# SA605

## High performance low power mixer FM IF system

Rev. 5 — 14 November 2014 **Product data sheet**

## 1. General description

The SA605 is a high performance monolithic low-power FM IF system incorporating a mixer/oscillator, two limiting intermediate frequency amplifiers, quadrature detector, muting, logarithmic received signal strength indicator (RSSI), and voltage regulator. The SA605 combines the functions of NXP SA602A and SA604A, but features a higher mixer input intercept point, higher IF bandwidth (25 MHz) and temperature compensated RSSI and limiters permitting higher performance application. The SA605 is available in 20-lead SO (surface-mounted miniature package) and 20-lead SSOP (shrink small outline package).

The SA605 and SA615 are functionally the same device types. The difference between the two devices lies in the guaranteed specifications. The SA615 has a higher $I_{CC}$, lower input third-order intercept point, lower conversion mixer gain, lower limiter gain, lower AM rejection, lower SINAD, higher THD, and higher RSSI error than the SA605. Both the SA605 and SA615 devices meet the EIA specifications for AMPS and TACS cellular radio applications.

## 2. Features and benefits

- Low power consumption: 5.7 mA typical at 6 V
- Mixer input to >500 MHz
- Mixer conversion power gain of 13 dB at 45 MHz
- Mixer noise figure of 4.6 dB at 45 MHz
- XTAL oscillator effective to 150 MHz (L/C oscillator to 1 GHz local oscillator can be injected)
- 102 dB of IF amplifier/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
- Two audio outputs — muted and unmuted
- Low external component count; suitable for crystal/ceramic/LC filters
- Excellent sensitivity: 0.22 $\mu$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
- SA605 meets cellular radio specifications
- ESD hardened

## 3. Applications

- Cellular radio FM IF
- High performance communications receivers
- Single conversion VHF/UHF receivers
- SCA receivers
- RF level meter
- Spectrum analyzer
- Instrumentation
- FSK and ASK data receivers
- Log amps
- Wideband low current amplification

## 4. Ordering information

**Table 1.    Ordering information**

| Type number | Topside marking | Package | | |
| --- | --- | --- | --- | --- |
| | | **Name** | **Description** | **Version** |
| SA605D/01 | SA605D | SO20 | plastic small outline package; 20 leads; body width 7.5 mm | SOT163-1 |
| SA605DK/01 | SA605DK | 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 |
| --- | --- | --- | --- | --- | --- |
| SA605D/01 | SA605D/01,112 | SO20 | Standard marking * IC's tube - DSC bulk pack | 1520 | $T_{amb}$ = −40 °C to +85 °C |
| | SA605D/01,118 | SO20 | Reel 13" Q1/T1 *Standard mark SMD | 2000 | $T_{amb}$ = −40 °C to +85 °C |
| SA605DK/01 | SA605DK/01,112 | SSOP20 | Standard marking * IC's tube - DSC bulk pack | 1350 | $T_{amb}$ = −40 °C to +85 °C |
| | SA605DK/01,118 | SSOP20 | Reel 13" Q1/T1 *Standard mark SMD | 2500 | $T_{amb}$ = −40 °C to +85 °C |

## 5. Block diagram



**Fig 1.    Block diagram**

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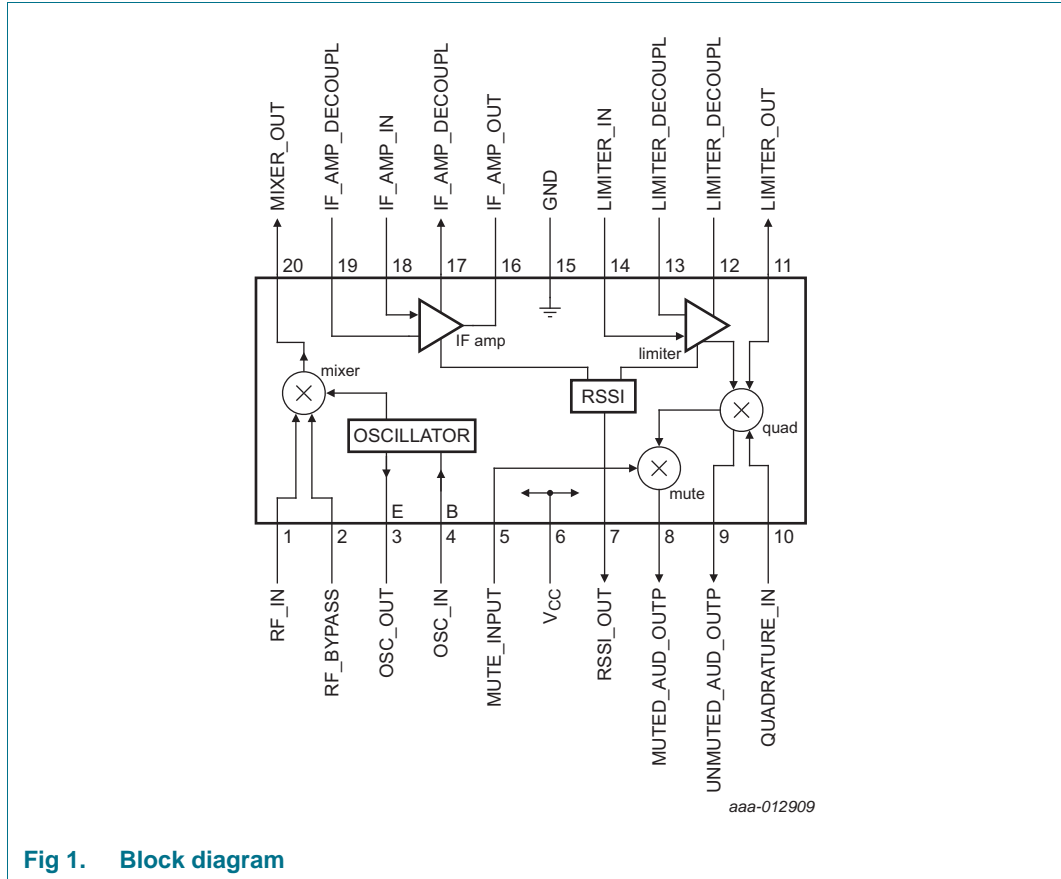
# 6. Pinning information

## 6.1 Pinning



| | |
|---|---|
| RF_IN [1] | [20] MIXER_OUT |
| RF_BYPASS [2] | [19] IF_AMP_DECOUPL |
| OSC_OUT [3] | [18] IF_AMP_IN |
| OSC_IN [4] | [17] IF_AMP_DECOUPL |
| MUTE_INPUT [5] | [16] IF_AMP_OUT |
| $V_{CC}$ [6] | [15] GND |
| RSSI_OUT [7] | [14] LIMITER_IN |
| MUTE_AUD_OUTP [8] | [13] LIMITER_DECOUPL |
| UNMUTE_AUD_OUTP [9] | [12] LIMITER_DECOUPL |
| QUADRATURE_IN [10] | [11] LIMITER_OUT |

SA605D/01

aaa-012910
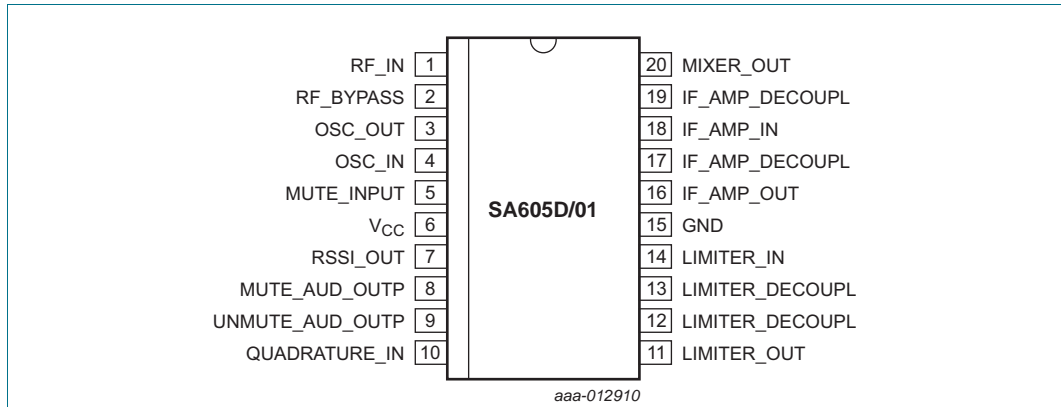
**Fig 2.   Pin configuration for SO20**



| | |
|---|---|
| RF_IN [1] | [20] MIXER_OUT |
| RF_BYPASS [2] | [19] IF_AMP_DECOUPL |
| OSC_OUT [3] | [18] IF_AMP_IN |
| OSC_IN [4] | [17] IF_AMP_DECOUPL |
| MUTE_INPUT [5] | [16] IF_AMP_OUT |
| $V_{CC}$ [6] | [15] GND |
| RSSI_OUT [7] | [14] LIMITER_IN |
| MUTE_AUD_OUTP [8] | [13] LIMITER_DECOUPL |
| UNMUTE_AUD_OUTP [9] | [12] LIMITER_DECOUPL |
| QUADRATURE_IN [10] | [11] LIMITER_OUT |

SA605DK/01

aaa-012911
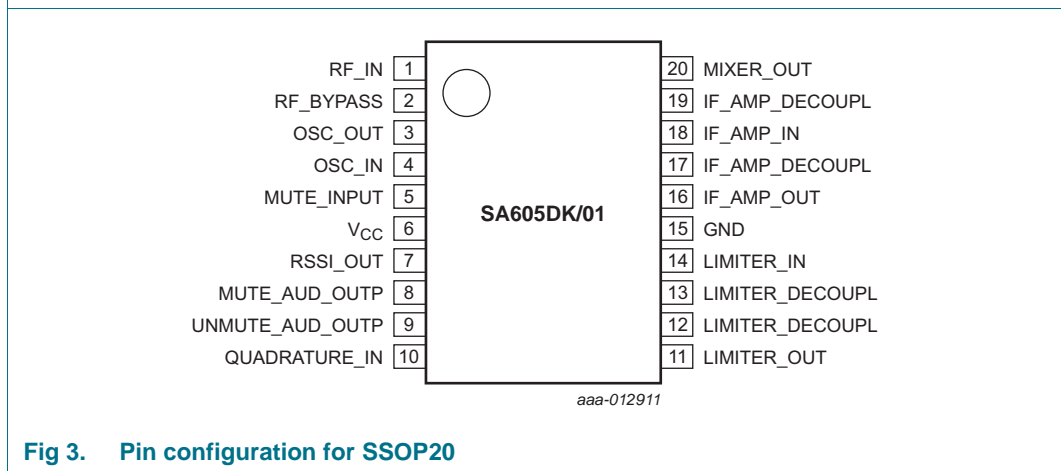
**Fig 3.   Pin configuration for SSOP20**

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### 6.2 Pin description

**Table 3.** **Pin description**

| Symbol | Pin | Description |
|---|---|---|
| RF_IN | 1 | RF input |
| RF_BYPASS | 2 | RF bypass pin |
| OSC_OUT | 3 | oscillator output |
| OSC_IN | 4 | oscillator input |
| MUTE_INPUT | 5 | mute input |
| $V_{CC}$ | 6 | positive supply voltage |
| RSSI_OUT | 7 | RSSI output |
| MUTED_AUD_OUTP | 8 | mute audio output |
| UNMUTED_AUD_OUTP | 9 | unmute audio output |
| QUADRATURE_IN | 10 | quadrature detector input terminal |
| LIMITER_OUT | 11 | limiter amplifier output |
| LIMITER_DECOUPL | 12 | limiter amplifier decoupling pin |
| LIMITER_DECOUPL | 13 | limiter amplifier decoupling pin |
| LIMITER_IN | 14 | limiter amplifier input |
| GND | 15 | ground; negative supply |
| IF_AMP_OUT | 16 | IF amplifier output |
| IF_AMP_DECOUPL | 17 | IF amplifier decoupling pin |
| IF_AMP_IN | 18 | IF amplifier input |
| IF_AMP_DECOUPL | 19 | IF amplifier decoupling pin |
| MIXER_OUT | 20 | mixer output |

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## 7. Limiting values

**Table 4.    Limiting values**
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | - | 9 | V |
| $T_{stg}$ | storage temperature | | −65 | +150 | °C |
| $T_{amb}$ | ambient temperature | operating | −40 | +85 | °C |

## 8. Thermal characteristics

**Table 5.    Thermal characteristics**

| Symbol | Parameter | Conditions | Typ | Unit |
|---|---|---|---|---|
| $Z_{th(j-a)}$ | transient thermal impedance from junction to ambient | SA605D/01 (SO20) | 90 | K/W |
| | | SA605DK/01 (SSOP20) | 117 | K/W |

## 9. Static characteristics

**Table 6.    Static characteristics**
*$V_{CC}$ = +6 V; $T_{amb}$ = 25 °C; unless specified otherwise.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | 4.5 | - | 8.0 | V |
| $I_{CC}$ | supply current | | 4.55 | 5.7 | 6.55 | mA |
| $V_{th}$ | threshold voltage | mute switch-on | 1.7 | - | - | V |
| | | mute switch-off | - | - | 1.0 | V |

## 10. Dynamic characteristics

**Table 7.    Dynamic characteristics**

*$T_{amb} = 25$ °C; $V_{CC} = +6$ V; unless specified otherwise. RF frequency = 45 MHz + 14.5 dBV RF input step-up.*
*IF frequency = 455 kHz; R17 = 5.1 kΩ; RF level = −45 dBm; FM modulation = 1 kHz with ±8 kHz peak deviation.*
*Audio output with C-message weighted filter and de-emphasis capacitor. Test circuit Figure 7. 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 improves many of the listed parameters.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Mixer/oscillator section (external LO = 300 mV)** | | | | | | |
| $f_i$ | input frequency | | - | 500 | - | MHz |
| $f_{osc}$ | oscillator frequency | | - | 150 | - | MHz |
| NF | noise figure | at 45 MHz | - | 5.0 | - | dB |
| $IP3_i$ | input third-order intercept point | FL1 = 45.0 MHz; FL2 = 45.06 MHz | - | −10 | - | dBm |
| $G_{p(conv)}$ | conversion power gain | matched 14.5 dBV step-up | 10 | 13 | 15 | dB |
| | | 50 Ω source | - | −1.7 | - | dB |
| $R_{i(RF)}$ | RF input resistance | single-ended input | 3.0 | 4.7 | - | kΩ |
| $C_{i(RF)}$ | RF input capacitance | | - | 3.5 | 4.0 | pF |
| $R_{o(mix)}$ | mixer output resistance | MIXER_OUT pin | 1.25 | 1.5 | - | kΩ |
| **IF section** | | | | | | |
| $G_{amp(IF)}$ | IF amplifier gain | 50 Ω source | - | 39.7 | - | dB |
| $G_{lim}$ | limiter gain | 50 Ω source | - | 62.5 | - | dB |
| $P_{i(IF)}$ | IF input power | for −3 dB input limiting sensitivity; R17 = 5.1 kΩ; test at IF_AMP_IN pin | - | −113 | - | dBm |
| $\alpha_{AM}$ | AM rejection | 80 % AM 1 kHz | 29 | 34 | 43 | dB |
| | audio level | RMS value; R10 = 100 kΩ; 15 nF de-emphasis | 80 | 150 | 260 | mV |
| | unmuted audio level | R11 = 100 kΩ; 150 pF de-emphasis | - | 480 | - | mV |
| SINAD | signal-to-noise-and-distortion ratio | RF level −118 dB | - | 16 | - | dB |
| THD | total harmonic distortion | | −34 | −42 | - | dB |
| S/N | signal-to-noise ratio | no modulation for noise | - | 73 | - | dB |
| $V_{o(RSSI)}$ | RSSI output voltage | IF; R9 = 100 kΩ [1] | | | | |
| | | IF level = −118 dBm | 0 | 160 | 650 | mV |
| | | IF level = −68 dBm | 1.9 | 2.5 | 3.1 | V |
| | | IF level = −18 dBm | 4.0 | 4.8 | 5.6 | V |
| $\alpha_{RSSI(range)}$ | RSSI range | R9 = 100 kΩ; IF_AMP_OUT pin | - | 90 | - | dB |
| $\Delta\alpha_{RSSI}$ | RSSI variation | R9 = 100 kΩ; IF_AMP_OUT pin | - | ±1.5 | - | dB |
| $Z_{i(IF)}$ | IF input impedance | | 1.40 | 1.6 | - | kΩ |
| $Z_{o(IF)}$ | IF output impedance | | 0.85 | 1.0 | - | kΩ |
| $Z_{i(lim)}$ | limiter input impedance | | 1.40 | 1.6 | - | kΩ |
| $R_o$ | output resistance | unmuted audio | - | 58 | - | kΩ |
| | | muted audio | - | 58 | - | kΩ |

**Table 7.**      **Dynamic characteristics** *…continued*

$T_{amb} = 25\ °C$; $V_{CC} = +6\ V$; unless specified otherwise. RF frequency = 45 MHz + 14.5 dBV RF input step-up.
IF frequency = 455 kHz; R17 = 5.1 kΩ; RF level = −45 dBm; FM modulation = 1 kHz with ±8 kHz peak deviation.
Audio output with C-message weighted filter and de-emphasis capacitor. Test circuit Figure 7. 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 improves many of the listed parameters.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **RF/IF section (internal LO)** | | | | | | |
| | unmuted audio level | RMS value; $V_{CC}$ = 4.5 V; RF level = −27 dBm | - | 450 | - | mV |
| $V_{o(RSSI)}$ | RSSI output voltage | system; $V_{CC}$ = 4.5 V; RF level = −27 dBm | - | 4.3 | - | V |

[1] The generator source impedance is 50 Ω, but the SA605 input impedance at pin 18 (IF_AMP_IN) is 1500 Ω. As a result, IF level refers to the actual signal that enters the SA605 input (pin 8, MUTED_AUD_OUTP) which is about 21 dB less than the 'available power' at the generator.
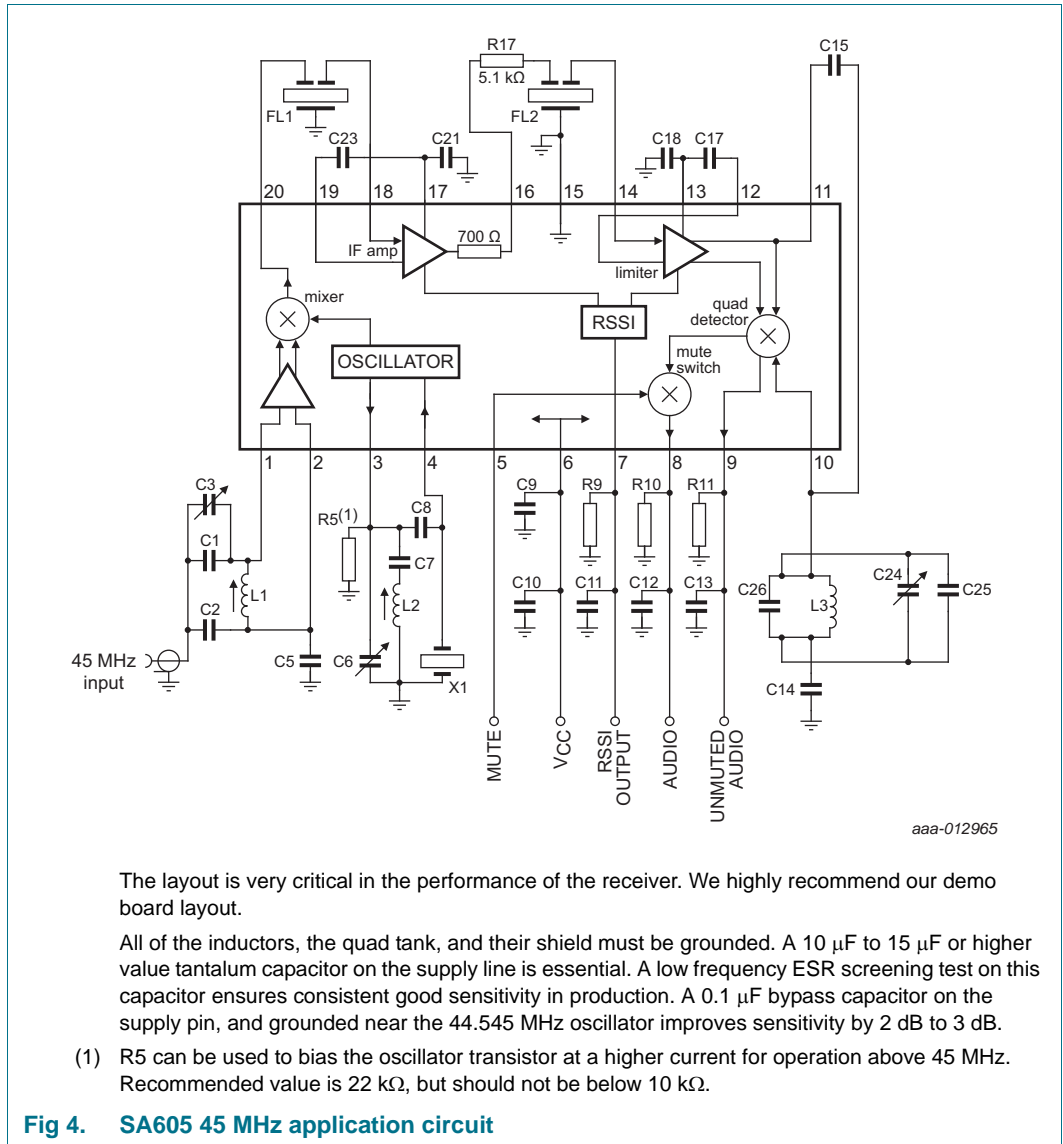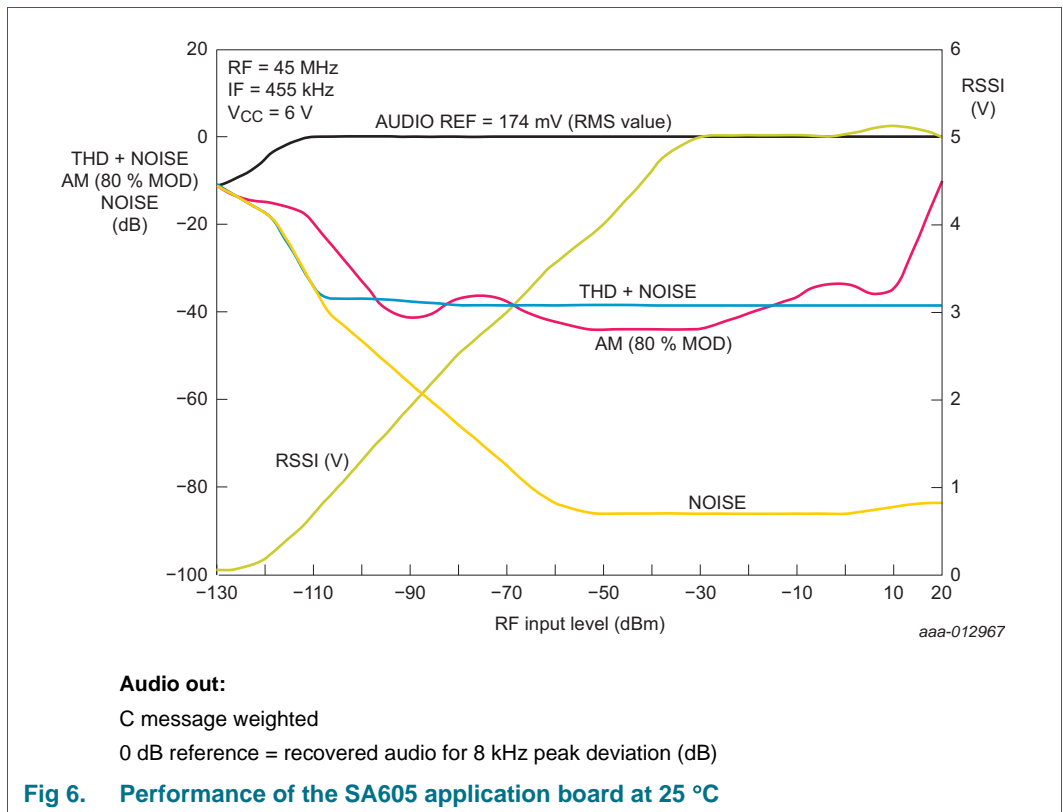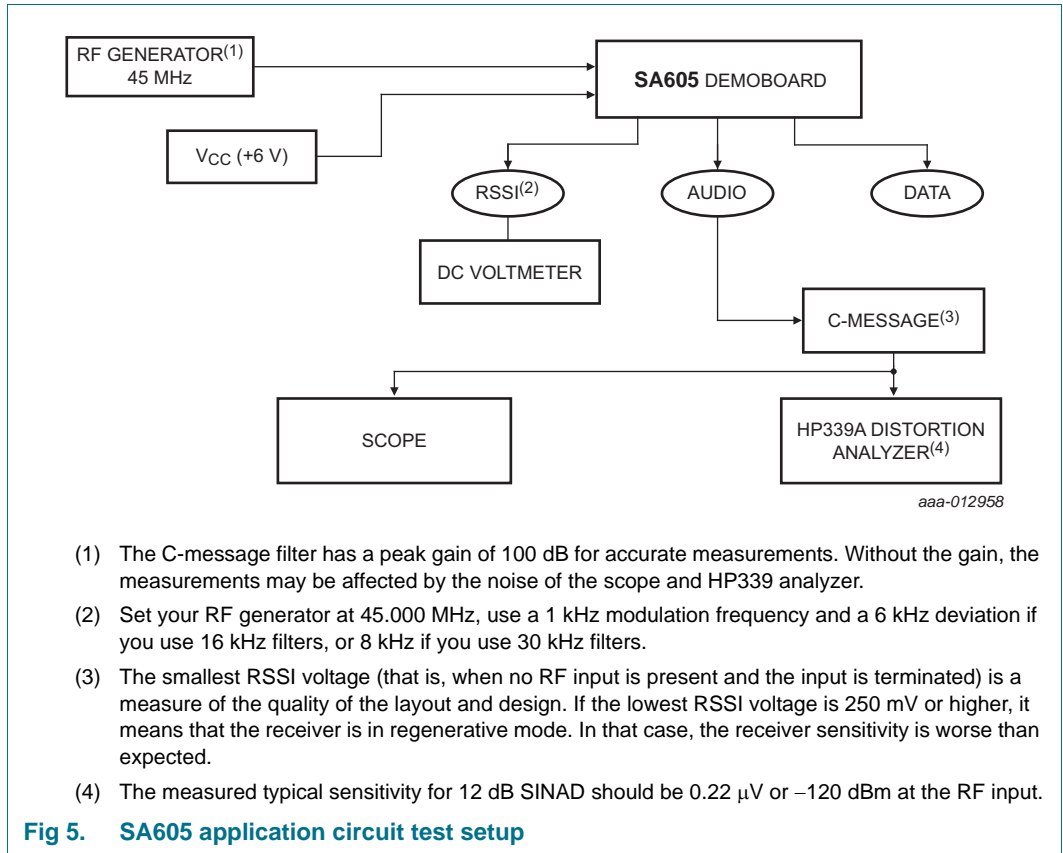
## 11. Application information



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

(1) R5 can be used to bias the oscillator transistor at a higher current for operation above 45 MHz. Recommended value is 22 kΩ, but should not be below 10 kΩ.

**Fig 4.** **SA605 45 MHz application circuit**

**Table 8.**    **SA605 application component list**

| Component | Value | Description | Package | Part number |
|---|---|---|---|---|
| C1 | 33 pF | NPO ceramic | C0805K | 445-127x-1-ND |
| C2 | 220 pF | NPO ceramic | C0805K | 445-7484-6-ND |
| C3 | 5 pF to 30 pF | NPO ceramic; Murata TZC3P300A 110R00 | TRIMCAP | 490-1994-2-ND |
| C5 | 100 nF ± 10 % | 100 nF ± 10 % monolithic ceramic | C0805K | 311-1036-1-ND |
| C6 | 5 pF to 30 pF | NPO ceramic; Murata TZC3P300A 110R00 | TRIMCAP | 490-1994-2-ND |
| C7 | 1 nF | ceramic | C0805K | 399-3293-1-ND |
| C8 | 10 pF | NPO ceramic | C0805K | 490-1994-2-ND |
| C9 | 100 nF ± 10 % | monolithic ceramic | C0805K | 311-1036-1-ND |
| C10[1] | 22 μF | tantalum | C1812 | 478-3117-1-ND |
| C11 | 100 nF ± 10 % | monolithic ceramic | C0805K | 311-1036-1-ND |
| C12 | 15 nF ± 10 % | ceramic | C0805K | 399-1161-1-ND |
| C13 | 150 pF ± 2 % | N1500 ceramic | C0805K | 399-1125-1-ND |
| C14 | 100 nF ± 10 % | monolithic ceramic | C0805K | 311-1036-1-ND |
| C15 | 10.0 pF | NPO ceramic | C0805K | 311-1036-1-ND |
| C17 | 100 nF ± 10 % | monolithic ceramic | C0805K | 311-1036-1-ND |
| C18 | 100 nF ± 10 % | monolithic ceramic | C0805K | 311-1036-1-ND |
| C21 | 100 nF ± 10 % | monolithic ceramic | C0805K | 311-1036-1-ND |
| C23 | 100 nF ± 10 % | monolithic ceramic | C0805K | 311-1036-1-ND |
| C24 | 5 pF to 30 pF trim | NPO ceramic; Murata TZC3P300A 110R00 | TRIMCAP | 490-1994-2-ND |
| C25 | 470 pF | monolithic ceramic | C0805K | |
| C26 | 39 pF | monolithic ceramic | C0805K | |
| CN1 | | 8-pin header | MA08-1 | 399-8083-10ND |
| CN2 | | BU-SMA-H | J502-ND-142-0701-881/886 | 520-142-0701-881 |
| FL1, FL2[2] | | ceramic filter; Murata CFUKF455KB4X or equivalent | surface mount | CFUKF455KB4X-R0 |
| L1 | 330 nH | Coilcraft 1008CS-331 | WE-KI_1008_B | 1008CS-331 |
| L2 | 1.2 μH | fixed inductor Coilcraft 1008CS-122XKLC | WE-KI_1008_B | 1008CS-122 |
| L3 | 220 μH | fixed inductor | WE-GF_L | 1812LS-224XJB |
| R9 | 100 kΩ ± 1 % | 1/4 W metal film | R0603 | 311-100KCRCT-ND |
| R10[3] | 100 kΩ ± 1 % | 1/4 W metal film | C0805K | 311-100KCRCT-ND |
| R11[3] | 100 kΩ ± 1 % | 1/4 W metal film | C0805K | 311-100KCRCT-ND |
| R17 | 5.1 kΩ ± 5 % | 1/4 W carbon composition | C0805K | 311-5.10KCRDKR-ND |
| U1 | | SA605DK | TSSOP20 | 568-2087-5-nd |
| X1 | 44.545 MHz | resonant 3rd-overtone crystal | UM-1 | 49HC/11453 |

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

[2]   The ceramic filters can be 30 kHz SFG455A3s made by Murata, which 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 wideband filter.

[3]   Optional.

(1) The C-message filter has a peak gain of 100 dB for accurate measurements. Without the gain, the measurements may be affected by the noise of the scope and HP339 analyzer.

(2) Set your RF generator at 45.000 MHz, use a 1 kHz modulation frequency and a 6 kHz deviation if you use 16 kHz filters, or 8 kHz if you use 30 kHz filters.

(3) The smallest RSSI voltage (that is, when no RF input is present and the input is terminated) is a measure of the quality of the layout and design. If the lowest RSSI voltage is 250 mV or higher, it means that the receiver is in regenerative mode. In that case, the receiver sensitivity is worse than expected.

(4) The measured typical sensitivity for 12 dB SINAD should be 0.22 $\mu$V or $-120$ dBm at the RF input.

**Fig 5.    SA605 application circuit test setup**



**Audio out:**

C message weighted

0 dB reference = recovered audio for 8 kHz peak deviation (dB)

**Fig 6.    Performance of the SA605 application board at 25 °C**

## 11.1 Circuit description

The SA605 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 39.7 dB of gain from a 50 $\Omega$ source. The bandwidth of the limiter is about 28 MHz with about 62.5 dB of gain from a 50 $\Omega$ source. However, 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 5 dB, conversion gain of 13 dB, and input third-order intercept of $-10$ dBm. The oscillator operates 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 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. To achieve optimum linearity of the log signal strength indicator, there must be a 12 dBV insertion loss between the first and second IF stages. If the IF filter or inter-stage network does not cause 12 dBV insertion loss, a fixed or variable resistor can be added between the first IF output (pin 16, IF_AMP_OUT) and the inter-stage 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 frequencies greater than 455 kHz, special care must be given to layout, termination, and inter-stage loss to avoid instability.

The demodulated output of the quadrature detector is available at two pins, one continuous and one with a mute switch. Signal attenuation with the mute activated is greater than 60 dB. The mute input is very high-impedance and is compatible with CMOS or TTL levels.

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.
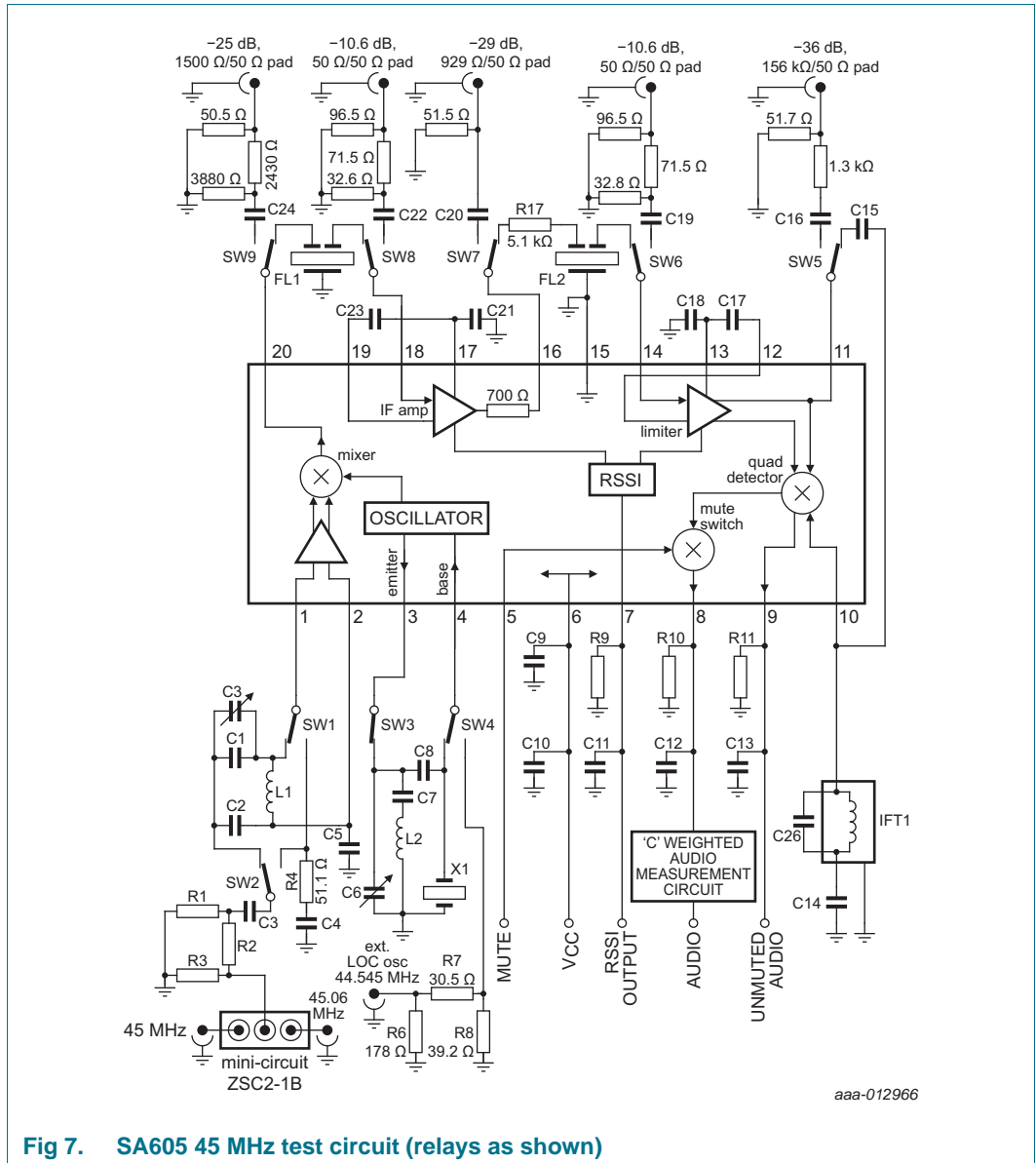
**Remark:** dBV = 20log $V_O$ / $V_I$.

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## 12. Test information



**Fig 7.    SA605 45 MHz test circuit (relays as shown)**

**Table 9.** **Automatic test circuit component list**

| Component | Description |
|---|---|
| C1 | 33 pF NPO ceramic |
| C2 | 180 pF NPO ceramic |
| C3, C6 | 5 pF to 30 pF variable capacitor; Murata TZC3P300A 110R00 |
| C5, C9, C11, C14, C17, C18, C21, C23 | 100 nF ± 10 % monolithic ceramic |
| C7 | 1 nF ceramic |
| C8, C15 | 10 pF NPO ceramic |
| C10[1] | 6.8 $\mu$F tantalum (minimum) |
| C12 | 15 nF ± 10 % ceramic |
| C13 | 150 pF ± 2 % N1500 ceramic |
| C26 | 390 pF ± 10 % monolithic ceramic |
| FL1 | ceramic filter Murata SFG455A3 or equivalent |
| FL2 | |
| IFT1 | 330 $\mu$H variable shielded inductor, Toko 836AN-0129Z |
| L1 | 330 nH Coilcraft 1008CS-331 |
| L2 | 1.2 $\mu$H Coilcraft 1008CS-122 |
| X1 | 44.545 MHz 3rd Overtone series resonant crystal in the HC-49U case |
| R9 | 100 k$\Omega$ ± 1 % 1/4 W metal film |
| R10, R11 | 100 k$\Omega$ ± 1 % 1/4 W metal film (optional) |
| R17 | 5.1 k$\Omega$ ± 5 % 1/4 W carbon composition |

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

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**Product data sheet**

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# 13. Package outline

**SO20: plastic small outline package; 20 leads; body width 7.5 mm** **SOT163-1**



**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | $\theta$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 2.65 | 0.3 0.1 | 2.45 2.25 | 0.25 | 0.49 0.36 | 0.32 0.23 | 13.0 12.6 | 7.6 7.4 | 1.27 | 10.65 10.00 | 1.4 | 1.1 0.4 | 1.1 1.0 | 0.25 | 0.25 | 0.1 | 0.9 0.4 | 8° |
| inches | 0.1 | 0.012 0.004 | 0.096 0.089 | 0.01 | 0.019 0.014 | 0.013 0.009 | 0.51 0.49 | 0.30 0.29 | 0.05 | 0.419 0.394 | 0.055 | 0.043 0.016 | 0.043 0.039 | 0.01 | 0.01 | 0.004 | 0.035 0.016 | 0° |

**Note**

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT163-1 | 075E04 | MS-013 | | | | ~~99-12-27~~ 03-02-19 |

**Fig 8.   Package outline SOT163-1 (SO20)**

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



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | A₁ | A₂ | A₃ | bₚ | c | D[1] | E[1] | e | Hₑ | L | Lₚ | Q | v | w | y | Z[1] | θ |
|------|--------|-----|-----|-----|-----|-----|------|------|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|
| mm | 1.5 | 0.15 0 | 1.4 1.2 | 0.25 | 0.32 0.20 | 0.20 0.13 | 6.6 6.4 | 4.5 4.3 | 0.65 | 6.6 6.2 | 1 | 0.75 0.45 | 0.65 0.45 | 0.2 | 0.13 | 0.1 | 0.48 0.18 | 10° 0° |

**Note**

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|-----|-------|-------|---|---------------------|------------|
| | IEC | JEDEC | JEITA | | | |
| SOT266-1 | | MO-152 | | | | ~~99-12-27~~ 03-02-19 |
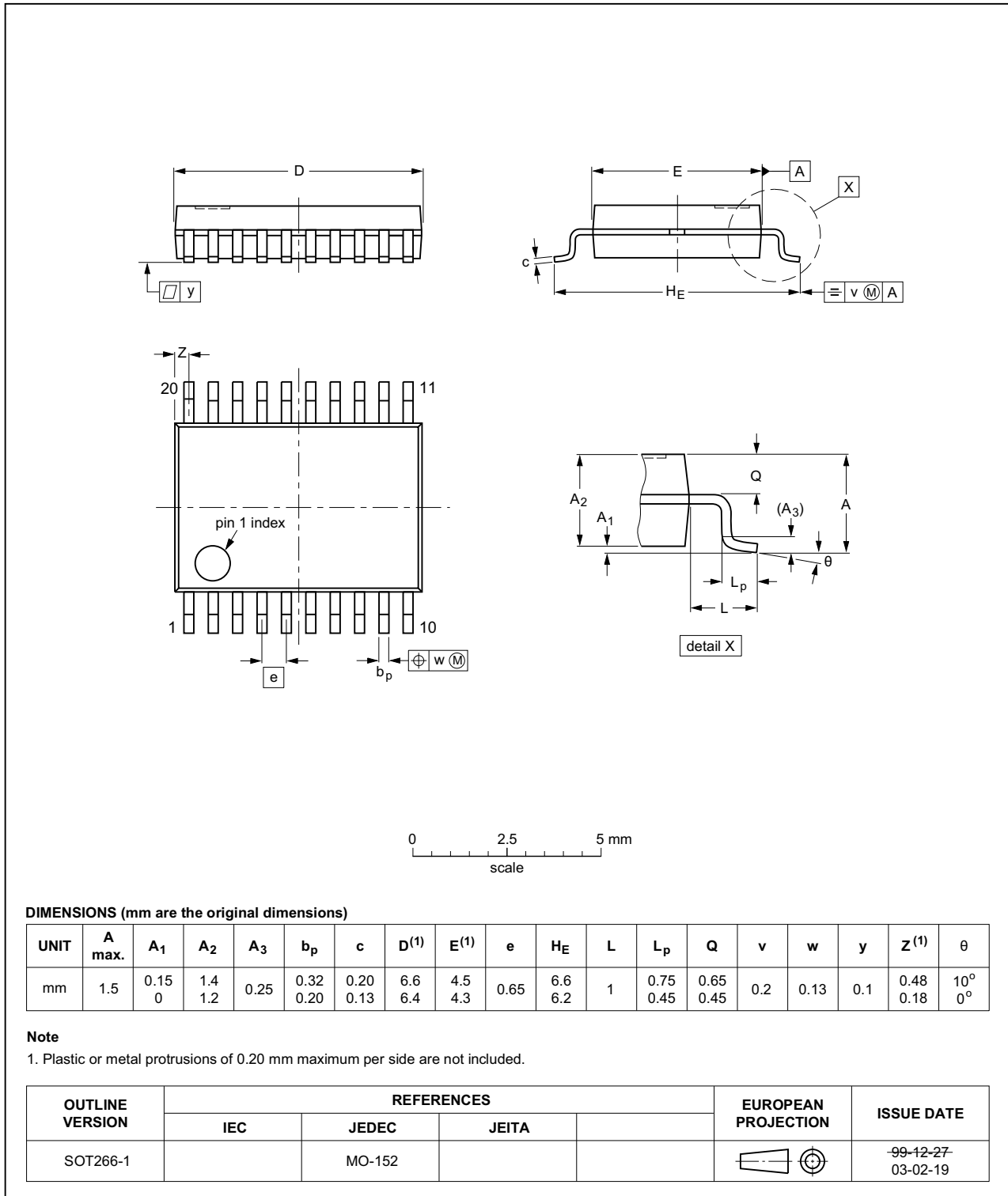
**Fig 9.    Package outline SOT266-1 (SSOP20)**

## 14. 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"*.

### 14.1 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.

### 14.2 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

### 14.3 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

## 14.4  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 10) 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 10 and 11

**Table 10.  SnPb eutectic process (from J-STD-020D)**

| Package thickness (mm) | Package reflow temperature (°C) | |
|---|---|---|
| | Volume (mm$^3$) | |
| | < 350 | ≥ 350 |
| < 2.5 | 235 | 220 |
| ≥ 2.5 | 220 | 220 |

**Table 11.  Lead-free process (from J-STD-020D)**

| Package thickness (mm) | Package reflow temperature (°C) | | |
|---|---|---|---|
| | Volume (mm$^3$) | | |
| | < 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 10.

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MSL: Moisture Sensitivity Level

**Fig 10. Temperature profiles for large and small components**
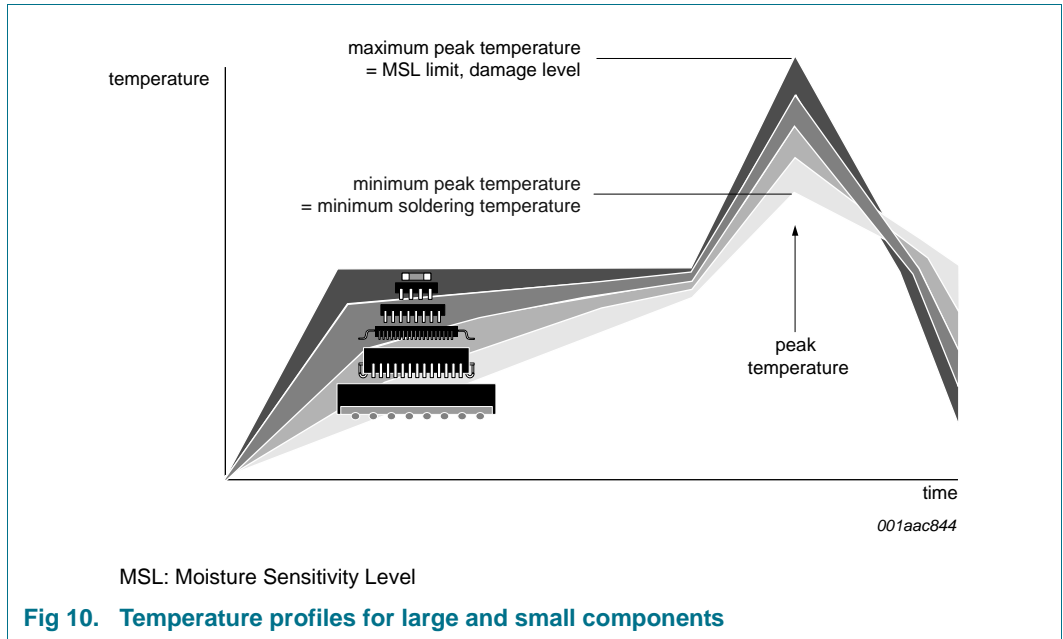
For further information on temperature profiles, refer to Application Note *AN10365 "Surface mount reflow soldering description"*.

## 15. Soldering: PCB footprints



solder lands

occupied area  placement accuracy ± 0.25  Dimensions in mm  sot163-1_fr

**Fig 11. PCB footprint for SOT163-1 (SO20); reflow soldering**



solder lands  solder resist

occupied area  placement accurracy ± 0.25  Dimensions in mm  sot163-1_fw

**Fig 12. PCB footprint for SOT163-1 (SO20); wave soldering**
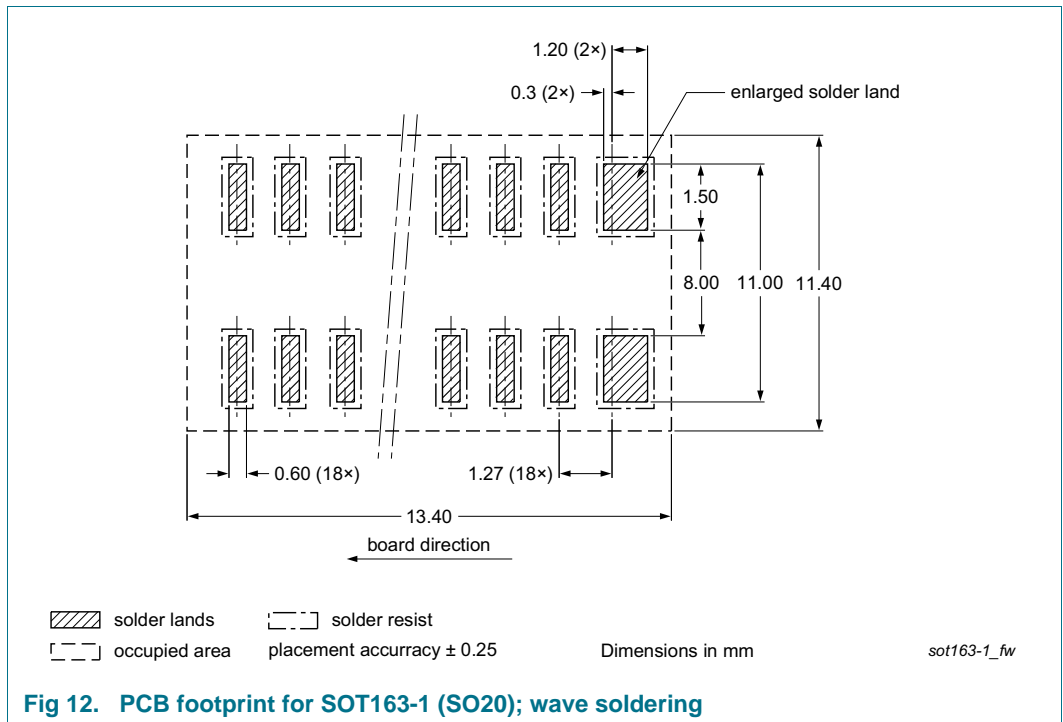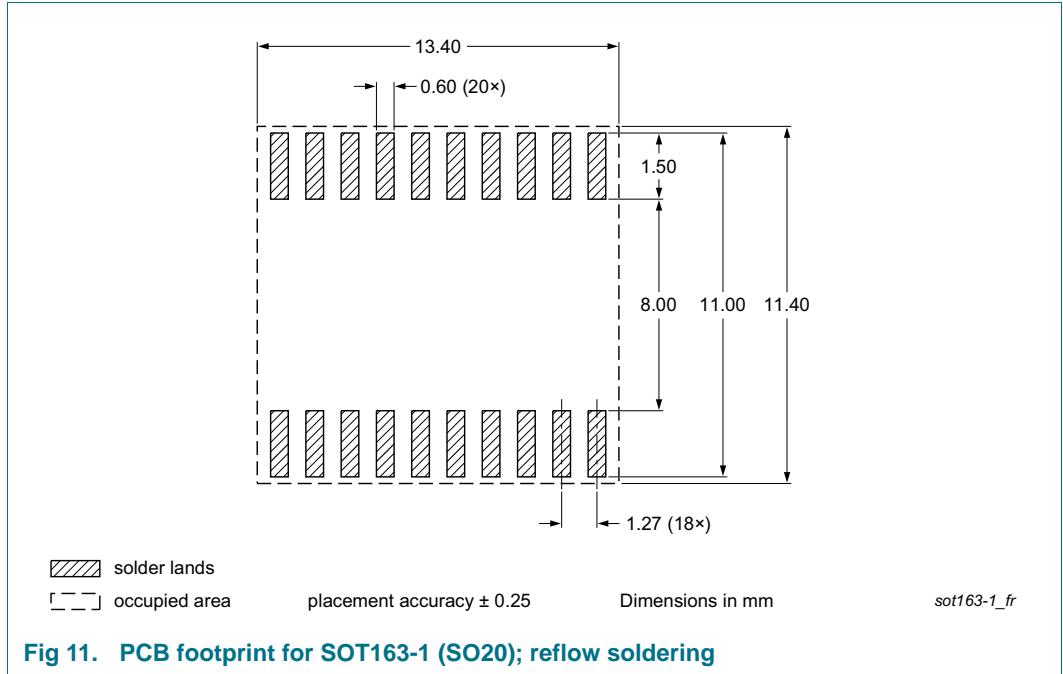
Footprint information for reflow soldering of SSOP20 package                    SOT266-1

solder land

- - - - occupied area

DIMENSIONS in mm

| P1 | P2 | Ay | By | C | D1 | D2 | Gx | Gy | Hx | Hy |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.650 | 0.750 | 7.200 | 4.500 | 1.350 | 0.400 | 0.600 | 6.900 | 5.300 | 7.300 | 7.450 |
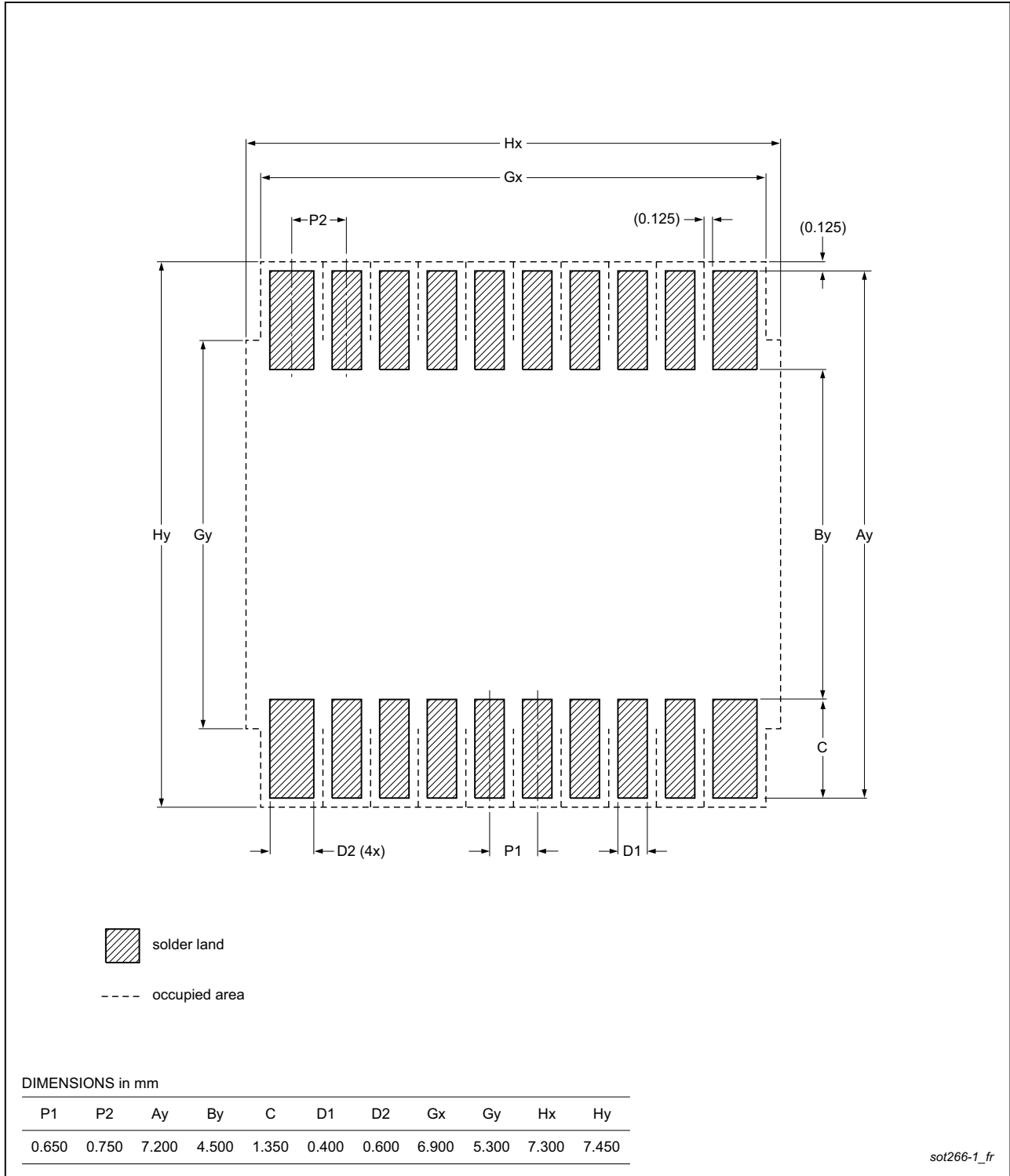
*sot266-1_fr*

**Fig 13.  PCB footprint for SOT266-1 (SSOP20); reflow soldering**

## 16. Abbreviations

**Table 12.    Abbreviations**

| Acronym | Description |
|---------|-------------|
| AM | Amplitude Modulation |
| AMPS | Advanced Mobile Phone System |
| ASK | Amplitude Shift Keying |
| CMOS | Complementary Metal-Oxide Semiconductor |
| ESD | ElectroStatic Discharge |
| ESR | Equivalent Series Resistor |
| FM | Frequency Modulation |
| FSK | Frequency Shift Keying |
| IF | Intermediate Frequency |
| L/C | inductor-capacitor filter |
| RF | Radio Frequency |
| RSSI | Received Signal Strength Indicator |
| SCA | Subsidiary Communications Authorization |
| SINAD | Signal-to-Noise-And-Distortion ratio |
| TACS | Total Access Communication System |
| THD | Total Harmonic Distortion |
| UHF | Ultra High Frequency |
| TTL | Transistor-Transistor Logic |
| VHF | Very High Frequency |

## 17. Revision history

**Table 13.    Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|-------------|--------------|-------------------|---------------|------------|
| SA605 v.5 | 20141114 | Product data sheet | - | SA605 v.4 |
| Modifications: | • Table 8 "SA605 application component list" updated <br> • Figure 4 "SA605 45 MHz application circuit" updated | | | |
| SA605 v.4 | 20140801 | Product data sheet | - | SA605 v.3 |
| SA605 v.3 | 20140501 | Product data sheet | - | SA605 v.2 |
| SA605 v.2 | 19971107 | Product specification | ECN 853-1401 18663 | SA605 v.1 |
| SA605 v.1 | 19921103 | Product specification | - | - |

# 18. Legal information

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| Document status[1][2] | Product status[3] | 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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