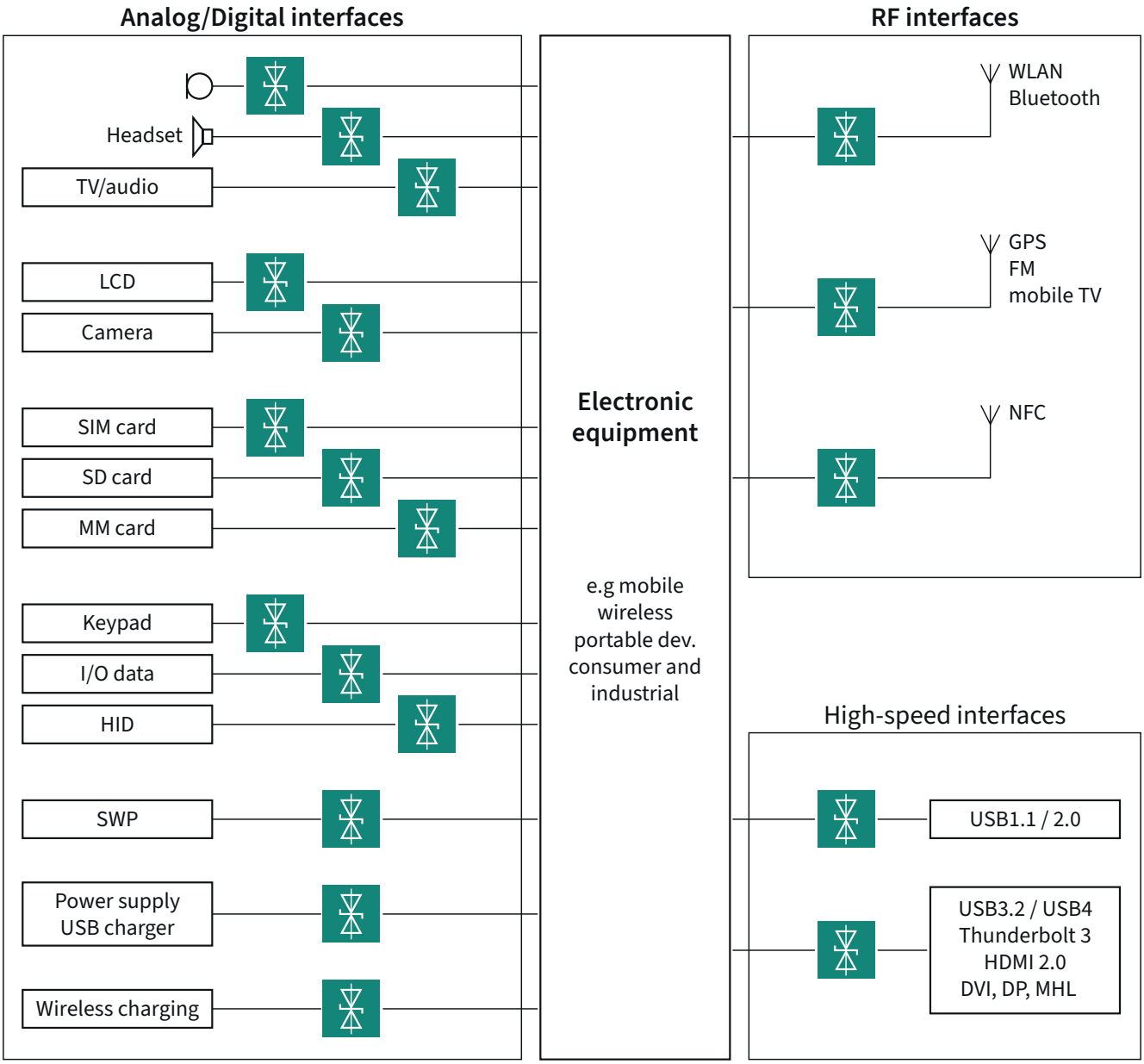
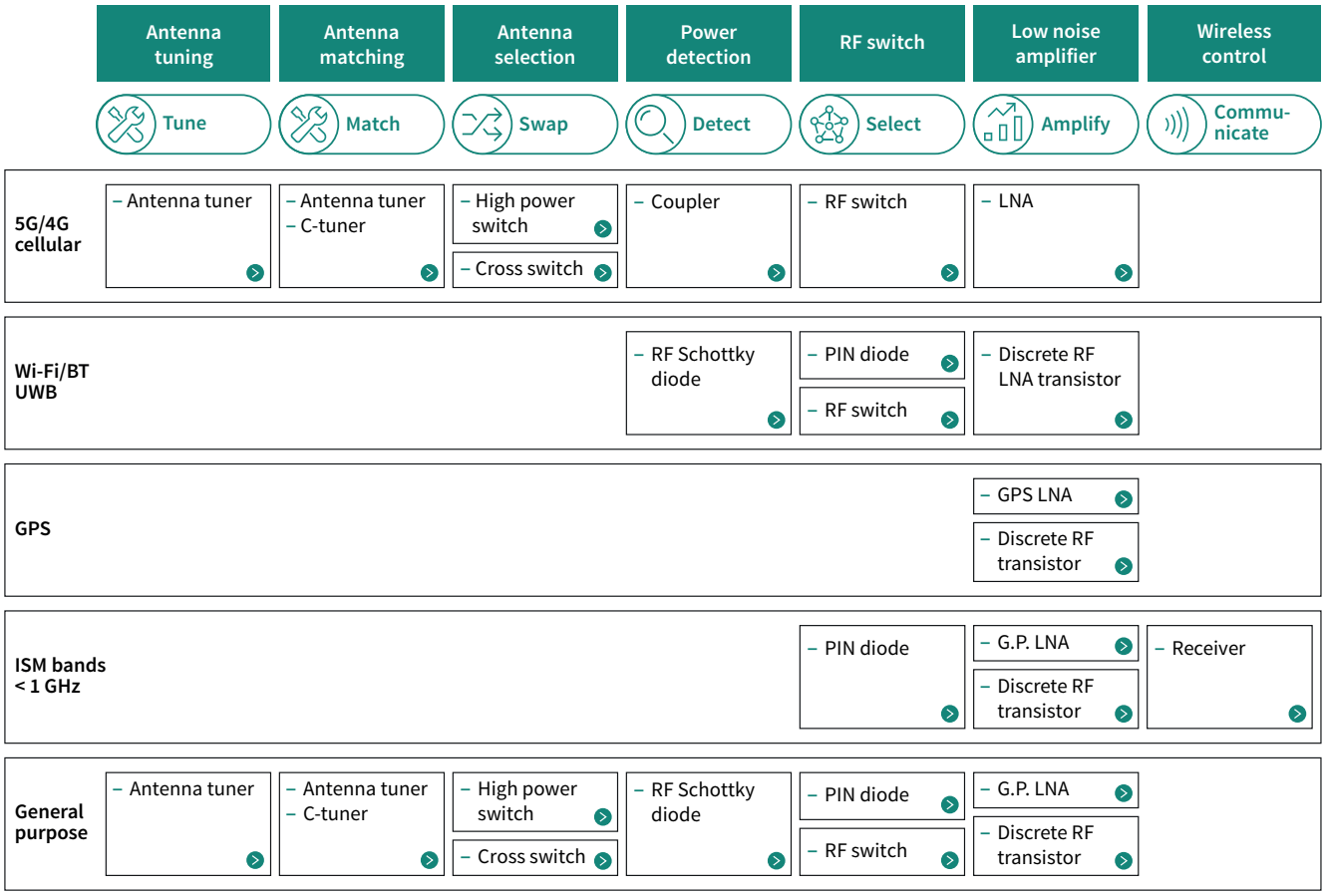


Figure 2 Overview of Infineon's ESD protection devices

Benefits of our RF solutions for your system

Infineon RF solutions are designed to meet customers' system needs for highest RF performance and reliable wireless connectivity. In this way, we support your devices to achieve higher data rates, better quality signal, and longer battery lifetime.



Please visit https://www.infineon.com/rf to discover our full portfolio.

2 Cellular communication in mobile devices

In this chapter, we would like to present the available devices for cellular phones and other cellular enabled mobile devices. With rich development experience for RF products, application know-how, an expanding product portfolio, and established industry contacts and partners, our components enable a high-perfor mance, high effiency RF Frontend with innovation.

Higher data rate

- Up to 40% higher data rate with external LNAs
- Tuned antenna for best performance
- 5G features enabled
- DLCA, ULCA and ENDC supported

Wider coverage

- Up to 40% area coverage extension With external LNAs
- Global operating frequency bands supported

More power efficiency

- Up to 50% PA power saving due to antenna Tuning and swapping
- Low product level DC Power consumption

Higher system robustness

- Well protected from ESD event
- Reduced antenna hand&head effect
- Less sensitive to jammer signals

Infineon's high quality cellular solutions

2.1 Antenna centric solutions

2.1.1 Antenna tuning switches

In mobile devices, an antenna should be able to perform well in several frequency bands. Hence there is a growing need to tune antennas according to the selected frequency bands. This can be done by applying Antenna Tuning which improves the overall antenna radiation efficiency.

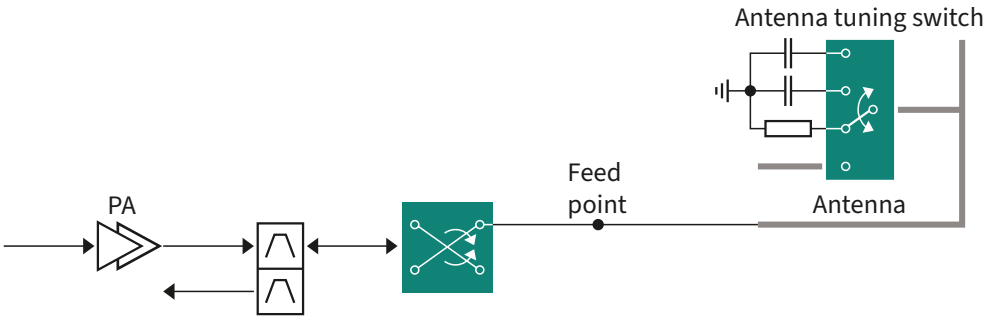


Figure 3 Antenna tuning application

Antenna tuners for best antenna efficiency

	Product	Type	App. note	Supply voltage [V]	R_{on} [Ω]	C_{OFF} [fF]	V_{RFmax} [V]	Control interface	Size [mm²]	Package
	BGSA11GN10	2xSPST series	on request	1.65…3.6	1.00	250	36	2 GPIO	1.1 × 1.5	TSNP-10-1
	BGSA12GN10	SPDT series	on request	1.65…3.6	1.60	120	36	2 GPIO	1.1 × 1.5	TSNP-10-1
	BGSA12UGL8	SPDT series	on request	1.65…3.6	0.59	270	40	2 GPIO	1.1 × 1.1	TSLP-8-1
	BGSA14GN10	SP4T series	on request	1.65…3.6	1.60	120	36	2 GPIO	1.1 × 1.5	TSNP-10-1
NEW	BGSA14M2N10	SP4T series	on request	1.65…1.95	0.85	160	45	MIPI2.1	0.95 × 1.3	TSNP-10-9
NEW	BGSA148MN10	SP4T series/shunt	on request	1.1…1.3 1.65…1.95	0.80	155	45	MIPI2.1	0.95 × 1.3	TSNP-10-9
NEW	BGSA149MN10	SP4T series/shunt	on request	1.1…1.3 1.65…1.95	1.50	80	50	MIPI2.1	0.95 × 1.3	TSNP-10-9
	BGSA143ML10	SP4T series/shunt	on request	1.65…1.95	1.15	140	42	MIPI2.0	1.1 × 1.5	TSLP-10-2
	BGSA143GL10	SP4T series/shunt	on request	1.65…3.6	1.15	140	42	3 GPIO	1.1 × 1.5	TSLP-10-2
	BGSA147ML10	SP4T series/shunt	on request	1.65…1.95	0.80	155	45	MIPI2.1	1.1 × 1.5	TSLP-10-3
NEW	BGSA144ML10	SP4T series/shunt	on request	1.65…1.95	1.74	89	80	MIPI2.1	1.1 × 1.5	TSLP-10-3
NEW	BGSA200ML9	2xSPST shunt to ground	on request	1.1…1.3 1.65…1.95	1.40	157	50	MIPI2.1 2 GPIO	1.1 × 1.1	TSLP-9-8
	BGSA20UGL8	2xSPST shunt to ground	on request	1.65…3.6	2.30	200	80	2 GPIO	1.1 × 1.1	TSLP-8-1
NEW	BGSA400ML10	4xSPST shunt to ground	on request	1.65…1.95	2.00	165	85	MIPI2.1	1.1 × 1.5	TSLP-10-3
NEW	BGSA403ML10	4xSPST shunt to ground	on request	1.65…1.95	0.98	205	48	MIPI2.1	1.1 × 1.5	TSLP-10-3

Please visit https://www.infineon.com/antennacentric for alternative devices. Click on green marked devices to visit product pages directly.

Product	Type	App. note	Supply voltage [V]	R_{on} [Ω]	Capacitance steps	Capacitance range [pF] @ 1.8 GHz	Control interface	Size [mm²]	Package
BGSC2341ML10	SPDT + RF C-tuner	on request	1.65…1.95	0.8	8	0.27–2.0	MIPI2.1	1.1 × 1.5	TSLP-10-2

2.1.2 Cross switches

The Figure 4 shows a typical application for a cross switch in a mobile phone. This device allows a designer to select the best performing antenna for optimizing transmit power for an Up-Link (UL) or improved receive sensitivity for a Down-Link (DL).

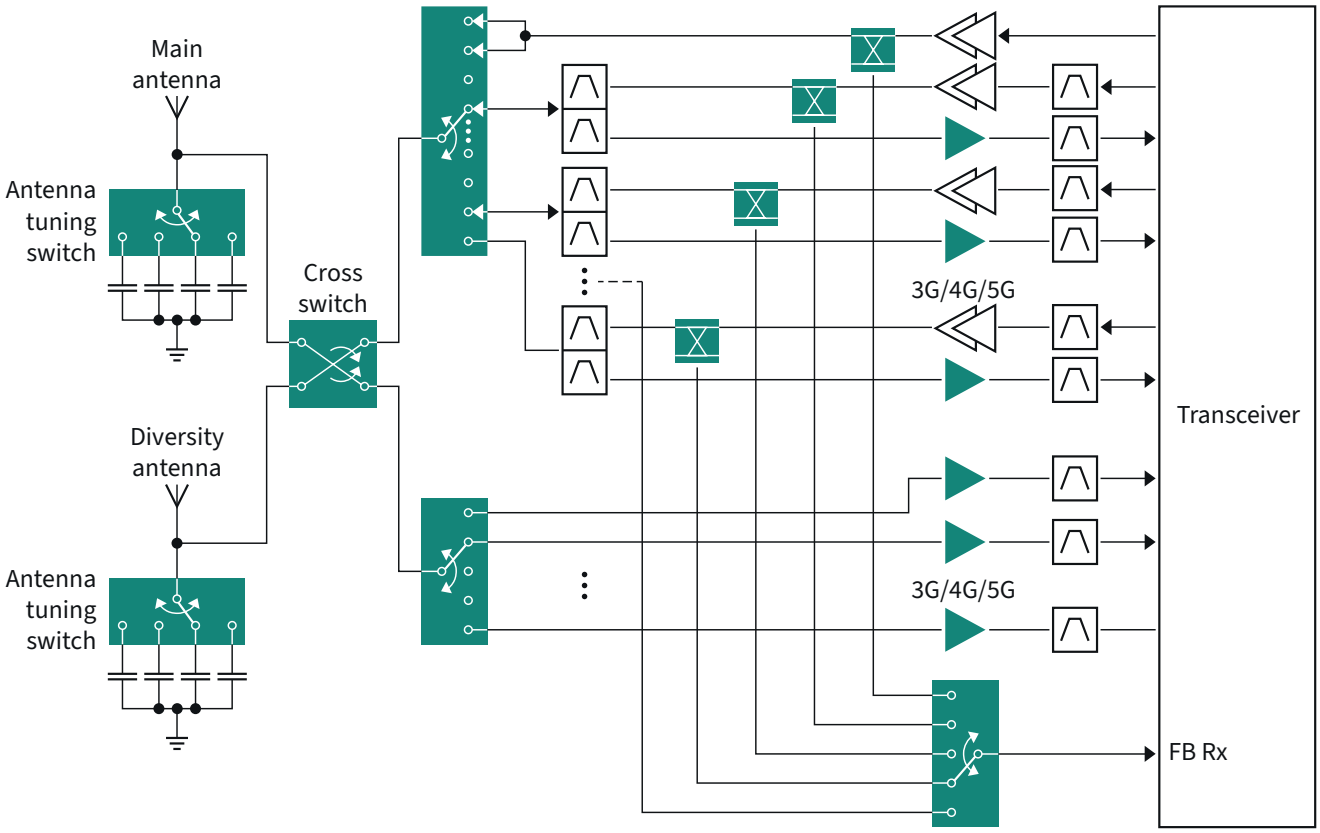


Figure 4 An example of cross switch application

Cross switches for antenna selection

	Product	Type	App. note	Supply V_{DD} [V]	IL[1] [dB]	Isolation[2] [dB]	$P_{rf,max}$[3] [dBm]	Control interface	Package
	BGSX22G5A10	DPDT	on request	1.65…3.4	0.28 / 0.37	49 / 43	37	GPIO	ATSLP-10-50
	BGSX24MU16	DP4T	on request	1.65…3.4	0.40 / 0.45	49 / 43	36.5	MIPI 2.1	ULGA-16-1
NEW	BGSX33M5U16	3P3T	on request	1.6…1.95	0.41 / 0.49	48 / 42	37 / 38 peak	MIPI 2.1	ULGA-16-5
NEW	BGSX22G6U10	DPDT	on request	1.6…3.6	0.29 / 0.34	37 / 29	37 / 39 peak	GPIO	ULGA-10-1
NEW	BGSX44MU18	4P4T	on request	1.6…3.6	0.46 / 0.58	43 / 35	36 / 37 peak	MIPI 2.1	WLGA-18-1

1) IL = Insertion Loss at 1.0/ 2.0 GHz
2) Isolation at 1.0/ 2.0 GHz
3) Max. power handling under operating conditions

Please visit https://www.infineon.com/antennacentric for alternative devices. Click on green marked devices to visit product pages directly.

2.1.3 Bi-directional coupler

A bi-directional coupler in RF front-ends of cellular phones is located between a power amplifier/antenna switch module (PA/ASM) and an antenna tuner. The coupler is used as a part of the power control and antenna tuning loops.

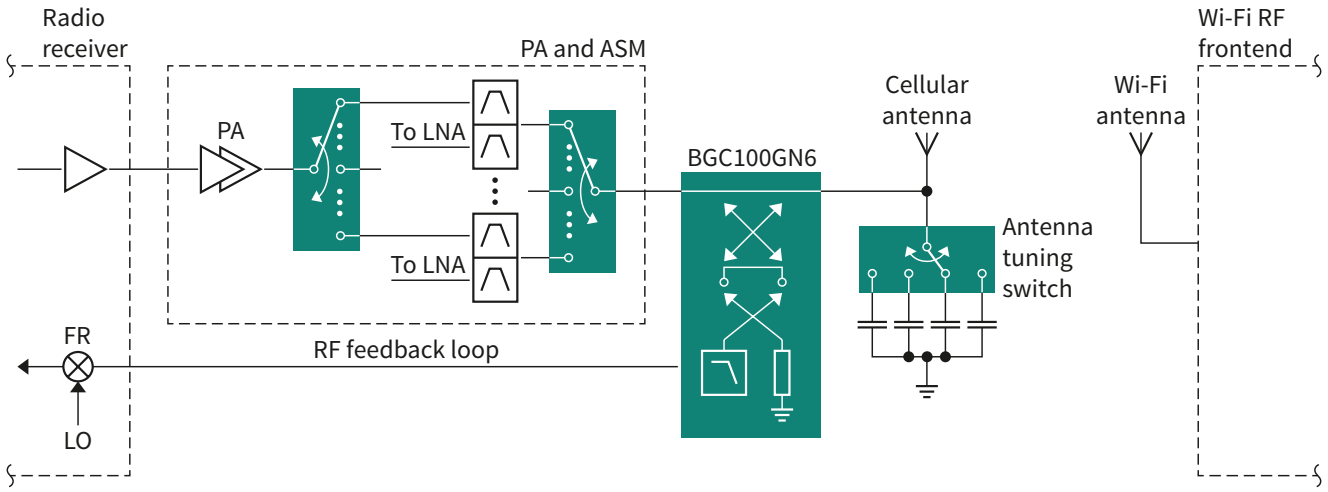


Figure 5 Block diagram of a cellular RF frontend

Bi-directional coupler

Product	Frequency [GHz]	IL @ 2.7 GHz [dB]	Coupling factor @ 2.7 GHz [dB]	Directivity @ 2.7 GHz [dB]	Max RF input power @ 2.7 GHz [dBm]	Control interface	Size [mm²]	Package
BGC100GN6	0.6–2.7	0.2	23	25	29	GPIO	1.1 × 0.7	TSNP-6-2

2.2 RF switches

Infineon's RF switches portfolio includes high-performance devices with low Insertion Loss (IL), high isolation and low harmonics generation. The RF switches are used for band selection and switching or diversity switching at the antenna or different RF paths within the RF (FE). These devices are manufactured using Infineon's patented MOS technology, with power capability up to +39 dBm.

2.2.1 High power RF switches

Below types feature high power handling capability, combining with excellent insertion loss and isolation performance, well fit for mobile phones.

High power switches

	Product	Type	App. note	Supply V_{DD} [V]	I_L [1] [dB]	Isolation [2] [dB]	$P_{rf,max}$ [3] [dBm]	Control interface	Package
	BGS12P2L6	SPDT	on request	1.65…3.4	0.20 / 0.25	45 / 39	37	GPIO	TSLP-6-4
	BGS12PN10	SPDT	AN497	1.8–3.6	0.16 / 0.22	39 / 32	38	GPIO	TSNP-10-1
	BGS14PN10	SP4T	AN498	1.8–3.6	0.18 / 0.29	41 / 32	38	GPIO	TSNP-10-1
NEW	BGS14M8U9	SP4T	on request	1.1…1.3 1.65…1.95	0.28 / 0.31	46 / 38	39 / 39 peak	MIPI 2.1	ULGA-9

1) IL = Insertion Loss at 1.0/ 2.0 GHz
2) Isolation at 1.0/ 2.0 GHz
3) Max. power handling under operating conditions

Please visit www.infineon.com/rfswitches for alternative devices. Click on green marked devices to visit product pages directly.

2.2.2 Diversity RF switches

The recent trend of mobile device users to download data at a higher rate requires a higher bandwidth and an additional receiver channel called the diversity path. To select the right receive band, one option is to use a diversity switch with low insertion loss and excellent RF performance. Diversity switches are more frequently used in smartphones and tablets.

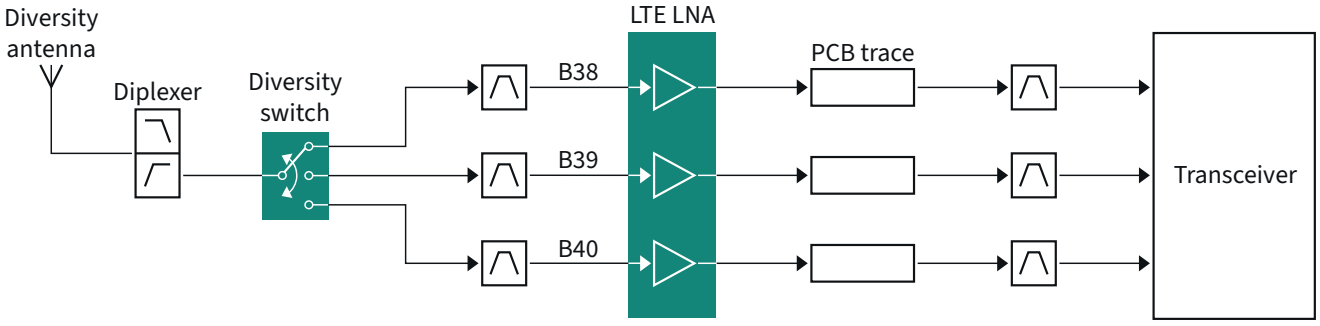


Figure 6 Example of TD-LTE band for diversity path

RF CMOS switches for diversity antenna

Product	Type	Supply V_{DD} [V]	I_L [1] [dB]	Isolation [2] [dB]	$P_{rf,max}$ [3] [dBm]	Control interface	Package
BGS12WN6	SPDT	1.65…3.6	0.16 / 0.19	46 / 39	26	GPIO	TSNP-6-10
BGS13SN8	SP3T	1.65…3.4	0.27 / 0.36	29 / 26	30	GPIO	TSNP-8-1
BGS14WMA9	SP4T	1.65…1.95	0.21 / 0.27	46 / 39	26	RFFE MIPI 2.1	ATSLP-9-50
BGS14MA11	SP4T	1.7…3.4	0.20 / 0.23	40 / 35	34	RFFE MIPI 2.0	ATSLP-11-1
BGS15MU14	SP5T	1.65…1.95	0.48 / 0.55	63 / 57	20	RFFE MIPI 2.1	ULGA-14-1
BGS16MA12	SP6T	1.65…1.95	0.30 / 0.38	50 / 43	32	RFFE MIPI 2.0	ATSLP-12-10
BGS18MA12	SP8T	1.65…1.95	0.37 / 0.48	40 / 34	32	RFFE MIPI 2.0	ATSLP-12-10

1) IL = Insertion Loss at 1.0/ 2.0 GHz
2) Isolation at 1.0/ 2.0 GHz
3) Max. power handling under operating conditions

Please visit www.infineon.com/rfswitches for alternative devices. Click on green marked devices to visit product pages directly.

2.3 Low noise amplifiers

Infineon has been one of the earliest companies developing Low Noise Ampiliers (LNAs) in Silicon Germanium (SiGe) based and Silicon Germanium Carbon (SiGe:C) based technology. Our Monolithic Microwave Integrated Circuit (MMIC) LNAs and Switch + LNA Modules feature excellent low noise figures, enhancing the sensitivity of the RF modem by about 3 dB, and offer system layout flexibility by suppressing noise contribution from losses of signal lines and from the filters as well as the receiver. High linearity assures optimal signal reception even with poorly isolated antennas and long line losses between antennas and transceivers. In very weak signal environment, LNAs can double the data rates compared to solutions without LNAs.

2.3.1 Single-band LNAs

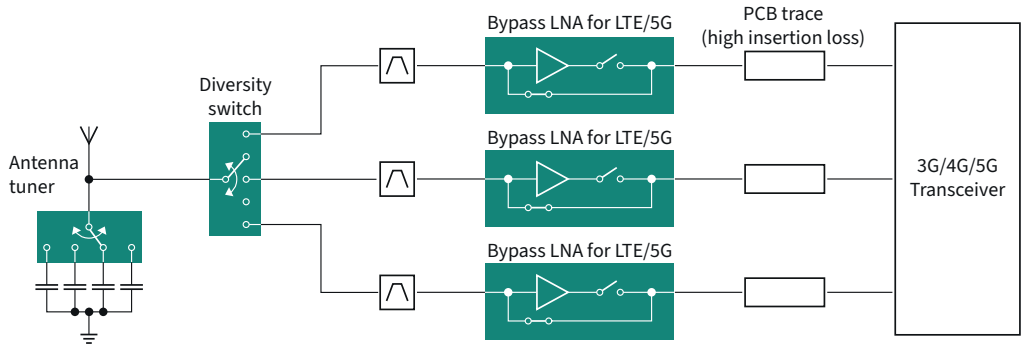


Figure 7 Three single-band LNAs implemented in the diversity path

Single-band MMIC LNAs with bypass function

Product	Freq. range [MHz]	Gain [2] [dB]	NF [2] [dB]	IP_{-1dB} [2] [dBm]	IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current [2] [mA]	Package
BGA5L1BN6 [1]	600–1000	18.5 / -2.7	0.7 / 2.7	-20 / +2	-7 / +11	1.5…3.6	8.2 / 0.085	TSNP-6-2
BGA5M1BN6 [1]	1805–2200	19.3 / -4.7	0.65 / 4.7	-17 / -2	-7 / +6	1.5…3.6	9.5 / 0.085	TSNP-6-2
BGA5H1BN6 [1]	2300–2690	18.1 / -5.2	0.7 / 5.2	-17 / -3	-7 / +6	1.5…3.6	8.5 / 0.085	TSNP-6-2
BGA7L1BN6 [1]	716–960	13.6 / -2.2	0.75 / 1.8	-1 / +6	+5 / +18	1.5…3.3	4.9 / 0.09	TSNP-6-2
BGA7H1BN6 [1]	1805–2690	11 / -3.5	0.85 / 2.7	-1 / +5	+5 / +16	1.5…3.3	4.3 / 0.09	TSNP-6-2
BGA729N6	70–600	16.0 / -4.0	1.05 / 4.3	-15 / +4	-6 / +20	1.5…3.3	6.3 / 0.55	TSNP-6-2
BGA8V1BN6	3300–3800	15.0 / -5.3	1.2 / 5.3	-15 / -3	-3 / +6	1.6…3.1	4.2 / 0.2	TSNP-6-2
BGA8U1BN6	4000–6000	14.0 / -5.0	1.6 / 5.0	-15 / -5	-3 / +11	1.6…3.1	4.0 / 0.2	TSNP-6-2

1) LNA with two gain modes (high-gain/low-gain) 2) Values in high-gain (HG)/low-gain (LG) mode

Single-band LTE-A MMIC LNAs

Product	App. note	Freq. range [MHz]	Gain [dB]	NF [dB]	IP_{-1dB} [dBm]	IIP_3 [dBm]	Supply V_{DD} [V]	Current [mA]	Package
BGA7L1N6	AN351 AN364 AN404	728–960	13.0	0.9	-6	-1	1.5…3.3	4.5	TSNP-6-2
BGA7M1N6	AN350 AN371 AN405 AN411	1805–2200	13.0	0.7	-3	7	1.5…3.3	4.5	TSNP-6-2
BGA7H1N6	AN349 AN365 AN406 AN432	2300–2690	13.0	0.7	-4	6	1.5…3.3	4.7	TSNP-6-2

Please visit www.infineon.com/ltelna for alternative devices. Click on green marked devices to visit product pages directly.

2.3.2 LNAs with multiple gain states

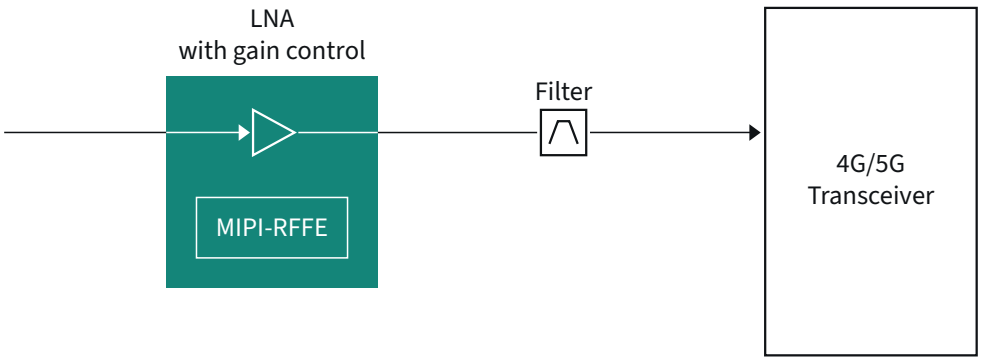


Figure 8 Multi gain state LNA implemented in the main path

MIPI LNA with gain control for 4G/5G

Product	Freq. range [MHz]	Gain [dB]	NF [dB]	IP_{-1dB} [dBm]	IIP_3 [dBm]	Supply V_{DD} [V]	Current [mA]	Package
BGA9H1MN9 [10]	1400–2700	17.1 [2]	1.01 [2]	-14.6 [2]	-7.3 [2]	1.2…1.8	3.5 [2] [3] [4] [5] [6] [7] [8]	TSNP-9-2
		14.6 [3]	1.01 [3]	-13.9 [3]	-7.1 [3]			
		13 [4]	1.34 [4]	-12.3 [4]	-4.9 [4]			
		10.5 [5]	1.53 [5]	-12.1 [5]	-4.9 [5]			
		7.3 [6]	1.92 [6]	-12.1 [6]	-5.1 [6]			
		-1.6 [7]	10.47 [7]	-0.4 [7]	9.7 [7]		3.2 [9]	
		-2.8 [8]	4.10 [8]	5.3 [8]	20.3 [8]		0.001 [10]	
BGA9V1MN9 [10]	3300–4200	21 [2]	0.75 [2]	-18 [2]	-6 [2]	1.1…2.0	3.5 [2] [3] [4] [5] [6] [7] [8] [9]	TSNP-9-2
		18 [3]	0.8 [3]	-17 [3]	-3 [3]			
		14.9 [4]	1.0 [4]	-16 [4]	-3 [4]			
		11.9 [5]	1.15 [5]	-16 [5]	-3 [5]			
		8.5 [6]	1.4 [6]	-16 [6]	-3 [6]			
		-2.7 [7]	11 [7]	1 [7]	8 [7]			
		-3.0 [8]	3.0 [8]	–	–		0.002 [10]	
BGA9C1MN9 [10]	4400–5500	19 [2]	0.9 [2]	-17 [2] [10]	-5 [2]	1.1…2.0	3.5 [2] [3] [4] [5] [6] [7] [8] [9]	TSNP-9-2
		16 [3]	0.95 [3]	-17 [3] [10]	-5 [3]			
		12.5 [4]	1.3 [4]	-12 [4] [10]	-1 [4]			
		9.6 [5]	1.45 [5]	-12 [5] [10]	0 [5]			
		6.1 [6]	1.85 [6]	-12 [6] [10]	0 [6]			
		-2.9 [7]	11 [7]	0 [7] [10]	13 [7]			
		-3.1 [8]	3.1 [8]	8 [7] [10]	–		0.002 [10]	
BGA9U1MN9 [10]	5500–7200	19.4 [2]	1.2 [2]	-19 [2]	-8 [2]	1.1…2.0	3.5 [2] [3] [4] [5] [6] [7] [8] [9]	TSNP-9-2
		16.6 [3]	1.2 [3]	-18 [3]	-7 [3]			
		13.7 [4]	1.35 [4]	-13 [4]	-2 [4]			
		10.8 [5]	1.45 [5]	-12 [5]	-1 [5]			
		7.4 [6]	1.8 [6]	-12 [6]	-1 [6]			
		-0.4 [7]	10.7 [7]	-1 [7]	9 [7]			
		-4.4 [8]	4.4 [8]	+2 [8]	19 [8]		0.002 [10]	

1) AN on request
2) Gain state: G0
3) Gain state: G1
4) Gain state: G2
5) Gain state: G3
6) Gain G4
7) Gain state: G5
8) Gain state: G6
9) Gain state: bypass
10) Based on preliminary datasheet

2.3.3 LNA banks

Product	Freq. range [MHz]	Gainmode	Gain [dB]	NF [dB]	IP_{-1dB} [dBm]	IIP_3 [dBm]	Supply V_{DD} [V]	Current [mA]	Package
NEW BGM687U50	617–960[1)]	G11	19.3	0.8	-13.2	-3.2	1.1…1.95	10.7	WF2BGA-50-1
		G10	–	–	–	–		5.6	
		G9	13.6	1.6	-12.6	1.8			
		G8	–	–	–	–		4.5	
		G7	7.7	3.2	-11.5	0.3			
		G6	–	–	–	–		3.5	
		G5	1.1	8.3	-8.9	2.4			
		G4	–	–	–	–		0.08	
		G3	-6.7	6.7	> 12	30			
		G2	–	–	–	–			
		G1	-12.5	12.5	> 12	30			
	1427–1518[2)]	G12	–	–	–	–	1.1…1.95	10.7	WF2BGA-50-1
		G11	19.3	0.9	-14.7	-4.4			
		G10	–	–	–	–		5.6	
		G9	13.6	1.6	-13.6	-0.1			
		G8	–	–	–	–		4.5	
		G7	7.6	3.1	-12.2	0.6			
		G6	–	–	–	–		3.5	
		G5	0.1	8.6	-9.2	3.7			
		G4	–	–	–	–		0.08	
		G3	-6.5	6.5	9.3	30			
		G2	–	–	–	–			
		G1	-12.3	12.3	9.3	30			
	1805–2200[2)]	G12	–	–	–	–	1.1…1.95	10.7	WF2BGA-50-1
		G11	19.1	0.9	-14.5	-4.2			
		G10	–	–	–	–		5.6	
		G9	13.7	1.5	-14.4	-2.2			
		G8	–	–	–	–		4.5	
		G7	7.7	3.1	-12.1	3.2			
		G6	–	–	–	–		3.5	
		G5	0.6	8.3	-9.3	5.6			
		G4	–	–	–	–		0.08	
		G3	-6.8	6.8	11.3	30			
		G2	–	–	–	–			
		G1	-12.8	12.8	11.3	30			
	2300–2690[2)]	G12	–	–	–	–	1.1…1.95	10.7	WF2BGA-50-1
		G11	17.7	1.0	-10.9	-2.5			
		G10	–	–	–	–		5.6	
		G9	12.9	1.6	-10.5	-1.6			
		G8	–	–	–	–		4.5	
		G7	7.3	3.2	-9.2	2.5			
		G6	–	–	–	–		3.5	
		G5	0.5	8.5	-6.3	5.9			
		G4	–	–	–	–		0.08	
		G3	-7.0	7.0	> 12	30			
		G2	–	–	–	–			
		G1	-13.1	13.1	> 12	30			

1) LNA1 & LNA2 2) LNA3 … LNA7 3) Partial performance data illustrated, for full performance data please contact Infineon local team
4) AN on request

3 Global navigation satellite systems

Global Navigation Satellite Systems (GNSSs) are among the most available applications in personal navigation devices, smart phones, wearable devices as well as vehicles. Several GNSS systems are in operation globally, such as GPS, Glonass, Galileo, BeiDou, IRNSS and QZSS.

The GNSS satellite signals transmit at an extremely low power level of about -130 dBm. High power jammer signals may leak into the GNSS receiver and affect the receiver's sensitivity by overdriving the receiver's LNA. This presents a major challenge to RF FE designers to maintain the receiver's sensitivity to weak incoming GNSS signals. Our diverse GNSS product portfolio enables customers to achieve excellent system sensitivity, low power consumption and quick time to first fix.

3.1 Single band GNSS frontend

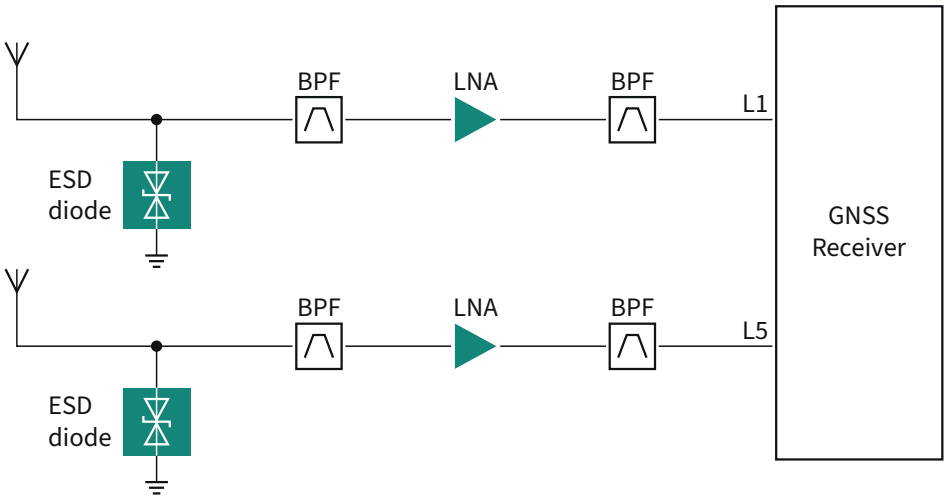


Figure 9 GNSS RF frontend for smart phones and wearable devices

RF MMIC LNAs for GNSS L1 band

	Product	App. note	Gain [1] [dB]	NF [1] [dB]	IP$_{-1dB}$ [1] [dBm]	Oob_IIP$_3$ [2] [dBm]	Supply V_{DD} [V]	Current [1] [mA]	Package
	BGA123L4	AN551 AN578 [4]	18.3 18.0	0.75 0.90	-15 -14	-7 -9	1.1…3.3	1.1 1.1	TSLP-4-11
NEW	BGA123N6	AN626 AN628 [4]	18.8 18.3	0.80 0.90	-15 -16	-10 -8	1.1…2.8	1.35 1.35	TSNP-6-2
	BGA524N6	AN400 AN575 [4]	19.6 19.1	0.65 0.95	-12 -15	-6 -4	1.5…3.3	2.5 2.5	TSNP-6-2
	BGA824N6	AN325 AN334 [4] AN618 [5]	17.0 16.4 16.5	0.65 0.90 1.10	-7 -9 -10	8 7 7	1.5…3.3	3.9 4.0 4.0	TSNP-6-2
	BGA855N6	AN596 [3]	17.0	0.75	-16		1.5…3.3	4.8	TSNP-6-2

1) Supply voltage at 1.8 V, with 0402 LQW inductor for matching
2) Input frequency at 1712.7 MHz, 1850 MHz; P_{in} = -20 dBm; measured at 1575.4 MHz
3) Retuned with additional output matching solutions
4) Band rejection LTE band 13
5) Band rejection N77 – N79 bands

RF MMIC LNAs for GNSS L2 band / L5 band

	Product	App. note	Gain [1] [dB]	NF [1] [dB]	IP$_{-1dB}$ [1] [dBm]	Oob_IIP$_3$ [2] [dBm]	Supply V_{DD} [V]	Current [1] [mA]	Package
	BGA123L4	AN572 [3]	16.2	0.85	-19	-12	1.1…3.3	1.1	TSLP-4-11
NEW	BGA125N6	AN627	19.9	0.85	-14	3	1.1…2.8	1.35	TSNP-6-2
	BGA524N6	AN537 [3]	18.2	0.75	-15	9	1.5…3.3	2.5	TSNP-6-2
	BGA824N6 [3]	AN542	17.5	0.75	-12	6	1.5…3.3	4.1	TSNP-6-2
	BGA855N6	AN580 AN596 AN619 [4]	18.0 17.6 17.4 [4]	0.65 0.70 0.90 [4]	-12 -12 -13 [4]	5 4 12 [4]	1.1…3.3	4.8 4.8 4.8	TSNP-6-2

1) Supply voltage at 1.8 V, with 0402 LQW inductor for matching
2) Input frequency at 1850 MHz, 2500 MHz; P_{in} = -25 dBm, measured at 1200 MHz
3) Retuned with additional output matching solutions
4) Band rejection N77 – N79 bands

For antenna protection solutions, please refer to chapter “Interface protection against ESD/surge”.

3.2 Dual band GNSS frontend

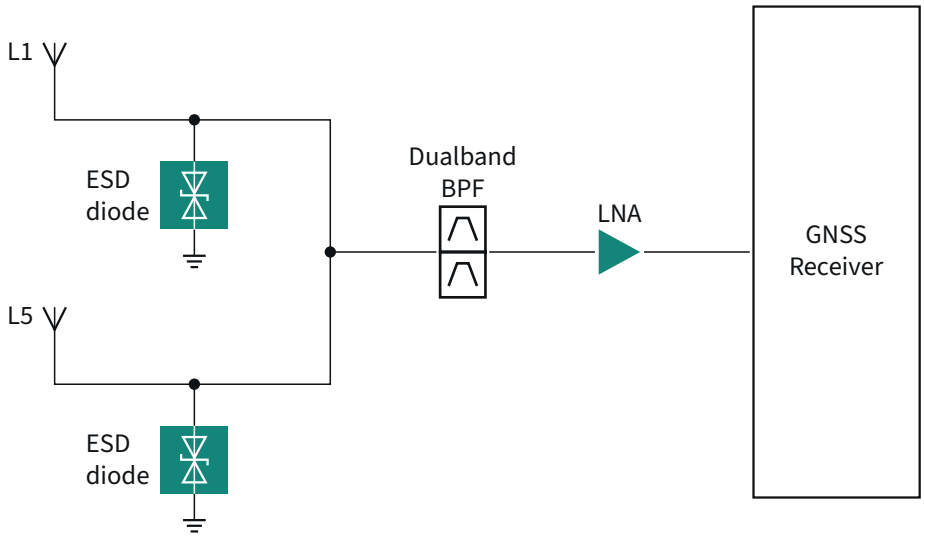


Figure 10 Dualband GNSS RF frontend for smart phones and wearable devices

RF MMIC LNAs for GNSS L1 band

	Product	App. note	Gain [1] [dB]	NF [1] [dB]	IP_{-1dB} [1] [dBm]	Oob_IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current [1] [mA]	Package
NEW	BGA525N6	AN656	18.0 17.0 15.0	0.75 0.85 1.00	-5 -9 -13	-6 -4 -8	1.1…3.3	3.5 2.3 1.5	TSNP-6-2

1) Supply voltage at 1.8 V, with 0402 LQW inductor for matching
2) Input frequency at 1712.7 MHz, 1850 MHz; P_{in} = -20 dBm; measured at 1575.4 MHz
3) Retuned with additional output matching solutions
4) Band rejection LTE band 13
5) Band rejection N77 – N79 bands

RF MMIC LNAs for GNSS L2 band / L5 band

	Product	App. note	Gain [1] [dB]	NF [1] [dB]	IP_{-1dB} [1] [dBm]	Oob_IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current [1] [mA]	Package
NEW	BGA525N6	AN656	19.5 18.0 15.8	0.70 0.80 0.90	-17 -12 -16	-4 -8 -11	1.1…3.3	3.5 2.3 1.5	TSNP-6-2

1) Supply voltage at 1.8 V, with 0402 LQW inductor for matching
2) Input frequency at 1850 MHz, 2500 MHz; P_{in} = -25 dBm; measured at 1200 MHz
3) Retuned with additional output matching solutions
4) Band rejection N77 – N79 bands

For antenna protection solutions, please refer to chapter “Interface protection against ESD/surge”.

3.3 GNSS-enabled active antenna modules

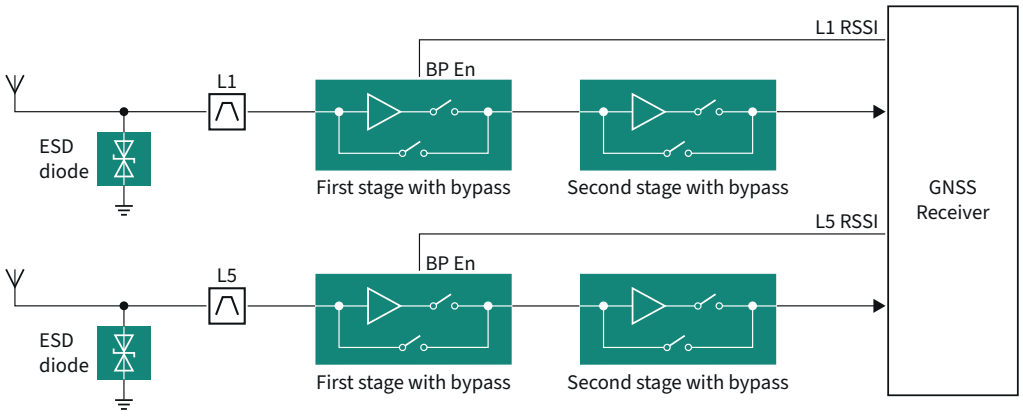


Figure 11 GNSS RF frontend for active antenna modules

RF MMIC LNAs for GNSS L1 band

Product	App. note	Gain [1] [dB]	NF [1] [dB]	IP_{-1dB} [1] [dBm]	IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current [1] [mA]	Package
BGA5L1BN6 [4]	on request	17.0	0.85	-15	–	1.5…3.3	8.5 / 0.09	TSNP-6-2
BGA5M1BN6 [4]	AN612	17.5 / -4.0	0.85 / 5.0	-20 / 4	-6 / 4 2)	1.5…3.3	9.5 / 0.09	TSNP-6-2
BGA824N6	AN325	17.0	0.65	-7	8	1.5…3.3	4.0	TSNP-6-2
BGB707L7ESD [4] [5]	AN_1805_PL32_1806_113119	19.9	0.99	-13.4	-0.83 3)	3	11.9	TSLP-7-1
BGB741L7ESD [4] [5]		19.2	1.14	-6.2	5.73)	3	9.3	TSLP-7-1

1) Supply voltage at 1.8 V, with 0402 LQW inductor for matching
2) Out-of-band IIP_3: input frequency at 1712.7 MHz, 1850 MHz; P_{in} = -20 dBm; measured at 1575.4 MHz
3) P_{in} = -30 dBm per tone, f_1 = 1575 MHz and f_2 = 1576 MHz
4) Retuned with additional matching components
5) Without bypass functions

RF MMIC LNAs for GNSS L2 band / L5 band

Product	App. note	Gain [1] [dB]	NF [1] [dB]	IP_{-1dB} [1] [dBm]	IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current [1] [mA]	Package
BGA5L1BN6 [4]	on request	16.3 / -2.0	0.9 / 5.0	-14 / 1	–	1.5…3.3	8.5 / 0.09	TSNP-6-2
BGA5M1BN6 [4]	AN611	16.0 / -4.0	1.0 / 5.0	-19 / -1	-9 [2]	1.5…3.3	9.5 / 0.09	TSNP-6-2
BGA855N6	AN580	18.0	0.65	-12	5	1.1…3.3	4.8	TSNP-6-2
BGB707L7ESD [4] [5]	AN_1805_PL32_1806_113119	20.5	1.03	-13.9	-1.3 [3]	3	11.9	TSLP-7-1
BGB741L7ESD [4] [5]		19.7	1.16	-6.5	5.1 [3]	3	9.3	TSLP-7-1
BGB707L7ESD [4] [5]		20.5	1.01	-14.1	-2.6 [3]	3	11.9	TSLP-7-1
BGB741L7ESD [4] [5]		19.6	1.16	-6.6	1.9 [3]	3	9.3	TSLP-7-1

1) Supply voltage at 1.8 V, with 0402 LQW inductor for matching
2) Out-of-band IIP_3: input frequency at 1850 MHz, 2500 MHz; P_{in} = -20 dBm; measured at 1200 MHz
3) P_{in} = -30 dBm per tone, f_1 = 1575 MHz and f_2 = 1576 MHz
4) Retuned with additional matching components
5) Without bypass functions

RF Transistor LNAs for GNSS L1 band (without bypass functions)

Product	App. note	Frequency [MHz]	Gain [1] [dB]	NF [1] [dB]	IP_{-1dB} [1] [dBm]	IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current [1] [mA]	Package
BFP640ESD	AN_1805_PL32_1806_113119	1575	17.8	0.82	-17.1	2.7	3	8.0	SOT343
BFP740			19.1	0.71	-16.4	2.6	3	9.8	SOT343
BFP740ESD			18.5	0.72	-18.1	0.8	3	9.4	SOT343
BFP842ESD			17.9	0.66	-13.0	2.7	3	10.9	SOT343
BFP640FESD			18.3	0.81	-17.9	1.1	3	8.0	TSFP-4-1
BFP740F			19.3	0.71	-17.6	1.2	3	9.4	TSFP-4-1
BFP740FESD			19.8	0.68	-17.3	1.8	3	9.8	TSFP-4-1

1) P_{in} = -30 dBm per tone, f_1 = 1575 MHz and f_2 = 1576 MHz

4 Wireless-LAN

4.1 Wireless-LAN routers and access points

The WLAN function is one of the most important connectivity functions between WLAN access points and smartphones, tablets, and laptops. Key performance metrics for the WLAN application are data transfer speed and coverage, which are greatly influenced by transmitted power, receiver sensitivity, noise and interference.

Infineon Technologies provides high-performance RF transistors and MMIC LNAs, which offer exceptionally low NF, high gain, and high linearity at low power consumption levels. The RF transistors are based on robust ultra-low-noise SiGe:C technologies, and their optimized inner transistor cell structure leads to best-in-class power gain and NF at high frequencies, including 2.4 GHz and 5 to 6 GHz frequency bands. Besides, Infineon also provides RF CMOS Switches and PIN diodes for wireless-LAN applications.

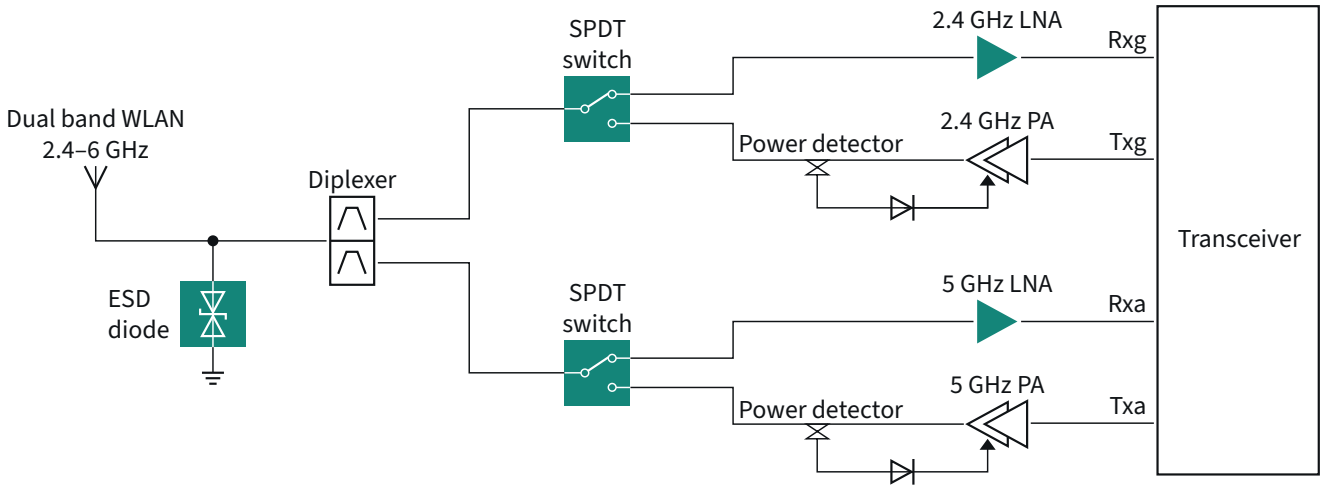


Figure 12 Dual-band (2.4/5.0 GHz) WLAN (IEEE 802.11a/b/g/n) frontend

RF transistor LNAs

Product	App. note	Frequency [MHz]	Gain [dB]	NF [dB]	OP_{-1dB} [dBm]	OIP_3 [1] [dBm]	Supply V_{DD} [V]	Current [mA]	Package
2.4 GHz LNA									
BFP740	AN_1805_PL32_1806_111452	2450	18.9	0.81	5.2	12.6	3	13.5	SOT343
BFP740ESD		2450	18.8	0.76	5.0	12.9	3	13.5	SOT343
BFP760		2450	16.6	0.82	6.6	17.5	3	16.6	SOT343
BFP842ESD		2450	18.5	0.76	8.9	22.3	3	8.6	SOT343
BFP740F		2450	17.1	0.71	2.1	11.1	3	11.6	TSFP-4-1
BFP740FESD		2450	16.6	0.76	1.5	10.7	3	11.0	TSFP-4-1
BFR840L3RHESD		2450	18.5	1.02	0.6	11.4	3	11.4	TSLP-3-9
5 GHz LNA									
BFP840ESD	AN_1805_PL32_1806_111452	5100	16.3	1.07	4.9	16.4	3	10.3	SOT343
		5900	15.3	1.04					
BFP840FESD		5100	19.2	1.01	7.4	18.6	3	14.3	TSFP-4-1
		5900	18.0	1.02					
BFR840L3RHESD		5100	15.0	0.99	4.9	16.4	3	9.2	TSLP-3-9
		5900	14.1	0.98					
6–7 GHz LNA									
BFP740	AN_2210_PL55_2211_114917	5930	14.3	0.94	8.7	24.7	3.3	14.5	SOT343
		7130	12.6	1.36					
BFP840ESD		5930	17.1	1.19	10.9	18.5	3.3	9.5	SOT343
		7130	15.0	1.35					
BFP840FESD		5930	18.0	1.36	6.0	20.7	3.3	14.6	TSFP-4-1
		7130	16.7	1.26					
BFR840L3RHESD		5930	15.4	1.08	6.9	13.8	3.3	12.6	TSLP-3-9
		7130	14.2	1.13					

1) P_{in} = -25 dBm per tone and tone spacing: 1 MHz

Please visit www.infineon.com/lna up to 12 GHz for alternative devices. Click on green marked devices to visit product pages directly.

RF CMOS switches < 500 ns switching speed

Product	Type	App. note	Supply V_{DD} [V]	IL[1] [dB]	Isolation[2] [dB]	$P_{rf,max}$[3] [dBm]	Control interface[4]	Package
BGS12WN6	SPDT	on request	1.65…3.6	0.16 / 0.19	46 / 39	26	GPIO	TSNP-6-10
BGS13SN8	SP3T	on request	1.65…3.4	0.27 / 0.36	29 / 26	30	GPIO	TSNP-8-1

1) IL = Insertion Loss at 1.0/ 2.0 GHz
2) Isolation at 1.0/ 2.0 GHz
3) Max. power handling under operating conditions

Please visit www.infineon.com/rfswitches for alternative devices. Click on green marked devices to visit product pages directly.

RF PIN diodes

Product	App. note	r_F [1] [Ω]	@I_F [mA]	r_F [1] [Ω]	@I_F [mA]	C_T [2] [pF]	@V_R [V]	CC_L [3] [ns]	Package
BAR90-02EL BAR90-02ELS	AN_1809_PL32_1810_172154	2.4	1	1.2	10	0.25	1.0	750	TSLP-2-19 TSSLP-2-3
BAR63-02L		1.2	5	1.0	10	0.21	5.0	75	TSLP-2-19
BAR50-02V		16.5	1	3.0	10	0.24	1.0	1100	SC79
BAR64-02V		10.1	1	2.1	10	0.20	20	1550	SC79
BAR64-04 BAR64-05 BAR64-06	–	10.7	1	2.3	10	0.23	20	1550	SOT23

1) At 100 MHz 2) At 1 MHz 3) The charge carrier life time between the forward bias of I_F = 10 mA and reverse bias of I_R = 6 or 3 mA

For antenna protection with TVS diodes, please refer to chapter "Interface protection against ESD/surge".

4.2 Wireless-LAN user equipments

MMIC LNAs with bypass function

	Product	Freq. range [MHz]	Gain[2] [dB]	NF[2] [dB]	IP_{-1dB} [2] [dBm]	IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current[2] [mA]	Package
	2.4 GHz LNA								
	BGA5H1BN6[1]	2300–2690	18.1 / -5.2	0.7 / 5.2	-17 / -3	-7 / +6	1.5…3.6	8.5 / 0.085	TSNP-6
	BGA7H1BN6[1]	1805–2690	12.3 / -3.1	0.85 / 1.7	-1 / +5	+5 / +16	1.5…3.6	4.3 / 0.087	TSNP-6
NEW	BGA9H1BN6	2300–2700	20 19 17 -4.5	0.6 0.6 0.8 –	-17 -16 -10 5	-7 -7 -11 22	3.3	5.5 4.2 2.2 –	TSNP-6
	5 GHz LNA								
	BGA8U1BN6	4000–6000	14.0 / -5.0	1.6 / 5.0	-15 / -5	-3 / +11	1.6…3.1	4.0 / 0.2	TSNP-6

1) LNA with two gain modes (high-gain/low-gain) 2) Values in high-gain (HG) / low-gain (LG) mode

Please visit www.infineon.com/ltelna for alternative devices. Click on green marked devices to visit product pages directly.

RF CMOS switches < 500 ns switching speed

Product	Type	App. note	Supply V_{DD} [V]	IL[1] [dB]	Isolation[2] [dB]	$P_{rf,max}$ [3] [dBm]	Control interface[4]	Package
BGS12WN6	SPDT	on request	1.65…3.6	0.16 / 0.19	46 / 39	26	GPIO	TSNP-6-10
BGS13SN8	SP3T	on request	1.65…3.4	0.27 / 0.36	29 / 26	30	GPIO	TSNP-8-1

1) IL = Insertion Loss at 1.0/ 2.0 GHz 3) Max. power handling under operating conditions
2) Isolation at 1.0/ 2.0 GHz

Please visit www.infineon.com/rfswitches for alternative devices. Click on green marked devices to visit product pages directly.

For antenna protection with TVS diodes, please refer to chapter "Interface protection against ESD/surge".

5 Wireless broadcasting

5.1 Digital Audio Broadcasting (DAB)

DAB as a broadcasting standard is widely present in infotainment equipments in cars and at home. The DAB and late DAB- utilizes frequency bands in VHF band (47 MHz to 240 MHz) as well as in L band (1452 MHz to 1492 MHz). It enables high audio quality broadcasting.

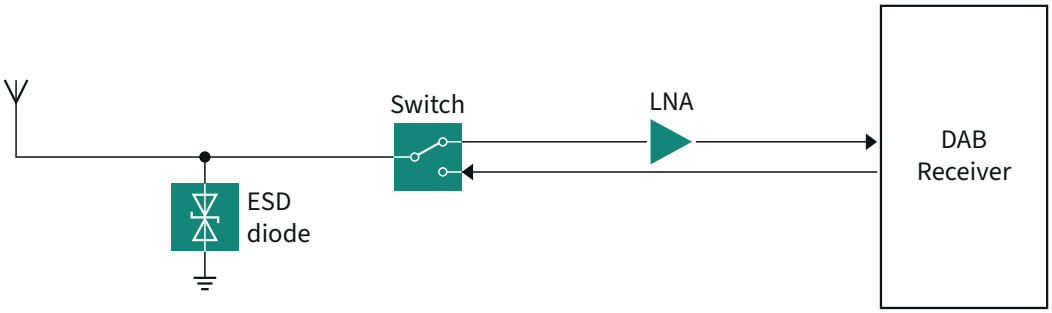


Figure 13 DAB function block

RF MMIC LNAs

Product	App. note	Gain [2] [dB]	NF [2] [dB]	IP_{-1dB} [2] [dBm]	IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current [2] [mA]	Package
BGA729N6	AN441 [1] AN505 [1]	17.0 / -6	1.1 / 4.3	-15 / +5	-6 / +17	1.5…3.3	6.5 / 0.5	TSNP-6-2
BGA9H1BN6	–	20.3 / -4.3	0.6 / 4.6	-17 / +5	-7 / +22	1.1…3.3	5.5 / 0.0006	TSNP-6-10
BGB707L7ESD	AN_1806_PL32_1808_171123	18.3	1.15	-14	-9.2	2.8	4	TSLP-7-1

1) For 50 Ω antenna
2) Values in high-gain (HG) / low-gain (LG) mode

RF transistor LNAs

Product	App. note	Frequency [MHz]	Gain [dB]	NF [dB]	OP_{-1dB} [dBm]	OIP_3 [dBm]	Supply V_{DD} [V]	Current [mA]	Package
Matched to high impedance at the input									
BFR340F	AN_1806_PL32_1808_171123	100	15.9	1.69	-13.7	1.5	1.8	3.3	TSFP-3-1
BFR460L3		100	14.6	1.04	-15.5	-1.4	1.8	3.5	TSLP-3-1
BFP540ESD		100	11.9	1.2	-18.6	-4.3	1.8	2.4	SOT343
Matched to 50 Ω at the input									
BFP460	AN_1806_PL32_1808_171123	100	15.2	1.41	-13	-0.8	1.8	3.1	SOT343
BFP460		100	18.7	1.24	-8.7	2.4	2.6	4.6	SOT343
BFR340F		100	16.2	1.86	-11.3	0.5	1.8	3.0	TSFP-3-1

5.2 FM radio

Frequency Modulation (FM) radio function is widely available. FM radio enabled active antennas can be present in all kinds of devices such as mobile phones, PDAs, portable FM radios, and active antennas, etc.

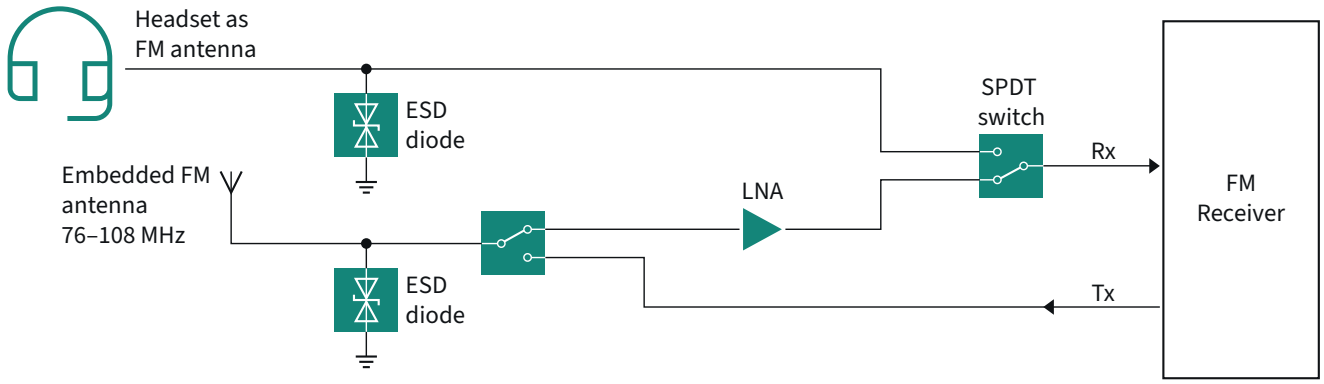


Figure 14 FM transmit/receive function block

RF MMIC LNAs

Product	App. note	Gain [2] [dB]	NF [2] [dB]	IP_{-1dB} [2] [dBm]	IIP_3 [2] [dBm]	Supply V_{DD} [V]	Current [2] [mA]	Package
BGA729N6	AN441 [1] AN505 [1]	17.0 / -6	1.1 / 4.3	-15 / +5	-6 / +17	1.5…3.3	6.5 / 0.5	TSNP-6-2
BGA9H1BN6	–	20.3 / -4.3	0.6 / 4.6	-17 / +5	-7 / +22	1.1…3.3	5.5 / 0.0006	TSNP-6-10
BGB707L7ESD	AN_1806_PL32_1808_171123	18.3	1.15	-14	-9.2	2.8	4	TSLP-7-1

1) For 50 Ω antenna
2) Values in high-gain (HG) / low-gain (LG) mode

RF transistor LNAs

Product	App. note	Frequency [MHz]	Gain [dB]	NF [dB]	OP_{-1dB} [dBm]	OIP_3 [dBm]	Supply V_{DD} [V]	Current [mA]	Package
Matched to high impedance at the input									
BFR340F	AN_1806_PL32_1808_171123	100	15.9	1.69	-13.7	1.5	1.8	3.3	TSFP-3-1
BFR460L3		100	14.6	1.04	-15.5	-1.4	1.8	3.5	TSLP-3-1
BFP540ESD		100	11.9	1.2	-18.6	-4.3	1.8	2.4	SOT343
Matched to 50 Ω at the input									
BFP460	AN_1806_PL32_1808_171123	100	15.2	1.41	-13	-0.8	1.8	3.1	SOT343
BFP460		100	18.7	1.24	-8.7	2.4	2.6	4.6	SOT343
BFR340F		100	16.2	1.86	-11.3	0.5	1.8	3.0	TSFP-3-1

RF CMOS switches

Product	Type	App. note	Supply V_{DD} [V]	IL [1] [dB]	Isolation [2] [dB]	$P_{rf,max}$ [3] [dBm]	Control interface	Package
BGS12WN6	SPDT	on request	1.65…3.6	0.16 / 0.19	46 / 39	26	GPIO	TSNP-6-10
BGS12P2L6	SPDT	on request	1.65…3.4	0.20 / 0.25	45 / 39	37	GPIO	TSLP-6-4

1) IL = Insertion Loss at 1.0/ 2.0 GHz 2) Isolation at 1.0/ 2.0 GHz 3) Max. power handling under operating conditions

Please visit www.infineon.com/rfswitches for alternative devices. Click on green marked devices to visit product pages directly.

5.3 SDARS and HD radio

SDARS is a digitally encoded satellite radio broadcasting in the S-band from 2320 – 2332.5 MHz and 2332.5 – 2345 MHz. SDARS provides paying subscribers with over 175 channels of “MP3-quality” digital radio. A general topology for the SDARS active antenna is shown below.

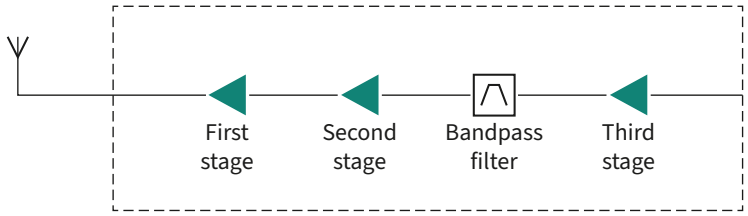


Figure 15 Block diagram example of the SDARS active antenna

RF transistor & MMIC LNAs

	Product	App. note	Frequency [MHz]	Gain [dB]	NF [dB]	OP_{-1dB} [dBm]	OIP_3 [dBm]	Supply V_{DD} [V]	Current [mA]	Package
	First stage									
	BFP740F	AN_1808_PL32_1810_120326	2332.5	18.2	0.7	5.6	23	3.3	13	TSFP-4-1
NEW	BGA9H1BN6	on request	2332.5	20 19 17 -4.5	0.6 0.6 0.8 –	-17 -16 -10 5	-7 -7 -11 22	3.3	5.5 4.2 2.2 –	TSNP-6
	Second stage									
	BFP640ESD	AN_1808_PL32_1810_120326	2332.5	18.7	1.0	13.4	30	3.3	24	SOT343
	BGA614	on request	2332.5	17.5	2.1	12	25	2.4…5.0	40	SOT343
	Third stage									
	BGA614	on request	2332.5	17.5	2.1	12	25	2.4…5.0	40	SOT343
	BGA616		2332.5	18.0	2.6	18	29	2.4…5.0	60	SOT343
	BFP650	AN_1808_PL32_1810_120326	2332.5	14.2	1.2	17.3	30	3.3	57	SOT343
	BFP450		2332.5	10.3	2.6	17.8	32.7	3.3	88	SOT343

5.4 TV reception

Mobile devices today have not only wireless functions for voice and data but also entertainment features. Mobile TV is one of the most fascinating features. It brings live news and entertainment programs onto the phone display and enables people not to miss their favorite programs. Product portfolios for mobile TV applications are described below.

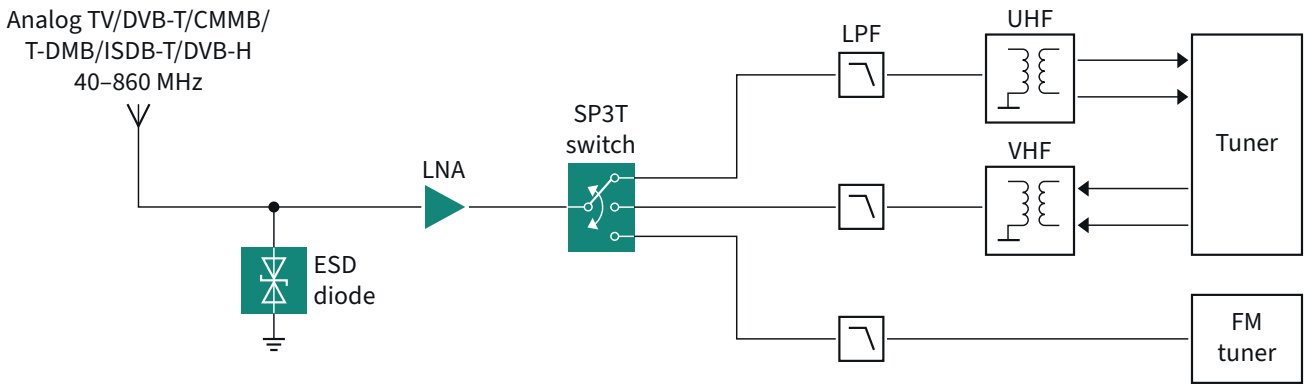


Figure 16 Block diagram of a FM/Mobile TV RF FE with band selection switch

RF MMIC LNAs

Product	App. note	Gain[4] [dB]	NF[4] [db]	IP_{-1dB}[4] [dBm]	IIP_3[4] [dBm]	Supply V_{DD} [V]	Current[4] [mA]	Package
BGA729N6	AN441[2] AN505[2]	16.3 / -4	1.1 / 4.3	-15 / +5	-6 / +17	1.5…3.3	6.5 / 0.5	TSNP-6-2
BGB707L7ESD	AN_1806_PL32_1808_171123[2]	18.3	1.15	-14	-9.2	2.8	4	TSLP-7-1

1) For high-ohmic antenna
2) For 50 Ω antenna
3) LNA with two gain modes (high-gain/low-gain)
4) Values in high-gain (HG) / low-gain (LG) mode
5) On request

Please visit www.infineon.com/ltelna for alternative devices. Click on green marked devices to visit product pages directly.

RF CMOS switches < 500 ns switching speed

Product	Type	App. note	Supply V_{DD} [V]	IL[1] [dB]	Isolation[2] [dB]	$P_{rf,max}$[3] [dBm]	Control interface	Package
BGS13SN8	SP3T	on request	1.65…3.4	0.27 / 0.36	29 / 26	30	GPIO	TSNP-8-1

1) IL = Insertion Loss at 1.0/ 2.0 GHz
2) Isolation at 1.0/ 2.0 GHz
3) Max. power handling under operating conditions

Please visit www.infineon.com/rfswitches for alternative devices. Click on green marked devices to visit product pages directly.

For antenna protection with TVS diodes, please refer to chapter “Interface protection against ESD/surge”.

6 Wearables, IoTs and others

6.1 Wearables

Wearable devices have been increasing popular thanks to their tiny weight, customized high-tec features, multiple wireless connectivity functions, and personalized outlooks. Typical examples are fitness trackers, smartwatches, smart footwears, etc.

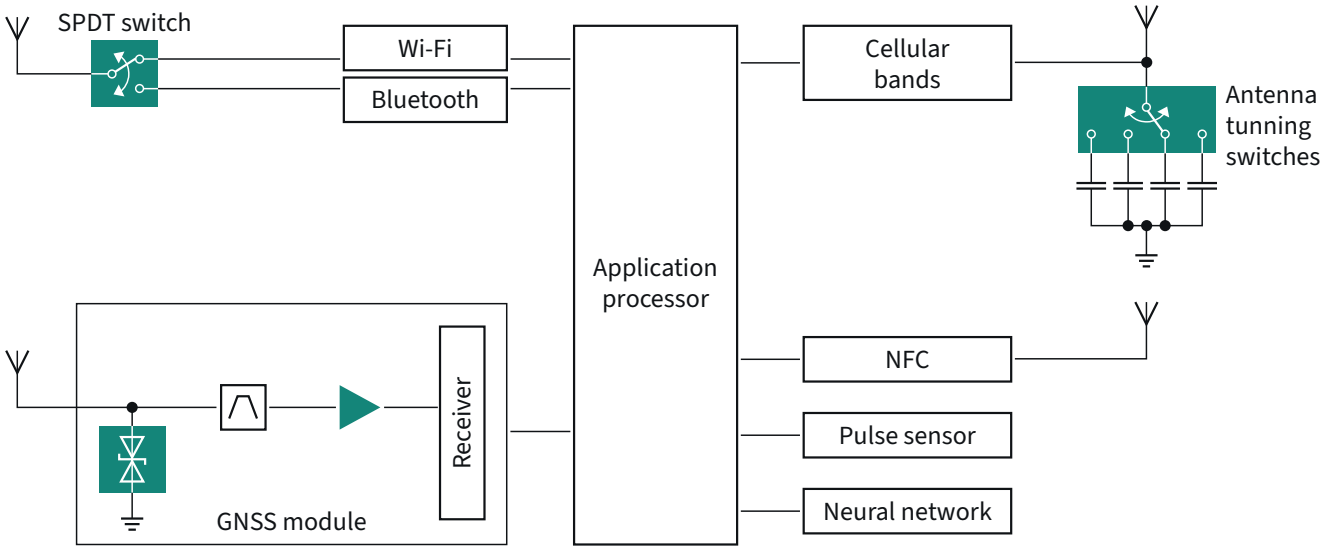


Figure 17 Block diagram of a smart watch

RF MMIC LNAs for GNSS L1 band

Product	App. note	Gain[1] [dB]	NF[1] [dB]	IP_{-1dB}[1] [dBm]	Oob_IIP_3[2] [dBm]	Supply V_{DD} [V]	Current[1] [mA]	Package
BGA123L4	AN551 AN578[4]	18.3 18.0	0.75 0.90	-15 -14	-7 -9	1.1…3.3	1.1 1.1	TSLP-4-11
BGA123N6	AN626 AN628[4]	18.8 18.3	0.80 0.90	-15 -16	-10 -8	1.1…-2.8	1.35 1.35	TSNP-6-2
BGA524N6	AN400 AN575[4]	19.6 19.1	0.65 0.95	-12 -15	-6 -4	1.5…3.3	2.5 2.5	TSNP-6-2
NEW BGA525 N6	AN656	18.5 17.0 15.0	0.75 0.85 1.00	-14 -11 -13	-6 -4 -8	1.1…3.3	3.5 2.3 1.5	TSNP-6-2

1) Supply voltage at 1.8 V, with 0402 LQW inductor for matching
2) Input frequency at 1712.7 MHz, 1850 MHz; P_{in} = -20 dBm; measured at 1575.4 MHz
3) Retuned with additional output matching solutions
4) Band rejection LTE band 13
5) Band rejection N77 – N79 bands

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RF MMIC LNAs for GNSS L2 band / L5 band

Product	App. note	Gain [1] [dB]	NF [1] [dB]	IP_{1dB} [1] [dBm]	Oob_IIP_3 [2] [dBm]	Supply voltage [V]	Current [1] [mA]	Package
BGA123L4 [3]	AN572	16.2	0.85	-19	-12	1.1…3.3	1.1	TSLP-4-11
BGA125N6	AN627	19.7	0.80	-14	3	1.1…2.8	1.35	TSNP-6-2
BGA524N6 [3]	AN418 [3] AN537 [4]	17.8 18.2	0.80 0.75	-14 -15	– –	1.5…3.3	2.5 2.5	TSNP-6-2
NEW BGA525N6	AN656	19.5 18.0 15.8	0.70 0.80 0.90	-14 -12 -10	-7 -8 -11	1.1…3.3	3.5 2.3 1.5	TSNP-6-2

1) Supply voltage at 1.8 V, with 0402 LQW inductor for matching
2) Input frequency at 1850 MHz, 2500 MHz; P_{in} = -25 dBm, measured at 1200 MHz
3) Retuned with additional output matching solutions

RF CMOS switches < 500 ns switching speed

Product	Type	App. note	Supply voltage [V]	IL [1] [dB]	Isolation [2] [dB]	$P_{rf,max}$ [3] [dBm]	Control interface	Package
BGS12WN6	SPDT	on request	1.65…3.6	0.16 / 0.19	46 / 39	26	GPIO	TSNP-6-10
BGS13SN8	SP3T	on request	1.65…3.4	0.27 / 0.36	29 / 26	30	GPIO	TSNP-8-1

1) IL = Insertion Loss at 1.0/ 2.0 GHz
2) Isolation at 1.0/ 2.0 GHz
3) Max. power handling under operating conditions

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Antenna tuners for best antenna efficiency

Product	Type	App. note	Supply voltage [V]	R_{ON} [Ω]	C_{OFF} [fF]	V_{RFmax} [V]	Control interface	Size [mm²]	Package
BGSA143GL10	SP4T series/shunt	on request	1.65…3.6	1.15	140	42	3 GPIO	1.1 × 1.5	TSLP-10
BGSA147ML10	SP4T series/shunt	on request	1.65…1.95	0.80	155	45	MIPI2.1	1.1 × 1.5	TSLP-10
BGSA14M2N10	SP4T series	on request	1.65…1.95	0.85	160	45	MIPI2.1	0.95 × 1.3	TSNP-10
BGSA149MN10	SP4T series/shunt	on request	1.1…1.3 1.65…1.95	1.50	80	50	MIPI2.1	0.95 × 1.3	TSNP-10

Please visit https://www.infineon.com/antennacentric for alternative devices. Click on green marked devices to visit product pages directly.

6.2 LiDAR

LiDAR is a remote sensing technique that measures the distance to a target and creates a 3D map of the target object. Its versatility and high resolution make it suitable for application in guidance, rangefinders, etc. LiDAR uses different architectures as direct and indirect Time-of-Flight (ToF) measurements, or triangulation for detection and ranging.

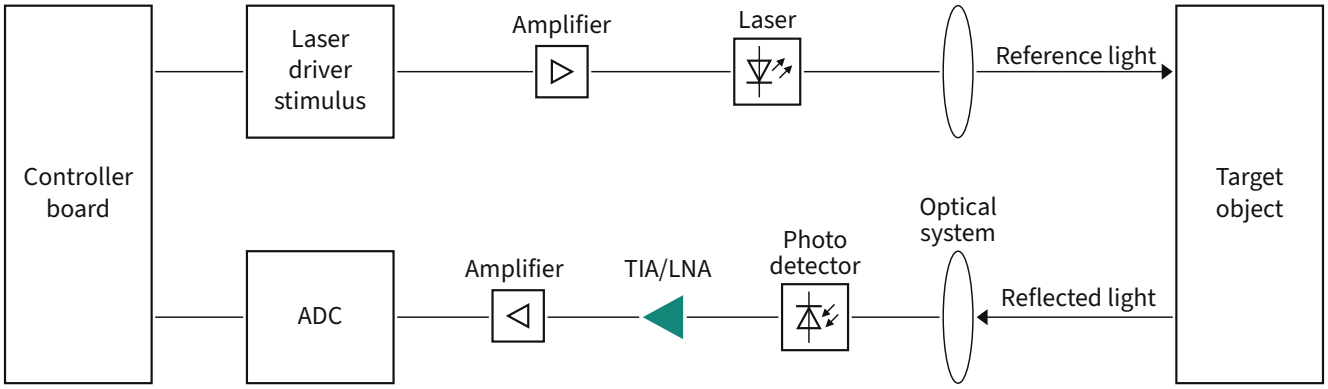

Figure 18 Block diagram example of the simplified LiDAR system

A low noise amplifier is required to detect the small current generated by the photo-diode as the amplitude of the return signal decreases proportionally to the square of the target distance. As a cost effective solution, broadband LNA can be built easily using a RF transistor with few external components.

RF transistor & MMIC LNAs

Product	App. note	3 dB Bandwidth [MHz]	Frequency [MHz]	Gain [dB]	NF [dB]	OP_{-1dB} [dBm]	OIP_3 [1] [dBm]	Supply V_{DD} [V]	Current [mA]	Package
BFR740L3RH	AN_1809_PL32_1811_161136	0.0028–450	10	22.2	1	0.4	9.2	3.3	13	TSLP-3-9
			200	21.8	1	0	7.3			
			400	20.6	1	0.2	5.6			
BFR340F	on request		100	16.2	1.9	-11.3	0.5	1.8	3	TSFP-3-1
BFP196W	on request		400	19.0	1.9		13.8	5	41	SOT343
BGA729N6	on request		200	17.0	1	-2	12	1.5…3.3	6.5 / 0.5	TSNP-6-2
			400	16.5	1	0	12			

1) P_{in} = -35 dBm per tone and tone spacing: 1 MHz

6.3 LoRaWAN

The LoRaWAN® is a Low Power, Wide Area (LPWA) networking protocol designed to wirelessly connect battery operated 'things' to the internet in regional, national or global networks, and targets key Internet of Things (IoT) requirements such as bi-directional communication, end-to-end security, mobility and localization services.
It operates in the frequency range of 860 MHz to 930 MHz.

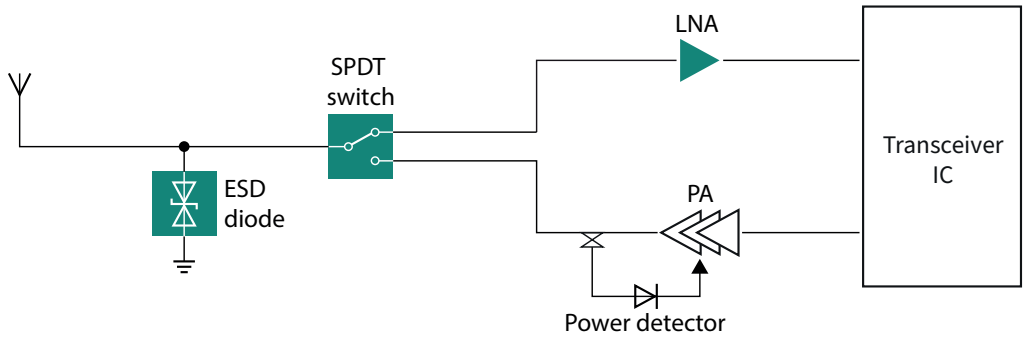

Figure 19 Block diagram example of the LoRaWAN frontend

A low noise amplifier serves to enhance the sensitity of the LoRaWAN frontend. The solutions based on RF transistors are robust and the integrated MMIC solution has low external part count and is highly space saving.

RF transistor & MMIC LNAs

Product	App. note	Frequency [MHz]	Gain [dB]	NF [dB]	OP_{-1dB} [dBm]	OIP_3 [1] [dBm]	Supply V_{DD} [V]	Current [mA]	Package
BGB707L7ESD	on request	700	21.0	1.0	5	19	3	12	TSLP-7-1
		800	20.5	1.0	5	19			
		900	20.0	1.1	5	19			
BGA729N6	on request	700	16.0	1.0	-1	11	1.5…3.3	6.5 / 0.5	TSNP-6-2
		800	16.0	1.0	-1	11			
		900	16.0	1.0	0	11			

1) P_{in} = -35 dBm per tone and tone spacing: 1 MHz

6.4 Walkie-talkie

Walkie-talkie is a two way radio system based in the frequency range of 100 MHz up to 900 MHz. It supports various radio communication techniques such as Family Radio Service (FRS), General Mobile Radio Service (GMRS) or Multi-Use Radio Service (MURS) as well as the Very High Frequency (VHF) and Ultra-High Frequency(UHF) bands. The range of two way communication runs up to a hundred kilometer depending on the type of cummnication system it selects.

RF transistor & MMIC LNAs

Product	App. note	Frequency [MHz]	Gain [dB]	NF [dB]	OP_{-1dB} [dBm]	OIP_3 [1] [dBm]	Supply V_{DD} [V]	Current [mA]	Package
BFR460L3	on request	100	14.6	1.04	-15.5	-1.4	1.8	3.5	TSLP-3-1
BFR740L3RH	on request	200	21.8	1.00	0	7.3	3.3	13	TSLP-3-9
		400	20.6	1.00	0.2	5.6			
BGA729N6	on request	170	17.0	1.00	-2	12	1.5…3.3	6.5 / 0.5	TSNP-6-2
		460	16.5	1.00	0	12			

1) P_{in} = -35 dBm per tone and tone spacing: 1 MHz

7 Interface protection against ESD/surge

Infineon ESD protection devices improve ESD immunity at the system level by providing first-class protection beyond the IEC61000-4-2 level-4 standard, and offer:

- Superior multi-strike absorption capability
- Safe and stable clamping voltages to protect even the most sensitive electronic equipment
- Full compliance with high-speed signal quality requirements
- Efficient PCB space usage thanks to small 0201 and 01005 package dimensions
- Extremely low leakage currents to extend battery life

In a mobile device, there are a lot of open access points such as charging port, microphones and buttons that could permit ESD strikes to reach the inner PCB. Often the point of entrance for an ESD strike is not obvious.

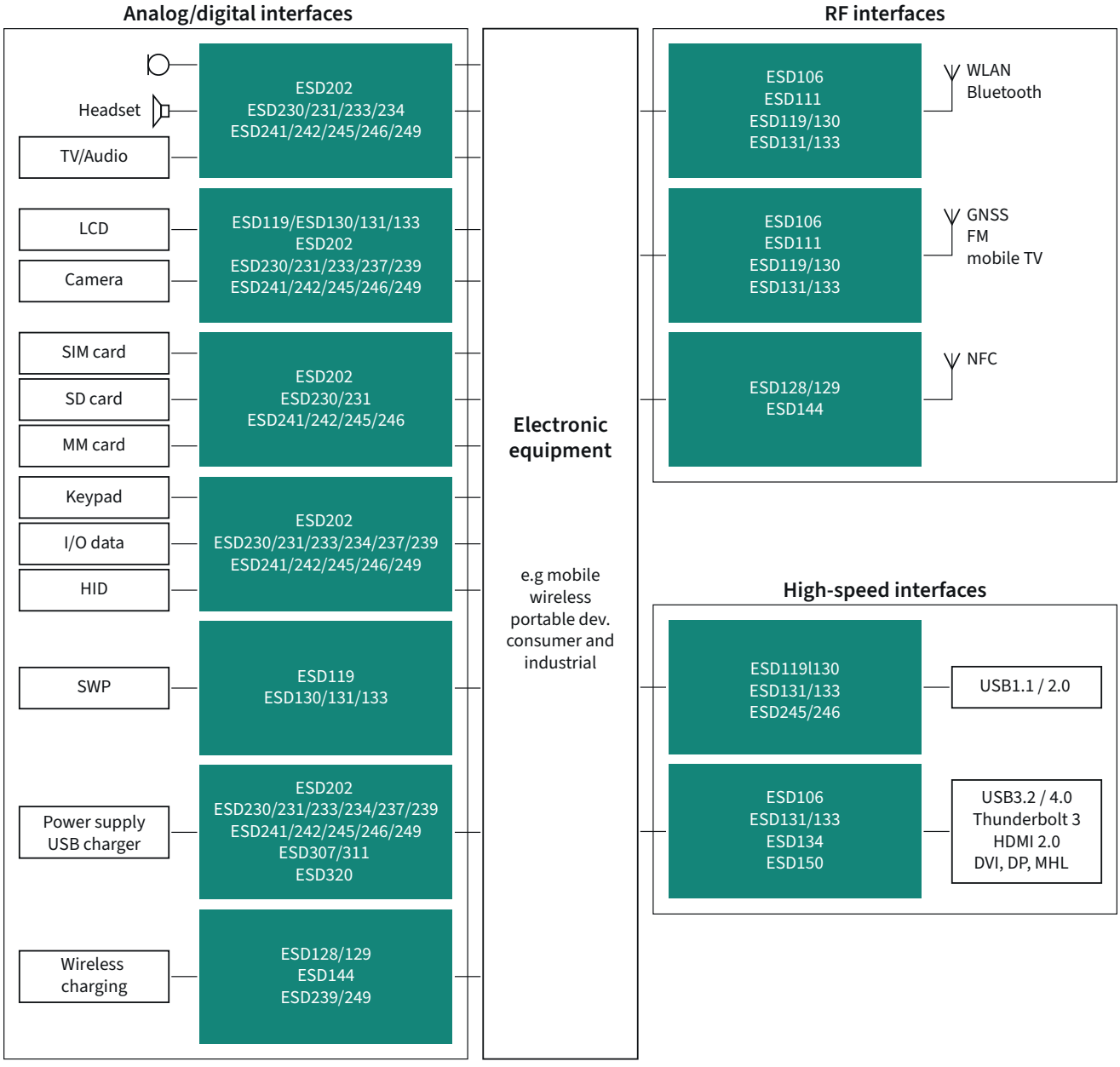

Figure 20 Interface protection with discrete ESD protection

To provide proper ESD protection for the inner PCB, it is mandatory to place fast-responding TVS protection diodes at specific locations. General-purpose TVS diodes can be used depending on the position to be protected (e.g. where the signal frequency is low and therefore device capacitance does not matter).

Dedicated low-capacitance TVS diodes must be used for high-speed data lines to avoid any impact on signal integrity. The higher the data rate, the more the device capacitance matters. Figure 32 shows the available ESD protection devices for various interfaces in mobile devices.

ESD protection diodes for general purpose interfaces

Product	Application	V_{RWM} [V]	ESD [1] [kV]	V_{CL} [2] [V_{CL}] @ [A]	R_{dyn} [3] [Ω]	I_{PP} [4] [A]	V_{CL} [5] [V]	C_T [6] [pF]	Protected lines	Package
ESD202-B1-W01005	Gen. purpose	±5.5	±16	±13 @ ±16 ±17 @ ±30	0.2	3	12	6.5	1	WLL-2-2
ESD230-B1-W0201	Gen. purpose	±5.5	±15	±13 @ ±16	0.22	3	14	7	1	WLL-2-1
ESD231-B1-W0201	Gen. purpose	±5.5	±30	±12 @ ±16 ±16 @ ±30	0.3	2 9	8 10	3.5	1	WLL-2-1
ESD233-B1-W0201	Gen. purpose	±5.5	±20	±13 @ ±16	0.2	3	12.5	33	1	WLL-2-1
ESD234-B1-W0201	Gen. purpose	±5.5	±20	±13 @ ±16	0.2	3	12.5	56	1	WLL-2-1
ESD237-B1-W0201	Gen. purpose	±8	±16	±13 @ ±16 ±17 @ ±30	0.21	3	12	7	1	WLL-2-1
ESD239-B1-W0201	Gen. purpose	±22	±16	±27 @ ±16	0.27	3		3.2	1	WLL-2-3
ESD241-B1-W0201 ESD242-B1-W01005	Gen. purpose	±3.3	±15	±6 @ ±16	0.1	4		6.5 6	1	WLL-2-3 WLL-2-2
ESD245-B1-W0201 ESD246-B1-W01005	Gen. purpose	±5.5	±15	±7.5 @ ±16	0.1	5		5.8 5.5	1	WLL-2-3 WLL-2-2
ESD249-B1-W0201	Gen. purpose	±18	±16	±23 @ ±16	0.27	3		4.2	1	WLL-2-3

1) Electrostatic discharge as per IEC61000-4-2, contact discharge
2) TLP clamping voltage for 100 ns pulse length
3) Dynamic resistance (ON-resistance) evaluated with TLP measurement (100 ns pulse length))
4) Maximum peak pulse current according to IEC61000-4-5 (8/20 µs)
5) Clamping voltage at $I_{PP,max}$ according to IEC61000-4-5 (8/20 µs)
6) Typical capacitance at 1 MHz (unless specified), 0 V, I/O vs. GND

Low capacitance ESD protection diodes for high speed and RF interfaces

Product	Application	V_{RWM} [V]	ESD [1] [kV]	V_{CL} [2] [V_{CL}] @ [A]	R_{dyn} [3] [Ω]	I_{PP} [4] [A]	V_{CL} [5] [V]	C_T [6] [pF]	Protected lines	Package
ESD106-B1-W0201	High-speed interfaces	±5.5	±12	±16 @ ±8 ±25 @ ±16	1.1	1.5	10	0.13	1	WLL-2-3
ESD111-B1-W0201	High linearity requirement	±5.5	±11	±19 @ ±8 ±30 @ ±16	1.29	2.0	11	0.12	1	WLL-2-3
ESD150-B1-W0201	USB 4, USB 3.x SuperSpeed"	±3.3	±12	±4.2 @ ±8 ±5.4 @ ±16	0.16	3.0	3.8	0.16	1	WLL-2-3
ESD119-B1-W01005 ESD130-B1-W0201	High-speed interfaces	±5.5	±25	±20 @ ±16 ±31 @ ±30	0.8	1.0 2.5	11 14	0.3	1	WLL-2-2 WLL-2-1
ESD128-B1-W0201 ESD129-B1-W01005	NFC-RF	±18	±15	±32 @ 16	0.85	1.0	18.5	0.3 0.25	1	WLL-2-1 WLL-2-2
ESD131-B1-W0201 ESD133-B1-W01005	High-speed interfaces	±5.5	±20	±8.5 @ ±8 ±13 @ ±16	0.6 0.56	3.0	5.5	0.25 0.23	1	WLL-2-3 WLL-2-2
ESD144-B1-W0201	NFC-RF	±18	±15	±13 @ ±16	0.6	2.0		0.25	1	WLL-2-3
ESD5V5U5ULC	USB2.0-HS, V_{CC}	+5.5	±25	8.9 @ 16 11.5 @ 30	0.2	6.0	10.0	0.45	4	SC74

1) Electrostatic discharge as per IEC61000-4-2, contact discharge
2) TLP clamping voltage for 100 ns pulse length
3) Dynamic resistance (ON-resistance) evaluated with TLP measurement (100 ns pulse length)
4) Maximum peak pulse current according to IEC61000-4-5 (8/20 µs)
5) Clamping voltage at $I_{PP,max}$ according to IEC61000-4-5 (8/20 µs)
6) Typical capacitance at 1 MHz (unless specified), 0 V, I/O vs. GND

Please visit https://www.infineon.com/esd for alternative devices. Click on green marked devices to visit product pages directly.

8 Support material

Please refer to the format from pocket guide

More detailed information on all available Infineon devices for wireless communications

www.infineon.com/mobiledevices

Datasheets/Application notes/Technical documents

Visit the product's internet pages and find them under "Document".
In this application guide, you can directly access the product pages, and the application notes from the product recommendation table.

www.infineon.com/rf

Component libraries for RF devices

To download the device simulation files such as S-parameters or ADS/MWO design kit,
visit the product's Internet pages and find them under "Simulation".

www.infineon.com/rfcomponentlibraries

This application guide is available for downloading at:

www.infineon.com/wireless-communication-guide

9 Abbreviations

Abbreviations	Terms
BDS	Beidou Navigation System
CA	Carrier Aggregation
CDMA	Code Division Multiple Access
CSP	Chip Scale Package
DAB	Digital Audio Broadcasting
DDA	Dual Diversity Antenna
DL	Downlink
DLCA	Downlink Carrier Aggregation
DPDT	Double Pole Double Throw
DP	Display Port
DSSS	Direct Sequence Spread Spectrum
EM	Electro-Magnetic
EMI	Electromagnetic Interference
ENDC	E-UTRAN New Radio – Dual Connectivity
ESD	Electro-Static Discharge
FDD	Frequency-Division Duplexing
FHSS	Frequency-Hopping Spread Spectrum
FM	Frequency Modulation
GLONASS	Global Orbiting Navigation Satellite System
GNSS	Global Navigation Satellite System
GPIO	General Purpose Input/Output
GPS	Global Positioning System
IL	Insertion Loss
IoT	Internet of Things
IMD	Intermodulation Distortion
IRNSS	Indian Regional Navigation Satellite System
ISM	Industrial, Science and Medicine
LAA	License Assisted Access
LiDAR	Light Detection And Ranging
LoRaWAN	Long Range Wide Area Network
LNA	Low Noise Amplifier
LMM	LNA multiplexer modules
LTE	Long-Term Evolution
LTE-A	LTE-Advanced
LTE-U	Unlicensed Long-Term Evolution
MIPI	Mobile Industry Processor Interface
MIPI RFFE	Mobile Industry Processor Interface for RF Frontend Devices
MMIC	Monolithic Microwave Integrated Circuit

Abbreviations	Terms
MIMO	Multiple Input Multiple Output
MU	Multi-User
NF	Noise Figure
NFC	Near-Field Communication
OFDM	Orthogonal Frequency Division Multiplexing
PA	Power Amplifier
PCB	Printed Circuit Board
PIFA	Planar Inverted F antenna
PIN-Diode	Positive-Intrinsic-Negative diode
QAM	Quadrature Amplitude Modulation
QZSS	Quasi-Zenith Satellite System
RF	Radio Frequency
RF FE	RF Front-End
RoHS	Restriction of Hazardous Substances
RX	Receiver
SAW	Surface Acoustic Wave
SD	Secure Digital Card
SDARS	Satellite Digital Audio Radio Service
SiGe:C	Silicon Germanium Carbon
SPxT	Single Pole x Throw
SRS	Souding Reference Signal
TDD	Time-division duplexing
TD-LTE	Time Division Long-Term Evolution
ToE	Time of Flight
TRP	Total Radiated Power
TSNP	Thin Small Non Leaded Package
TSLP	Thin Small Leaded Package
TVS	Transient Voltage Suppression
TX	Transmitter
UL	Uplink
ULCA	Uplink Carrier Aggregation
USB	Universal Serial Bus
UWB	Ultra Wide Band
VoIP	Voice over IP
W-CDMA	Wideband-Code Division Multiple Access
WLAN	Wireless Local Area Network
3GPP	3rd Generation Partnership Project
5G NR	5G New Radio

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