

DATA SHEET

SA2421

2.45 GHz low voltage RF transceiver

Product specification
Supersedes data of 2000 Feb 11

2000 Mar 13

2.45 GHz low voltage RF transceiver

SA2421

DESCRIPTION

The SA2421 transceiver is a combined low-noise amplifier, receive mixer, transmit mixer and LO buffer IC designed using a 20 GHz f_T BiCMOS process, QUBiC2, for high-performance low-power communication systems for 2.4–2.5 GHz applications. The LNA has a 3.2 dB noise figure at 2.45 GHz with 14.3 dB gain and an IP3 intercept of -3 dBm at the input. The wide-dynamic-range receive mixer has a 11.2 dB noise figure and an input IP3 of +2.5 dBm at 2.45 GHz. The nominal current drawn from a single 3 V supply is 34 mA in transmit mode and 20 mA in receive mode. The SA2421 differs from the SA2420 by removal of the LO doubler and LO switch. The LNA reverse isolation is improved, and a separate pin is allocated for the transmit output.

FEATURES

- Low current consumption: 34 mA nominal transmit mode and 20 mA nominal receive mode
- High system power gain: 24 dB (LNA + Mixer) at 2.45 GHz
- Excellent gain stability versus temperature and supply voltage
- Separate Rx IN and Tx OUT pins
- Wide IF range: 50–500 MHz
- -10dBm typical LO input power
- Improved LNA reverse isolation S12
- TSSOP24 package

PIN CONFIGURATION

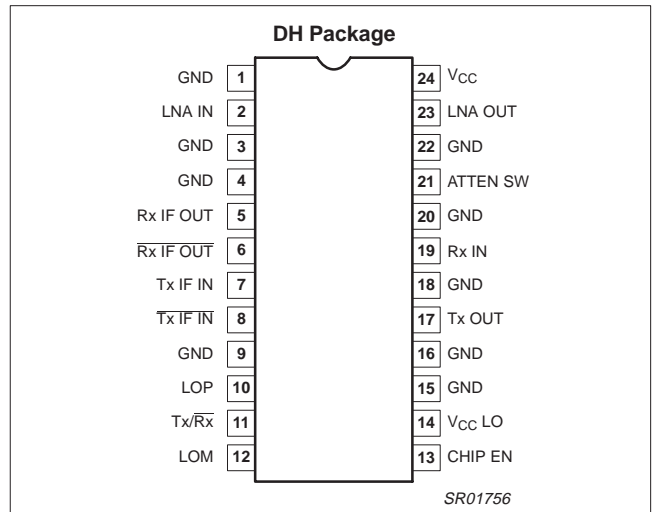


Figure 1. Pin configuration

APPLICATIONS

- IEEE 802.11 (WLAN)
- 2.45 GHz ISM band

ORDERING INFORMATION

| DESCRIPTION | TEMPERATURE RANGE | ORDER CODE | DWG # |
|---|-------------------|------------|----------|
| 24-Pin Plastic Thin Shrink Small Outline Package (Surface-mount, TSSOP) | -40°C to +85°C | SA2421DH | SOT355-1 |

BLOCK DIAGRAM

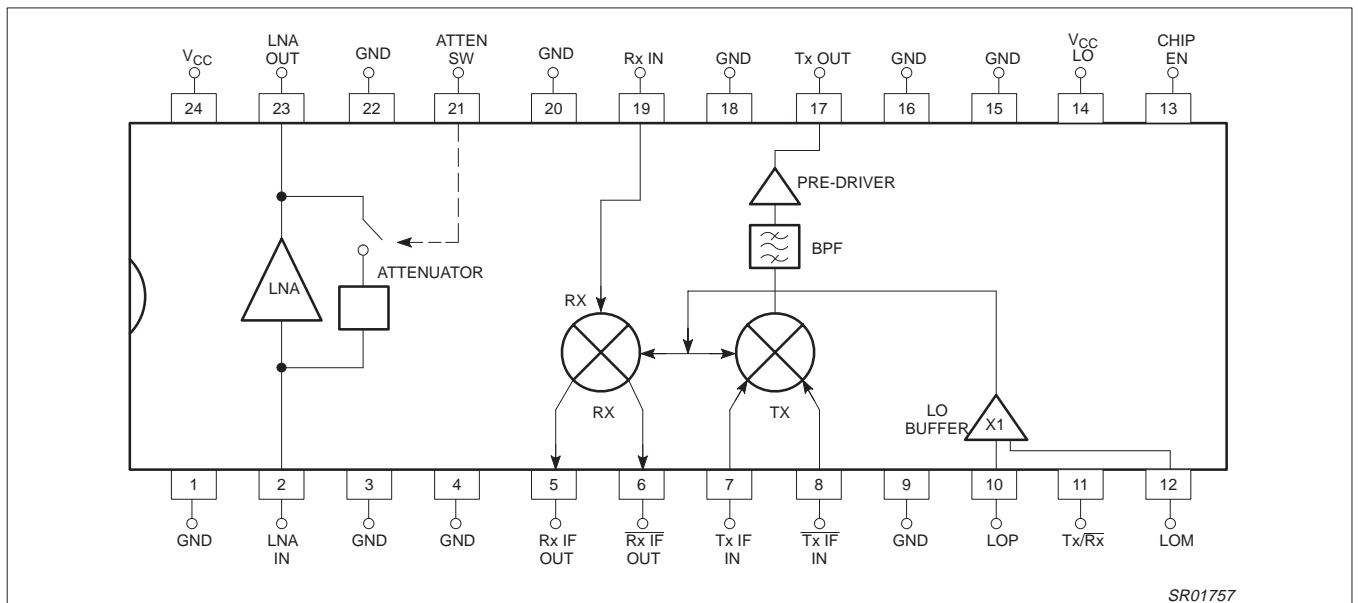


Figure 2. SA2421 block diagram

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ABSOLUTE MAXIMUM RATINGS

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

NOTES:

- Transients exceeding these conditions may damage the product.
- Maximum dissipation is determined by the operating ambient temperature and the thermal resistance, and absolute maximum ratings may impact product reliability θ_{JA} : 24-Pin TSSOP = $117^\circ\text{C}/\text{W}$
- IC is protected for ESD voltages up to 2000 V, human body model.

RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | RATING | UNITS |
|-----------|-------------------------------------|------------|------------------|
| V_{CC} | Supply voltage | 2.7 to 5.5 | V |
| T_{amb} | Operating ambient temperature range | -40 to +85 | $^\circ\text{C}$ |

DC ELECTRICAL CHARACTERISTICS

$V_{CC} = +3\text{V}$, $T_{amb} = 25^\circ\text{C}$; unless otherwise stated.

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | UNITS |
|---------------|--------------------------------|--|--------|-------|----------|---------------|
| | | | MIN | TYP | MAX | |
| I_{CCTX} | Total supply current, Transmit | Tx/Rx = Hi | 22 | 34 | 42 | mA |
| I_{CCRX} | Total supply current, Receive | Tx/Rx mode = Lo, LNA = Hi gain | 14 | 20 | 26 | mA |
| $I_{CC\ OFF}$ | Power down mode | $Tx/\overline{Rx} = \text{GND}$ Atten SW = V_{CC} Enable = GND | | | 10 | μA |
| V_{LNA-IN} | LNA input voltage | Receive mode | | 0.855 | | V |
| $V_{LO\ GHz}$ | LO buffer DC input voltage | Tx/Rx = Lo | -0.1 | | V_{CC} | V |
| $V_{TX\ IF}$ | Tx Mixer input voltage | Tx/Rx = Hi | | 1.7 | | V |
| $V_{TX\ IFB}$ | Tx Mixer input voltage | Tx/Rx = Hi | | 1.7 | | V |
| I_{BIAS} | Input bias current | Logic 1 | | 6 | | μA |
| | | Logic 0 | | 0 | | μA |

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AC ELECTRICAL CHARACTERISTICS

$V_{CC} = +3\text{ V}$, $T_{amb} = 25^\circ\text{C}$; $LO_{IN} = -10\text{ dBm}$ @ 2.1 GHz; $f_{RF} = 2.45\text{ GHz}$; unless otherwise stated.

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | | | UNITS |
|--|---|---|--------|-------------|-------|-------------|-----|-------|
| | | | MIN | -3 σ | TYP | +3 σ | MAX | |
| f_{RF} | RF frequency range ³ | | 2.4 | | 2.45 | | 2.5 | GHz |
| f_{IF} | IF frequency range ³ | | 300 | | 350 | | 400 | MHz |
| LNA High gain mode (In = Pin 2; Out = 23) | | | | | | | | |
| S_{21} | Amplifier gain | LNA gain = Hi | | 13.3 | 14.3 | 15.3 | | dB |
| S_{12} | Amplifier reverse isolation | LNA gain = Hi | | | -32 | | | dB |
| S_{11} | Amplifier input match ¹ | LNA gain = Hi | | | -10 | | | dB |
| S_{22} | Amplifier output match ¹ | LNA gain = Hi | | | -9 | | | dB |
| ISO | Isolation: LO_X to LNA_{IN} | LNA gain = Hi | | | -43 | | | dB |
| P_{-1dB} | Amplifier input 1dB gain compression | LNA gain = Hi | | | -15 | | | dBm |
| IP3 | Amplifier input third order intercept | $f_1 - f_2 = 1\text{ MHz}$, LNA gain = Hi | | -4.5 | -3.2 | -1.9 | | dBm |
| NF | Amplifier noise figure (50 Ω) | LNA gain = Hi | | 3.1 | 3.2 | 3.3 | | dB |
| LNA High Overload Mode (low gain mode) | | | | | | | | |
| S_{21} | Amplifier gain | LNA gain = Low | | -18.5 | -19.4 | -20.3 | | dB |
| S_{12} | Amplifier reverse isolation | LNA gain = Low | | | -26 | | | dB |
| S_{11} | Amplifier input match ¹ | LNA gain = Low | | | -8 | | | dB |
| S_{22} | Amplifier output match ¹ | LNA gain = Low | | | -8 | | | dB |
| ISO | Isolation: LO_X to LNA_{IN} | LNA gain = Low | | | -45 | | | dB |
| P_{-1dB} | Amplifier input 1dB gain compression | LNA gain = Low | | | 2 | | | dBm |
| IP3 | Amplifier input third order intercept | $f_1 - f_2 = 1\text{ MHz}$, LNA gain = Low | | | 18 | | | dBm |
| NF | Amplifier noise figure (50 Ω) | LNA gain = Low | | | 18.5 | | | dB |
| Rx Mixer (Rx IN = Pin 19, IF = Pins 5 and 6, LO = Pin 10 or 12, $P_{LO} = -10\text{ dBm}$) | | | | | | | | |
| PG_C | Power conversion gain into 50 Ω : matched to 50 Ω using external balun circuitry. | $f_S = 2.45\text{ GHz}$, $f_{LO} = 2.1\text{ GHz}$, $f_{IF} = 350\text{ MHz}$ | | 9.5 | 10 | 10.5 | | dB |
| S_{11-RF} | Input match at RF (2.45 GHz) ¹ | | | | -11 | | | dB |
| NF_M | SSB noise figure (2.45 GHz) (50 Ω) | | | 9.8 | 11.2 | 12.5 | | dB |
| P_{-1dB} | Mixer input 1 dB gain compression | | | | -10.5 | | | dBm |
| IP3 | Input third order intercept | $f_1 - f_2 = 1\text{ MHz}$ | | 1.8 | 2.2 | 2.6 | | dBm |
| Rx Mixer Spurious Components ($P_{IN} = P_{-1dB}$) | | | | | | | | |
| P_{RF-IF} | RF feedthrough to IF ⁴ | $C_L = 2\text{ pF}$ per side | | | -35 | | | dBc |
| P_{LO-IF} | LO feedthrough to IF ⁵ | $C_L = 2\text{ pF}$ per side | | | -32 | | | dBc |

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AC ELECTRICAL CHARACTERISTICS (continued)

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | | | UNITS |
|---|---|---|--------|-------------|------|-------------|-----|---------|
| | | | MIN | -3 σ | TYP | +3 σ | MAX | |
| Tx Mixer (Tx OUT = Pin 17, IF = Pins 7 and 8, LO = Pin 10 or 12, P_{LO} = -10 dBm) | | | | | | | | |
| P _{GC} | Power conversion gain: R _L = 50 Ω R _S = 50 Ω | f _S = 2.45 GHz, f _{LO} = 2.1 GHz, f _{IF} = 350 MHz | | 22.5 | 23 | 23.5 | | dB |
| S _{11-RF} | Output match at RF (2.45 GHz) ¹ | | | | -10 | | | dB |
| NF _M | SSB noise figure (2.45 GHz) (50 Ω) | | | 10.9 | 11.2 | 11.5 | | dB |
| P _{-1dB} | Output 1dB gain compression | | | | 4.2 | | | dBm |
| IP3 | Output third order intercept | f ₁ - f ₂ = 1 MHz | | 10.1 | 12.2 | 14.3 | | dBm |
| Tx Mixer Spurious Components (P_{OUT} = P_{-1dB}) | | | | | | | | |
| P _{IF-RF} | IF feedthrough to RF ⁴ | | | | -50 | | | dBc |
| P _{LO-RF} | LO feedthrough to RF ⁵ | | | | -22 | | | dBc |
| P _{IMAGE-RF} | Image feedthrough to RF ⁶ | | | | -20 | | | dBc |
| LO Buffer | | | | | | | | |
| P _{LO IN} | LO drive level | | -15 | | -10 | | -5 | dBm |
| S _{11-LO} | Mixer input match (LO = 2.1 GHz) | | | | -10 | | | dB |
| f _{LOG} | LOG frequency range ³ | | 1.9 | | 2.1 | | 2.3 | GHz |
| Switching² | | | | | | | | |
| t _{Rx-Tx} | Receive-to-transmit switching time | | | | 1 | | | μ s |
| t _{Tx-Rx} | Transmit-to-Receive switching time | | | | 1 | | | μ s |
| t _{POWER UP} | Chip enable time | | | | 1 | | | μ s |
| t _{PWR DWN} | Chip disable time | | | | 1 | | | μ s |

NOTES:

1. With simple external matching
2. With 50 pF coupling capacitors on all RF and IF parts
3. This part has been optimized for the stated frequency range. Operation outside this frequency range may yield performance other than specified in this datasheet.
4. Measured 5dB lower than 1dB compression point, with typical output matching network.
5. Measured at 1dB compression point.
6. With typical output matching network (no image reject mixer is used).

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Table 1. Truth Table

| Chip-En | ATT-SW | T _X -R _X | Mode | LNA Gain | R _X Mixer | T _X Mixer and Predriver |
|---------|--------|--------------------------------|----------|----------|----------------------|------------------------------------|
| 0 | X | X | Sleep | N/S | off | off |
| 1 | 1 | 0 | Receive | +14.3 dB | on | off |
| 1 | 0 | 0 | Receive | -19 dB | on | off |
| 1 | X | 1 | Transmit | N/S | off | on |

FUNCTIONAL DESCRIPTION

The SA2421 is a 2.45 GHz 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. There is an enable/disable switch available to power up/down the entire chip in 1 μs, typically. This transceiver has several unique features.

The LNA has two operating modes: 1) high gain mode with a gain = +14.3 dB; and 2) low gain mode with a gain -19 dB. 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). 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.

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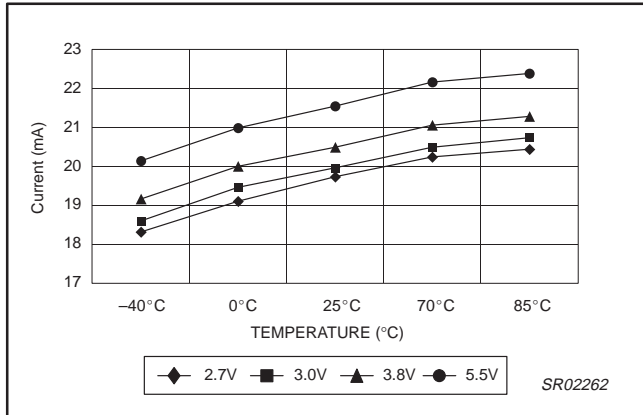


Figure 3. LNA / Receive Supply Current vs Supply Voltage and Temperature

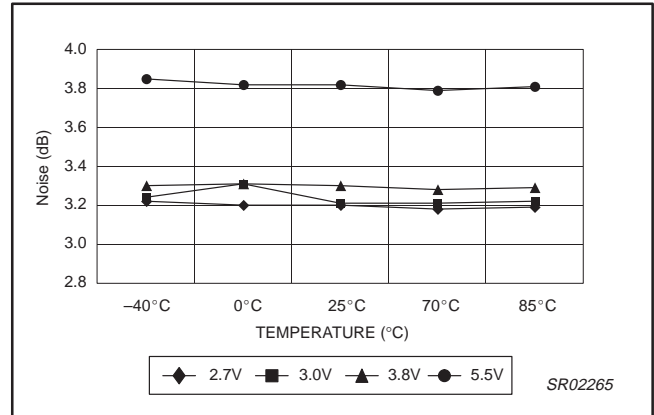


Figure 6. LNA Noise Figure vs Supply Voltage and Temperature

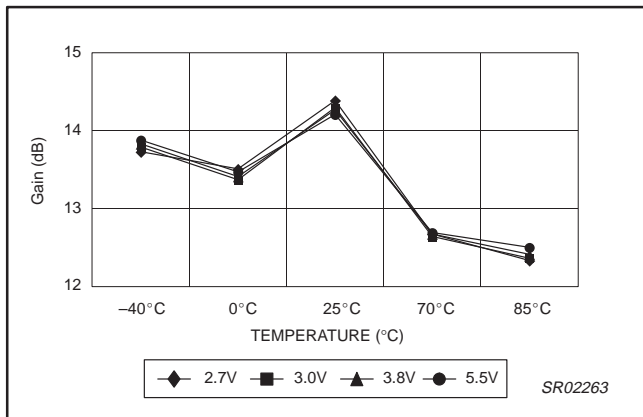


Figure 4. LNA Gain vs Supply Voltage and Temperature

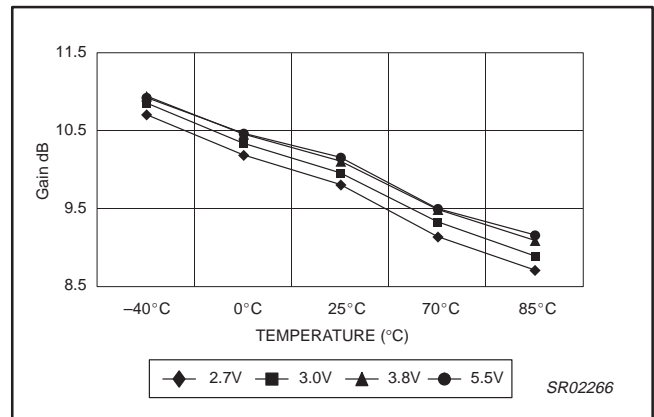


Figure 7. RX Gain vs Supply Voltage and Temperature

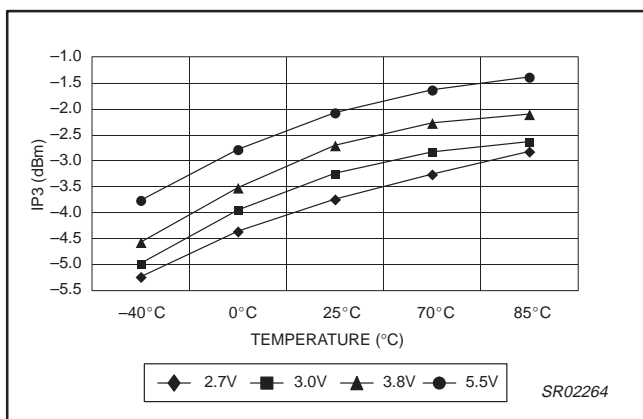


Figure 5. LNA Input IP3 vs Supply Voltage and Temperature

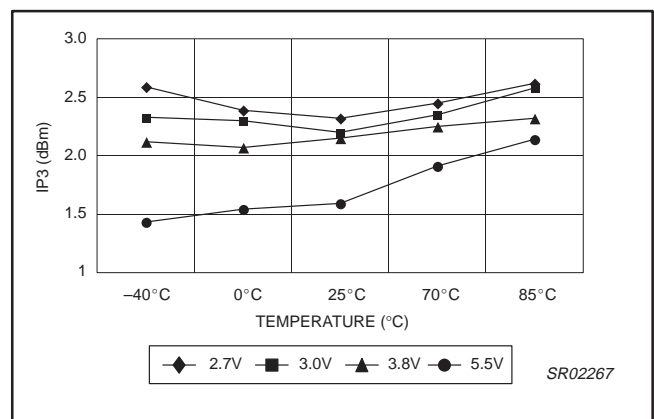


Figure 8. Receive Input IP3 vs Supply Voltage and Temp

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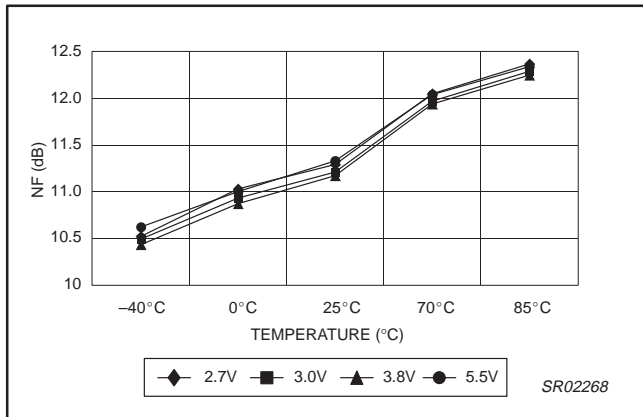


Figure 9. Receive Noise Figure vs Supply Voltage and Temp

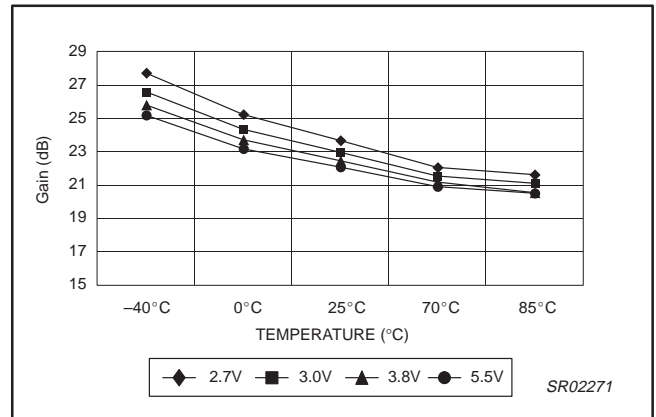


Figure 12. Transmit Gain vs Supply Voltage and Temp

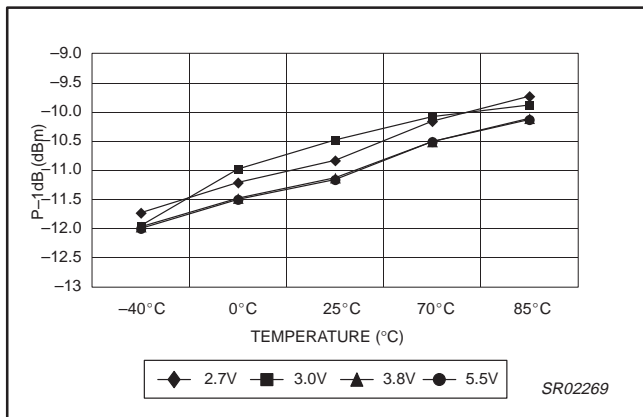


Figure 10. RX 1dB Compression vs Supply Voltage and Temp

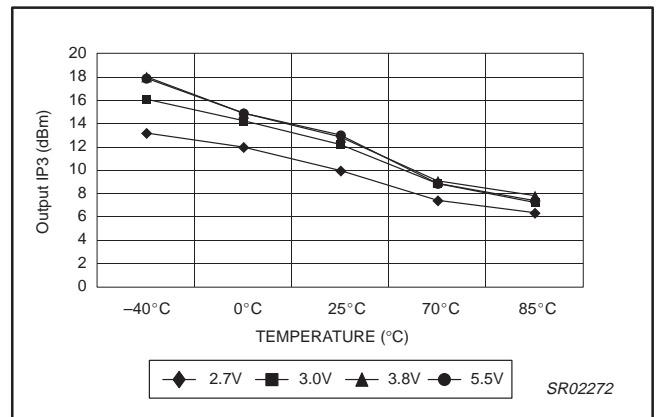


Figure 13. Transmit Output IP3 vs Supply Voltage and Temp

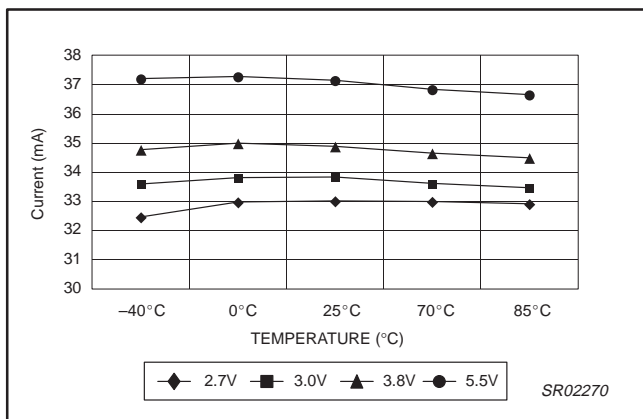


Figure 11. Transmit Current vs Supply Voltage and Temp

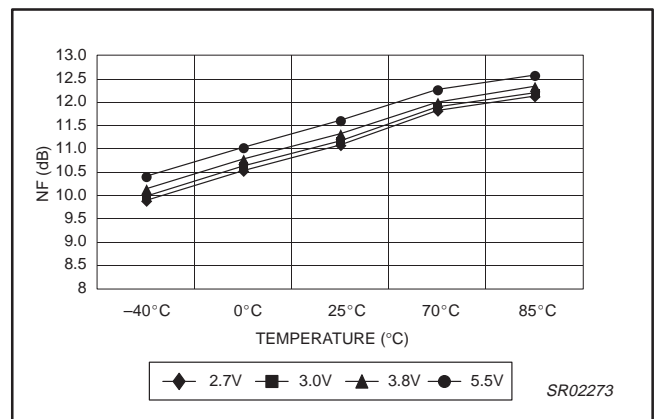


Figure 14. Transmit Noise Figure vs Supply Voltage and Temp

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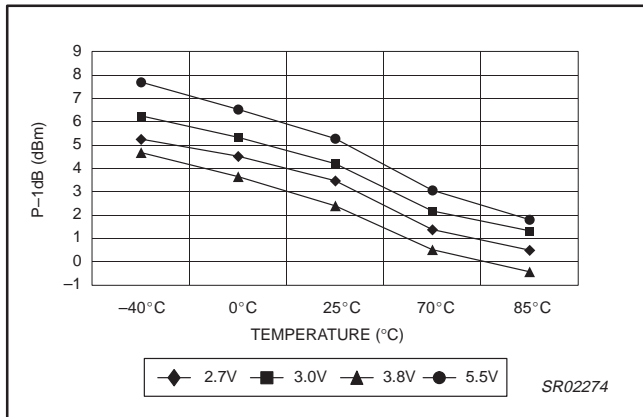


Figure 15. TX 1dB compression vs Supply Voltage and Temp

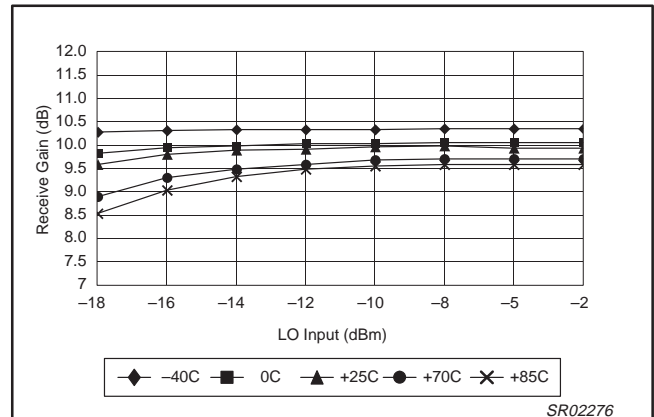


Figure 17. Receive Gain vs LO Input over Temp Range

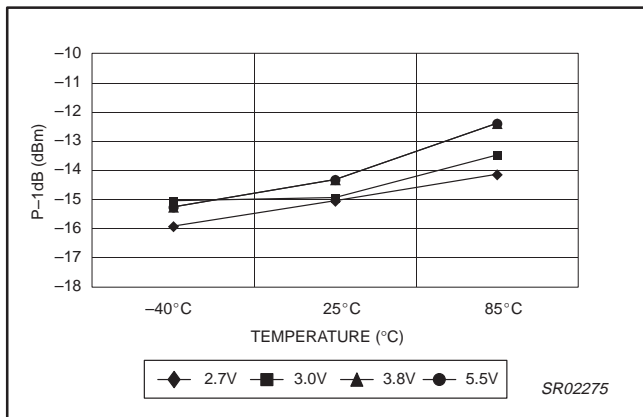


Figure 16. LNA 1dB compression vs Supply Voltage and Temp

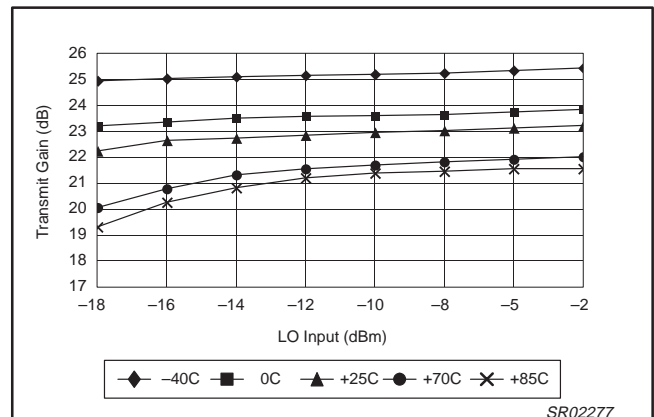


Figure 18. Transmit Gain vs LO Input over Temp Range

The Rx IN port is matched to 50 Ω and has an input IP3 of +2.2 dBm (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 an input pin to output pin gain of 23 dB. The output of the up-converter is designed for a power level = +4.2 dBm (P_{-1dB}).

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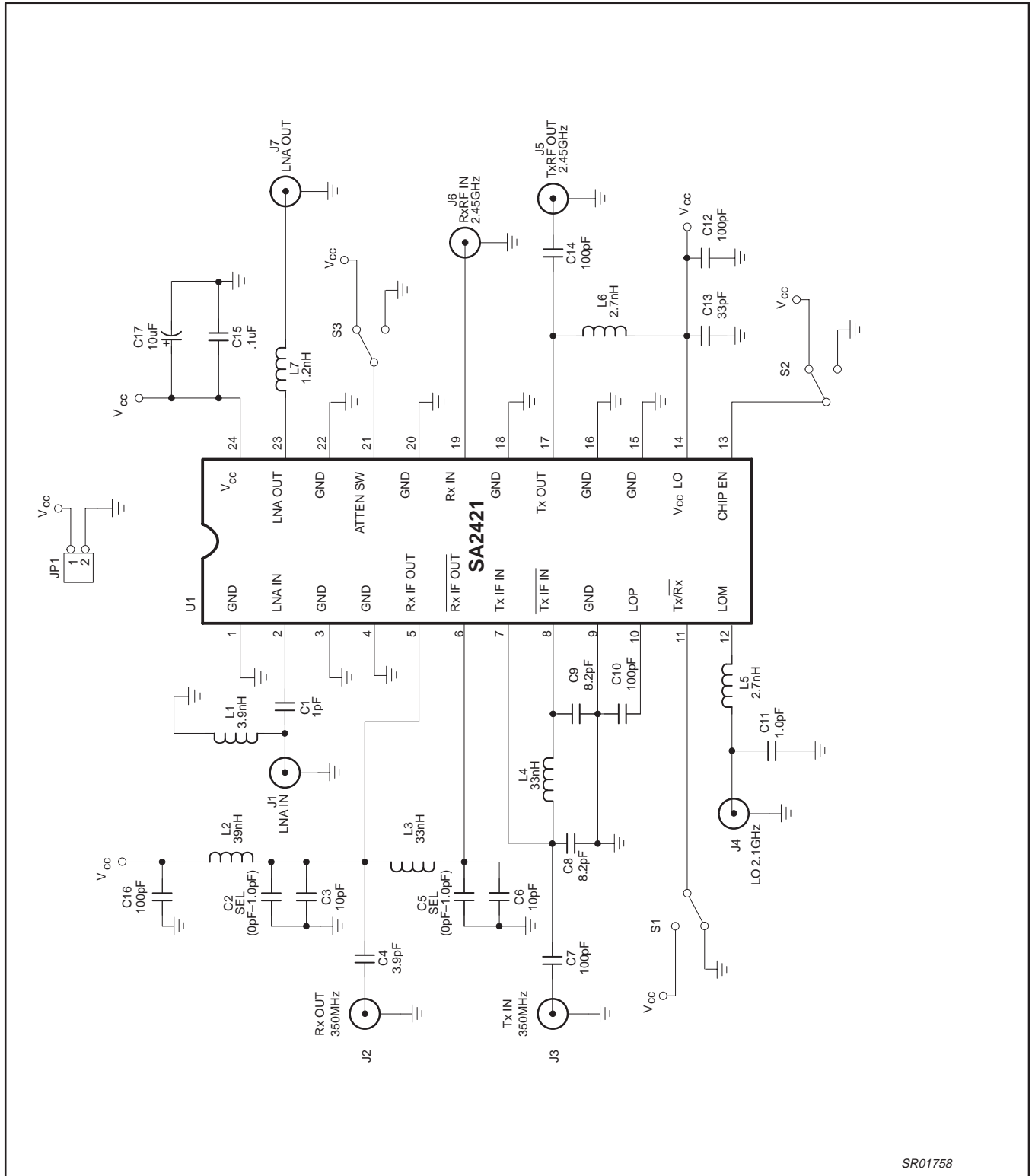


Figure 19.

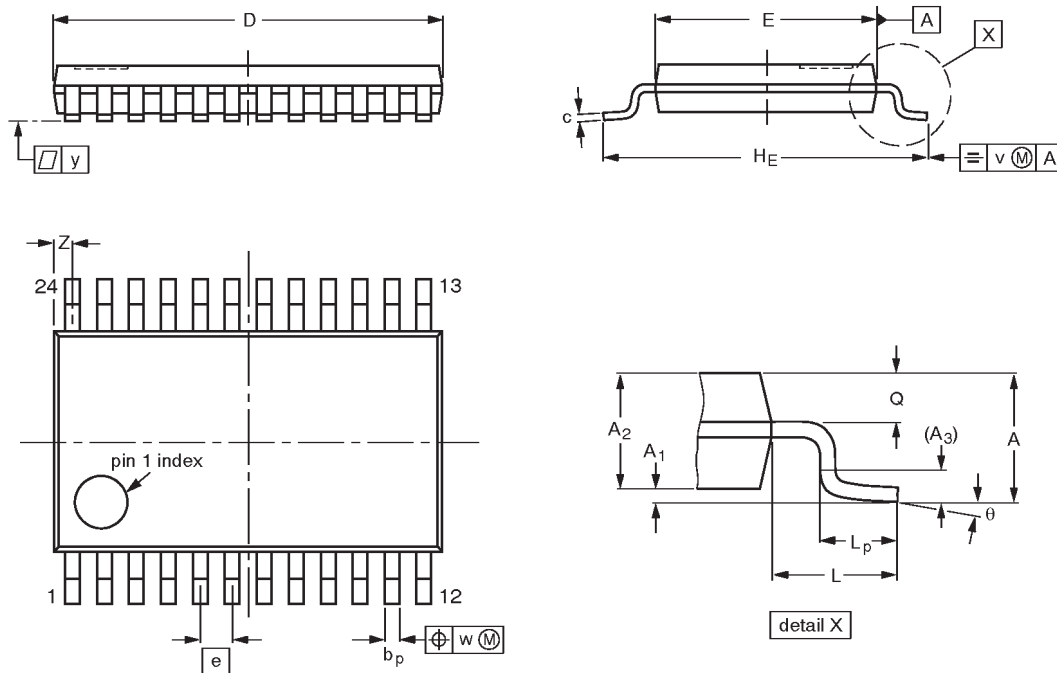
SR01758

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TSSOP24: plastic thin shrink small outline package; 24 leads; body width 4.4 mm

SOT355-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽²⁾ | e | H _E | L | L _p | Q | v | w | y | Z ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|------------|------------------|------------------|------|----------------|-----|----------------|------------|-----|------|-----|------------------|----------|
| mm | 1.10 | 0.15 0.05 | 0.95 0.80 | 0.25 | 0.30 0.19 | 0.2 0.1 | 7.9 7.7 | 4.5 4.3 | 0.65 | 6.6 6.2 | 1.0 | 0.75 0.50 | 0.4 0.3 | 0.2 | 0.13 | 0.1 | 0.5 0.2 | 8° 0° |

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT355-1 | | MO-153AD | | | | 93-06-16 95-02-04 |

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Data sheet status

| Data sheet status | Product status | Definition [1] |
|---------------------------|----------------|--|
| Objective specification | Development | This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice. |
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[1] Please consult the most recently issued datasheet before initiating or completing a design.

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