SP6335A: Single Channel 3.3 GHz – 4.2 GHz, Receiver Switch & LNA Front End Module

General Description

The SP6335A is a single-channel, integrated radio frequency (RF), front-end module designed for time division duplexing (TDD) applications that operate in the 5G frequency bands between 3.3 GHz and 4.2 GHz. The SP6335A is configured with a cascading two-stage low noise amplifier (LNA) and a high-power silicon single-pole, double-throw (SPDT) switch.

The device comes in a RoHS compliant, compact, 3 mm × 3 mm, 16-lead package.

Applications

- Wireless Infrastructure
- TDD massive multiple input and multiple output and active antenna systems
- TDD-Based communication systems

Features

- Integrated single-channel RF front end with 2 stage LNA and high power SPDT switch along with on-chip bias and matching
- Single supply operation
- Gain: 36 dB typical at 3.8 GHz
- Low noise figure: 1.2 dB typical at 3.8 GHz
- Low insertion loss: 0.4 dB typical at 3.8 GHz
- High OIP3: 31 dBm typical
- High power handling at T_{CASE} = 105°C
  - Full lifetime 5G NR average power (9 dB PAR): 40 dBm
  - Single event (<10 sec operation) 5G NR average power (9 dB PAR): 43 dBm
- Low supply current
  - Receive: 100 mA typical at 5 V
  - Transmit: 12 mA typical at 5 V
- 3 mm x 3 mm, 16-lead LFCSP package.

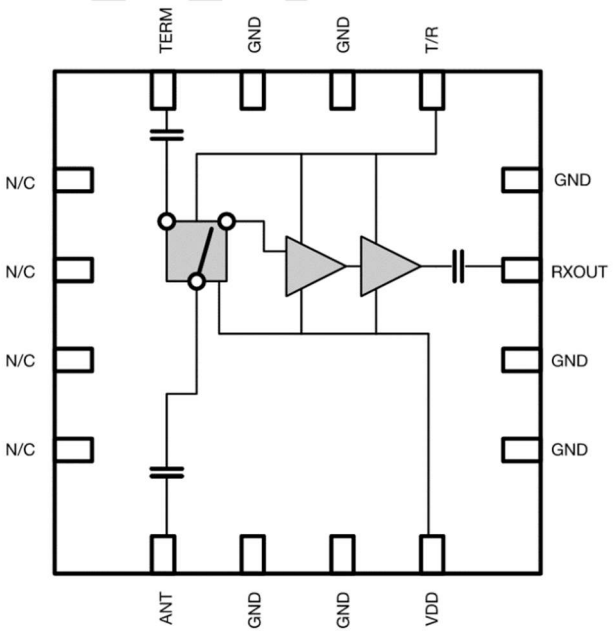

Figure 1 Functional Diagram

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1 Pin Configuration

1.1 Pin Configuration Diagram

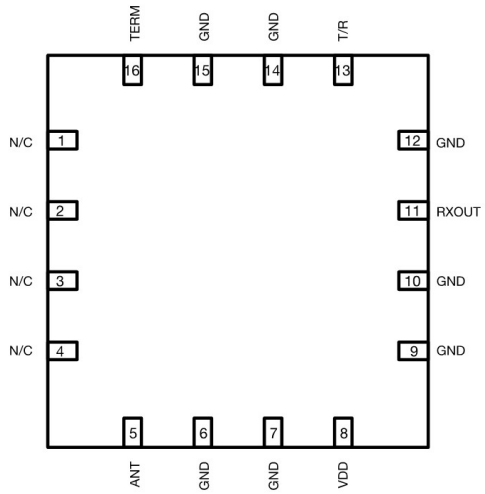

Figure 2 SP6335A Pin Configuration

1.2 Pin Description

Table 1 Pin Functions

PIN Name	Pin No.	Description
ANT	5	RF Input
VDD	8	Supply voltage
RXOUT	11	RF Output. This pin is the receiver path.
T/R	13	Logic control
TERM	16	Termination Output. This pin is the transmit path.
GND	5, 7, 9, 10, 12, 14, 15	Ground
NIC	1, 2, 3, 4	Not internally connected. It is recommended to connect NIC to the RF ground of the PCB.
EPAD		Exposed Pad. The exposed pad must be connected to RF or dc ground.

2 Electrical Specifications

Table 2 Absolute Maximum Ratings

Parameter		Symbol	Min	Max	Units
Positive Supply Voltage	VDD		-0.3	5.5	V
Digital Control Input Voltage	TR		-0.3	5.5	V
RF Input Power	Transmit Input Power	5G NR Peak		52	dBm
	Receive Input Power	5G NR peak		25	dBm
Temperature	Storage		-65	150	°C
	Reflow			260	°C
Electrostatic Discharge Sensitivity (ESD)	Human Body Model	HBM		1000	V
	Charged Device Model	CDM		500	V

Notes:

- Operation of this device outside the parameter ranges given above may cause permanent damage.
- Operation of this device at the maximum operating ranges for extended periods of time may affect product reliability

Table 3 Electrical Specifications DC and Control

Parameter		Conditions	Min	Typ	Max	Unit
Supply Current (I_{DD})	Receive	VDD = 5 V		100		mA
	Transmit	VDD = 5 V		12		mA
Digital Currents	TR	TR = 3.3 V		35		uA
DIGITAL INPUT						
TR	Low (V_{IL})		0		0.63	V
	High (VIH)		1.17		VDD	V

Table 4 Electrical Specifications

VDD = 5 V; TR = 0 V or 3.3V; Testing Frequency: 3.8 GHz. Case Temperature (T_{CASE}) = 25 °C, 50 Ω system, unless otherwise noted.

Parameter		Condition	Min	Typ	Max	Units
Operating Frequency			3.3		4.2	GHz
Gain[1]	Receive Mode	Receive operation		36		dB
Gain Flatness[1]	Receive Mode	Receive operation in any 100 MHz bandwidth		0.6		dB
Input return loss (ANT)		Receive operation		-15		dB
Output return loss (RXOUT)		Receive operation		-15		dB
Input return loss (ANT)		Transmit operation		-20		dB
Output return loss (TERM)		Transmit operation		-20		dB
Noise Figure(NF)[1]	Receive Mode	Receive operation		1.2		dB
Output Third-Order Intercept Point (OIP3)[1]	Receive Mode	Receive operation, two-tone output power = +3 dBm per tone at 1 MHz tone spacing		31		dBm
Output 1 dB Compression (OP1dB)	Receive Mode	Receive operation		17		dBm
Insertion Loss[1]		Transmit operation		0.4		dB
Reverse Isolation	Between RXOUT AND ANT	Receive operation		-50		dB
Switch Isolation	ANT TO RXOUT	Transmit operation		-55		dB
Switching time		50% control voltage to 90%, 10% of RF		600		ns

Notes:

1. Refer Truth Tables, Table 7 and Table 8

Table 5 Recommended Operating Conditions

Parameter	Conditions	Min	Typ	Max	Unit
Bias Voltage Range	VDD	4.75	5	5.25	V
Control Voltage Range	TR	0		VDD	V
RF Input Power at ANT	TR = 3.3 V, T_{CASE} = 105°C				
	9 dB PAR 5G NR full lifetime average			40	dBm
	9 dB PAR 5G NR single event (<10 sec) average			43	dBm
Case Temperature Range T_{CASE} [2]		−40		+105	°C
Junction Temperature at Maximum T_{CASE}[2]	Receive operation[1]			TBD	°C
	Transmit operation[1]			TBD	°C

Notes:

1. Refer Truth Tables, Table 7 and Table 8
2. Measured at EPAD.

Table 6 Thermal Resistance

Package Type		θJC	Unit
CP-40-15	High Gain and Low Gain Mode	TBD	°C/W
	Power-Down Mode	TBD	°C/W

3 Detailed Functional Description

3.1 Functional Block Diagram

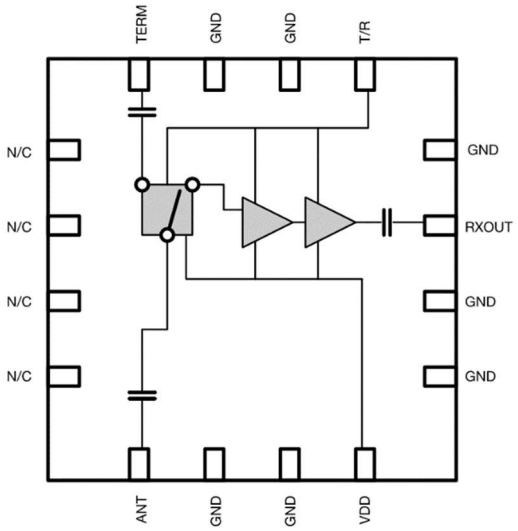

Figure 3 Functional Block Diagram

3.2 Overview

The SP6335A is a single-channel, integrated radio frequency (RF), front-end IC designed for time division duplexing (TDD) applications that operate in the 5G frequency bands between 3.3 and 4.2 GHz. The SP6335A is configured with a cascading two-stage low noise amplifier (LNA) and a high-power silicon single-pole, double-throw (SPDT) switch.

In receive mode, the cascaded two-stage LNA and switch offer a low noise figure (NF) of 1.2 dB, a high gain of 36 dB at 3.8 GHz, with current consumption of 100 mA. In transmit mode, the LNAs are turned off and the device draws 12 mA.

In transmit operation, when RF inputs are connected to a termination pin (TERM), the switch provides a low insertion loss of 0.4 dB at 3.8 GHz and handles an 5G NR signal with an average power (9 dB peak to average ratio, (PAR)) of 40 dBm for full lifetime operation and 43 dBm for single event (<10 sec).

The SP6335A requires a positive supply voltage applied to VDD. Correct decoupling is required on the power supply lines for optimum noise performance, see application diagram for details.

3.3 Biasing Sequence

To Bias up the SP6335A, perform the following steps.

1. Ensure RF pins (ANT, RXOUT, TERM) are correctly terminated with 50 Ohm.
2. Connect GND to ground.
3. Bias up VDD.
4. Bias up TR.
5. Apply an RF input signal.

To Bias down, perform these steps in the reverse order.

Table 7 Truth Table Signal Path

TR	Signal Path Select	
	Transmit Operation[1]	Receive Operation
High	Off	On
Low or No Connect	On	Off

Notes:
1. See the signal path descriptions in Table 8

Table 8 Truth Table Operation

Operation	TR	Signal Path
Receive operation	High	ANT to RXOUT
Transmit Operation	Low	ANT to TERM

4 Package Information

4.1 Package Marking and Dimensions

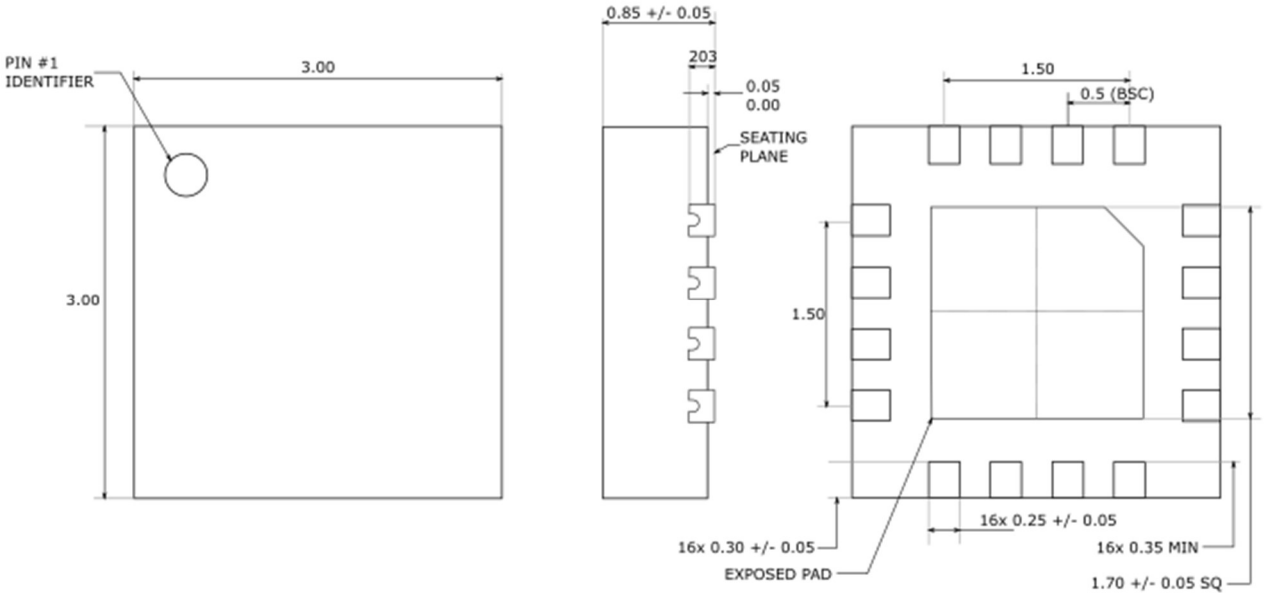

Figure 4 Package Dimensions

5 Ordering Information

Table 9 SP6335A Ordering Information

Ordering Part Number (OPN)	Marking	Package information	Temperature Range
TBD	TBD	16 QFN	-40°C to 105°C

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