1-Channel GNSS Interference Resistant RF Front-End IC

1. OVERVIEW

NT1069-1 is a single channel interference resistant RF Receiver which is intended for reception of all existing Global Navigational Satellite Systems (GNSS) such as GPS, GLONASS, Galileo, BeiDou, NavIC, QZSS in L1, L2, L3, L5, E1, E5a, E5b, E6, B1, B2, B3, S bands. The distinctive feature of NT1069-1 is high interference immunity, which is achieved by high linearity of the channels maintaining low noise figure. Given about 100mA per channel consumption NT1069-1 provides a good opportunity for developers of professional positioning systems to reduce a power budget for RF Front End.

Each channel is independent and consists of LNA, highly linear mixer, 2-stage IFA and output linear buffer and is configured individually. IFA is built on two stages, which are covered with negative feedback to ensure high linearity.

NT1069-1 assumes a delivery of LO signal from external source and has a very simple interface for direct control of operation mode and gain settings.

2. FEATURES

- Single conversion super heterodyne receiver including LNA, highly linear mixer, 2-stage IFA and output linear buffer
- LNA gain external control via pins #9–10
- IFA gain external control via pins #15–17, 20–22
- Interference resistance
- Channel input 3rd order intercept point up to +2dBm
- Analog differential output with two options of voltage swing 1Vp-p and 2Vp-p
- Two options of channel output frequency range – up to 50MHz and 100MHz
- 2-stage RF frequency external filtration
- External LO frequency input
- 5x5mm QFN32 package or 2.5x2.5mm WLSCP

3. APPLICATIONS

- GNSS based driverless car systems
- Professional drones
- Space-time processing (antenna arrays)
- Anti-jamming systems

4. DESCRIPTION

4.1. BLOCK DIAGRAM

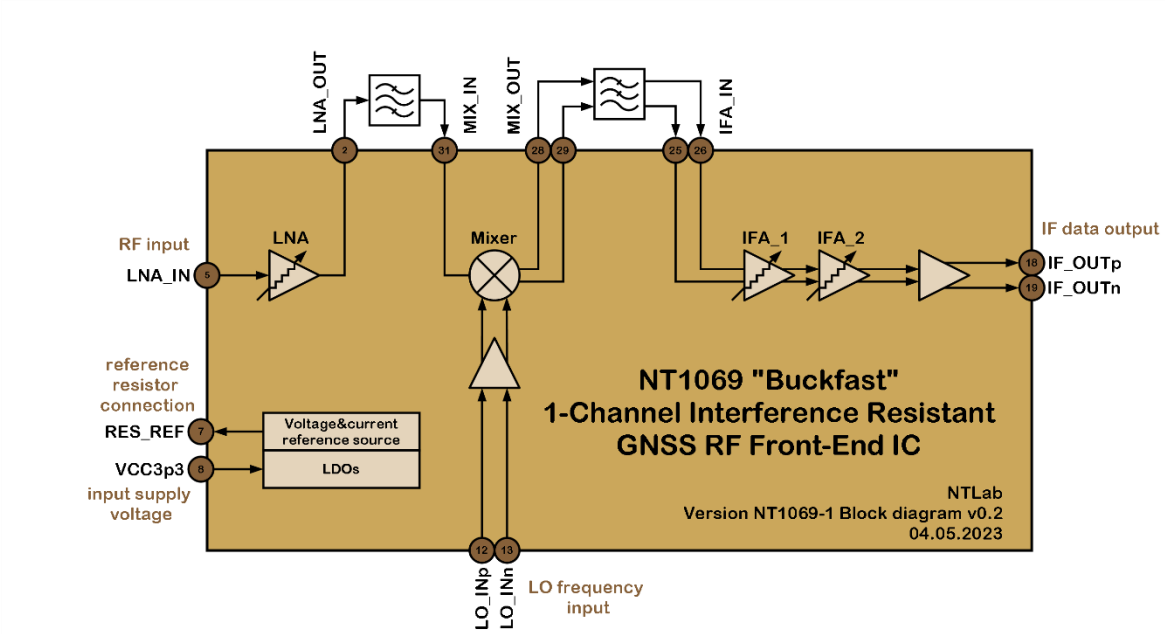

Figure 4.1: NT1069-1 “Buckfast” Block diagram

4.2. PINS DESCRIPTION

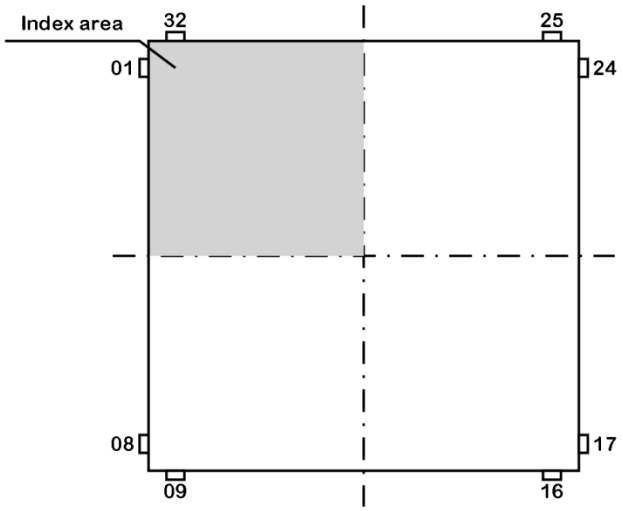

Figure 4.2: NT1069-1 “Buckfast” Pin configuration

Table 4.1: NT1069 pins description

#	Name	Description
1	MODE0	Operation mode (MODE0+MODE1): “00” Shutdown “01” Service mode “10” Service mode “11” Active mode
2	LNA_OUT	LNA output
3	RF_VCC	RF blocks supply voltage filtering capacitor
4	LNA_GND	LNA ground
5	LNA_IN	RF input
6	LNA_GND	LNA ground
7	RES_REF	External resistor for reference source
8	VCC3p3	Supply voltage 3.3V
9 10	LNA_GAIN0 LNA_GAIN1	LNA manual gain control inputs: “00” Preset 1 “01” Preset 2 “10” Preset 3 “11” Preset 4
11	LO_GND	Local oscillator buffer ground
12 13	LO_INp LO_INn	Local oscillator differential input
14	LO_GND	Local oscillator buffer ground
15 16 17	IFA_GAIN0 IFA_GAIN1 IFA_GAIN2	IFA manual gain control inputs: “000000” 1.7 dB “010000” 13.6 dB “100000” 25.7 dB “110000” 37.7 dB “000001” 2.4 dB “010001” 14.4 dB “100001” 26.5 dB “110001” 38.5 dB “000010” 3.3 dB “010010” 15.2 dB “100010” 27.3 dB “110010” 39.3 dB “000011” 4.0 dB “010011” 16.0 dB “100011” 28.0 dB “110011” 40.0 dB “000100” 4.6 dB “010100” 16.7 dB “100100” 28.7 dB “110100” 40.1 dB “000101” 5.4 dB “010101” 17.5 dB “100101” 29.5 dB “110101” 40.9 dB “000110” 6.1 dB “010110” 18.3 dB “100110” 30.3 dB “110110” 41.6 dB “000111” 6.9 dB “010111” 19.1 dB “100111” 31.1 dB “110111” 42.3 dB “001000” 7.6 dB “011000” 19.9 dB “101000” 31.8 dB “111000” 42.0 dB “001001” 8.3 dB “011001” 20.7 dB “101001” 32.6 dB “111001” 42.8 dB “001010” 9.2 dB “011010” 21.4 dB “101010” 33.4 dB “111010” 43.5 dB “001011” 9.9 dB “011011” 22.2 dB “101011” 34.2 dB “111011” 44.2 dB “001100” 10.6 dB “011100” 23.3 dB “101100” 34.9 dB “111100” 43.4 dB “001101” 11.4 dB “011101” 24.0 dB “101101” 35.7 dB “111101” 44.2 dB “001110” 12.2 dB “011110” 24.8 dB “101110” 36.5 dB “111110” 44.9 dB “001111” 13.0 dB “011111” 25.6 dB “101111” 37.2 dB “111111” 45.6 dB
18 19	IF_OUTp IF_OUTn	IF data differential output
20 21 22	IFA_GAIN3 IFA_GAIN4 IFA_GAIN5	IFA manual gain control inputs (continue)
23	IRQ	Interrupt request: “0” Normal operation “1” Maximum current exceeded
24	IFA_VCC	IFA supply voltage filtering capacitor

#	Name	Description
25 26	IFA_INn IFA_INp	IFA differential input
27	IFA_GND	IFA ground
28 29	MIX_OUTp MIX_OUTn	Mixer differential output
30	MIX_GND	Mixer ground
31	MIX_IN	Mixer input
32	MODE1	Operation mode (refer to MODE0)

4.3. APPLICATION SCHEMATIC

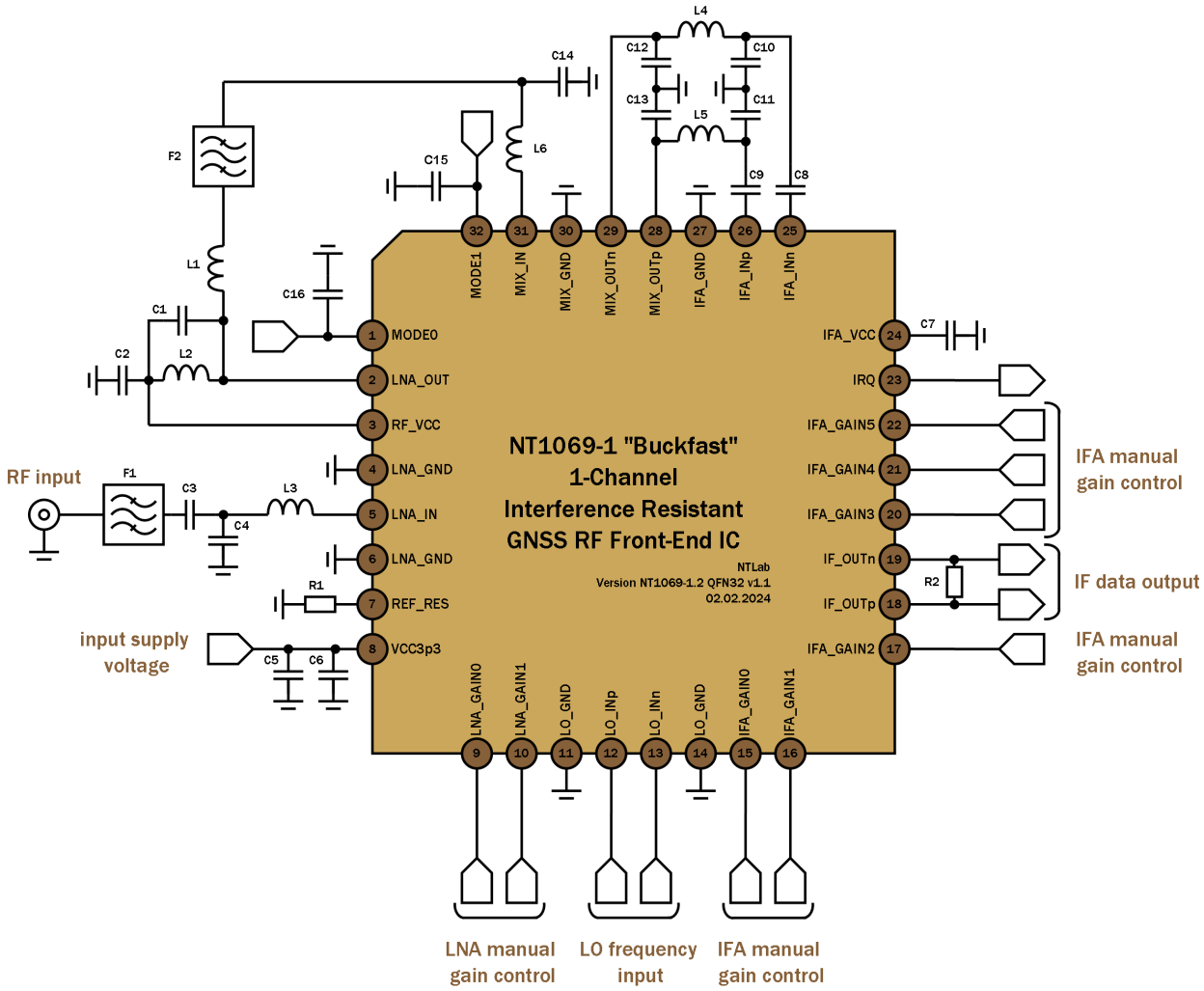

Figure 4.3: NT1069-1 “Buckfast” Application schematic (Active mode)

Table 4.2: External components description

Component	Nominal value	Notes
C1	1pF	Matching LNA output network capacitor for L1 band
	2pF	Matching LNA output network capacitor for L2/L3/L5 band
	–	Matching LNA output network capacitor for S band
C2	100nF	Supply voltage filtering capacitor
C3	22pF	DC decoupling capacitor for L1 band
	22pF	DC decoupling capacitor for L2/L3/L5 band
	10pF	DC decoupling capacitor for S band
C4	2pF	Matching LNA input network capacitor for L1 band
	1.5pF	Matching LNA input network capacitor for L2/L3/L5 band
	–	Matching LNA input network capacitor for S band
C5	10µF	Main supply voltage filtering capacitor
C6	1nF	Main supply voltage filtering capacitor
C7	100nF	Supply voltage filtering capacitor
C8	10nF	DC decoupling capacitor
C9	10nF	DC decoupling capacitor
C10	5pF	External filter
C11	5pF	
C12	5pF	
C13	5pF	
C14	2.7pF	Matching mixer input network capacitor for L1 band
	3.3pF	Matching mixer input network capacitor for L2/L3/L5 band
	1.2pF	Matching mixer input network capacitor for S band
C15	100p	Blocking capacitor
C16	100p	Blocking capacitor
L1	1.5nH	Matching LNA output network inductor for L1 band
	7.5nH	Matching LNA output network inductor for L2/L3/L5 band
	0Ohm	Matching LNA output network inductor for S band
L2	4.3nH	LNA load inductor for L1 band
	8.7nH	LNA load inductor for L2/L3/L5 band
	1.3nH	LNA load inductor for S band
L3	4.3nH	Matching LNA input network inductor for L1 band
	7.5nH	Matching LNA input network inductor for L2/L3/L5 band
	1.3nH	Matching LNA input network inductor for S band
L4	51nH	External filter
L5	51nH	
L6	6.2nH	Matching mixer input network inductor for L1 band
	12nH	Matching mixer input network inductor for L2/L3/L5 band
	2.5nH	Matching mixer input network inductor for S band
R1	61.9kOhm	External reference resistor
R2	100Ohm/ 200Ohm	Load resistor

5. OPERATING CHARACTERISTICS

5.1. DC ELECTRICAL CHARACTERISTICS

The values of electrical characteristics are specified for V_{cc} = 3.0 V to 3.6V, T_a =–60…+115°C. Typical values are at V_{cc} = 3.3 V, T_a =+25°C, unless otherwise specified.

Parameter	Symbol	Condition		Value			Unit
				min	typ	max	
Overall							
Supply voltage	V_{CC}			3.0	3.3	3.6	V
Current consumption	I_{CC}	NT1069-1 version A	Active mode	–	115	–	mA
		NT1069-1 version B		–	TBD	–	mA
	I_{SHD}	Shutdown		–	15	–	nA
Input logic-level high	V_{IH}	–		0.9×V_{CC}	–	–	V
Input logic-level low	V_{IL}	–		–	–	0.1×V_{CC}	V
Output logic-level high	V_{OH}			0.9×V_{CC}	–	–	V
Output logic-level low	V_{OL}			–	–	0.1×V_{CC}	V
IFA output DC level	V_{DC_IFA}	–		–	1.7	–	V
RF supply voltage level	V_{RF_VCC}	–		–	3.0	–	V
IFA supply voltage level	V_{IFA_VCC}	–		–	3.0	–	V

5.2. AC ELECTRICAL CHARACTERISTICS

The values of electrical characteristics are specified for V_{cc} = 3.0 V to 3.6V, T_a =–60…+115°C. Typical values are at V_{cc} = 3.3 V, T_a =+25°C, unless otherwise specified.

Parameter	Symbol	Condition			Value			Unit
					min	typ	max	
Overall								
Channel input frequency range	F_{IN}	L1 band			1557	–	1611	MHz
		L2/L3/L5 band			1167	–	1294	
		S band			2484	–	2500	
Channel input resistance	R_{IN}	–			–	50	–	Ohm
Channel input VSWR	$VSWR_{IN}$	L1 band	@50Ohm, with matching circuits		–	1.1	–	–
		L2/L3/L5 band			–	1.6	–	
		S band			–	2.0	–	
Channel output frequency range	F_{OUT}	NT1069-1.2 version A			2	–	50	MHz
		NT1069-1.2 version B			2	–	100	MHz
Channel load resistance	R_{LOAD}	–			–	100/200	–	Ohm
Channel maximum power gain	G_{P_MAX}	L1 band	Note 1		–	64.8	–	dB
		L2/L3/L5 band				67.1		
		S band				56.3		
Channel minimum power gain	G_{P_MIN}	L1 band	Note 1		–	10.9	–	dB
		L2/L3/L5 band				13.0		
		S band				-2.0		
Channel noise figure	NF	G_{P_LNA}= Preset 1	L1 band	Note 2	–	6.2	–	dB
			L2/L3/L5 band			8.4		
			S band			8.9		
		G_{P_LNA}= Preset 3	L1 band		–	10.2	–	dB
			L2/L3/L5 band			13.0		
			S band			17.4		

Note 1: Without filters F1 and F2 losses; V_{OUT_IFA}=1Vp-p; R_{LOAD} = 100Ohm.

Note 2: Without filter F1, filter F2 losses 3.0dB, total G_P=33dB; R_{LOAD_IFA}=100Ohm, F_{OUT}=20MHz, P_{LO}=+5dBm.

Parameter	Symbol	Condition			Value			Unit
					min	typ	max	
Channel input 1dB compression point	IP_{1dB}	G_{P_LNA}= Preset 1	L1 band	Note 3	–	-16.0	–	dBm
			L2/L3/L5 band			-18.5		
			S band			-14.5		
		G_{P_LNA}= Preset 3	L1 band		–	-9.0	–	
			L2/L3/L5 band			-13.5		
			S band			-4.5		
Channel input 3rd order intercept point	IIP3	G_{P_LNA}= Preset 1	L1 band	Note 4	–	-6.8	–	dBm
			L2/L3/L5 band			-14.7		
			S band			-10.0		
		G_{P_LNA}= Preset 3	L1 band		–	-2.1	–	
			L2/L3/L5 band			-9.8		
			S band			2.7		

Note 3: Without filter F1, filter F2 losses 3.0dB, minimum IFA G_P; R_{LOAD_IFA}=100Ohm, F_{OUT}=20MHz, P_{LO}=+5dBm.
Note 4: Without filter F1, filter F2 losses 3.0dB, total G_P=33dB; V_{OUT_IFA}=1Vp-p, R_{LOAD_IFA}=100Ohm, F_{OUT}=15&20MHz, P_{LO}=+5dBm.

Parameter	Symbol	Condition		Value			Unit
				min	Typ	max	
LNA							
LNA operating frequency range	F_{IN_LNA}	L1 band		1557	–	1611	MHz
		L2/L3/L5 band		1167	–	1294	
		S band		2484	–	2500	
LNA input resistance	R_{IN_LNA}	–		–	50	–	Ohm
LNA output resistance	R_{OUT_LNA}	–		–	50	–	Ohm
LNA input VSWR	$VSWR_{IN\_LNA}$	L1 band	@50Ohm, with matching circuits	–	1.1	–	–
		L2/L3/L5 band		–	1.6	–	–
		S band		–	2.0	–	–
LNA output VSWR	$VSWR_{OUT\_LNA}$	L1 band	@50Ohm, with matching circuits	–	1.3	–	–
		L2/L3/L5 band		–	3.2	–	–
		S band		–	2.4	–	–
LNA power gain	G_{P_LNA}	L1 band	Preset 1	–	17.8	–	dB
			Preset 2	–	14.4	–	
			Preset 3	–	11.0	–	
			Preset 4	–	7.8	–	
		L2/L3/L5 band	Preset 1	–	18.5	–	
			Preset 2	–	15.3	–	
			Preset 3	–	11.9	–	
			Preset 4	–	8.3	–	
		S band	Preset 1	–	14.1	–	
			Preset 2	–	8.7	–	
			Preset 3	–	4.9	–	
			Preset 4	–	-0.3	–	
LNA noise figure	$NF_{\_LNA}$	L1 band	Preset 1	–	2.5	–	dB
			Preset 3	–	3.1	–	
		L2/L3/L5 band	Preset 1	–	2.5	–	
			Preset 3	–	2.9	–	
		S band	Preset 1	–	3.7	–	
			Preset 3	–	5.0	–	
LNA input 1dB compression point	IP_{1dB_LNA}	L1 band	Preset 1	–	-9.5	–	dBm
			Preset 3	–	-4.0	–	
		L2/L3/L5 band	Preset 1	–	-10.5	–	
			Preset 3	–	-4.0	–	
		S band	Preset 1	–	-14.0	–	
			Preset 3	–	-5.0	–	
LNA input 3rd order intercept point	$IIP3_{\_LNA}$	L1 band	Preset 1	–	4.5	–	dBm
		L2/L3/L5 band		–	4.5	–	
		S band		–	-6.7	–	
Mixer							
Mixer input frequency range	F_{IN_MIX}	L1 band		1557	–	1611	MHz
		L2/L3/L5 band		1167	–	1294	
		S band		2484	–	2500	
Mixer input resistance	R_{IN_MIX}	–		–	50	–	Ohm
Mixer input VSWR	$VSWR_{IN\_MIX}$	L1 band	@50Ohm, with matching circuits	–	1.8	–	–
		L2/L3/L5 band		–	2.5	–	–
		S band		–	2.0	–	–
Mixer output resistance	R_{OUT_MIX}	Differential output		–	200	–	Ohm

Parameter	Symbol	Condition		Value			Unit
				min	Typ	max	
Mixer output frequency range	F_{OUT_MIX}	–		2	–	100	MHz
LO frequency range	F_{LO}	–		1100	–	2550	MHz
LO frequency input resistance	R_{IN_LO}	Differential input		–	100	–	Ohm
LO frequency input level	P_{LO}	–		–10	–	+5	dBm
Mixer power gain	G_{P_MIX}	L1 band	Note 5	–	1.4	–	dB
		L2/L3/L5 band		–	3.0	–	
		S band		–	-3.4	–	
Mixer noise figure	$NF_{\_MIX}$	L1 band		–	14.5	–	dB
		L2/L3/L5 band		–	16.0	–	
		S band		–	17.9	–	
Mixer input 1dB compression point	IP_{1dB_MIX}	L1 band		–	0.5	–	dBm
		L2/L3/L5 band		–	-3.0	–	
		S band		–	4.5	–	
Mixer input 3rd order intercept point	$IIP3_{\_MIX}$	L1 band	Note 6	–	10.7	–	dBm
		L2/L3/L5 band		–	7.1	–	
		S band		–	11.6	–	
IFA							
IFA operating frequency range	F_{IFA}	NT1069-1.2 version A	C_{LOAD}=10pF	2	–	50	MHz
		NT1069-1.2 version B		2	–	100	
IFA input resistance	R_{IN_IFA}	Differential input		–	200	–	Ohm
IFA load resistance	R_{LOAD_IFA}	Differential output		–	100/200	–	
IFA maximum power gain	$G_{P\_IFA\_MAX}$	R_{LOAD_IFA} =100Ohm/200Ohm		–	45.6/45.0	–	dB
IFA minimum power gain	$G_{P\_IFA\_MIN}$	R_{LOAD_IFA} =100Ohm/200Ohm		–	1.7/1.1	–	dB
IFA gain resolution	$G_{P\_RES\_IFA}$	–		–	6	–	bit
IFA power gain step	ΔG_{P_IFA}	–		–	0.7	–	dB
IFA noise figure	$NF_{\_IFA}$	G_{P_IFA} = 1.7dB	R_{LOAD_IFA} = 100Ohm	–	25.1	–	dB
		Gain = 22.7dB		–	10.0	–	
		Gain = 45.6dB		–	9.1	–	
IFA input 1dB compression point	IP_{1dB_IFA}	Gain = 1.7dB	R_{LOAD_IFA} = 100Ohm	–	9.0	–	dBm
		Gain = 22.2dB		–	-12.0	–	
		Gain = 45.6dB			-35.0		
IFA input 3rd order intercept point	$IIP3_{\_IFA}$	Gain = 1.7dB	R_{LOAD_IFA} = 100Ohm	–	27.7	–	dBm
		Gain = 22.2dB		–	11.8	–	
		Gain = 45.6dB		–	-13.9	–	
Maximum voltage at the differential linear outputs	V_{OUT_IFA}	–		2	3	–	Vp-p

Note 5: P_{OUT_MIX} = -10dBm; F_{OUT}=20MHz, P_{LO}=+5dBm.

Note 6: P_{OUT_MIX}= -10dBm, F_{OUT}=19&20MHz, P_{LO}=+5dBm.

6. PACKAGE INFORMATION

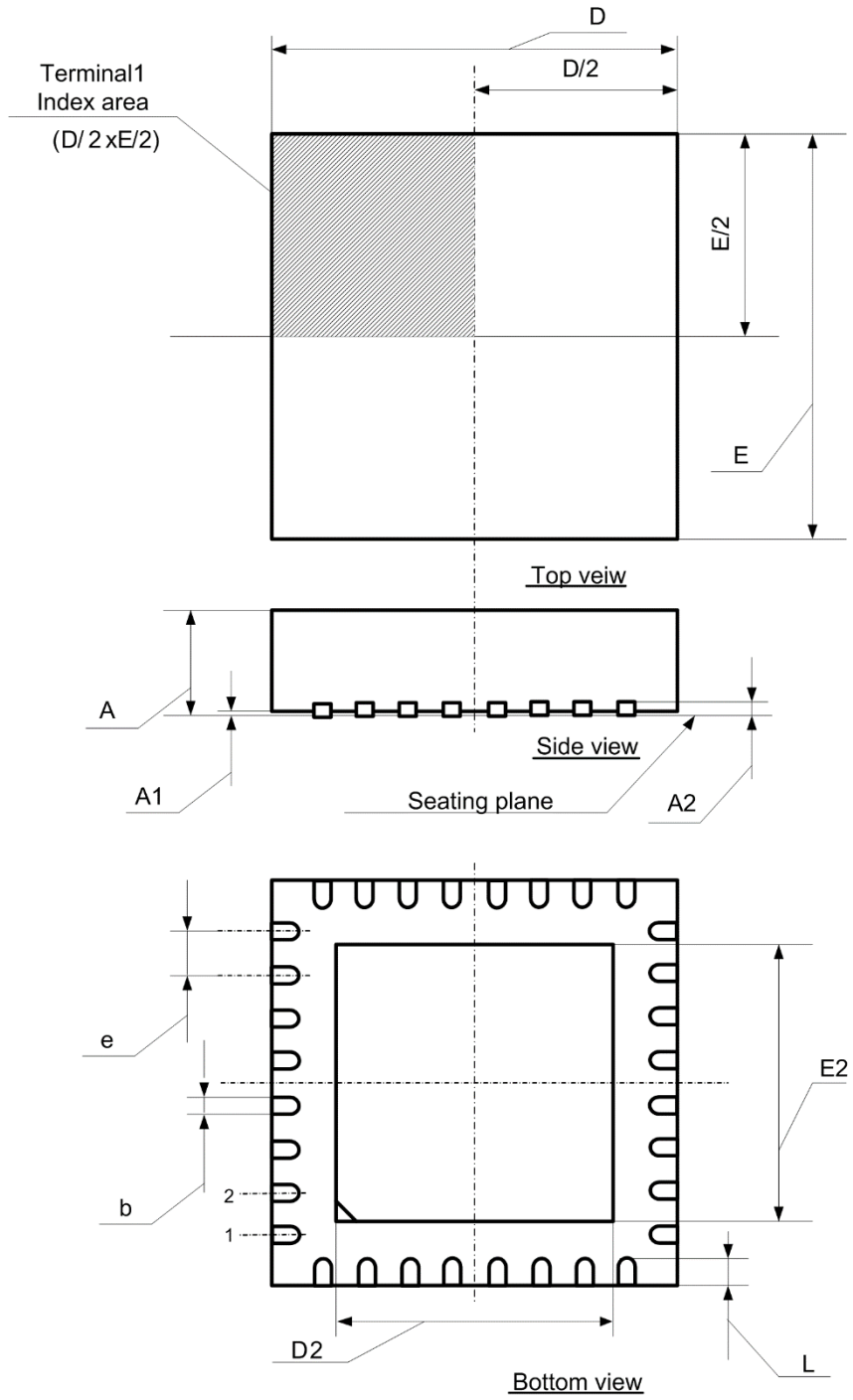

Figure 6.1: Package QFN32 5×5

Table 6.1: Package QFN32 5×5 dimension

Unit	A	A1	A2	b	D	D2	E	E2	e	L
min, mm	0.80	0.00	0.203 REF	0.18	4.90	3.15	4.90	3.15	0.50 BSC	0.35
typ., mm	0.85	0.02		0.25	5.00	3.20	5.00	3.20		0.40
max, mm	0.90	0.05		0.30	5.10	3.25	5.10	3.25		0.45