

# SA636

## Low voltage high performance mixer FM IF system with high-speed RSSI

Rev. 8 — 8 October 2019

Product data sheet

### 1. General description

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The SA636 is a low-voltage high performance monolithic FM IF system with high-speed RSSI incorporating a mixer/oscillator, two limiting intermediate frequency amplifiers, quadrature detector, logarithmic Received Signal Strength Indicator (RSSI), voltage regulator, wideband data output and fast RSSI op amps. The SA636 is available in 20-lead SSOP (Shrink Small Outline Package) and HVQFN20 (quad flat package).

The SA636 was designed for high bandwidth portable communication applications and will function down to 2.7 V. The RF section is similar to the famous SA605. The data output has a minimum bandwidth of 600 kHz. This is designed to demodulate wideband data. The RSSI output is amplified. The RSSI output has access to the feedback pin. This enables the designer to adjust the level of the outputs or add filtering.

SA636 incorporates a power-down mode which powers down the device when POWER\_DOWN\_CTRL pin is LOW. Power-down logic levels are CMOS and TTL compatible with high input impedance.

SA636DK/02 is identical to SA636DK/01 except that  $V_{o(RSSI)}$  RSSI output voltage where IF level = -118 dBm is screened 0.15 V to 0.45 V for applications that work best within this range of operation.

### 2. Features and benefits

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- Wideband data output (600 kHz minimum)
- Fast RSSI rise and fall times
- Low power consumption: 6.5 mA typical at 3 V
- Mixer input to >500 MHz
- Mixer conversion power gain of 11 dB at 240 MHz
- Mixer noise figure of 12 dB at 240 MHz
- XTAL oscillator effective to 150 MHz (LC oscillator to 1 GHz local oscillator can be injected)
- 92 dB of IF amp/limiter gain
- 25 MHz limiter small signal bandwidth
- Temperature compensated logarithmic Received Signal Strength Indicator (RSSI) with a dynamic range in excess of 90 dB
- RSSI output internal op amp
- Internal op amps with rail-to-rail outputs
- Low external component count; suitable for crystal/ceramic/LC filters



- Excellent sensitivity: 0.54  $\mu\text{V}$  into 50  $\Omega$  matching network for 12 dB SINAD (Signal-to-Noise And Distortion ratio) for 1 kHz tone with RF at 240 MHz and IF at 10.7 MHz
- 10.7 MHz filter matching (330  $\Omega$ )
- Power-down mode ( $I_{\text{CC}} = 200 \mu\text{A}$ )
- ESD protection exceeds 2000 V HBM per JESD22-A114 and 1000 V CDM per JESD22-C101
- Latch-up testing is done to JEDEC Standard JESD78 Class II, Level B

### 3. Applications

- DECT (Digital European Cordless Telephone)
- Digital cordless telephones
- Digital cellular telephones
- Portable high performance communications receivers
- Single conversion VHF/UHF receivers
- FSK and ASK data receivers
- Wireless LANs

### 4. Ordering information

Table 1. Ordering information

| Type number | Topside mark | Package |  |          |
|-------------|--------------|---------|--|----------|
|             |              | Name    | Description  | Version  |
| SA636BS     | 636B         | HVQFN20 | plastic thermal enhanced very thin quad flat package; no leads; 20 terminals; body 4 × 4 × 0.85 mm | SOT917-1 |
| SA636DK/01  | SA636DK      | SSOP20  | plastic shrink small outline package; 20 leads; body width 4.4 mm                                  | SOT266-1 |
| SA636DK/02  | SA636DK      | SSOP20  | plastic shrink small outline package; 20 leads; body width 4.4 mm                                  | SOT266-1 |

#### 4.1 Ordering options

Table 2. Ordering options

| Type number | Orderable part number | Package | Packing method  | Minimum order quantity | Temperature   |
|-------------|-----------------------|---------|-----------------|------------------------|---|
| SA636BS     | SA636BS,115           | HVQFN20 | REEL 7" Q1 NDP  | 1500                   | $T_{\text{amb}} = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$ |
| SA636DK/01  | SA636DK/01,118        | SSOP20  | REEL 13" Q1 NDP | 2500                   | $T_{\text{amb}} = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$ |
| SA636DK/02  | SA636DK/02J           | SSOP20  | REEL 13" Q1 NDP | 2500                   | $T_{\text{amb}} = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$ |

5. Block diagram

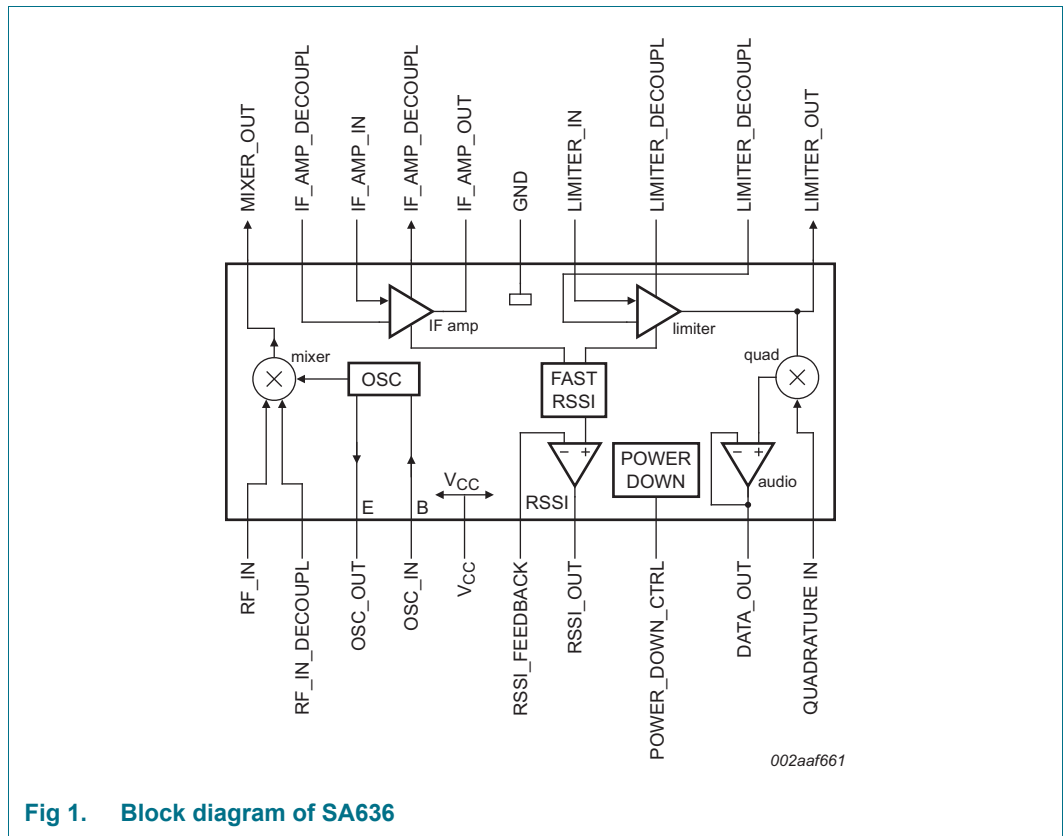


Fig 1. Block diagram of SA636

## 6. Pinning information

### 6.1 Pinning

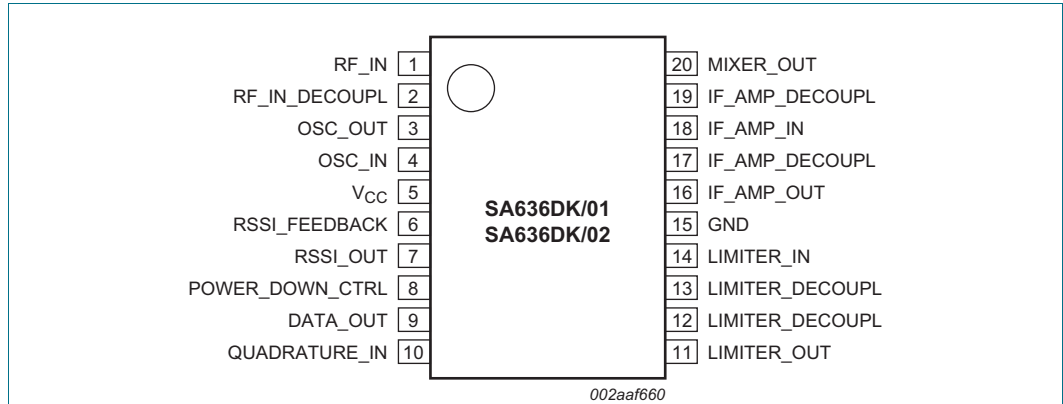


Fig 2. Pin configuration for SSOP20

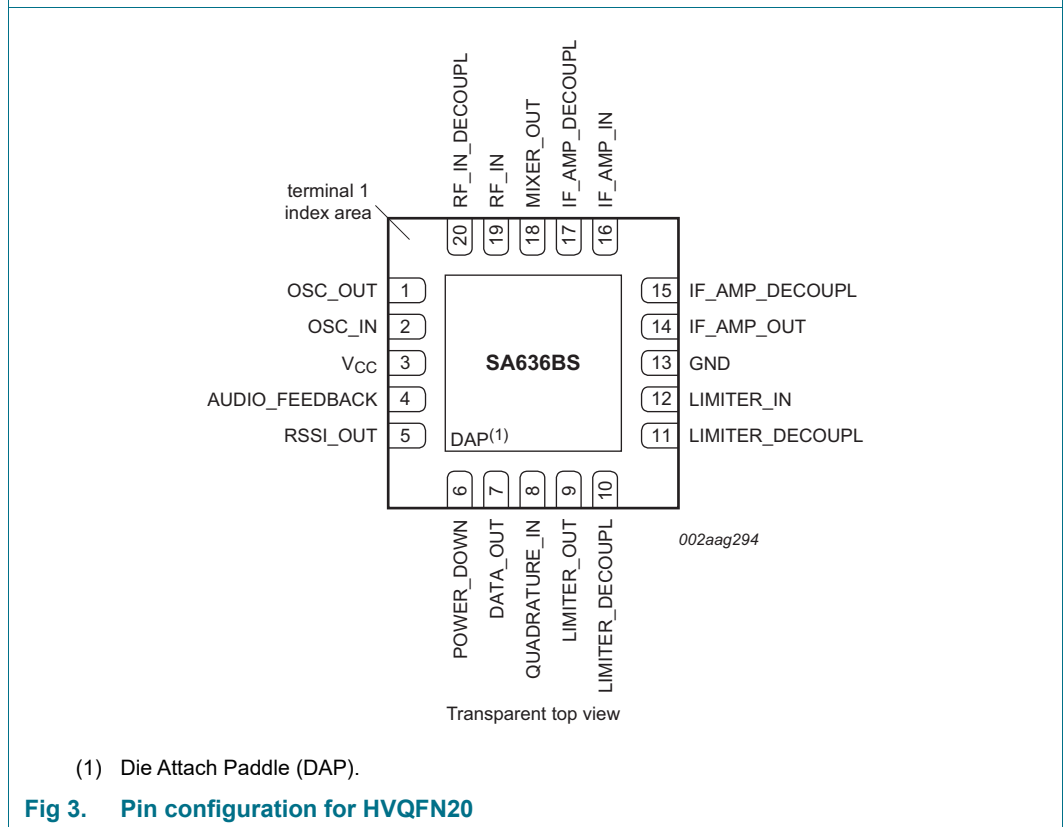


Fig 3. Pin configuration for HVQFN20

## 6.2 Pin description

Table 3. Pin description

| Symbol          | Pin    |                   | Description                                  |
|-----------------|--------|-------------------|--|
|                 | SSOP20 | HVQFN20           |  |
| RF_IN           | 1      | 19                | RF input                                     |
| RF_IN_DECOUPL   | 2      | 20                | RF input decoupling pin                      |
| OSC_OUT         | 3      | 1                 | oscillator output (emitter)                  |
| OSC_IN          | 4      | 2                 | oscillator input (base)                      |
| V <sub>CC</sub> | 5      | 3                 | positive supply voltage                      |
| RSSI_FEEDBACK   | 6      | 4                 | RSSI amplifier negative feedback terminal    |
| RSSI_OUT        | 7      | 5                 | RSSI output                                  |
| POWER_DOWN_CTRL | 8      | 6                 | power-down control; active HIGH              |
| DATA_OUT        | 9      | 7                 | data output                                  |
| QUADRATURE_IN   | 10     | 8                 | quadrature detector input terminal           |
| LIMITER_OUT     | 11     | 9                 | limiter amplifier output                     |
| LIMITER_DECOUPL | 12     | 10                | limiter amplifier decoupling pin             |
| LIMITER_DECOUPL | 13     | 11                | limiter amplifier decoupling pin             |
| LIMITER_IN      | 14     | 12                | limiter amplifier input                      |
| GND             | 15     | 13 <sup>[1]</sup> | ground; negative supply                      |
| IF_AMP_OUT      | 16     | 14                | IF amplifier output                          |
| IF_AMP_DECOUPL  | 17     | 15                | IF amplifier decoupling pin                  |
| IF_AMP_IN       | 18     | 16                | IF amplifier input                           |
| IF_AMP_DECOUPL  | 19     | 17                | IF amplifier decoupling pin                  |
| MIXER_OUT       | 20     | 18                | mixer output                                 |
| -               | -      | DAP               | exposed die attach paddle; connect to ground |

- [1] For the HVQFN20 package, the exposed die attach paddle must be connected to device ground pin 13 and the PCB ground plane. GND pin must be connected to supply ground for proper device operation. For enhanced thermal, electrical, and board level performance, the exposed pad needs to be soldered to the board using a corresponding thermal pad on the board and for proper heat conduction through the board, thermal vias need to be incorporated in the printed-circuit board in the thermal pad region.

## 7. Functional description

The SA636 is an IF signal processing system suitable for second IF or single conversion systems with input frequency as high as 1 GHz. The bandwidth of the IF amplifier is about 40 MHz with 38 dB of gain from a 50  $\Omega$  source. The bandwidth of the limiter is about 28 MHz with about 54 dB of gain from a 50  $\Omega$  source. However, the gain/bandwidth distribution is optimized for 10.7 MHz, 330  $\Omega$  source applications. The overall system is well-suited to battery operation as well as high performance and high-quality products of all types such as cordless and cellular hand-held phones.

The input stage is a Gilbert cell mixer with oscillator. Typical mixer characteristics include a noise figure of 14 dB, conversion gain of 11 dB, and input third-order intercept of -16 dBm. The oscillator will operate in excess of 1 GHz in L/C tank configurations. Hartley or Colpitts circuits can be used up to 100 MHz for crystal configurations. Butler oscillators are recommended for crystal configurations up to 150 MHz.

The output of the mixer is internally loaded with a 330  $\Omega$  resistor permitting direct connection to a 10.7 MHz ceramic filter for narrowband applications. The input resistance of the limiting IF amplifiers is also 330  $\Omega$ . With most 10.7 MHz ceramic filters and many crystal filters, no impedance matching network is necessary. For applications requiring wideband IF filtering, such as DECT, external LC filters are used (see [Figure 15](#)).

To achieve optimum linearity of the log signal strength indicator, there must be a 6 dBV insertion loss between the first and second IF stages. If the IF filter or interstage network does not cause 6 dBV insertion loss, a fixed or variable resistor can be added between the first IF output (IF\_AMP\_OUT) and the interstage network.

The signal from the second limiting amplifier goes to a Gilbert cell quadrature detector. One port of the Gilbert cell is internally driven by the IF. The other output of the IF is AC-coupled to a tuned quadrature network. This signal, which now has a 90° phase relationship to the internal signal, drives the other port of the multiplier cell.

Overall, the IF section has a gain of 90 dB for operation at intermediate frequency at 10.7 MHz. Special care must be given to layout, termination, and interstage loss to avoid instability.

The demodulated output (DATA\_OUT) of the quadrature is a voltage output. This output is designed to handle a minimum bandwidth of 600 kHz. This is designed to demodulate wideband data, such as in DECT applications.

A Received Signal Strength Indicator (RSSI) completes the circuitry. The output range is greater than 90 dB and is temperature compensated. This log signal strength indicator exceeds the criteria for AMPS or TACS cellular telephone, DECT and RCR-28 cordless telephone. This signal drives an internal op amp. The op amp is capable of rail-to-rail output. It can be used for gain, filtering, or second-order temperature compensation of the RSSI, if needed.

**Remark:**  $\text{dBV} = 20 \log V_O/V_I$ .

## 8. Internal circuitry

**Table 4. Internal circuits for each pin**

Pin numbers shown for SSOP20 package; HVQFN20 pins shown in parentheses in 'Pin' column.

| Symbol                 | Pin              | DC V               | Equivalent circuit |
|------------------------|------------------|--------------------|--------------------|
| RF_IN<br>RF_IN_DECOUPL | 1 (19)<br>2 (20) | +1.07 V<br>+1.07 V |                    |
| OSC_OUT<br>OSC_IN      | 3 (1)<br>4 (2)   | +1.57 V<br>+2.32 V |                    |
| V <sub>CC</sub>        | 5 (3)            | +3.00 V            |                    |
| RSSI_FEEDBACK          | 6 (4)            | +0.20 V            |                    |

**Table 4. Internal circuits for each pin ...continued**

Pin numbers shown for SSOP20 package; HVQFN20 pins shown in parentheses in 'Pin' column.

| Symbol          | Pin    | DC V    | Equivalent circuit |
|-----------------|--------|---------|--------------------|
| RSSI_OUT        | 7 (5)  | +0.20 V |                    |
| POWER_DOWN_CTRL | 8 (6)  | +2.75 V |                    |
| DATA_OUT        | 9 (7)  | +1.09 V |                    |
| QUADRATURE_IN   | 10 (8) | +3.00 V |                    |
| LIMITER_OUT     | 11 (9) | +1.35 V |                    |



**Table 4. Internal circuits for each pin ...continued**

Pin numbers shown for SSOP20 package; HVQFN20 pins shown in parentheses in 'Pin' column.

| Symbol          | Pin     | DC V    | Equivalent circuit |
|-----------------|---------|---------|--------------------|
| LIMITER_DECOUPL | 12 (10) | +1.23 V | <p>002aac993</p>   |
| LIMITER_DECOUPL | 13 (11) | +1.23 V |                    |
| LIMITER_IN      | 14 (12) | +1.23 V |                    |
| GND             | 15 (13) | 0 V     | -                  |
| IF_AMP_OUT      | 16 (14) | +1.22 V | <p>002aac994</p>   |
| IF_AMP_DECOUPL  | 17 (15) | +1.22 V | <p>002aac995</p>   |
| IF_AMP_IN       | 18 (16) | +1.22 V |                    |
| IF_AMP_DECOUPL  | 19 (17) | +1.22 V |                    |
| MIXER_OUT       | 20 (18) | +1.03 V | <p>002aac996</p>   |

## 9. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol           | Parameter                | Conditions | Min  | Max                   | Unit |
|------------------|--------------------------|------------|------|-----------------------|------|
| V <sub>CC</sub>  | supply voltage           |            | 0.3  | 7                     | V    |
| V <sub>n</sub>   | voltage on any other pin |            | -0.3 | V <sub>CC</sub> + 0.3 | V    |
| T <sub>stg</sub> | storage temperature      |            | -65  | +150                  | °C   |
| T <sub>amb</sub> | ambient temperature      | operating  | -40  | +85                   | °C   |

## 10. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol               | Parameter  | Conditions          | Max | Unit |
|----------------------|--|---------------------|-----|------|
| Z <sub>th(j-a)</sub> | transient thermal impedance from junction to ambient | SA636DK/0x (SSOP20) | 117 | K/W  |
|                      |  | SA636BS (HVQFN20)   | 40  | K/W  |

## 11. Static characteristics

**Table 7. Static characteristics**

V<sub>CC</sub> = 3 V; T<sub>amb</sub> = 25 °C; unless otherwise specified.

| Symbol               | Parameter              | Conditions                                  | Min                   | Typ | Max                   | Unit |
|----------------------|------------------------|---|-----------------------|-----|-----------------------|------|
| V <sub>CC</sub>      | supply voltage         |   | 2.7                   | 3.0 | 5.5                   | V    |
| I <sub>CC</sub>      | supply current         | DC current drain;<br>POWER_DOWN_CTRL = HIGH | 5.5                   | 6.5 | 7.5                   | mA   |
| I <sub>I</sub>       | input current          | POWER_DOWN_CTRL = LOW                       | -10                   | -   | +10                   | μA   |
|                      |                        | POWER_DOWN_CTRL = HIGH                      | -10                   | -   | +10                   | μA   |
| V <sub>I</sub>       | input voltage          | POWER_DOWN_CTRL = LOW                       | 0                     | -   | 0.3 × V <sub>CC</sub> | V    |
|                      |                        | POWER_DOWN_CTRL = HIGH                      | 0.7 × V <sub>CC</sub> | -   | V <sub>CC</sub>       | V    |
| I <sub>CC(stb)</sub> | standby supply current | POWER_DOWN_CTRL = LOW                       | -                     | 0.2 | 0.5                   | mA   |
| t <sub>ON</sub>      | power-up time          | RSSI valid (10 % to 90 %)                   | -                     | 10  | -                     | μs   |
| t <sub>OFF</sub>     | power-down time        | RSSI invalid (90 % to 10 %)                 | -                     | 5   | -                     | μs   |

## 12. Dynamic characteristics

**Table 8. Dynamic characteristics**

$T_{amb} = 25\text{ °C}$ ;  $V_{CC} = +3\text{ V}$ , unless otherwise stated. RF frequency = 240.05 MHz + 14.5 dBV RF input step-up; IF frequency = 10.7 MHz; RF level = -45 dBm; FM modulation = 1 kHz with  $\pm 125\text{ kHz}$  peak deviation. Audio output with C-message weighted filter and de-emphasis capacitor. Test circuit [Figure 19](#). The parameters listed below are tested using automatic test equipment to assure consistent electrical characteristics. The limits do not represent the ultimate performance limits of the device. Use of an optimized RF layout will improve many of the listed parameters.

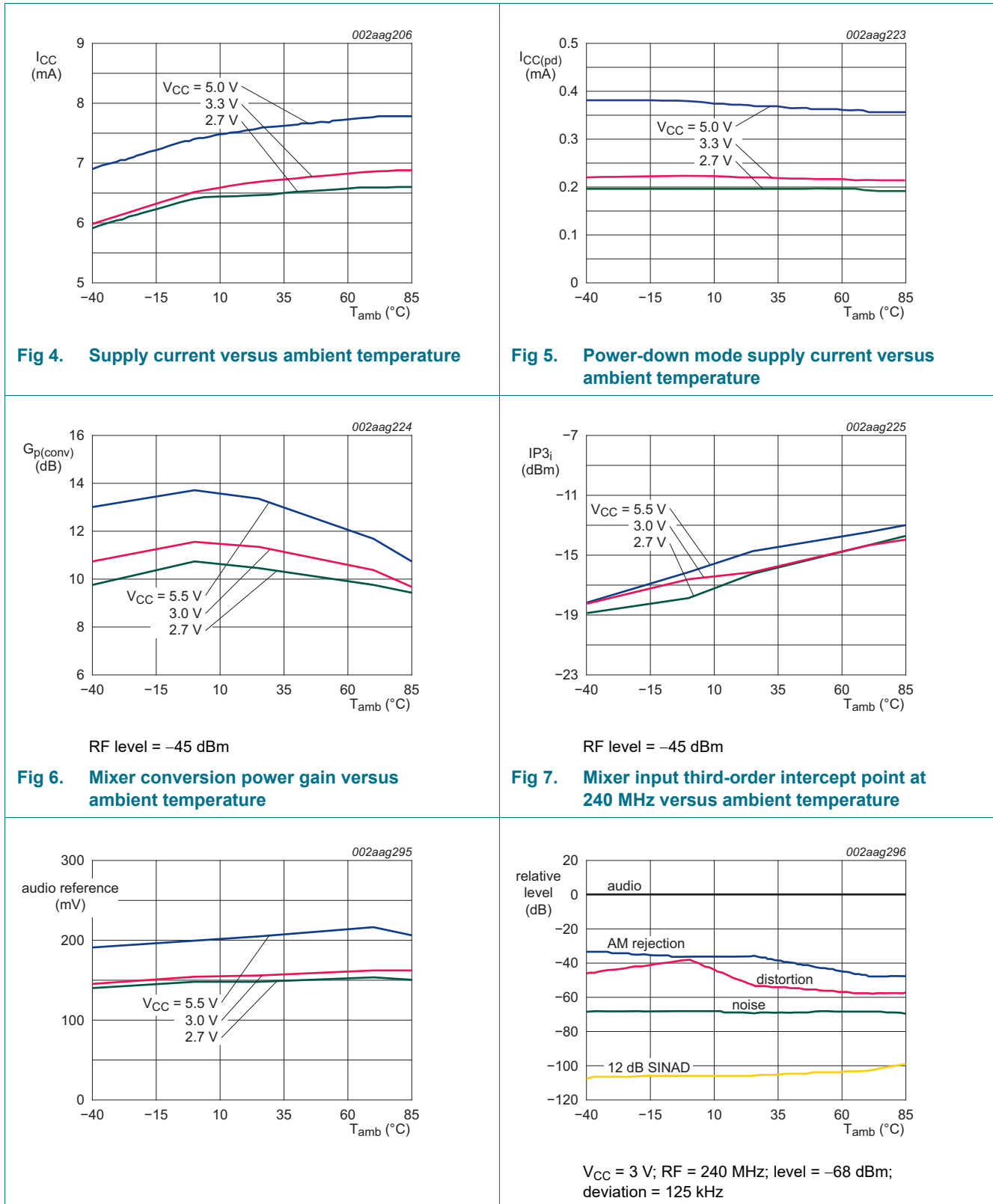
| Symbol   | Parameter                            | Conditions   | Min  | Typ  | Max  | Unit          |
|--|--------------------------------------|--|------|------|------|---------------|
| <b>Mixer/oscillator section (external LO = 160 mV RMS value)</b> |                                      |  |      |      |      |               |
| $f_i$  | input frequency                      |  | -    | 500  | -    | MHz           |
| $f_{osc}$  | oscillator frequency                 | external oscillator (buffer)   | -    | 500  | -    | MHz           |
| NF   | noise figure                         | at 240 MHz   | -    | 12   | -    | dB            |
| IP3 <sub>i</sub>   | input third-order intercept point    | matched f1 = 240.05 MHz;<br>f2 = 240.35 MHz  | -    | -16  | -    | dBm           |
| $G_{p(conv)}$  | conversion power gain                | matched 14.5 dBV step-up   | 8    | 11   | 14   | dB            |
| $R_{i(RF)}$  | RF input resistance                  | single-ended input   | -    | 700  | -    | $\Omega$      |
| $C_{i(RF)}$  | RF input capacitance                 |  | -    | 3.5  | -    | pF            |
| $R_{o(mix)}$   | mixer output resistance              | MIXER_OUT pin  | -    | -    | -    |               |
| <b>IF section</b>  |                                      |  |      |      |      |               |
| $G_{amp(IF)}$  | IF amplifier gain                    | 330 $\Omega$ load  | -    | 38   | -    | dB            |
| $G_{lim}$  | limiter gain                         | 330 $\Omega$ load  | -    | 54   | -    | dB            |
| $P_{i(IF)}$  | IF input power                       | for -3 dB input limiting sensitivity;<br>test at IF_AMP_IN pin   | -    | -105 | -    | dBm           |
| $\alpha_{AM}$  | AM rejection                         | 80 % AM 1 kHz  | -    | 40   | -    | dB            |
| $V_{o(RMS)}$   | RMS output voltage                   | $R_L = 100\text{ k}\Omega$   | 120  | 130  | -    | mV            |
| $B_{3dB}$  | 3 dB bandwidth                       |  | 600  | 700  | -    | kHz           |
| SINAD  | signal-to-noise-and-distortion ratio | RF level = -111 dBm  | -    | 16   | -    | dB            |
| THD  | total harmonic distortion            |  | -    | -43  | -38  | dB            |
| S/N  | signal-to-noise ratio                | no modulation for noise  | -    | 60   | -    | dB            |
| $V_{o(RSSI)}$  | RSSI output voltage                  | IF with buffer   |      |      |      |               |
|  |                                      | IF level = -118 dBm<br>(SA636DK/01 and SA636BS)  | -    | 0.2  | 0.5  | V             |
|  |                                      | IF level = -118 dBm<br>(SA636DK/02)  | 0.15 | 0.2  | 0.45 | V             |
|  |                                      | IF level = -68 dBm   | 0.3  | 0.6  | 1.0  | V             |
|  |                                      | IF level = -10 dBm   | 0.9  | 1.3  | 1.8  | V             |
| $t_{r(o)}$   | output rise time                     | IF RSSI output; 10 kHz pulse;<br>no 10.7 MHz filter;<br>no RSSI bypass capacitor;<br>IF frequency = 10.7 MHz |      |      |      |               |
|  |                                      | RF level = -56 dBm   | -    | 1.2  | -    | $\mu\text{s}$ |
|  |                                      | RF level = -28 dBm   | -    | 1.1  | -    | $\mu\text{s}$ |

**Table 8. Dynamic characteristics ...continued**

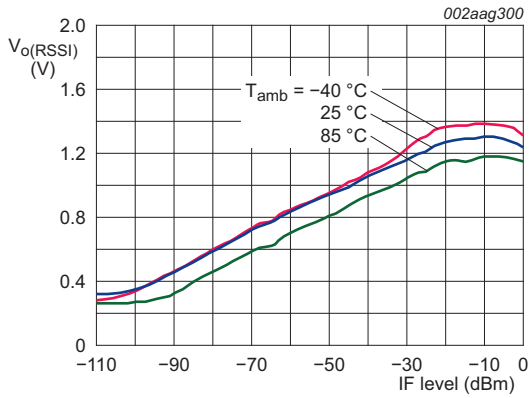
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = +3\text{ V}$ , unless otherwise stated. RF frequency = 240.05 MHz + 14.5 dBV RF input step-up; IF frequency = 10.7 MHz; RF level = -45 dBm; FM modulation = 1 kHz with  $\pm 125\text{ kHz}$  peak deviation. Audio output with C-message weighted filter and de-emphasis capacitor. Test circuit [Figure 19](#). The parameters listed below are tested using automatic test equipment to assure consistent electrical characteristics. The limits do not represent the ultimate performance limits of the device. Use of an optimized RF layout will improve many of the listed parameters.

| Symbol                               | Parameter                            | Conditions   | Min | Typ       | Max | Unit          |
|--------------------------------------|--------------------------------------|--|-----|-----------|-----|---------------|
| $t_{f(o)}$                           | output fall time                     | IF RSSI output; 10 kHz pulse;<br>no 10.7 MHz filter;<br>no RSSI bypass capacitor;<br>IF frequency = 10.7 MHz |     |           |     |               |
|                                      |                                      | RF level = -56 dBm   | -   | 2.0       | -   | $\mu\text{s}$ |
|                                      |                                      | RF level = -28 dBm   | -   | 7.3       | -   | $\mu\text{s}$ |
| $\alpha_{\text{RSSI}(\text{range})}$ | RSSI range                           |  | -   | 90        | -   | dB            |
| $\Delta\alpha_{\text{RSSI}}$         | RSSI variation                       |  | -   | $\pm 1.5$ | -   | dB            |
| $Z_{i(\text{IF})}$                   | IF input impedance                   |  | -   | 330       | -   | $\Omega$      |
| $Z_{o(\text{IF})}$                   | IF output impedance                  |  | -   | 330       | -   | $\Omega$      |
| $Z_{i(\text{lim})}$                  | limiter input impedance              |  | -   | 330       | -   | $\Omega$      |
| $Z_{o(\text{lim})}$                  | limiter output impedance             |  | -   | 300       | -   | $\Omega$      |
| $V_{o(\text{RMS})}$                  | RMS output voltage                   | limiter output level with no load  | -   | 130       | -   | mV            |
| <b>RF/IF section (internal LO)</b>   |                                      |  |     |           |     |               |
| $V_{o(\text{RSSI})}$                 | RSSI output voltage                  | system; RF level = -10 dBm   | -   | 1.4       | -   | V             |
| SINAD                                | signal-to-noise-and-distortion ratio | system; RF level = -106 dBm  | -   | 12        | -   | dB            |

### 13. Performance curves

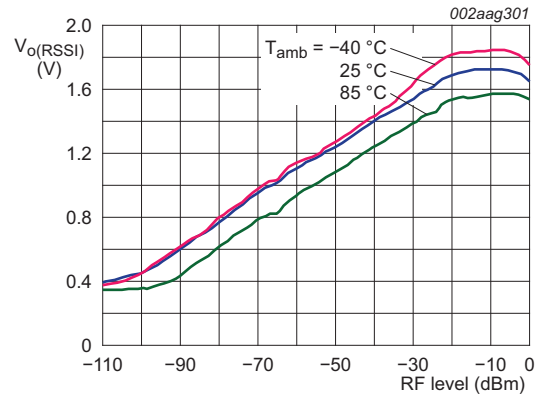


**Fig 8. Audio reference level versus ambient temperature**

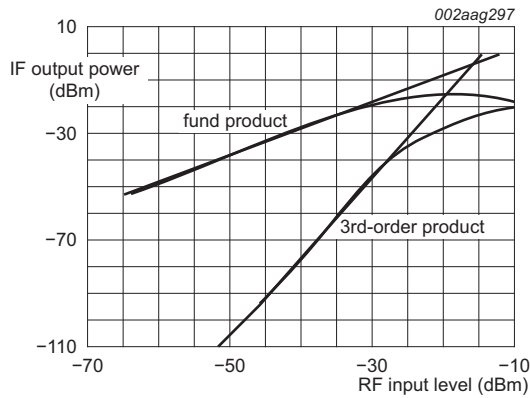


**Fig 10. RSSI output voltage versus IF level**

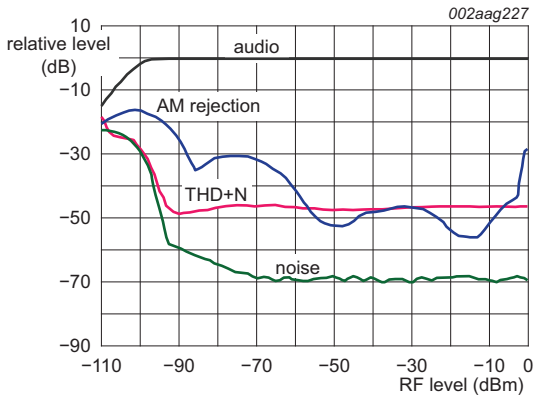
**Fig 9. 12 dB SINAD and relative audio, THD, noise, and AM rejection versus ambient temperature**



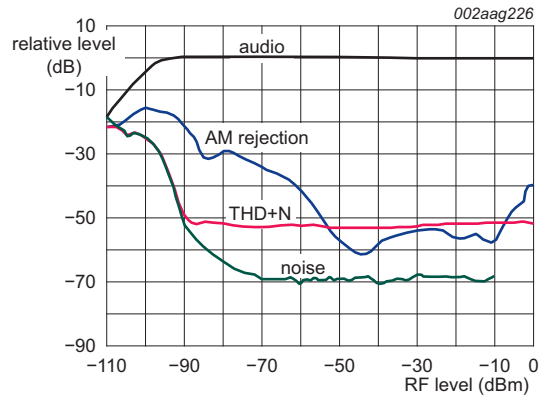
**Fig 11. RSSI output voltage versus RF level**



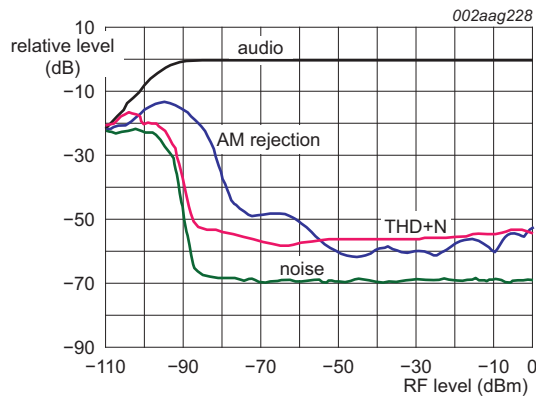
**Fig 12. Mixer third-order intercept and compression**



a.  $T_{amb} = -40\text{ }^{\circ}\text{C}$ ;  $V_{o(aud)RMS} = 118\text{ mV}$

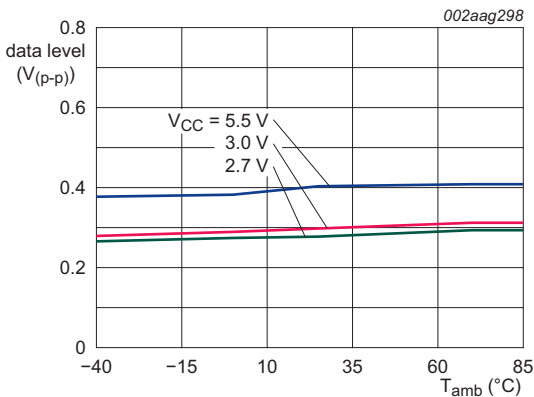


b.  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{o(aud)RMS} = 129\text{ mV}$



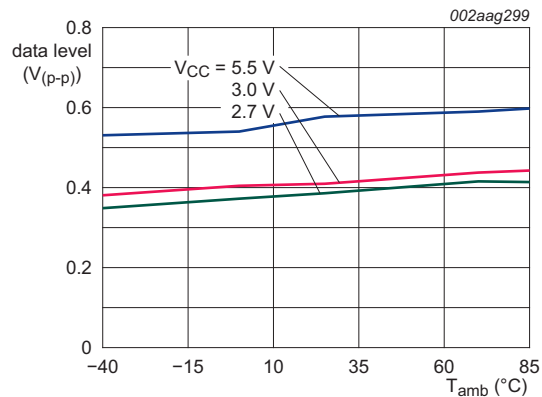
c.  $T_{amb} = 85\text{ }^{\circ}\text{C}$ ;  $V_{o(aud)RMS} = 131\text{ mV}$

**Fig 13. Relative level of audio, AM rejection, THD+N and noise versus RF level**



a. 600 kHz data rate

IF = 9.85 MHz; deviation = 288 kHz; RF = -40 dBm



b. 1 kHz data rate

**Fig 14. Data level versus ambient temperature**

14. Application information

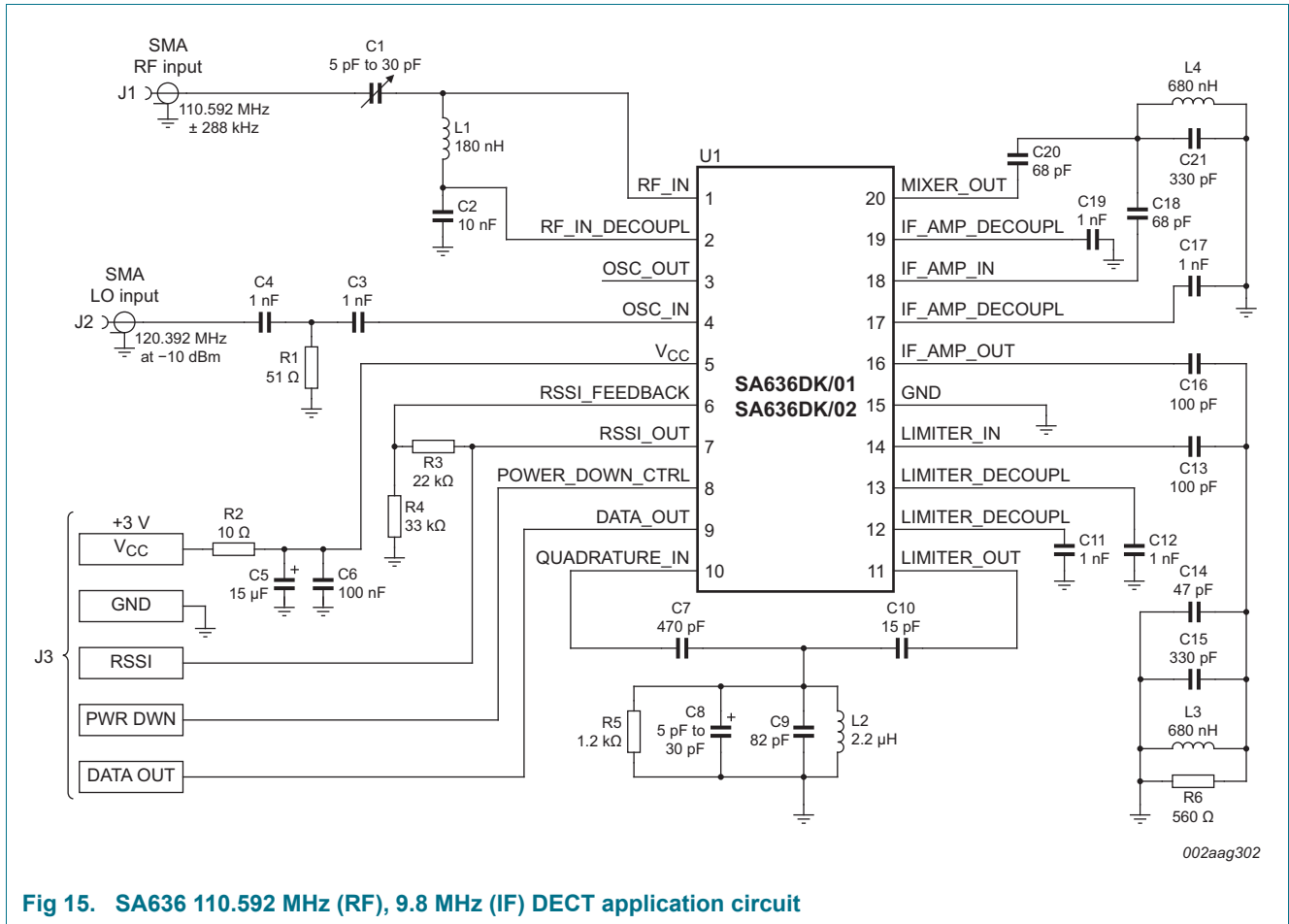


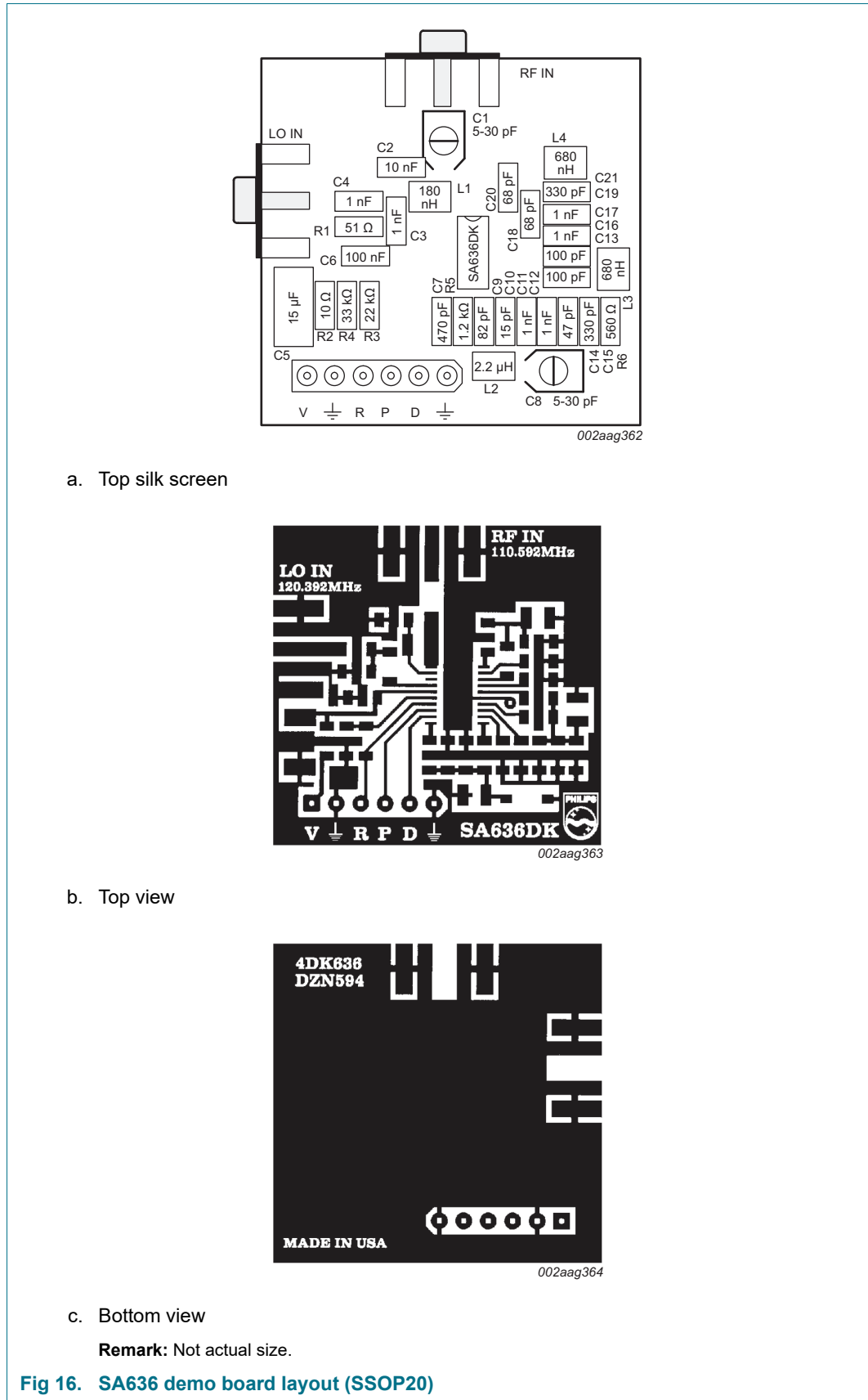
Fig 15. SA636 110.592 MHz (RF), 9.8 MHz (IF) DECT application circuit



**Table 9. DECT application circuit electrical characteristics**

RF frequency = 110.592 MHz; IF frequency = 9.8 MHz; RF level = -45 dBm; FM modulation = 100 kHz with  $\pm 288$  kHz peak deviation.

| Symbol   | Parameter                         | Conditions                                    | Min | Typ | Max | Unit     |
|--|-----------------------------------|---|-----|-----|-----|----------|
| <b>Mixer/oscillator section (external LO = 160 mV RMS value)</b> |                                   |   |     |     |     |          |
| $G_{p(\text{conv})}$   | conversion power gain             |   | -   | 13  | -   | dB       |
| NF   | noise figure                      | at 110 MHz                                    | -   | 12  | -   | dB       |
| $IP3_i$  | input third-order intercept point | matched f1 = 110.592 MHz;<br>f2 = 110.892 MHz | -   | -15 | -   | dBm      |
| $R_{i(\text{RF})}$   | RF input resistance               |   | -   | 690 | -   | $\Omega$ |
| $C_{i(\text{RF})}$   | RF input capacitance              |   | -   | 3.6 | -   | pF       |
| <b>IF section</b>  |                                   |   |     |     |     |          |
| $G_{\text{amp(IF)}}$   | IF amplifier gain                 | 330 $\Omega$ load                             | -   | 38  | -   | dB       |
| $G_{\text{lim}}$   | limiter gain                      | 330 $\Omega$ load                             | -   | 54  | -   | dB       |
| $V_{o(\text{RMS})}$  | RMS output voltage                | $R_L = 3 \text{ k}\Omega$                     | -   | 130 | -   | mV       |
| $B_{3\text{dB}}$   | 3 dB bandwidth                    |   | -   | 700 | -   | kHz      |
| <b>RF/IF section (internal LO)</b>                               |                                   |   |     |     |     |          |
| $V_{o(\text{RSSI})}$   | RSSI output voltage               | system; RF level = -10 dBm                    | -   | 1.4 | -   | V        |
| S/N  | signal-to-noise ratio             | system; RF level = -83 dBm                    | -   | 10  | -   | dB       |



a. Top silk screen

b. Top view

c. Bottom view

Remark: Not actual size.

Fig 16. SA636 demo board layout (SSOP20)

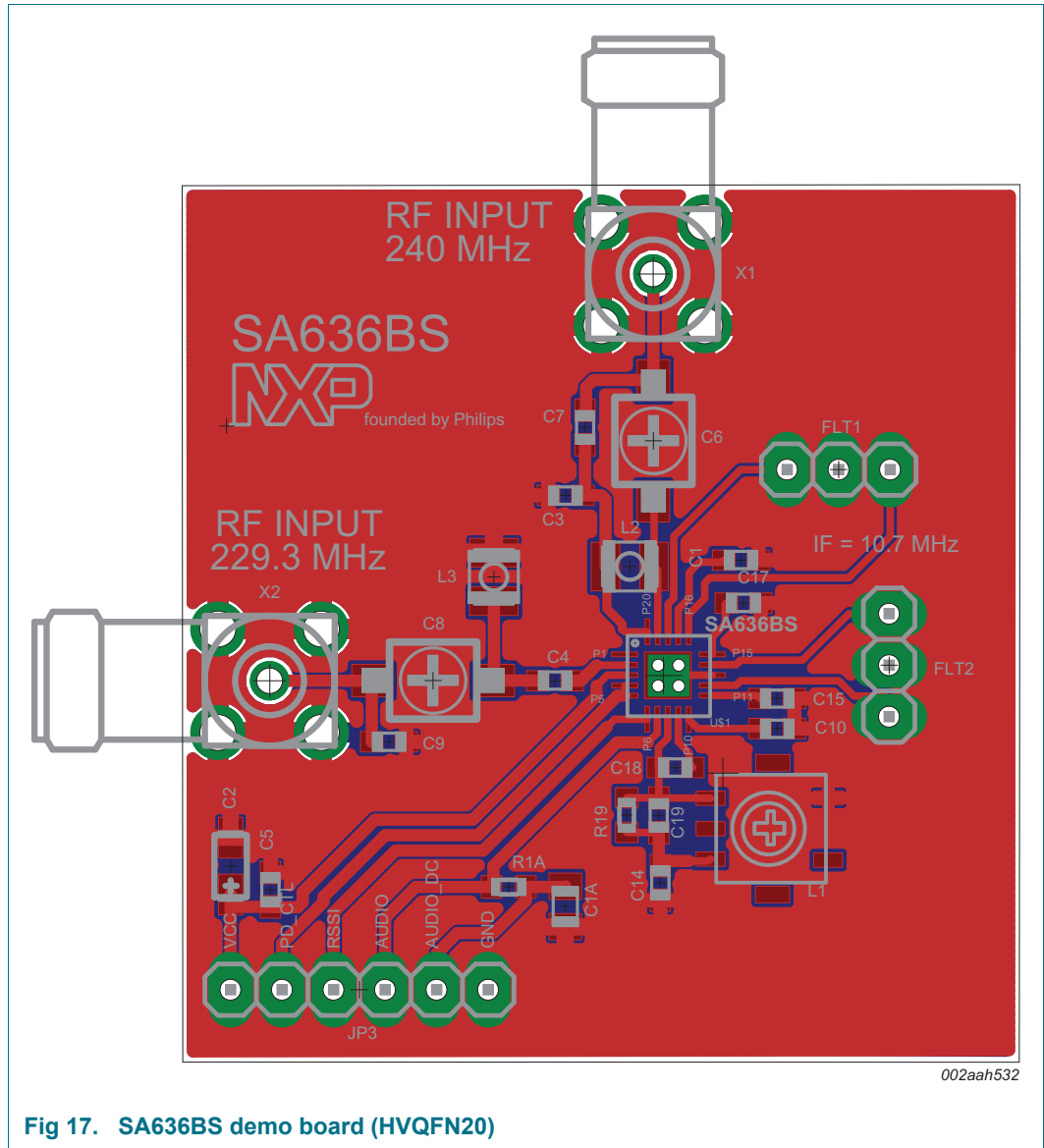
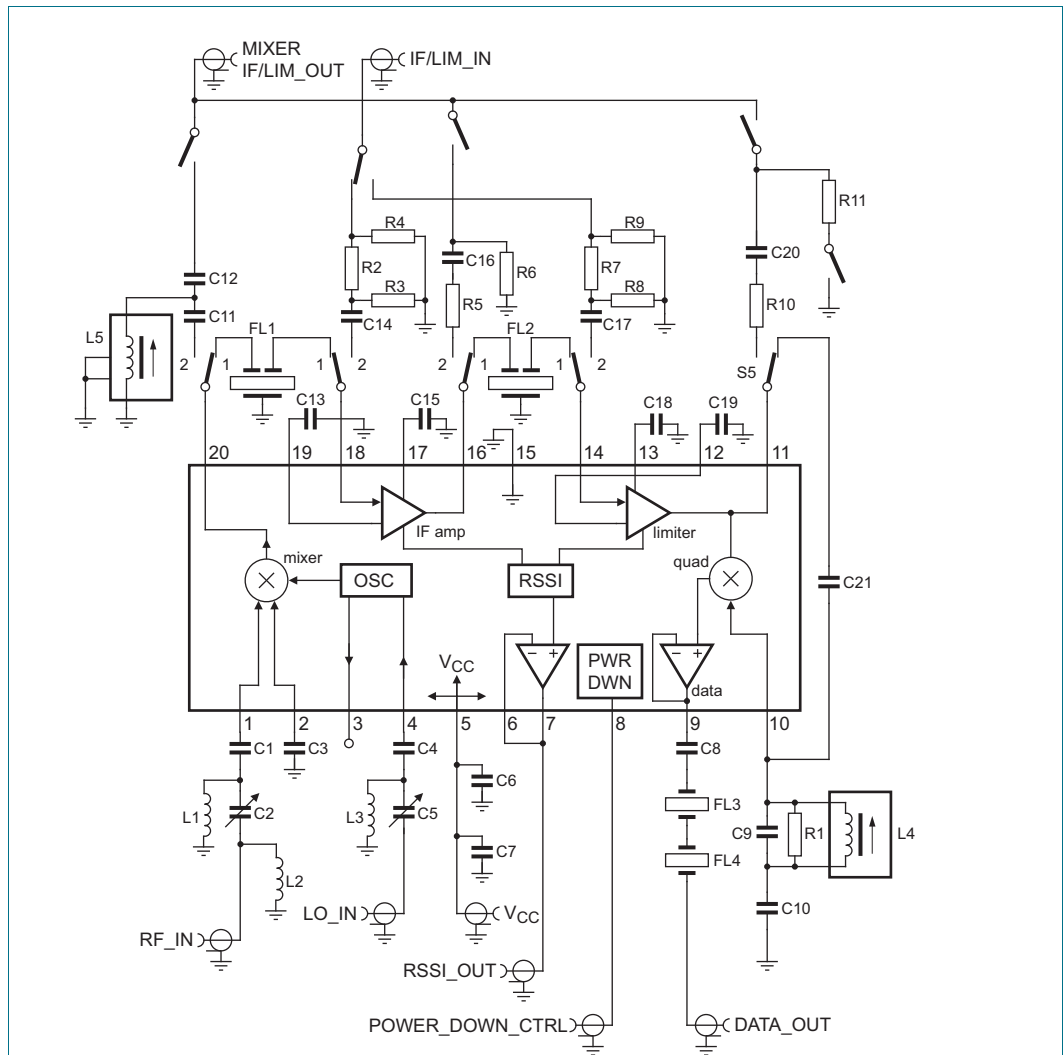


Fig 17. SA636BS demo board (HVQFN20)



15. Test information



002aag360

The layout is very critical in the performance of the receiver. We highly recommend our demo board layout.

All of the inductors, the quad tank, and their shield must be grounded. A 0.1  $\mu$ F bypass capacitor on the supply pin improves sensitivity.

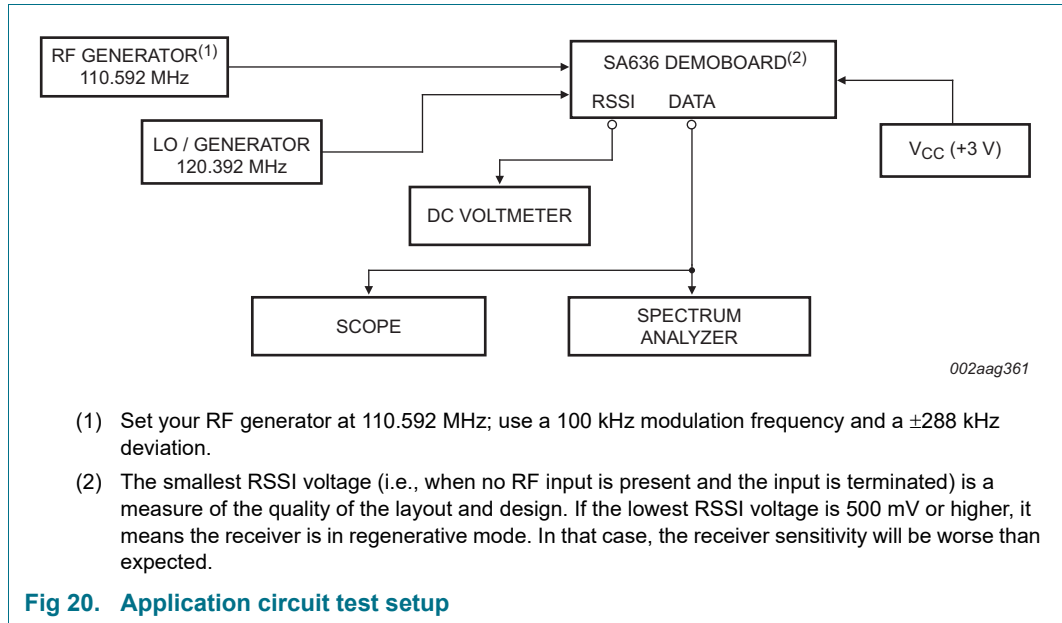
For the HVQFN20 package, the die attach paddle must be connected to the ground of PCB.

**Fig 19. 240.05 MHz (RF) / 10.7 MHz (IF) test circuit**

Table 10. Automatic test circuit component list

| Component                             | Description   |
|---------------------------------------|---|
| R1                                    | 7.5 k $\Omega$ resistor; select   |
| R2, R7                                | 6.49 k $\Omega$ resistor  |
| R3, R8                                | 347.8 $\Omega$ resistor   |
| R4, R6, R9, R11                       | 49.9 $\Omega$ resistor  |
| R5, R10                               | 1 k $\Omega$ resistor   |
| R12, R14                              | 60.4 $\Omega$ resistor  |
| R13                                   | 249 $\Omega$ resistor   |
| C1, C4                                | 10 nF capacitor   |
| C2                                    | 5.6 pF capacitor; select for input match  |
| C3, C10, C11, C14, C16, C17, C20, C22 | 0.1 $\mu$ F capacitor   |
| C5                                    | 5 pF to 300 pF variable capacitor; Murata TZC3P300A 110R00  |
| C6                                    | 100 pF capacitor  |
| C7                                    | 15 $\mu$ F, 20 V capacitor <sup>[1]</sup>   |
| C8                                    | 1 $\mu$ F capacitor   |
| C9                                    | 39 pF capacitor; select   |
| C10, C13, C15, C18, C19               | 1000 pF capacitor   |
| C12                                   | 150 pF capacitor; select  |
| C21                                   | 2.7 pF capacitor  |
| L2                                    | 27 nH inductor <sup>[1]</sup> ; Coilcraft 1008HT-27NT or Garret PM20-RO27; select for input match |
| L3                                    | 39 nH inductor; Coilcraft 1008HQ-39NX; select for input match                                     |
| L4                                    | 5.6 $\mu$ H variable, shielded inductor, 5 mm SMD; Toko 613BN-9056Z; select for input match       |
| L5                                    | 1.27 $\mu$ H to 2.25 $\mu$ H variable shielded inductor; 5 mm SMD; select for mixer output match  |
| FL1, FL2                              | 10.7 MHz filter (Murata SFE10.7MA5-A)   |
| FL3                                   | 'C' message weighted filter   |
| FL4                                   | active de-emphasis filter   |

[1] This value can be reduced when a battery is the power source.



16. Package outline

SSOP20: plastic shrink small outline package; 20 leads; body width 4.4 mm

SOT266-1

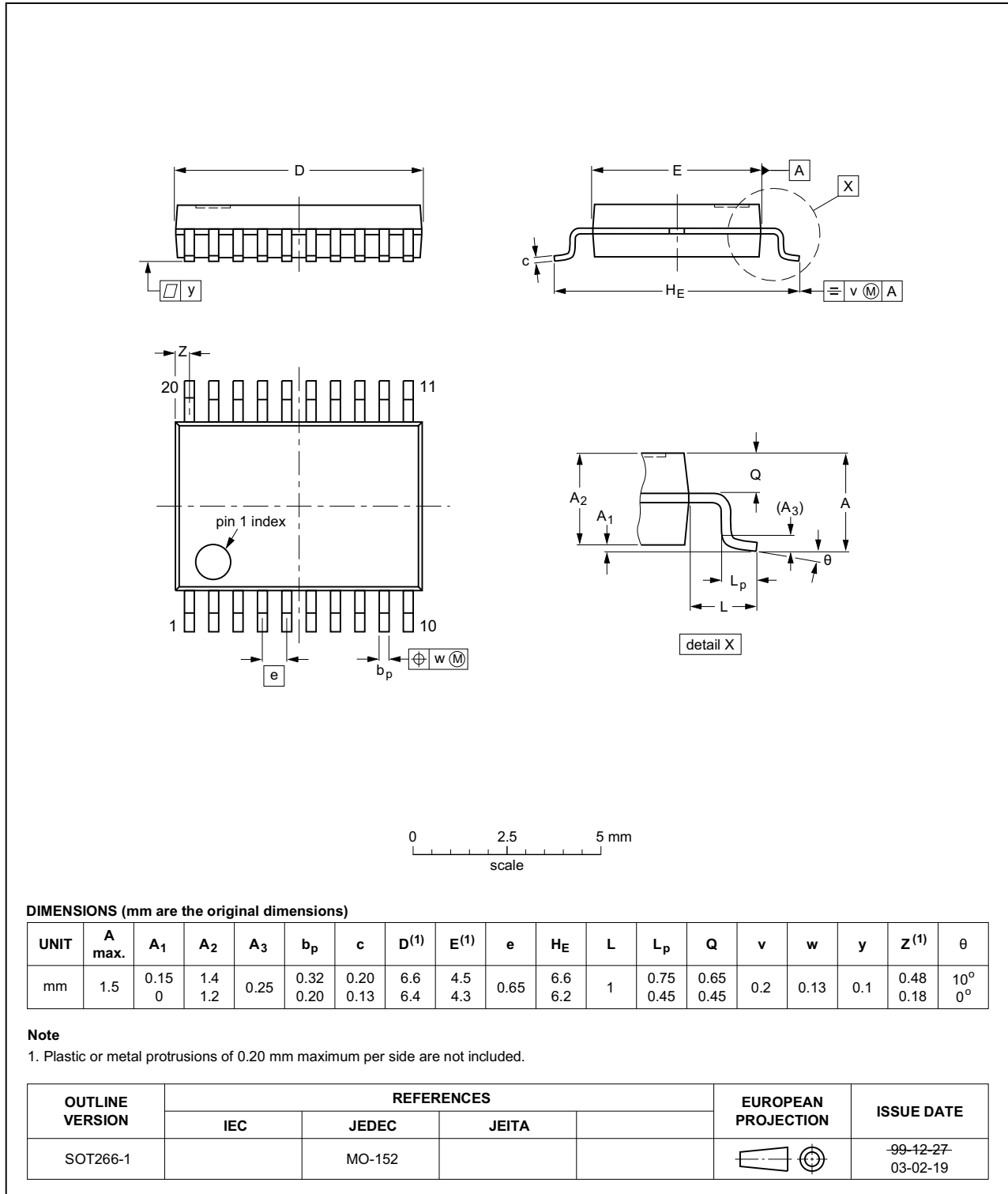


Fig 21. Package outline SOT266-1 (SSOP20)



HVQFN20: plastic thermal enhanced very thin quad flat package; no leads; 20 terminals; body 4 x 4 x 0.85 mm

SOT917-1

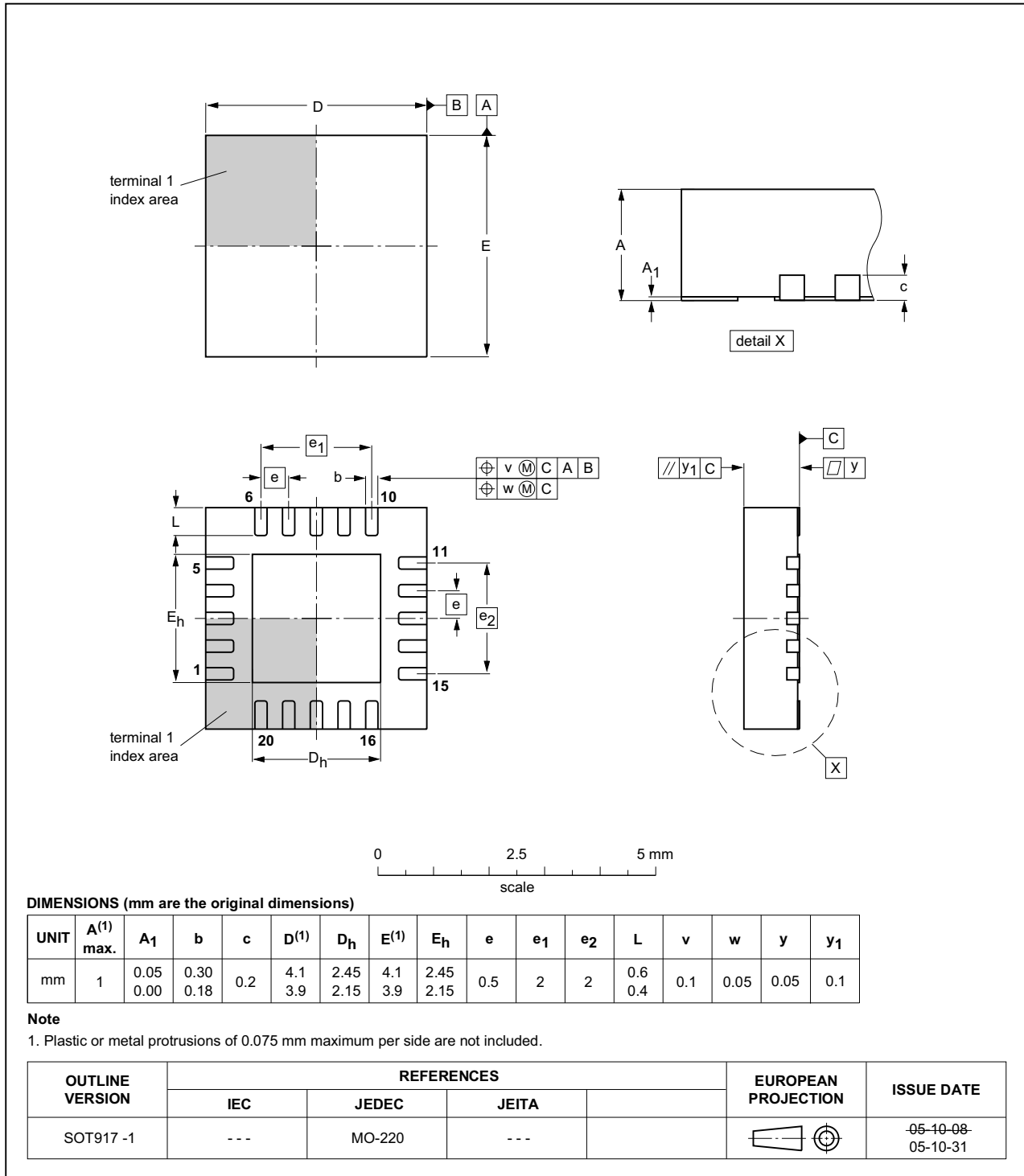


Fig 22. Package outline SOT917-1 (HVQFN20)

## 17. Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

### 17.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

### 17.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

### 17.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

### 17.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 23](#)) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 11](#) and [12](#)

**Table 11. SnPb eutectic process (from J-STD-020D)**

| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                  | 235                             | 220   |
| ≥ 2.5                  | 220                             | 220   |

**Table 12. Lead-free process (from J-STD-020D)**

| Package thickness (mm) | Package reflow temperature (°C) |             |        |
|------------------------|---------------------------------|-------------|--------|
|                        | Volume (mm <sup>3</sup> )       |             |        |
|                        | < 350                           | 350 to 2000 | > 2000 |
| < 1.6                  | 260                             | 260         | 260    |
| 1.6 to 2.5             | 260                             | 250         | 245    |
| > 2.5                  | 250                             | 245         | 245    |

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 23](#).

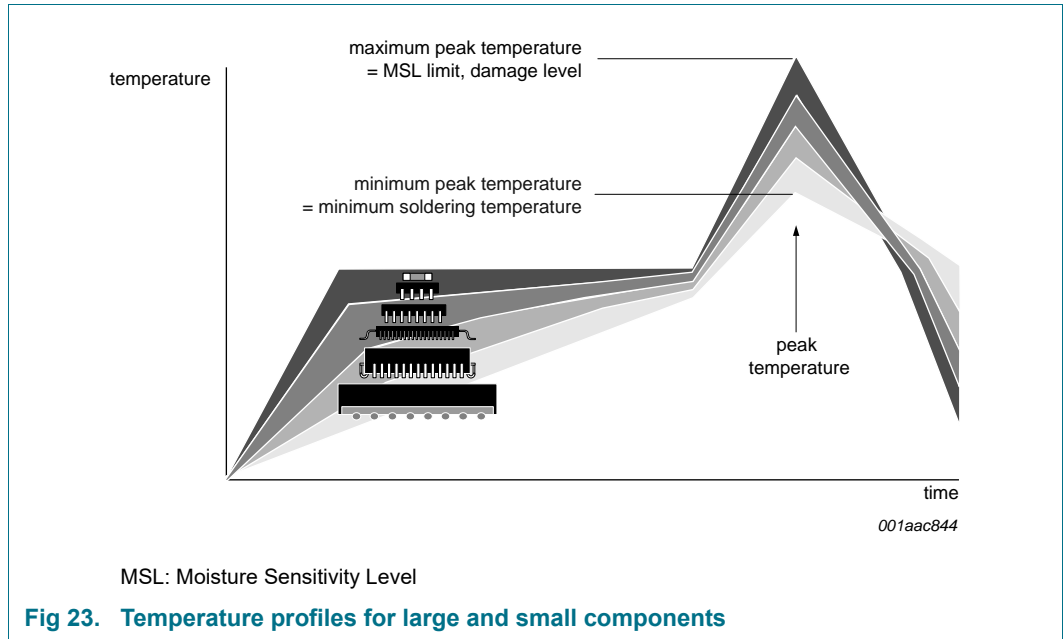


Fig 23. Temperature profiles for large and small components

For further information on temperature profiles, refer to Application Note AN10365 “Surface mount reflow soldering description”.

## 18. Abbreviations

Table 13. Abbreviations

| Acronym | Description                                       |
|---------|---|
| AMPS    | Advanced Mobile Phone System                      |
| ASK     | Amplitude Shift Keying                            |
| BER     | Bit Error Rate                                    |
| CDM     | Charged-Device Model                              |
| CMOS    | Complementary Metal-Oxide Semiconductor           |
| DECT    | Digital European Cordless Telephone               |
| ESD     | ElectroStatic Discharge                           |
| FM      | Frequency Modulation                              |
| FSK     | Frequency Shift Keying                            |
| HBM     | Human Body Model                                  |
| IF      | Intermediate Frequency                            |
| LAN     | Local Area Network                                |
| LC      | inductor-capacitor filter                         |
| RCR     | Research and development Center for Radio systems |
| RF      | Radio Frequency                                   |
| RSSI    | Received Signal Strength Indicator                |
| SINAD   | Signal-to-Noise And Distortion ratio              |
| SMD     | Surface Mount Device                              |
| TACS    | Total Access Communication System                 |

Table 13. Abbreviations ...continued

| Acronym | Description                 |
|---------|-----------------------------|
| TTL     | Transistor-Transistor Logic |
| UHF     | Ultra High Frequency        |
| VHF     | Very High Frequency         |

## 19. Revision history

Table 14. Revision history

| Document ID    | Release date   | Data sheet status     | Change notice                        | Supersedes |
|----------------|--|-----------------------|--------------------------------------|------------|
| SA636 v.8      | 20191008   | Product data sheet    | -                                    | SA636 v.7  |
| Modifications: | <ul style="list-style-type: none"> <li>Added new device SA636DK/02 - identical to SA636DK/01 except for small change to test program</li> </ul>  |                       |                                      |            |
| SA636 v.7      | 20160616   | Product data sheet    | -                                    | SA636 v.6  |
| Modifications: | <ul style="list-style-type: none"> <li><a href="#">Figure 2 "Pin configuration for SSOP20"</a>: Corrected pin assignments for OSC_IN and OSC_OUT; no change to device.</li> </ul>  |                       |                                      |            |
| SA636 v.6      | 20121205   | Product data sheet    | -                                    | SA636 v.5  |
| Modifications: | <ul style="list-style-type: none"> <li><a href="#">Table 3 "Pin description"</a>:                             <ul style="list-style-type: none"> <li>appended "connect to ground" to description of DAP (HVQFN20)</li> <li><a href="#">Table note [1]</a>: first sentence is re-written</li> </ul> </li> <li><a href="#">Figure 19 "240.05 MHz (RF) / 10.7 MHz (IF) test circuit"</a>: added 3rd paragraph (just above figure title)</li> <li>Added <a href="#">Figure 17 "SA636BS demo board (HVQFN20)"</a></li> <li>Added <a href="#">Figure 18 "SA636BS schematic (HVQFN20)"</a></li> </ul> |                       |                                      |            |
| SA636 v.5      | 20120724   | Product data sheet    | -                                    | SA636 v.4  |
| SA636 v.4      | 20110909   | Product data sheet    | -                                    | SA636 v.3  |
| SA636 v.3      | 20030801   | Product data          | ECN 853-1757 30101 dated 15 Jul 2003 | SA636 v.2  |
| SA636 v.2      | 19971107   | Product data          | ECN 853-1757 18664 dated 07 Nov 1997 | SA636 v.1  |
| SA636 v.1      | 19940616   | Product specification | ECN 853-1757 13150 dated 07 Nov 1997 | -          |

## 20. Legal information

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| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition  |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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Date of release: 8 October 2019

Document identifier: SA636



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