2.4GHz low voltage RF transceiver — SA2420

DESCRIPTION

The SA2420 transceiver is a combined low-noise amplifier, receive mixer, transmit mixer and LO buffer IC designed for high-performance low-power communication systems for 2.4-2.5GHz. The LNA has a 2.5dB noise figure at 2.4GHz with 13dB gain and an IP3 intercept of -6dBm at the input. The gain is stabilized by on-chip compensation to vary less than ±0.2dB over the -40 to +85°C temperature range. The wide-dynamic-range receive mixer has a 10dB noise figure and an input IP3 of -3dBm at 2.4GHz. The nominal current drawn from a single 3V supply is 34mA in transmit mode and 21mA in receive mode.

FEATURES

- Low current consumption: 34mA nominal transmit mode and 21mA nominal receive mode
- Fabricated on a high volume, rugged BiCMOS technology
- High system power gain: 24dB (LNA + Mixer) at 2.45GHz
- TSSOP24 package
- Excellent gain stability versus temperature and supply voltage
- -10dBm LO can be used to drive the mixer
- Operates with either full or half frequency LO
- Wide IF range: 50–500MHz
- ESD protected

PIN CONFIGURATION

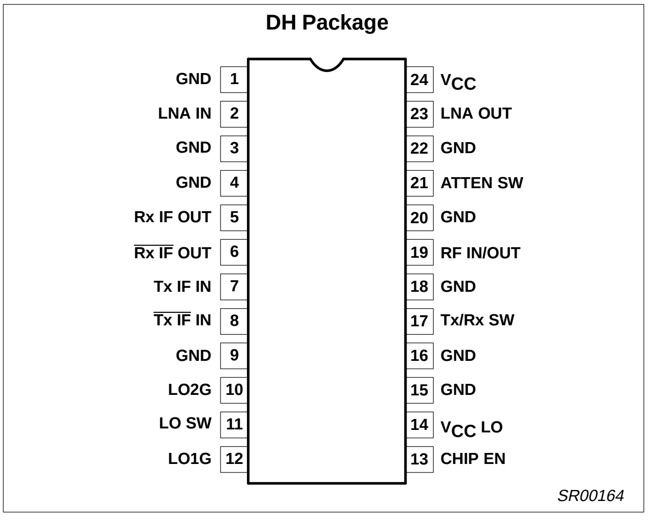

Figure 1. Pin Configuration

APPLICATIONS

- 2.45GHz WLAN front-end (802.11, ISM)

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
24-Pin Plastic Thin Shrink Small Outline Package (Surface-mount, TSSOP)	-40 to +85°C	SA2420DH	SOT355-1

BLOCK DIAGRAM

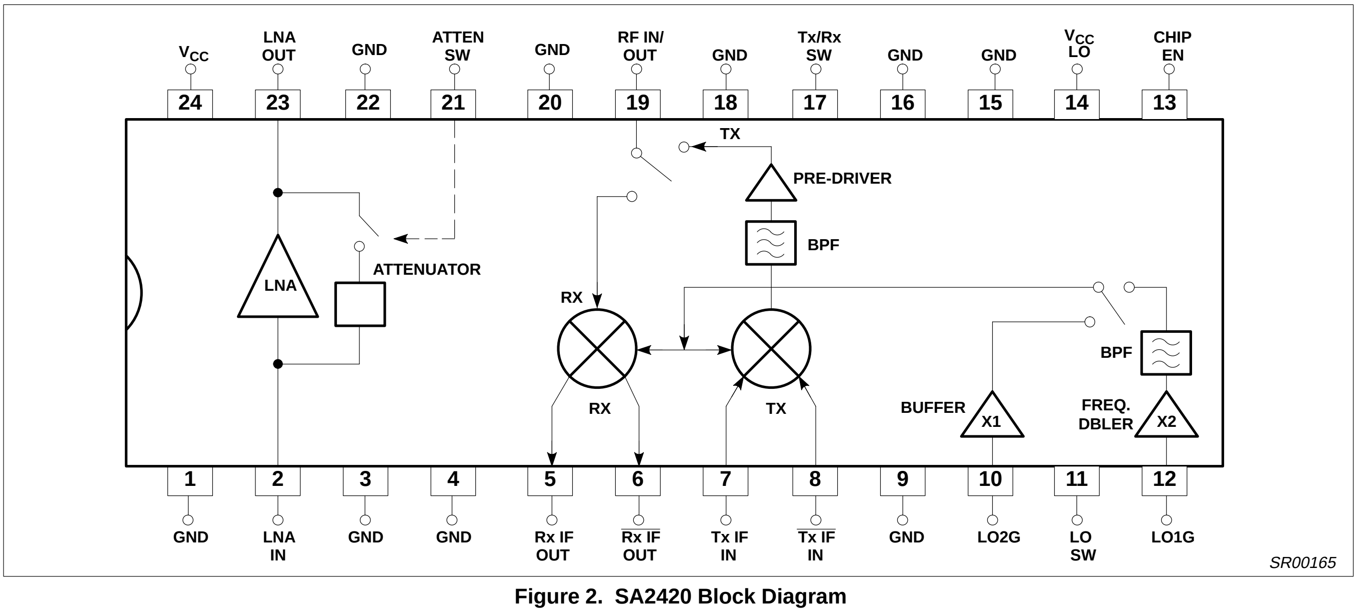

Figure 2. SA2420 Block Diagram

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNITS
V_{CC}	Supply voltage[1]	-0.3 to +6	V
V_{IN}	Voltage applied to any pin	-0.3 to (V_{CC} + 0.3)	V
P_D	Power dissipation, T_A = 25°C (still air)[2] 24-Pin Plastic TSSOP	555	mW
T_{JMAX}	Maximum operating junction temperature	150	°C
P_{MAX}	Maximum power (RF/IF/LO pins)	+20	dBm
T_{STG}	Storage temperature range	–65 to +150	°C

NOTE:
1. Transients exceeding 8V on V_{CC} pin may damage the product.
2. Maximum dissipation is determined by the operating ambient temperature and the thermal resistance,
   θ_{JA}: 24-Pin TSSOP = 117°C/W

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	RATING	UNITS
V_{CC}	Supply voltage	2.7 to 5.5	V
T_A	Operating ambient temperature range	-40 to +85	°C
T_J	Operating junction temperature	-40 to +105	°C

DC ELECTRICAL CHARACTERISTICS

V_{CC} = +3V, T_A = 25°C; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS					UNITS
			MIN	-3σ	TYP	+3σ	MAX	
I_{CCTX}	Supply current, Transmit	LO mode = Hi	25		34		42	mA
I_{CCRX}	Supply current, Receive	LO mode = Hi	15		21		26	mA
$I_{CC\ OFF}$	Power down mode (Tx/Rx SW = Low)	LO mode = Hi, LNA gain = Hi			0		10	μA
V_{LNA-IN}	LNA input voltage	Receive mode			0.855			V
$I_{LNA-OUT}$	LNA output bias current	Receive mode			4.0			mA
$V_{LO\ 2.1}$	LO buffer DC input voltage	LO mode = Hi			2.1			V
$V_{LO\ 1.05}$	LO buffer DC input voltage	LO mode = Low			2.1			V
$V_{TX\ IF}$	Tx Mixer input voltage	Transmit mode			1.7			V
$V_{TX\ IFB}$	Tx Mixer input voltage	Transmit mode			1.7			V

AC ELECTRICAL CHARACTERISTICS

V_{CC} = +3V, T_A = 25°C; LO_{IN} = -10dBm @ 2.2GHz; f_{RF} = 2.4GHz; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS					UNITS
			MIN	-3σ	TYP	+3σ	MAX	
Low Noise Amplifier (In = Pin 2; Out = 23)								
S_{21}	Amplifier gain	LNA gain = Hi			13.0			dB
$\Delta S_{21}/\Delta T$	Gain temperature sensitivity	LNA gain = Hi			-0.002			dB/°C
$\Delta S_{21}/\Delta V_{CC}$	Gain V_{CC} drift	LNA gain = Hi			0.3			dB/V
S_{12}	Amplifier reverse isolation	LNA gain = Hi			-27			dB
S_{11}	Amplifier input match[1]	LNA gain = Hi			-10			dB
S_{22}	Amplifier output match[1]	LNA gain = Hi			-10			dB
ISO	Isolation: LO_1 to LNA_{IN}	LO mode = Hi, LNA gain = Hi			-36			dB
P_{-1dB}	Amplifier input 1dB gain compression	LNA gain = Hi			-15			dBm
IP3	Amplifier input third order intercept	f_1 - f_2 = 1MHz, LNA gain = Hi			-6			dBm
NF	Amplifier noise figure (50Ω)	LNA gain = Hi			2.5			dB
LNA High Overload Mode								
S_{21}	Amplifier gain	LNA gain = Low			-11			dB
$\Delta S_{21}/\Delta T$	Gain temperature sensitivity	LNA gain = Low			-0.01			dB/°C
$\Delta S_{21}/\Delta V_{CC}$	Gain V_{CC} drift	LNA gain = Low			0.3			dB/V
S_{12}	Amplifier reverse isolation	LNA gain = Low			-24			dB
S_{11}	Amplifier input match[1]	LNA gain = Low			-10			dB
S_{22}	Amplifier output match[1]	LNA gain = Low			-10			dB
ISO	Isolation: LO_1 to LNA_{IN}	LO mode = Hi, LNA gain = Low			-38			dB
P_{-1dB}	Amplifier input 1dB gain compression	LNA gain = Low			5			dBm
IP3	Amplifier input third order intercept	f_1 - f_2 = 1MHz, LNA gain = Low			13			dBm
NF	Amplifier noise figure (50Ω)	LNA gain = Low			17			dB
Rx Mixer (RF = Pin 19, IF = Pins 5 and 6, LO = Pin 10 or 12, P_{LO} = -10dBm)								
PG_{C1}	Power conversion gain: R_L = 240Ω diff. (120Ω per side), R_S = 50Ω	f_S = 2.4GHz, f_{LO} = 2.2GHz, f_{IF} = 200MHz			0			dB
PG_{C2}	Power conversion gain: R_L = 1200Ω diff. (600Ω per side), R_S = 50Ω	f_S = 2.4GHz, f_{LO} = 2.2GHz, f_{IF} = 200MHz			7			dB
$\Delta G_C/\Delta T$	Gain temperature drift				-0.016			dB/°C
$\Delta G_C/\Delta V_{CC}$	Gain V_{CC} drift				0.34			dB/V
S_{11-RF}	Input match at RF (2.4GHz)[1]				-10			dB
NF_M	SSB noise figure (2.4GHz) (50Ω)				10			dB
P_{-1dB}	Mixer input 1dB gain compression				-6			dBm
IP3	Input third order intercept	f_1 - f_2 = 1MHz			3			dBm
IP_{2INT}	Mixer input second order intercept				TBD			dBm
f_{RF}	RF frequency range		2.2		2.45		2.7	GHz
f_{IF}	IF frequency range		50		200		500	MHz

AC ELECTRICAL CHARACTERISTICS (continued)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS					UNITS
			MIN	-3σ	TYP	$+3\sigma$	MAX	
Rx Mixer Spurious Components								
$P_{RF\text{-}IF}$	RF feedthrough to IF	C_L = 2pF per side			-50			dBc
$P_{LO\text{-}IF}$	LO feedthrough to IF	C_L = 2pF per side			-35			dBc
Tx Mixer (RF = Pin 19, IF = Pins 7 and 8, LO = Pin 10 or 12, P_{LO} = -10dBm)								
PG_C	Power conversion gain: $R_L = 50\Omega$ $R_S = 50\Omega$	f_S = 2.4GHz, f_{LO} = 2.2GHz, f_{IF} = 200MHz			15			dB
$\Delta G_C/\Delta T$	Gain temperature drift				-0.007			dB/°C
$\Delta G_C/\Delta V_{CC}$	Gain voltage drift				0.4			dB/V
S_{11-RF}	Output match at RF (2.4GHz)[1]				-10			dB
NF_M	SSB noise figure (2.4GHz) (50Ω)				12			dB
P_{-1dB}	Output 1dB gain compression				0			dBm
IP3	Output third order intercept	$f_1 - f_2$ = 1MHz			7			dBm
IP_{2INT}	Output second order intercept				TBD			dBm
f_{RF}	RF frequency range		2.2		2.45		2.7	GHz
f_{IF}	IF frequency range		50		200		500	MHz
Tx Mixer Spurious Components								
$P_{IF\text{-}RF}$	IF feedthrough to RF				-29			dBc
$P_{LO\text{-}RF}$	LO feedthrough to RF				-22			dBc
$P_{2LO\text{-}RF}$	2*LO feedthrough to RF				-22			dBc
$P_{IMAGE\text{-}RF}$	Image feedthrough to RF				-3			dBc
LO Buffer: Full and Half Frequency inputs								
P_{LO}	LO drive level		-10		-7		5	dBm
$S_{11\text{-}LO1}$	Mixer input match (LO = 2.2GHz)	LO mode = Hi			-11			dB
$S_{11\text{-}LO2}$	Mixer input match (LO = 1.1GHz)	LO mode = Low			-11			dB
f_{LO2G}	LO2G frequency range	LO mode = Hi	2		2.2		2.4	GHz
f_{LO1G}	LO1G frequency range	LO mode = Low	1		1.1		1.2	GHz
Switching[2]								
$t_{Rx\text{-}Tx}$	Receive-to-transmit switching time				1			μs
$t_{Tx\text{-}Rx}$	Transmit-to-Receive switching time				1			μs
$t_{POWER\ UP}$	Chip enable time				1			μs
$t_{PWR\ DWN}$	Chip disable time				1			μs

NOTES:
1. With simple external matching
2. With 50pF coupling capacitors on all RF and IF ports

Table 8. Truth Table

Chip-En	TxRx-SW	LNA-SW	LO-SW	Mode	LNA Gain	LO Freq. (Typ)
0	X	X	X	Sleep	N/S	N/S
1	0	1	1	Receive	+13dB	2.1GHz
1	0	0	1	Receive	-11dB	2.1GHz
1	0	1	0	Receive	+13dB	1.05GHz
1	0	0	0	Receive	-11dB	1.05GHz
1	1	X	1	Transmit	N/S	2.1GHz
1	1	X	0	Transmit	N/S	1.05GHz

FUNCTIONAL DESCRIPTION

The SA2420 is a 2.4GHz transceiver front-end available in the TSSOP-24 package. This integrated circuit (IC) consists of a low noise amplifier (LNA) and up- and down-converters. The injection of the local oscillator (LO) signal has two options: 1) direct injection of the LO signal at approximately 2GHz, or 2) injection of an LO signal at approximately 1GHz through an on-chip doubler. The SA2420 functions with a supply voltage range of 3 – 5 V (nominally). There is an enable/disable switch available to power up/down the entire chip in 1μs, typically. This transceiver has several unique features.

The LNA has two operating modes: 1) high gain mode with a gain = +13dB; and 2) low gain mode with a gain <-10dB. The switch for this option is internal and is controlled externally by high and low logic to the pin. When the LNA is switched into the attenuation mode, active matching circuitry (on-chip) is switched in (reducing the number of off-chip components required). The input and output are internally matched to 50Ω. To reduce power consumption when the chip is transmitting, the LNA is automatically switched into a “sleep” mode (internally) without the use of external circuitry.

The up and down frequency converters are single-ended at the RF port of the mixers. The up and down converters share the same (RF) pin and use an internal switch for transmitting (up-converting) or receiving (down-converting) modes. The switch is controlled externally by high and low logic states. The RF port is matched to 50Ω and has an input IP3 of +3dBm (mixer only). The down-convert mixer is buffered and has open collectors at the pins to allow for matching to common SAW filters. The up-convert mixer has differential inputs (IF port) and single-ended output (RF port), with an input pin to output pin gain of 10dB. The output of the up-converter is designed for a power level = 0dBm (P_{-1dB}). The mixers are fed by the two LO options.

The available LO options are: direct injection (2.1GHz at the pin) or through an on-chip doubler. The doubler has a simple LC bandpass filter (internal) at its output which passes the second harmonic to the mixers. Through an internal switch (controlled externally), either LO can be used depending on the designer’s application. If an application requires the use of a 1.05GHz VCO, then the doubler option would be used to double the frequency (2 × 1.05GHz = 2.1GHz) before being injected into the mixers. For a 2.1GHz VCO, the direct option would be used. With this option, the signal passes through an on-chip buffer and is then injected into the mixers.