

# SA616

## Low-voltage high performance mixer FM IF system

Rev. 3 — 21 June 2010

Product data sheet

### 1. General description

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The SA616 is a low-voltage high performance monolithic FM IF system incorporating a mixer/oscillator, two limiting intermediate frequency amplifiers, quadrature detector, logarithmic Received Signal Strength Indicator (RSSI), voltage regulator and audio and RSSI op amps. The SA616 is available in SSOP20 and HVQFN20 packages.

The SA616 was designed for portable communication applications and will function down to 2.7 V. The RF section is similar to the famous SA615. The audio and RSSI outputs have amplifiers with access to the feedback path. This enables the designer to adjust the output levels or add filtering.

### 2. Features and benefits

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- Low power consumption: 3.5 mA typical at 3 V
- Mixer input to >150 MHz
- Mixer conversion power gain of 17 dB at 45 MHz
- XTAL oscillator effective to 150 MHz (LC oscillator or external oscillator can be used at higher frequencies)
- 102 dB of IF amp/limiter gain
- 2 MHz IF amp/limiter small signal bandwidth
- Temperature compensated logarithmic RSSI with a 80 dB dynamic range
- Low external component count; suitable for crystal/ceramic/LC filters
- Excellent sensitivity: 0.31  $\mu$ V into 50  $\Omega$  matching network for 12 dB SINAD (Signal-to-Noise-and-Distortion ratio) for 1 kHz tone with RF at 45 MHz and IF at 455 kHz
- SA616 meets cellular radio specifications
- Audio output internal op amp
- RSSI output internal op amp
- Internal op amps with rail-to-rail outputs
- ESD protection: Human Body Model 2 kV; Robot Model 200 V

### 3. Applications

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- Portable cellular radio FM IF
- Cordless phones
- Wireless systems
- RF level meter
- Spectrum analyzer
- Instrumentation



- FSK and ASK data receivers
- Log amps
- Portable high performance communication receiver
- Single conversion VHF receivers

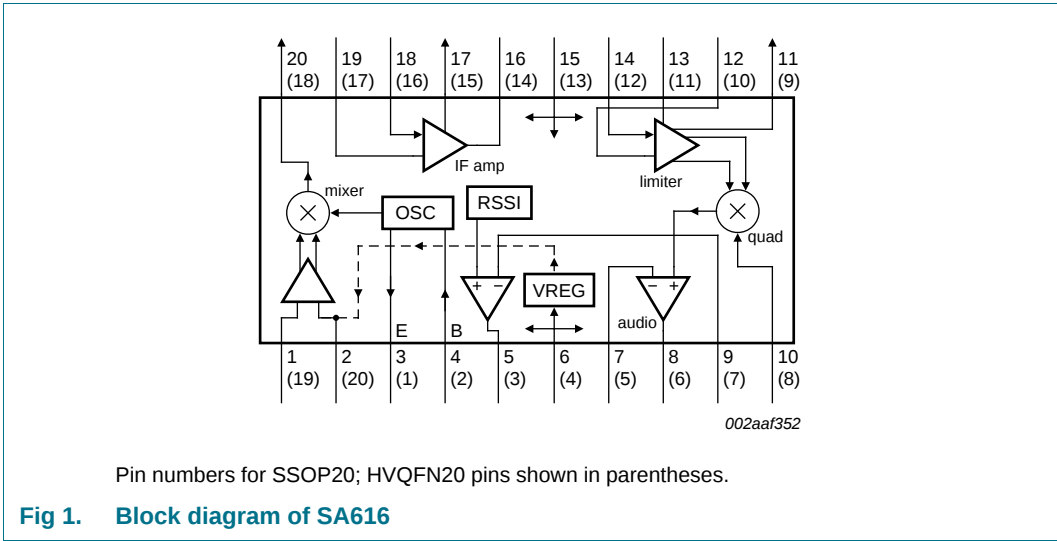
4. Ordering information

Table 1. Ordering information

T<sub>amb</sub> = -40 °C to +85 °C

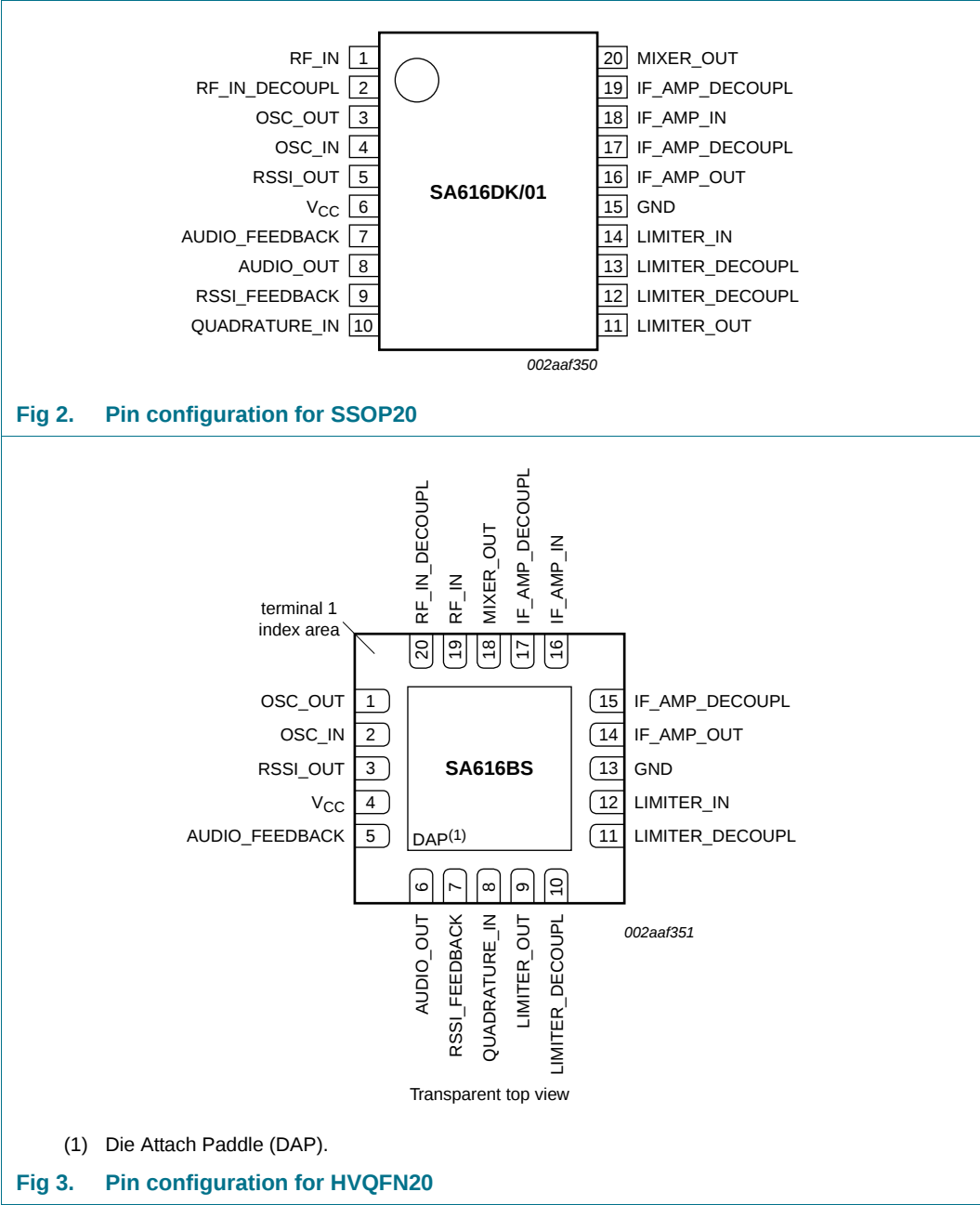
| Type number | Topside mark | Package |                                                                                                    |          |
|-------------|--------------|---------|----------------------------------------------------------------------------------------------------|----------|
|             |              | Name    | Description                                                                                        | Version  |
| SA616DK/01  | SA616DK      | SSOP20  | plastic shrink small outline package; 20 leads; body width 4.4 mm                                  | SOT266-1 |
| SA616BS     | 616B         | HVQFN20 | plastic thermal enhanced very thin quad flat package; no leads; 20 terminals; body 4 × 4 × 0.85 mm | SOT917-1 |

5. Block diagram



6. Pinning information

6.1 Pinning



## 6.2 Pin description

Table 2. 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                          |
| OSC_IN          | 4      | 2                 | oscillator input                           |
| RSSI_OUT        | 5      | 3                 | RSSI output                                |
| V <sub>CC</sub> | 6      | 4                 | positive supply voltage                    |
| AUDIO_FEEDBACK  | 7      | 5                 | audio amplifier negative feedback terminal |
| AUDIO_OUT       | 8      | 6                 | audio amplifier output                     |
| RSSI_FEEDBACK   | 9      | 7                 | RSSI amplifier negative feedback terminal  |
| 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                  |

- [1] HVQFN20 package supply ground is connected to both GND pin and exposed center pad. 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 PCB in the thermal pad region.

## 7. Functional description

The SA616 is an IF signal processing system suitable for second IF systems with input frequency as high as 150 MHz. The bandwidth of the IF amplifier and limiter is at least 2 MHz with 90 dB of gain. The gain/bandwidth distribution is optimized for 455 kHz, 1.5 k $\Omega$  source applications. The overall system is well-suited to battery operation as well as high performance and high quality products of all types.

The input stage is a Gilbert cell mixer with oscillator. Typical mixer characteristics include a noise figure of 6.2 dB, conversion gain of 17 dB, and input third-order intercept of -9 dBm. The oscillator will operate in excess of 200 MHz 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 impedance of the mixer is a 1.5 k $\Omega$  resistor permitting direct connection to a 455 kHz ceramic filter. The input resistance of the limiting IF amplifiers is also 1.5 k $\Omega$ . With most 455 kHz ceramic filters and many crystal filters, no impedance matching network is necessary. The IF amplifier has 43 dB of gain and 5.5 MHz bandwidth. The IF limiter has 60 dB of gain and 4.5 MHz bandwidth.

To achieve optimum linearity of the log signal strength indicator, there must be a 12 dB(v) insertion loss between the first and second IF stages. If the IF filter or interstage network does not cause 12 dB(v) insertion loss, a fixed or variable resistor or an L pad for simultaneous loss and impedance matching can be added between the first IF output (IF\_AMP\_OUT) and the interstage network. The overall gain will then be 90 dB with 2 MHz bandwidth.

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.

The demodulated output of the quadrature drives an internal op amp. This op amp can be configured as a unity gain buffer, or for simultaneous gain, filtering, and second-order temperature compensation if needed. It can drive an AC load as low as 5 k $\Omega$  with a rail-to-rail output.

A log signal strength 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. 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:**  $\text{dB(v)} = 20\log V_O/V_I$ .

## 8. Limiting values

**Table 3. Limiting values***In accordance with the Absolute Maximum Rating System (IEC 60134).*

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

## 9. Thermal characteristics

**Table 4. Thermal characteristics**

| Symbol               | Parameter                                            | Conditions          | Max | Unit |
|----------------------|------------------------------------------------------|---------------------|-----|------|
| Z <sub>th(j-a)</sub> | transient thermal impedance from junction to ambient | SA616DK/01 (SSOP20) | 117 | K/W  |
|                      |                                                      | SA616BS (HVQFN20)   | 40  | K/W  |

## 10. Static characteristics

**Table 5. Static characteristics***V<sub>CC</sub> = 3 V; T<sub>amb</sub> = 25 °C; unless specified otherwise.*

| Symbol          | Parameter      | Conditions | Min | Typ | Max | Unit |
|-----------------|----------------|------------|-----|-----|-----|------|
| V <sub>CC</sub> | supply voltage |            | 2.7 | -   | 7.0 | V    |
| I <sub>CC</sub> | supply current |            | -   | 3.5 | 5.0 | mA   |

## 11. Dynamic characteristics

**Table 6. Dynamic characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 3\text{ V}$ ; unless specified otherwise. RF frequency = 45 MHz + 14.5 dBV RF input step-up. IF frequency = 455 kHz;  $R17 = 2.4\text{ k}\Omega$  and  $R18 = 3.3\text{ k}\Omega$ . RF level = -45 dBm; FM modulation = 1 kHz with  $\pm 8\text{ kHz}$  peak deviation. Audio output with de-emphasis filter and C-message weighted filter. Test circuit [Figure 21](#). 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.

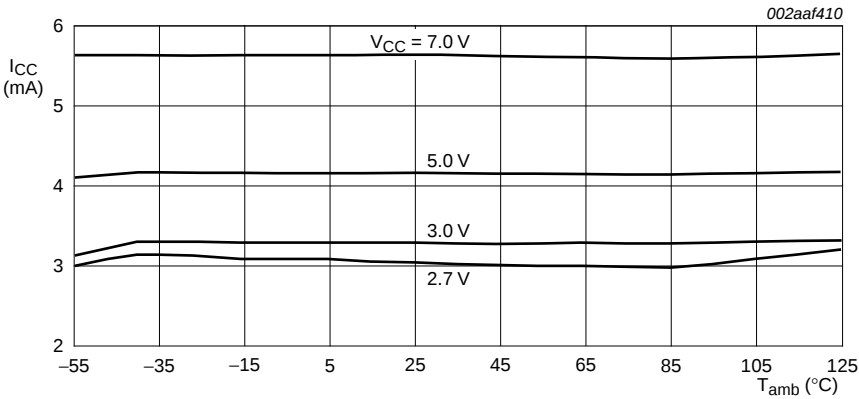
| Symbol                                                           | Parameter                            | Conditions                                                                                                                                               | Min  | Typ     | Max | Unit      |
|------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------|-----|-----------|
| <b>Mixer/oscillator section (external LO = 220 mV RMS value)</b> |                                      |                                                                                                                                                          |      |         |     |           |
| $f_i$                                                            | input frequency                      |                                                                                                                                                          | -    | 150     | -   | MHz       |
| $f_{osc}$                                                        | oscillator frequency                 |                                                                                                                                                          | -    | 150     | -   | MHz       |
| NF                                                               | noise figure                         | at 45 MHz                                                                                                                                                | -    | 6.8     | -   | dB        |
| $IP3_i$                                                          | input third-order intercept point    | 50 $\Omega$ source;<br>$f_1 = 45.0\text{ MHz}$ ; $f_2 = 45.06\text{ MHz}$ ;<br>input RF level = -52 dBm                                                  | -    | -9      | -   | dB        |
| $G_{p(conv)}$                                                    | conversion power gain                | matched 14.5 dBV step-up                                                                                                                                 | 11   | 17      | -   | dB        |
|                                                                  |                                      | 50 $\Omega$ source                                                                                                                                       | -    | 2.5     | -   | dB        |
| $R_{i(RF)}$                                                      | RF input resistance                  | single-ended input                                                                                                                                       | -    | 8       | -   | $k\Omega$ |
| $C_{i(RF)}$                                                      | RF input capacitance                 |                                                                                                                                                          | -    | 3.0     | 4.0 | pF        |
| $R_{o(mix)}$                                                     | mixer output resistance              | MIXER_OUT pin                                                                                                                                            | 1.25 | 1.5     | -   | $k\Omega$ |
| <b>IF section</b>                                                |                                      |                                                                                                                                                          |      |         |     |           |
| $G_{amp(IF)}$                                                    | IF amplifier gain                    | 50 $\Omega$ source                                                                                                                                       | -    | 44      | -   | dB        |
| $G_{lim}$                                                        | limiter gain                         | 50 $\Omega$ source                                                                                                                                       | -    | 58      | -   | dB        |
| $P_{i(IF)}$                                                      | IF input power                       | for -3 dB input limiting sensitivity;<br>$R17 = 2.4\text{ k}\Omega$ ; $R18 = 3.3\text{ k}\Omega$<br>( <a href="#">Figure 21</a> ); test at IF_AMP_IN pin | -    | -105    | -   | dBm       |
| $\alpha_{AM}$                                                    | AM rejection                         | 80 % AM 1 kHz                                                                                                                                            | -    | 40      | -   | dB        |
| $V_{o(aud)}$                                                     | audio output voltage                 | gain of two (2 $k\Omega$ AC load)                                                                                                                        | 60   | 120     | -   | mV        |
| SINAD                                                            | signal-to-noise-and-distortion ratio | IF level -110 dBm                                                                                                                                        | -    | 17      | -   | dB        |
| THD                                                              | total harmonic distortion            |                                                                                                                                                          | -30  | -45     | -   | dB        |
| S/N                                                              | signal-to-noise ratio                | no modulation for noise                                                                                                                                  | -    | 62      | -   | dB        |
| $V_{o(RSSI)}$                                                    | RSSI output voltage                  | RF; $R9 = 2\text{ k}\Omega$                                                                                                                              |      |         |     |           |
|                                                                  |                                      | RF level = -118 dBm                                                                                                                                      | -    | 0.3     | 0.8 | V         |
|                                                                  |                                      | RF level = -68 dBm                                                                                                                                       | 0.7  | 1.1     | 2   | V         |
|                                                                  |                                      | RF level = -23 dBm                                                                                                                                       | 1.0  | 1.8     | 2.5 | V         |
| $\alpha_{RSSI(range)}$                                           | RSSI range                           |                                                                                                                                                          | -    | 80      | -   | dB        |
| $\Delta\alpha_{RSSI}$                                            | RSSI variation                       |                                                                                                                                                          | -    | $\pm 2$ | -   | dB        |
| $Z_{i(IF)}$                                                      | IF input impedance                   | IF_AMP_IN pin                                                                                                                                            | 1.3  | 1.5     | -   | $k\Omega$ |
| $Z_{o(IF)}$                                                      | IF output impedance                  | IF_AMP_OUT pin                                                                                                                                           | -    | 0.3     | -   | $k\Omega$ |
| $Z_{i(lim)}$                                                     | limiter input impedance              | LIMITER_IN pin                                                                                                                                           | 1.3  | 1.5     | -   | $k\Omega$ |
| $Z_{o(lim)}$                                                     | limiter output impedance             | LIMITER_OUT pin                                                                                                                                          | -    | 0.3     | -   | $k\Omega$ |
| $V_{o(RMS)}$                                                     | RMS output voltage                   | LIMITER_OUT pin                                                                                                                                          | -    | 130     | -   | mV        |

**Table 6. Dynamic characteristics ...continued**

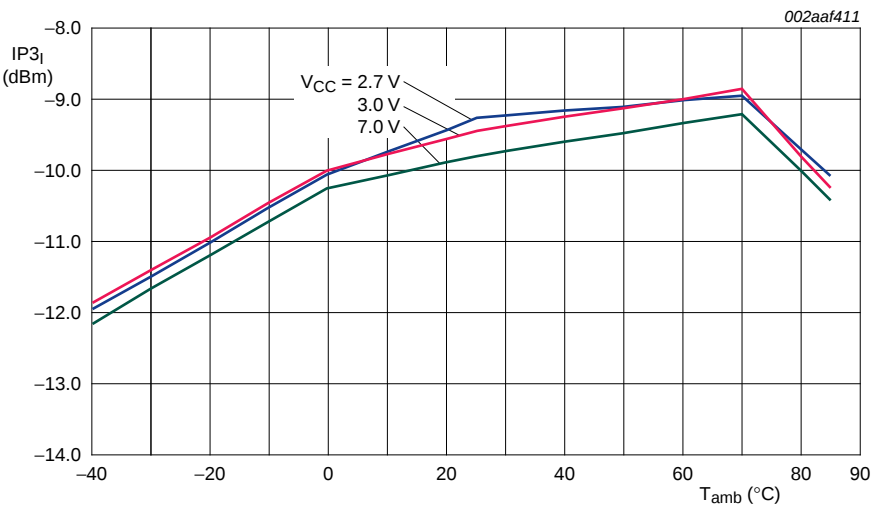
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 3\text{ V}$ ; unless specified otherwise. RF frequency = 45 MHz + 14.5 dBV RF input step-up. IF frequency = 455 kHz;  $R_{17} = 2.4\text{ k}\Omega$  and  $R_{18} = 3.3\text{ k}\Omega$ . RF level = -45 dBm; FM modulation = 1 kHz with  $\pm 8\text{ kHz}$  peak deviation. Audio output with de-emphasis filter and C-message weighted filter. Test circuit [Figure 21](#). 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>RF/IF section (internal LO)</b> |                                      |                                                       |     |     |     |      |
| $V_{o(aud)RMS}$                    | RMS audio output voltage             | $V_{CC} = 3\text{ V}$ ; RF level = -27 dBm            | -   | 120 | -   | mV   |
| $V_{o(RSSI)}$                      | RSSI output voltage                  | system; $V_{CC} = 3\text{ V}$ ;<br>RF level = -27 dBm | -   | 2.2 | -   | V    |
| SINAD                              | signal-to-noise-and-distortion ratio | system; RF level = -117 dBm                           | -   | 12  | -   | dB   |

## 12. Performance curves



**Fig 4. Supply current versus ambient temperature**



**Fig 5. Third order intercept point versus ambient temperature and supply voltage**

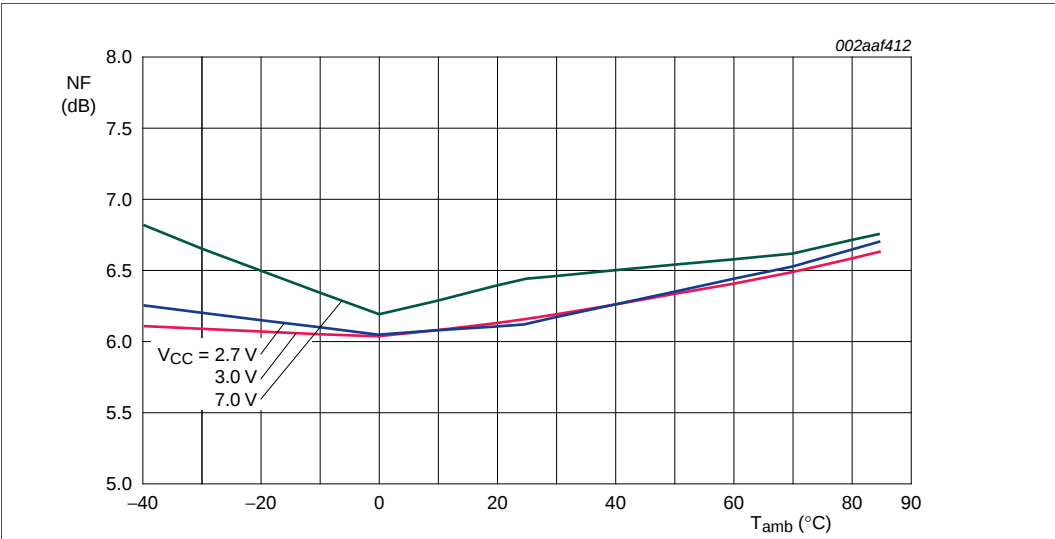


Fig 6. Mixer noise figure versus ambient temperature and supply voltage

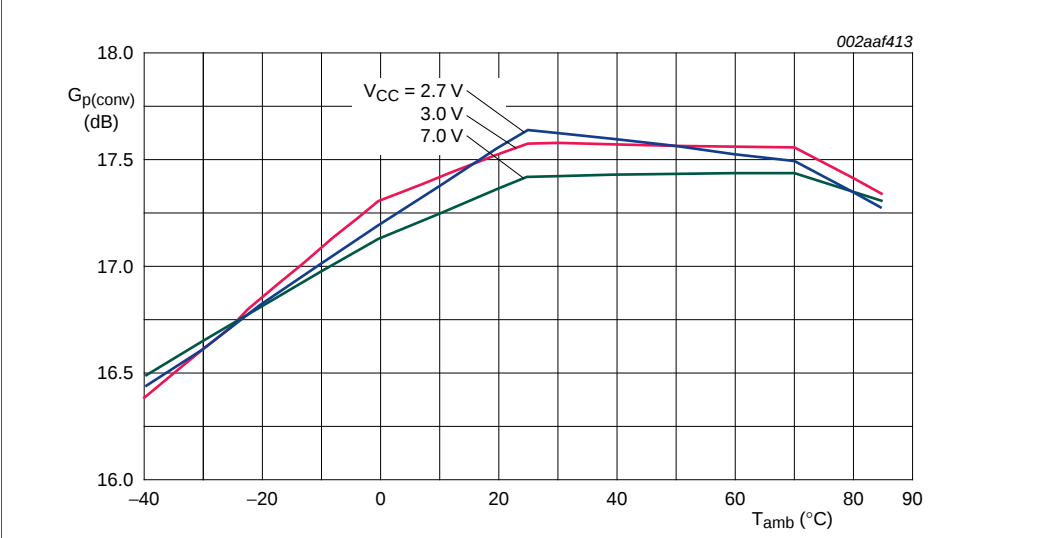
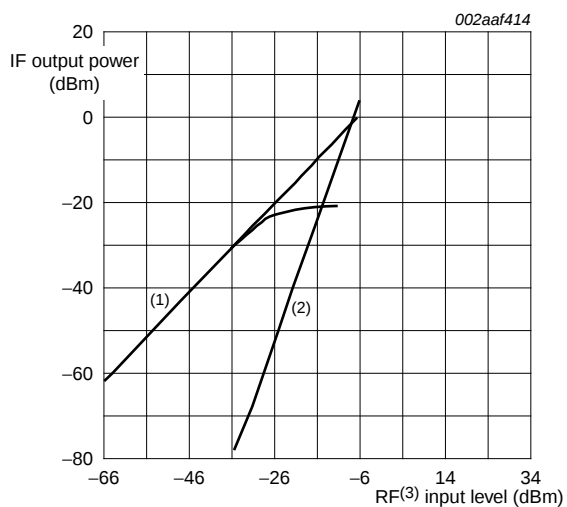


Fig 7. Conversion gain versus ambient temperature and supply voltage



RF = 45 MHz; IF = 455 kHz.

- (1) Fund product.
- (2) Third order product.
- (3) 50  $\Omega$  input.

**Fig 8. Mixer third order intercept and compression**

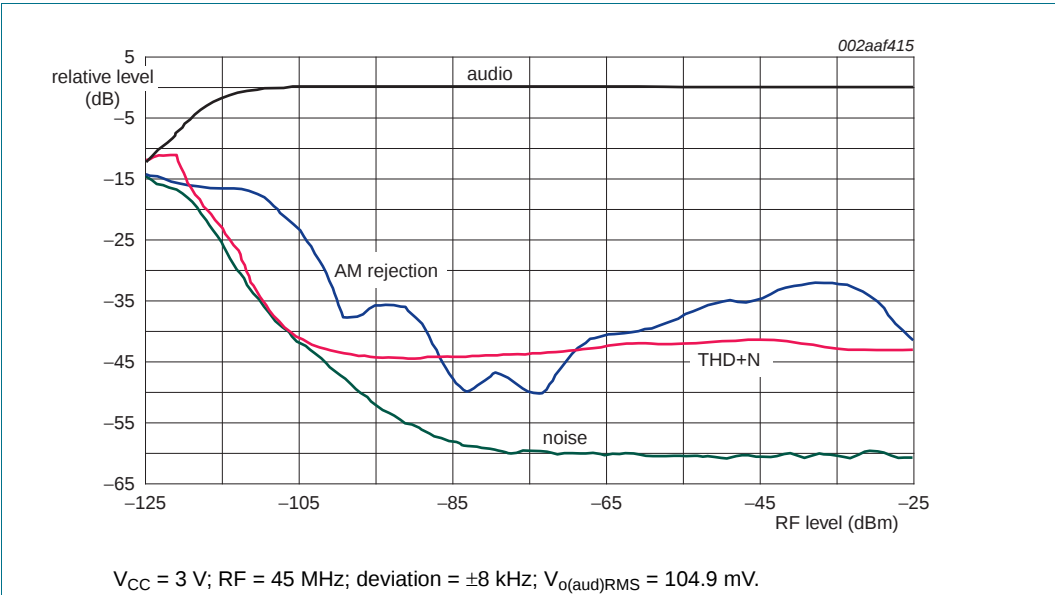


Fig 9. Relative level of audio, AM rejection, THD+N and noise versus RF level ( $T_{amb} = -40\text{ }^{\circ}\text{C}$ )

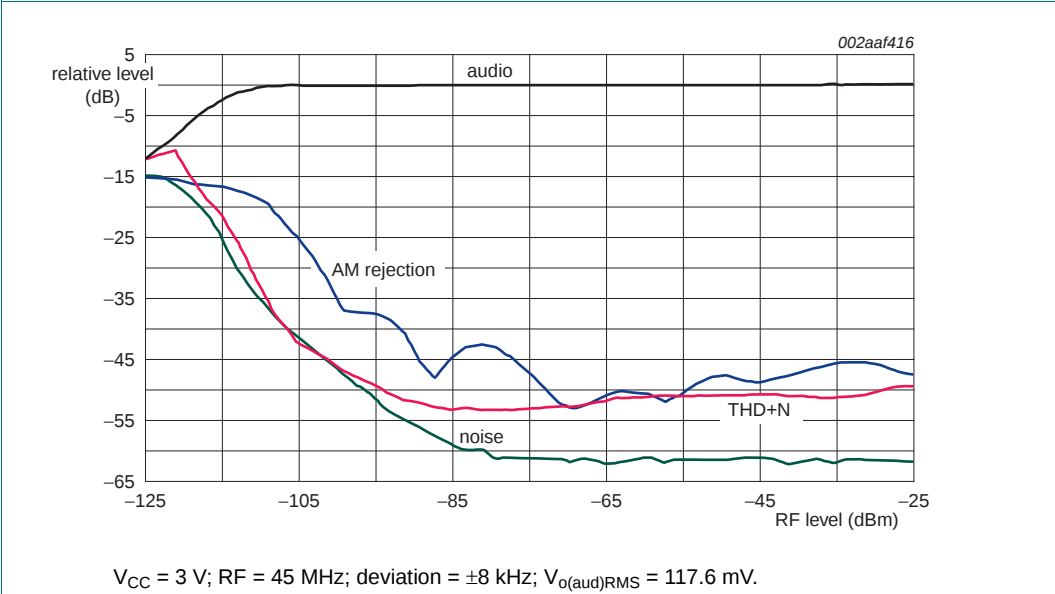
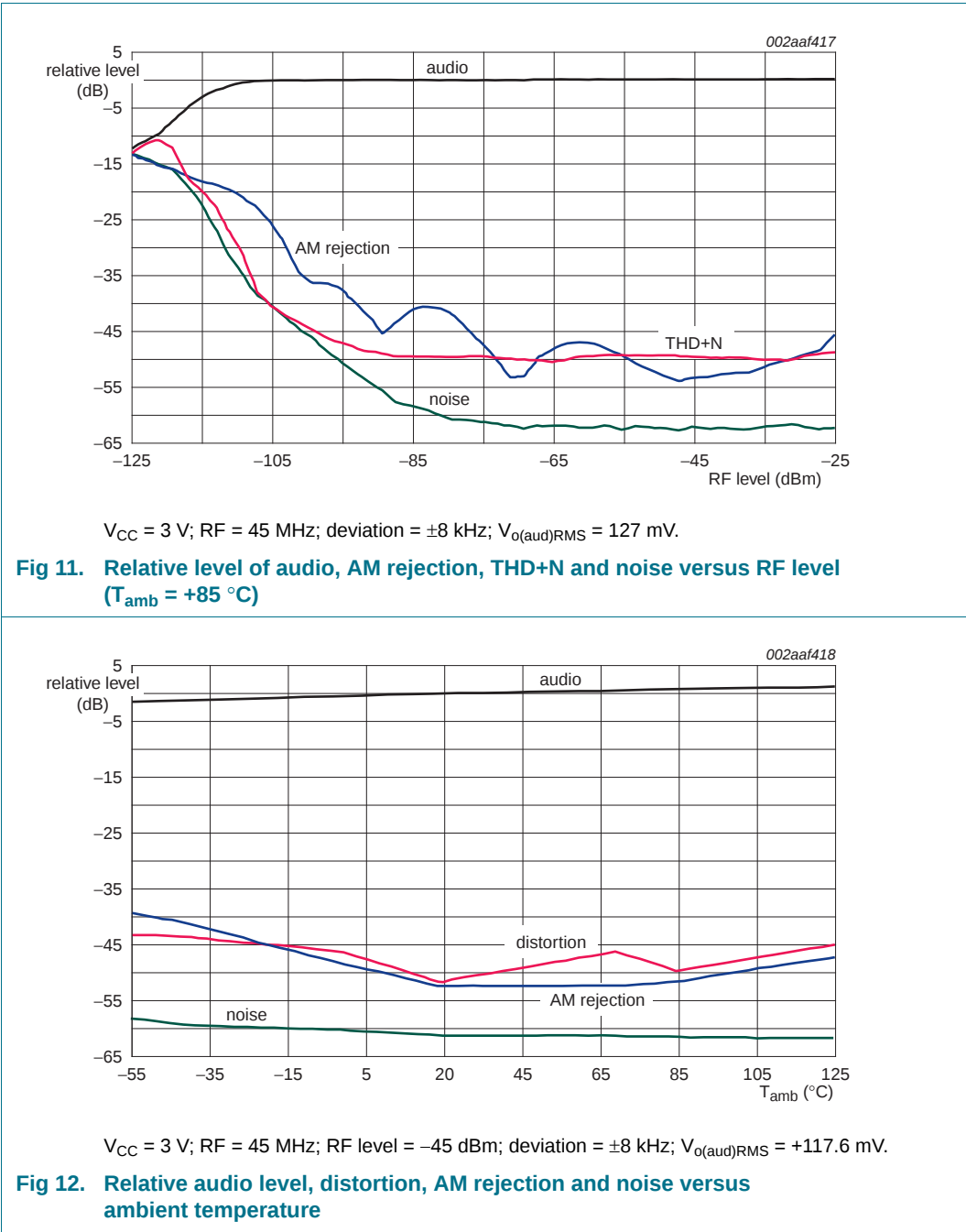


Fig 10. Relative level of audio, AM rejection, THD+N and noise versus RF level ( $T_{amb} = +25\text{ }^{\circ}\text{C}$ )



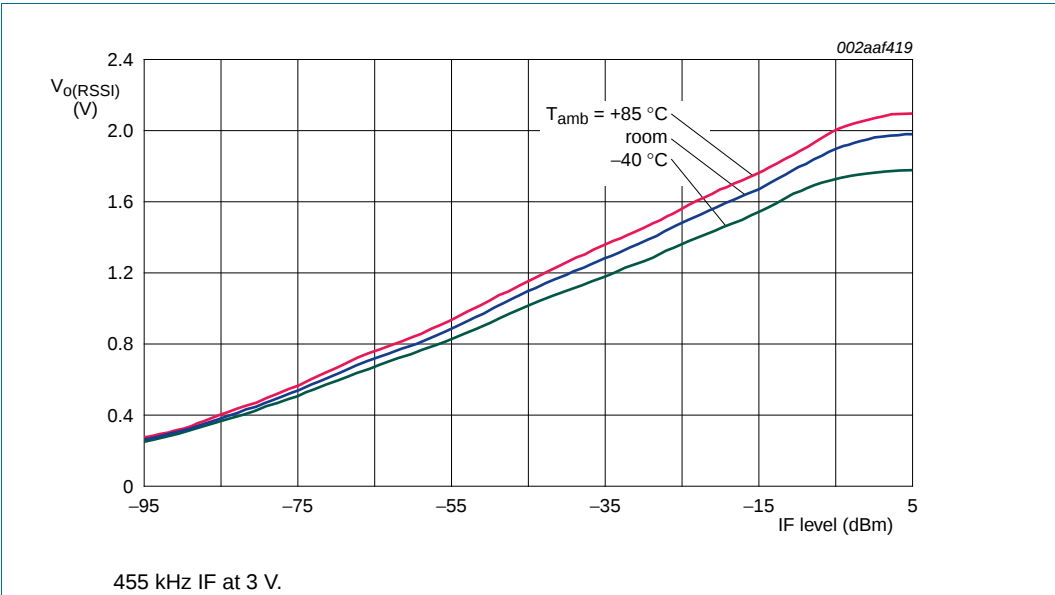


Fig 13. RSSI output voltage versus IF level

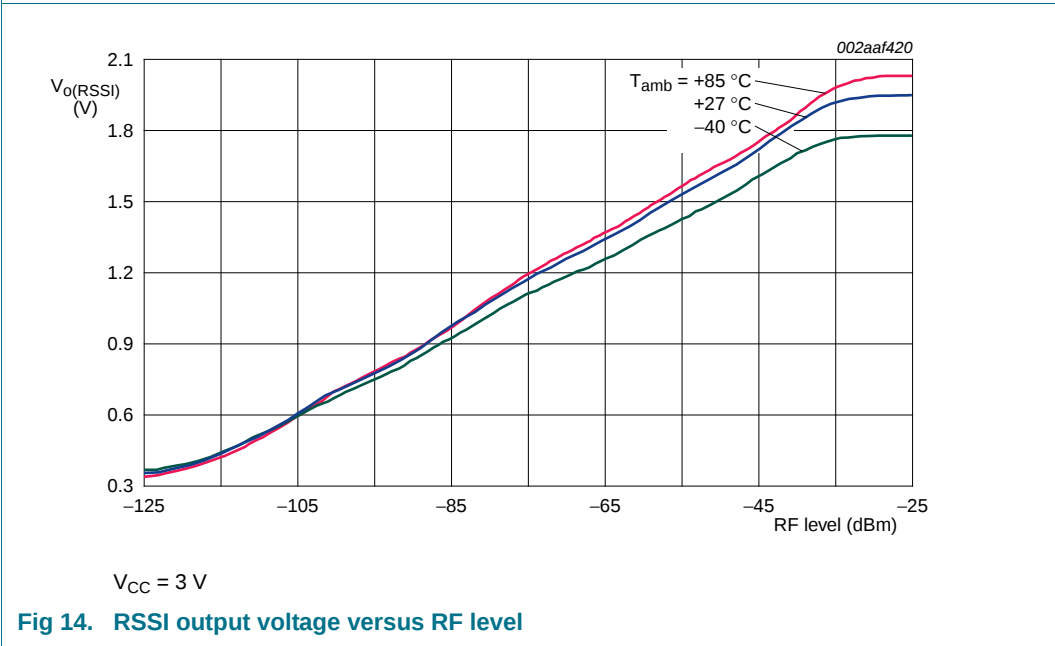


Fig 14. RSSI output voltage versus RF level

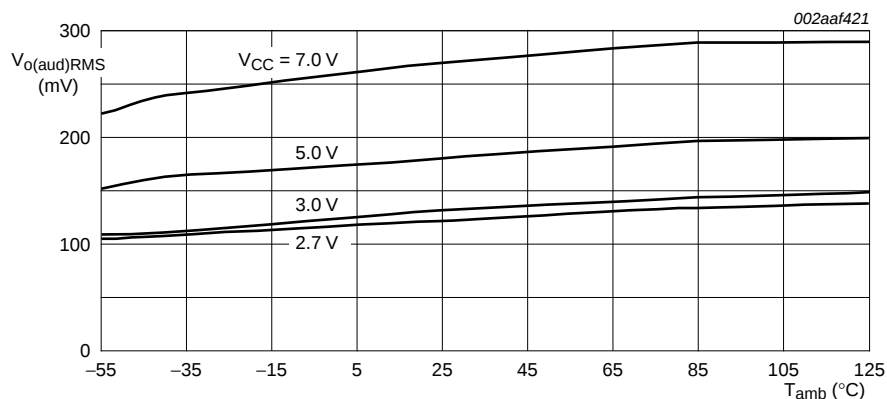
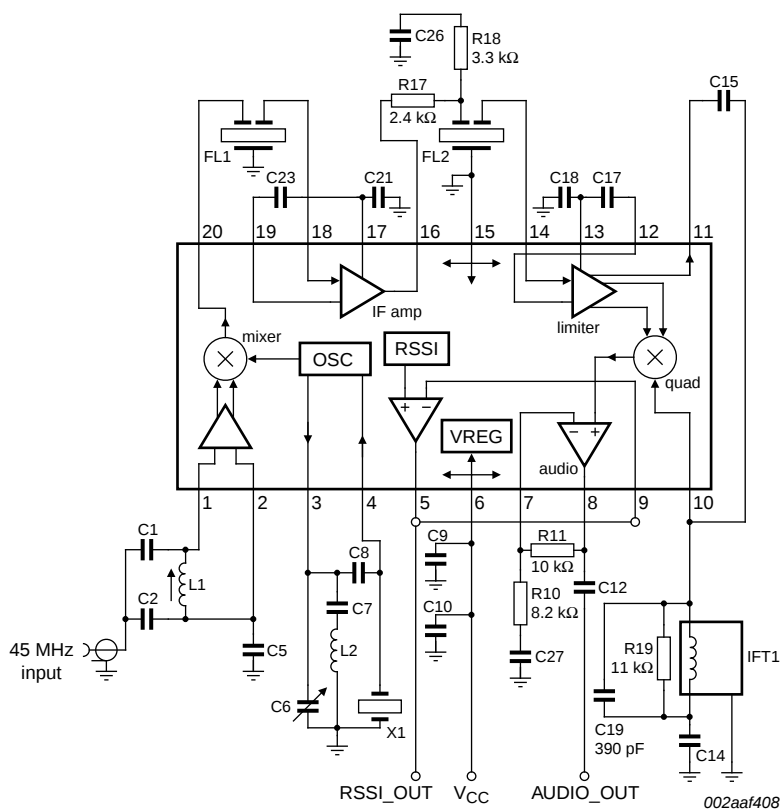


Fig 15. RMS audio output voltage versus ambient temperature

### 13. Application information



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 10  $\mu$ F to 15  $\mu$ F or higher value tantalum capacitor on the supply line is essential. A low frequency ESR screening test on this capacitor will ensure consistent good sensitivity in production. A 0.1  $\mu$ F bypass capacitor on the supply pin, and grounded near the 44.545 MHz oscillator improves sensitivity by 2 dB to 3 dB.

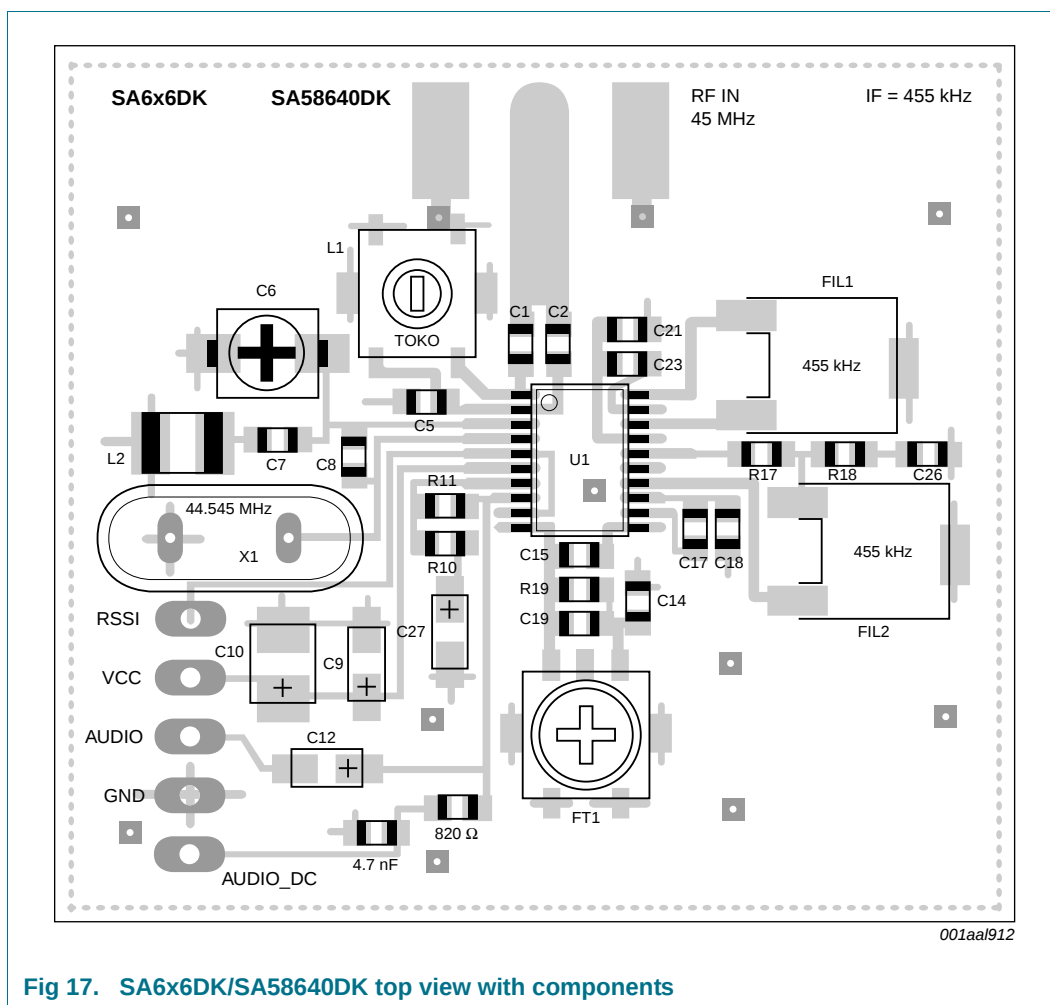
Fig 16. SA616 45 MHz application circuit (SA616DK demo board)

Table 7. SA616DK demo board component list

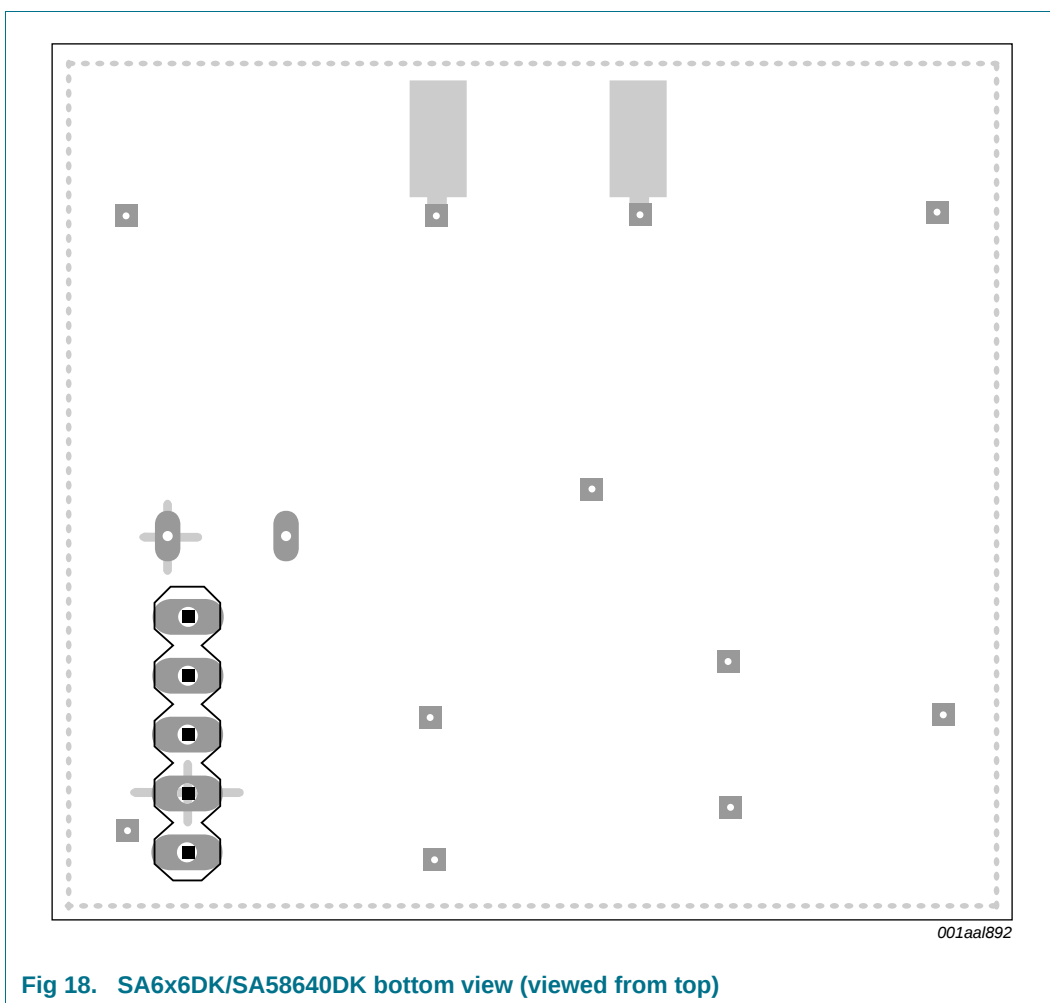
| Component                            | Description                                      |
|--------------------------------------|--------------------------------------------------|
| C1                                   | 51 pF NPO ceramic                                |
| C2                                   | 220 pF NPO ceramic                               |
| C5, C9, C14, C17, C18, C21, C23, C26 | 100 nF $\pm$ 10 % monolithic ceramic             |
| C6                                   | 30 pF trim cap                                   |
| C7                                   | 1 nF ceramic                                     |
| C8, C15                              | 10.0 pF NPO ceramic                              |
| C10                                  | 15 $\mu$ F tantalum (minimum)                    |
| C12                                  | 2.2 $\mu$ F $\pm$ 10 % tantalum                  |
| C19                                  | 390 pF $\pm$ 10 % monolithic ceramic             |
| C27                                  | 2.2 $\mu$ F tantalum                             |
| FL1, FL2 <sup>[1]</sup>              | ceramic filter Murata SFG455A3 or equivalent     |
| IFT1                                 | 330 $\mu$ H Toko 836AN-0129Z                     |
| L1                                   | 0.33 $\mu$ H Toko A638AN-0158Z                   |
| L2                                   | 1.2 $\mu$ H Toko FSLM2520-1R2K                   |
| X1                                   | 44.545 MHz crystal ICM4712701                    |
| R5 <sup>[2]</sup>                    | not used in application board                    |
| R10                                  | 8.2 k $\Omega$ $\pm$ 5 % 1/4W carbon composition |
| R11                                  | 10 k $\Omega$ $\pm$ 5 % 1/4W carbon composition  |
| R17                                  | 2.4 k $\Omega$ $\pm$ 5 % 1/4W carbon composition |
| R18                                  | 3.3 k $\Omega$ $\pm$ 5 % 1/4W carbon composition |
| R19                                  | 11 k $\Omega$ $\pm$ 5 % 1/4W carbon composition  |

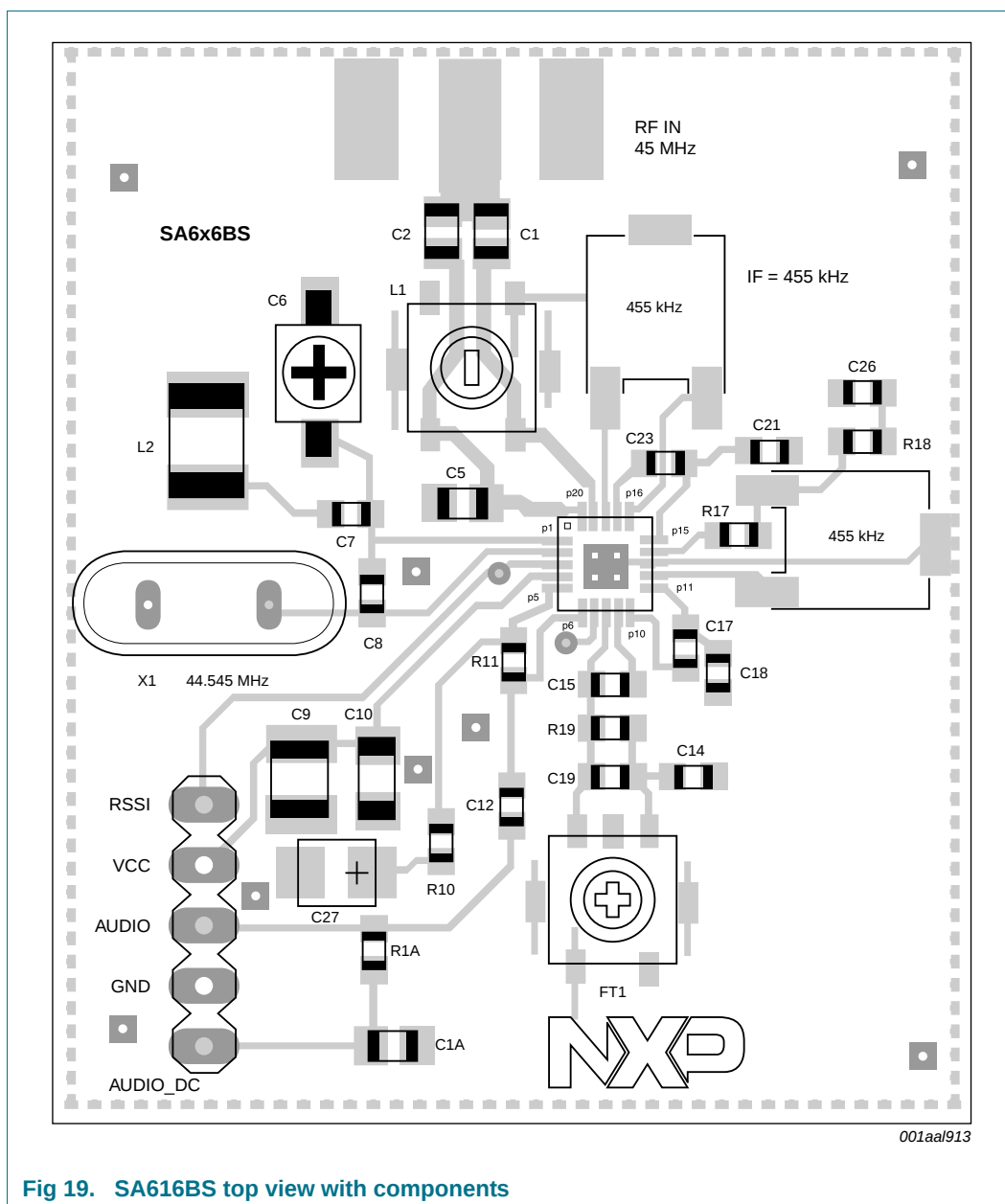
[1] The ceramic filters can be 30 kHz SFG455A3s made by Murata that have 30 kHz IF bandwidth (they come in blue), or 16 kHz CFU455Ds, also made by Murata (they come in black). All of our specifications and testing are done with the more wide-band filter.

[2] R5 can be used to bias the oscillator transistor at a higher current for operation above 45 MHz. Recommended value is 22 k $\Omega$ , but should not be below 10 k $\Omega$ .

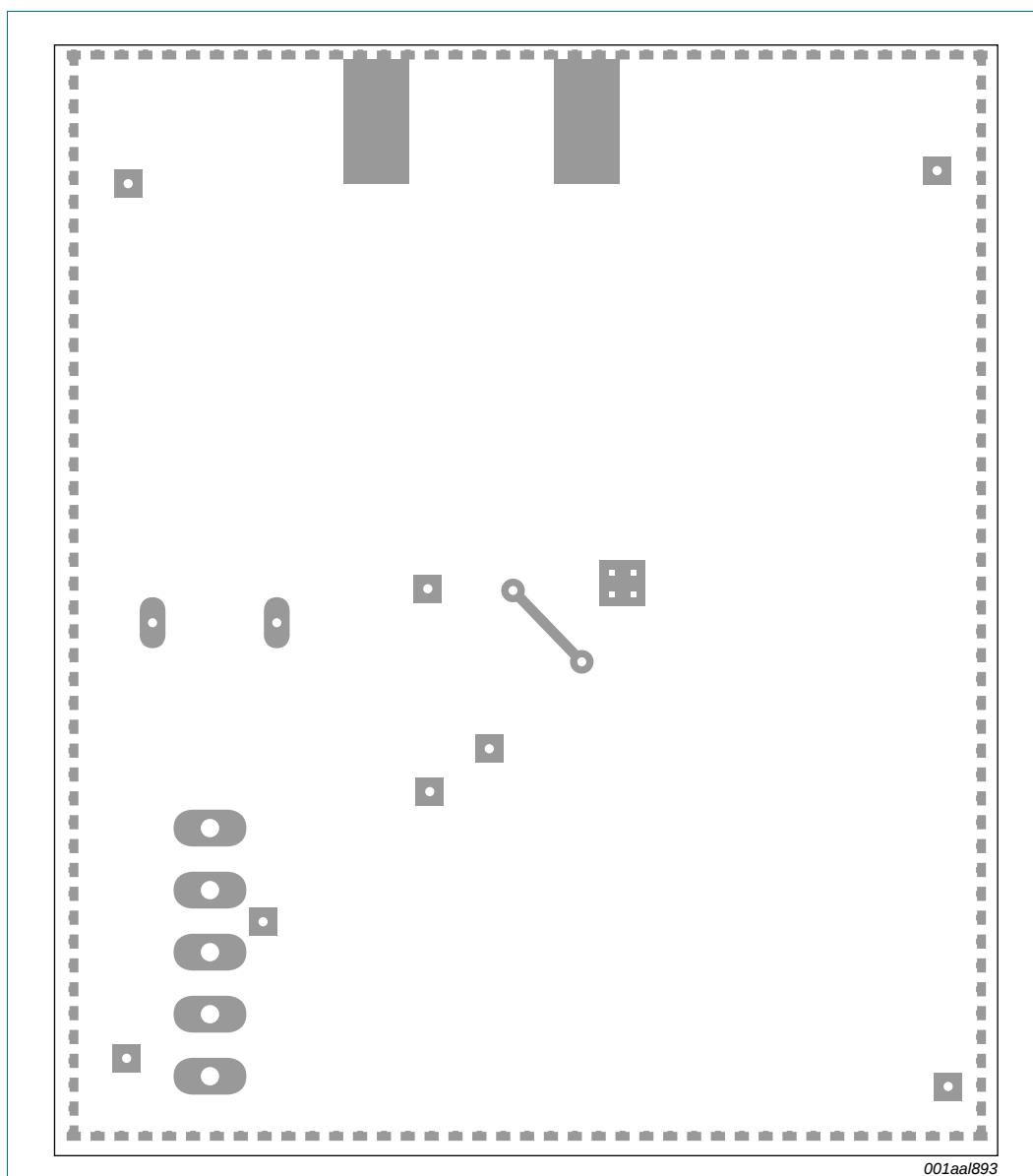


**Fig 17. SA6x6DK/SA58640DK top view with components**





**Fig 19. SA616BS top view with components**



**Fig 20. SA616BS bottom view (viewed from top)**

14. Test information

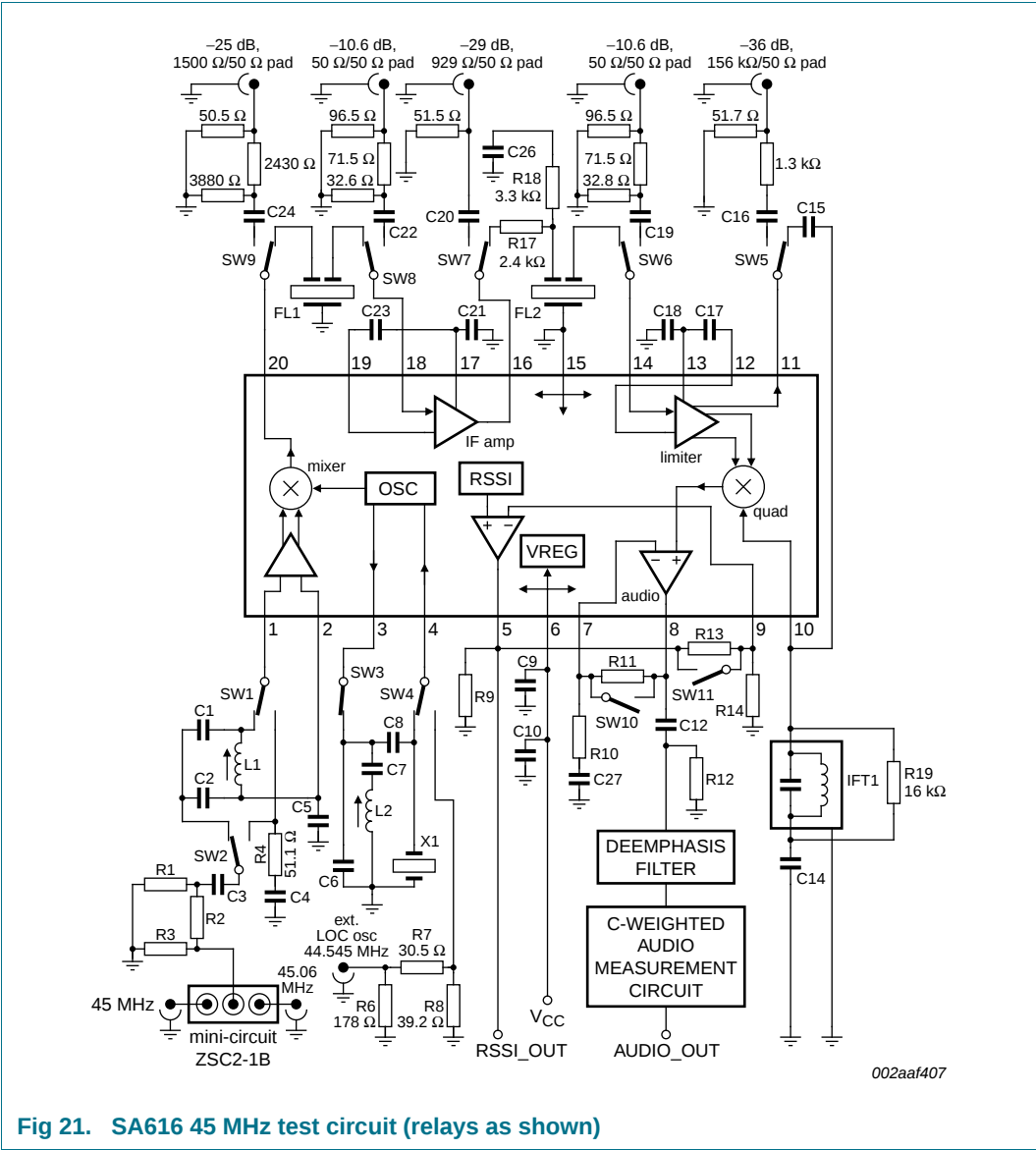
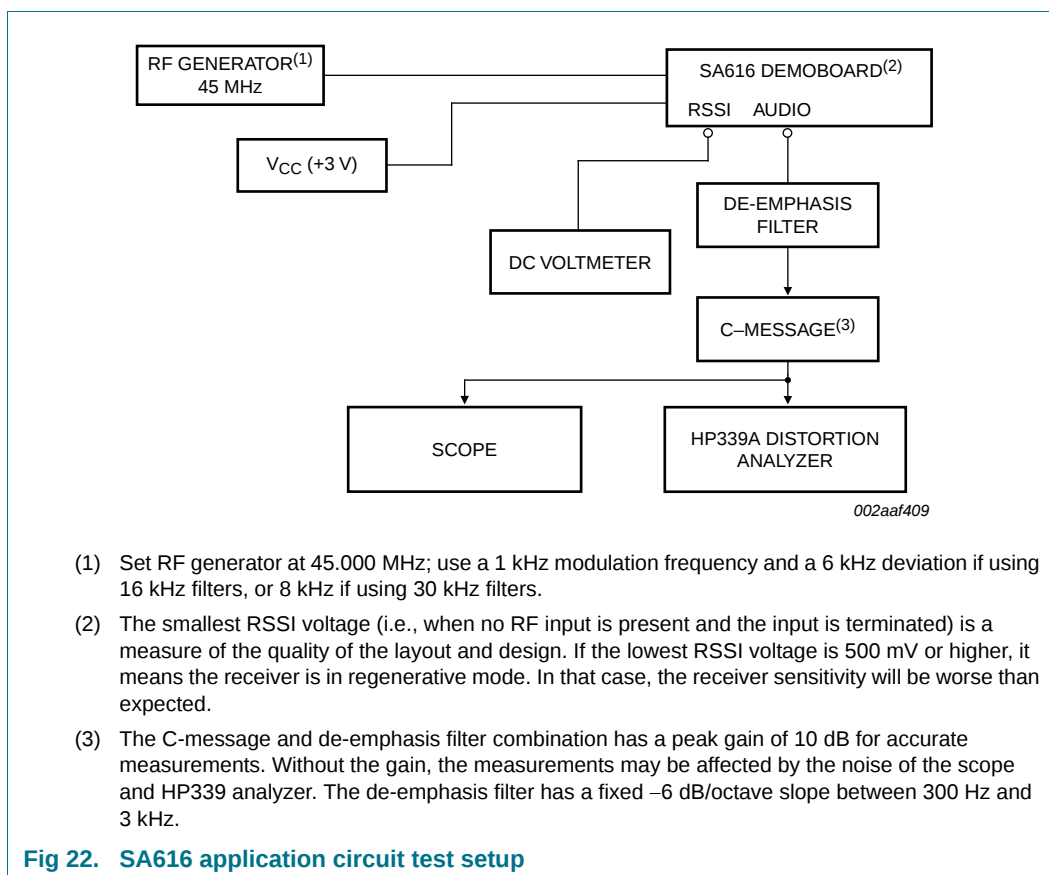


Table 8. Automatic test circuit component list

| Component                                      | Description                                       |
|------------------------------------------------|---------------------------------------------------|
| C1                                             | 100 pF NPO ceramic                                |
| C2                                             | 390 pF NPO ceramic                                |
| C5, C9, C14, C17, C18, C21, C23, C25, C26, C27 | 100 nF $\pm$ 10 % monolithic ceramic              |
| C6                                             | 22 pF NPO ceramic                                 |
| C7                                             | 1 nF ceramic                                      |
| C8, C15                                        | 10 pF NPO ceramic                                 |
| C10                                            | 15 $\mu$ F tantalum (minimum)                     |
| C12                                            | 2.2 $\mu$ F                                       |
| FL1, FL2                                       | ceramic filter, Murata SFG455A3 or equivalent     |
| IFT1                                           | 455 kHz (Ce = 180 pF) Toko RMC-2A6597H            |
| L1                                             | 147 nH to 160 nH Coilcraft UNI-10/142-04J08S      |
| L2                                             | 0.8 $\mu$ H nominal; Toko 292CNS-T1038Z           |
| R9                                             | 2 k $\Omega$ $\pm$ 1 % 1/4 W metal film           |
| R10                                            | 8.2 k $\Omega$ $\pm$ 1 %                          |
| R11, R14                                       | 10 k $\Omega$ $\pm$ 1 %                           |
| R12                                            | 2 k $\Omega$ $\pm$ 1 %                            |
| R13                                            | 20 k $\Omega$ $\pm$ 1 %                           |
| R17                                            | 2.4 k $\Omega$ $\pm$ 5 % 1/4 W carbon composition |
| R18                                            | 3.3 k $\Omega$                                    |
| R19                                            | 16 k $\Omega$                                     |
| X1                                             | 44.545 MHz crystal ICM4712701                     |



15. Package outline

SSOP20: plastic shrink small outline package; 20 leads; body width 4.4 mm SOT266-1

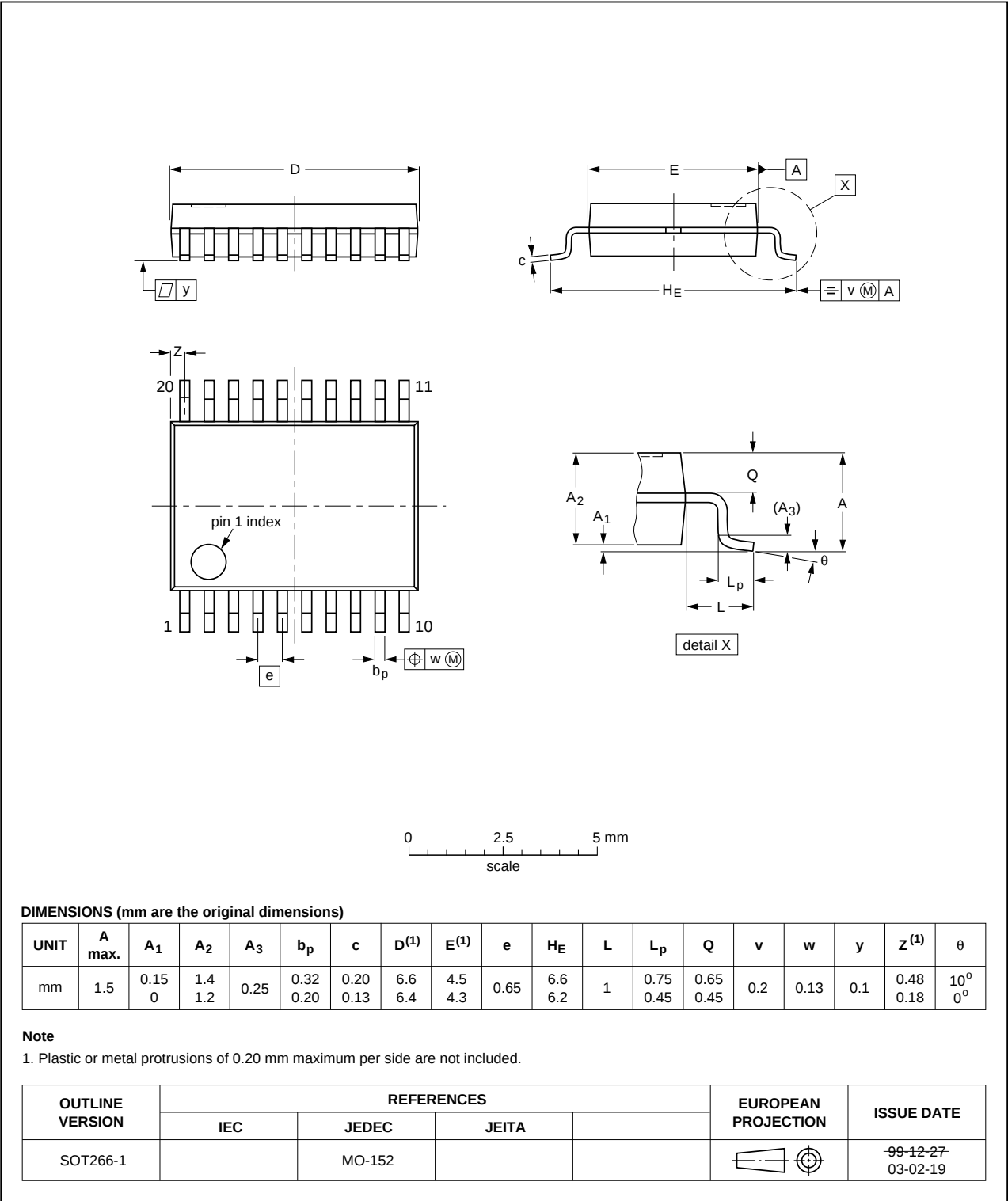


Fig 23. Package outline SOT266-1 (SSOP20)

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

SOT917-1

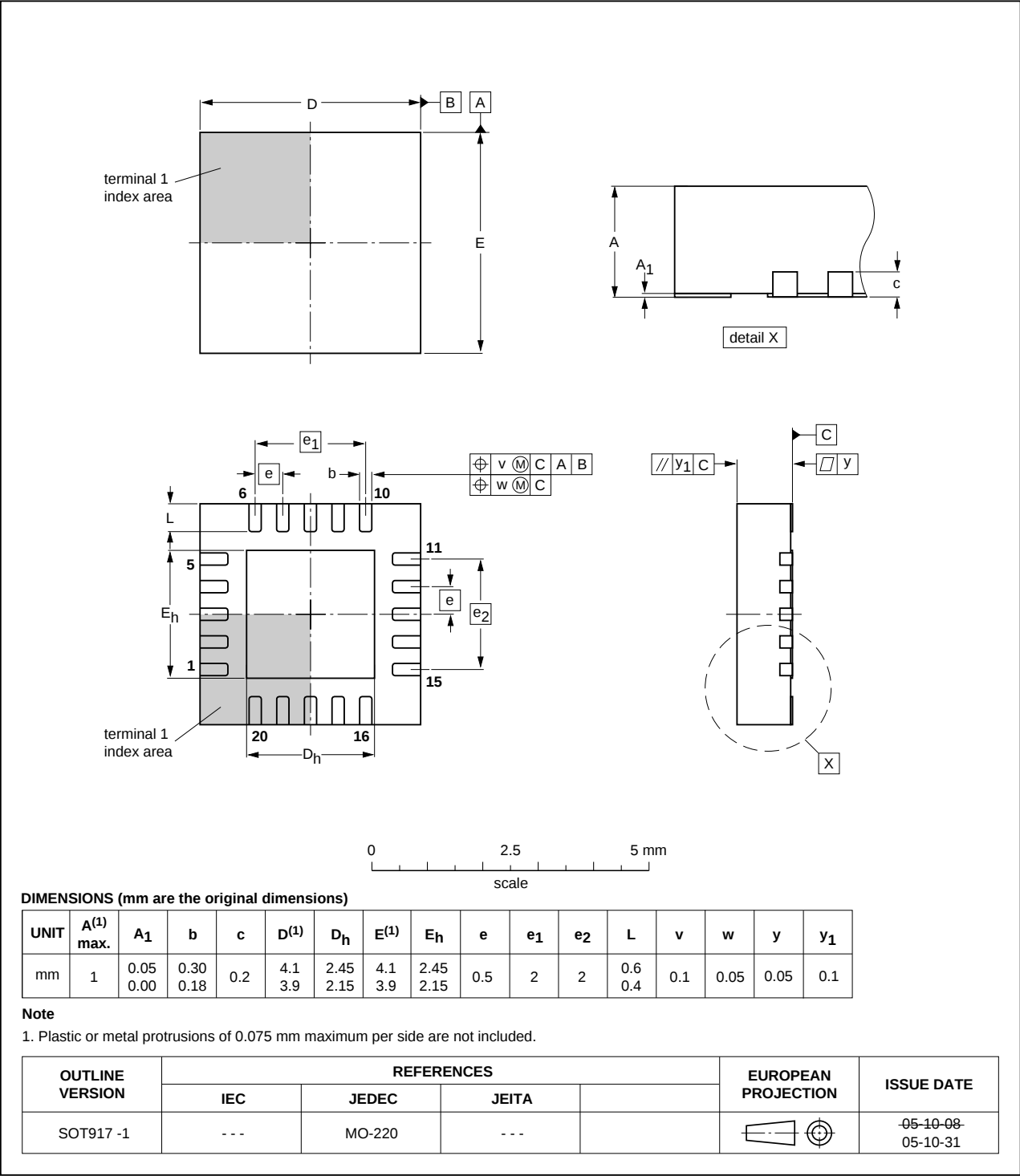


Fig 24. Package outline SOT917-1 (HVQFN20)

## 16. 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”.

### 16.1 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.

### 16.2 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
- Leadless 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, leadless 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. Leadless 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

### 16.3 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

## 16.4 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 25](#)) 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 9](#) and [10](#)

**Table 9. SnPb eutectic process (from J-STD-020C)**

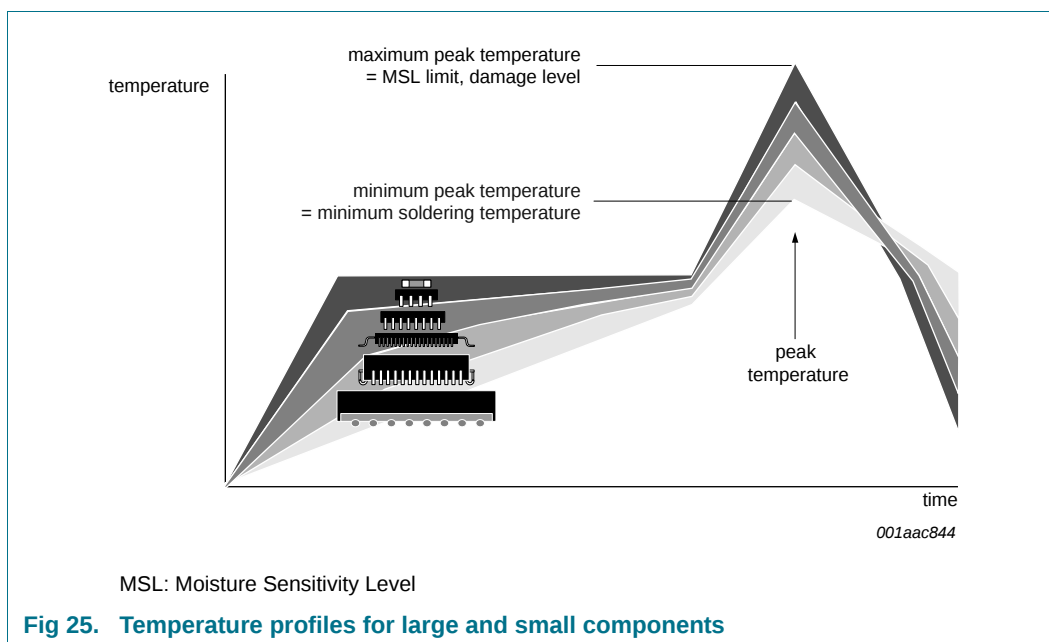
| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                 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

**Table 10. Lead-free process (from J-STD-020C)**

| 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 25](#).



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

## 17. Abbreviations

**Table 11. Abbreviations**

| Acronym | Description                          |
|---------|--------------------------------------|
| AM      | Amplitude Modulation                 |
| AMP     | Active Monitor Present               |
| ASK     | Amplitude Shift Keying               |
| ESD     | ElectroStatic Discharge              |
| ESR     | Equivalent Series Resistance         |
| FM      | Frequency Modulation                 |
| FSK     | Frequency Shift Keying               |
| IF      | Intermediate Frequency               |
| LC      | inductor/capacitor filter            |
| LO      | Local Oscillator                     |
| PCB     | Printed-Circuit Board                |
| RF      | Radio Frequency                      |
| RMS     | Root Mean Squared                    |
| RSSI    | Received Signal Strength Indicator   |
| SINAD   | Signal-to-Noise And Distortion ratio |
| TAC     | Telenet Access Controller            |
| VHF     | Very High Frequency                  |

## 18. Revision history

**Table 12. Revision history**

| Document ID    | Release date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Data sheet status     | Change notice                        | Supersedes |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------------------|------------|
| SA616 v.3      | 20100621                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Product data sheet    | -                                    | SA616_2    |
| Modifications: | <ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li>Added HVQFN20 package.</li> <li>Symbol and Parameter definitions are updated to new NXP presentation standards.</li> <li>Moved <math>Z_{th(j-a)}</math> specification from <a href="#">Table 3 "Limiting values"</a> to (new) <a href="#">Table 4 "Thermal characteristics"</a></li> <li><a href="#">Table 7 "SA616DK demo board component list"</a>: <ul style="list-style-type: none"> <li>component IFT1 changed from "303LN-1130" to "836AN-01297Z"</li> <li>component L1 changed from "SCB-1320Z" to "A638AN-0158Z"</li> <li>component L2: appended "Toko FSLM2520-1R2K"</li> </ul> </li> <li>(Old) Figure 18 replaced with <a href="#">Figure 17 "SA6x6DK/SA58640DK top view with components"</a> and <a href="#">Figure 18 "SA6x6DK/SA58640DK bottom view (viewed from top)"</a>.</li> <li>Added <a href="#">Figure 19 "SA616BS top view with components"</a> and <a href="#">Figure 20 "SA616BS bottom view (viewed from top)"</a>.</li> </ul> |                       |                                      |            |
| SA616_2        | 19971107                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Product specification | ECN 853-1676 18665 dated 1997 Nov 07 | SA616_1    |
| SA616_1        | 19931215                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Product specification | ECN 853-1676 11649 dated 1993 Dec 15 | -          |

## 19. Legal information

### 19.1 Data sheet status

| 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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## 21. Contents

|           |                                            |           |
|-----------|--------------------------------------------|-----------|
| <b>1</b>  | <b>General description</b> . . . . .       | <b>1</b>  |
| <b>2</b>  | <b>Features and benefits</b> . . . . .     | <b>1</b>  |
| <b>3</b>  | <b>Applications</b> . . . . .              | <b>1</b>  |
| <b>4</b>  | <b>Ordering information</b> . . . . .      | <b>2</b>  |
| <b>5</b>  | <b>Block diagram</b> . . . . .             | <b>2</b>  |
| <b>6</b>  | <b>Pinning information</b> . . . . .       | <b>3</b>  |
| 6.1       | Pinning . . . . .                          | 3         |
| 6.2       | Pin description . . . . .                  | 4         |
| <b>7</b>  | <b>Functional description</b> . . . . .    | <b>5</b>  |
| <b>8</b>  | <b>Limiting values</b> . . . . .           | <b>6</b>  |
| <b>9</b>  | <b>Thermal characteristics</b> . . . . .   | <b>6</b>  |
| <b>10</b> | <b>Static characteristics</b> . . . . .    | <b>6</b>  |
| <b>11</b> | <b>Dynamic characteristics</b> . . . . .   | <b>7</b>  |
| <b>12</b> | <b>Performance curves</b> . . . . .        | <b>8</b>  |
| <b>13</b> | <b>Application information</b> . . . . .   | <b>14</b> |
| <b>14</b> | <b>Test information</b> . . . . .          | <b>20</b> |
| <b>15</b> | <b>Package outline</b> . . . . .           | <b>23</b> |
| <b>16</b> | <b>Soldering of SMD packages</b> . . . . . | <b>25</b> |
| 16.1      | Introduction to soldering . . . . .        | 25        |
| 16.2      | Wave and reflow soldering . . . . .        | 25        |
| 16.3      | Wave soldering . . . . .                   | 25        |
| 16.4      | Reflow soldering . . . . .                 | 26        |
| <b>17</b> | <b>Abbreviations</b> . . . . .             | <b>27</b> |
| <b>18</b> | <b>Revision history</b> . . . . .          | <b>28</b> |
| <b>19</b> | <b>Legal information</b> . . . . .         | <b>29</b> |
| 19.1      | Data sheet status . . . . .                | 29        |
| 19.2      | Definitions . . . . .                      | 29        |
| 19.3      | Disclaimers . . . . .                      | 29        |
| 19.4      | Trademarks . . . . .                       | 30        |
| <b>20</b> | <b>Contact information</b> . . . . .       | <b>30</b> |
| <b>21</b> | <b>Contents</b> . . . . .                  | <b>31</b> |

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