# DATA SHEET

# TDA9813T
## VIF-PLL with QSS-IF and dual FM-PLL demodulator

Preliminary specification
File under Integrated Circuits, IC02

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Semiconductors

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# VIF-PLL with QSS-IF and dual FM-PLL demodulator

# TDA9813T

## FEATURES

- 5 V supply voltage
- Gain controlled wide band VIF-amplifier (AC-coupled)
- True synchronous demodulation with active carrier regeneration (very linear demodulation, good intermodulation figures, reduced harmonics, excellent pulse response)
- Separate video amplifier for sound trap buffering with high video bandwidth
- VIF AGC detector for gain control, operating as peak sync detector
- Tuner AGC with adjustable takeover point (TOP)
- AFC detector without extra reference circuit
- AC-coupled limiter amplifier for sound intercarrier signal
- Two alignment-free FM-PLL demodulators with high linearity
- SIF input for single reference QSS mode (PLL controlled); SIF AGC detector for gain controlled SIF amplifier; single reference QSS mixer able to operate in high performance single reference QSS mode
- Stabilizer circuit for ripple rejection and to achieve constant output signals.

## GENERAL DESCRIPTION

The TDA9813T is an integrated circuit for vision IF signal processing and sound dual FM demodulation, with single reference QSS-IF in TV and VCR sets. For negative modulation standards only.

## QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_P$ | supply voltage | | 4.5 | 5 | 5.5 | V |
| $I_P$ | supply current | | 93 | 109 | 125 | mA |
| $V_{i\ VIF(rms)}$ | vision IF input signal voltage sensitivity (RMS value) | –1 dB video at output | – | 60 | 100 | μV |
| $V_{o\ CVBS(p-p)}$ | CVBS output signal voltage (peak-to-peak value) | | 1.7 | 2.0 | 2.3 | V |
| $B_{-3}$ | –3 dB video bandwidth on pin CVBS | B/G standard; $C_L$ < 20 pF; $R_L$ > 1 kΩ; AC load | 7 | 8 | – | MHz |
| S/N (W) | weighted signal-to-noise ratio for video | | 56 | 60 | – | dB |
| $IM_{\alpha 1.1}$ | intermodulation attenuation at ‘blue’ | f = 1.1 MHz | 58 | 64 | – | dB |
| $IM_{\alpha 3.3}$ | intermodulation attenuation at ‘blue’ | f = 3.3 MHz | 58 | 64 | – | dB |
| $\alpha_{H(sup)}$ | suppression of harmonics in video signal | | 35 | 40 | – | dB |
| $V_{i\ SIF(rms)}$ | sound IF input signal voltage sensitivity (RMS value) | –3 dB at intercarrier output | – | 30 | 70 | μV |
| $V_{o(rms)}$ | audio output signal voltage for FM (RMS value) | B/G standard; 54% modulation | – | 0.5 | – | V |
| THD | total harmonic distortion | 54% modulation | – | 0.15 | 0.5 | % |
| S/N (W) | weighted signal-to-noise ratio | 54% modulation | – | 60 | – | dB |

## ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | |
|---|---|---|---|
| | NAME | DESCRIPTION | VERSION |
| TDA9813T | SO28 | plastic small outline package; 28 leads; body width 7.5 mm | SOT136-1 |

**BLOCK DIAGRAM**

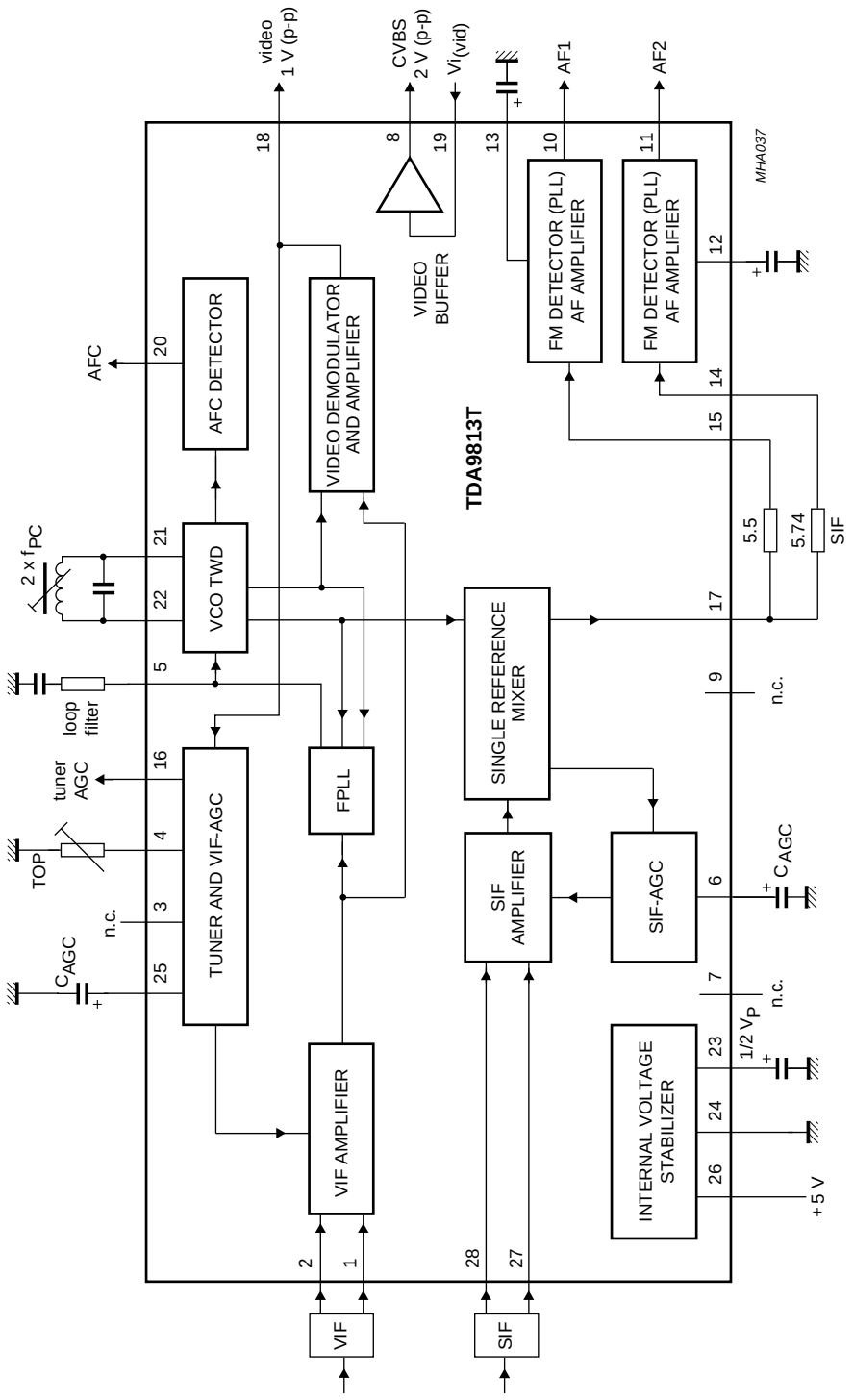



Fig.1 Block diagram.

## PINNING

| SYMBOL | PIN | DESCRIPTION |
|---|---|---|
| $V_{i\ VIF1}$ | 1 | VIF differential input signal voltage 1 |
| $V_{i\ VIF2}$ | 2 | VIF differential input signal voltage 2 |
| n.c. | 3 | not connected |
| TADJ | 4 | tuner AGC takeover adjust (TOP) |
| $T_{PLL}$ | 5 | PLL loop filter |
| $C_{SAGC}$ | 6 | SIF AGC capacitor |
| n.c. | 7 | not connected |
| $V_{o\ CVBS}$ | 8 | CVBS output signal voltage |
| n.c. | 9 | not connected |
| $V_{o\ AF1}$ | 10 | audio voltage frequency output 1 |
| $V_{o\ AF2}$ | 11 | audio voltage frequency output 2 |
| $C_{DEC2}$ | 12 | decoupling capacitor 2 |
| $C_{DEC1}$ | 13 | decoupling capacitor 1 |
| $V_{i\ FM2}$ | 14 | sound intercarrier input voltage 2 |
| $V_{i\ FM1}$ | 15 | sound intercarrier input voltage 1 |
| TAGC | 16 | tuner AGC output |
| $V_{o\ QSS}$ | 17 | single reference QSS output voltage |
| $V_{o(vid)}$ | 18 | composite video output voltage |
| $V_{i(vid)}$ | 19 | video buffer input voltage |
| AFC | 20 | AFC output |
| VCO1 | 21 | VCO1 reference circuit for $2f_{PC}$ |
| VCO2 | 22 | VCO2 reference circuit for $2f_{PC}$ |
| $C_{ref}$ | 23 | $\frac{1}{2}V_P$ reference capacitor |
| GND | 24 | ground |
| $C_{VAGC}$ | 25 | VIF AGC capacitor |
| $V_P$ | 26 | supply voltage |
| $V_{i\ SIF1}$ | 27 | SIF differential input signal voltage 1 |
| $V_{i\ SIF2}$ | 28 | SIF differential input signal voltage 2 |

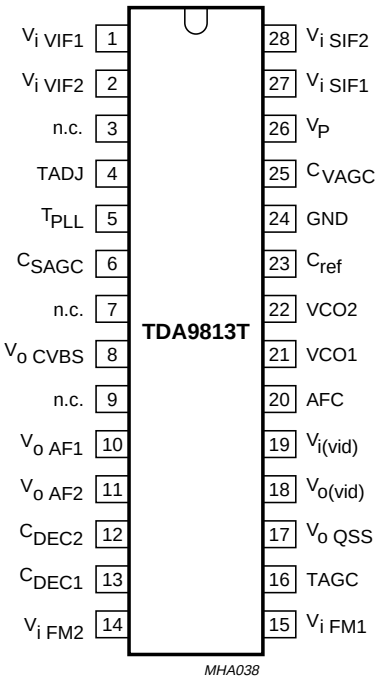



Fig.2 Pin configuration.

## FUNCTIONAL DESCRIPTION

### Vision IF amplifier

The vision IF amplifier consists of three AC-coupled differential amplifier stages. Each differential stage comprises a feedback network controlled by emitter degeneration.

### Tuner and VIF AGC

The AGC capacitor voltage is transferred to an internal IF control signal, and is fed to the tuner AGC to generate the tuner AGC output current (open-collector output). The tuner AGC takeover point can be adjusted. This allows the tuner and the SWIF filter to be matched to achieve the optimum IF input level.

The AGC detector charges/discharges the AGC capacitor to the required voltage for setting of VIF and tuner gain in order to keep the video signal at a constant level. Therefore the sync level of the video signal is detected.

### Frequency Phase Locked Loop (FPLL) detector

The VIF-amplifier output signal is fed into a frequency detector and into a phase detector via a limiting amplifier. During acquisition the frequency detector produces a DC current proportional to the frequency difference between the input and the VCO signal. After frequency lock-in the phase detector produces a DC current proportional to the phase difference between the VCO and the input signal. The DC current of either frequency detector or phase detector is converted into a DC voltage via the loop filter, which controls the VCO frequency.

### VCO, travelling wave divider and AFC

The VCO operates with a resonance circuit (with L and C in parallel) at double the PC frequency. The VCO is controlled by two integrated variable capacitors. The control voltage required to tune the VCO from its free-running frequency to actually double the PC frequency is generated by the Frequency-Phase detector and fed via the loop filter to the first variable capacitor (FPLL). This control voltage is amplified and additionally converted into a current which represents the AFC output signal. At centre frequency the AFC output current is equal to zero.

The oscillator signal is divided-by-two with a Travelling Wave Divider (TWD) which generates two differential output signals with a 90 degree phase difference independent of the frequency.

### Video demodulator and amplifier

The video demodulator is realized by a multiplier which is designed for low distortion and large bandwidth. The vision IF input signal is multiplied with the ‘in phase’ signal of the travelling wave divider output.

The demodulator output signal is fed via an integrated low-pass filter for attenuation of the carrier harmonics to the video amplifier. The video amplifier is realized by an operational amplifier with internal feedback and high bandwidth. A low-pass filter is integrated to achieve an attenuation of the carrier harmonics. The video output signal is 1 V (p-p) for nominal vision IF modulation.

### Video buffer

For an easy adaption of the sound traps an operational amplifier with internal feedback is used. This amplifier is featured with a high bandwidth and 7 dB gain. The input impedance is adapted for operating in combination with ceramic sound traps. The output stage delivers a nominal 2 V (p-p) positive video signal. Noise clipping is provided.

### SIF amplifier and AGC

The sound IF amplifier consists of two AC-coupled differential amplifier stages. Each differential stage comprises a controlled feedback network provided by emitter degeneration.

The SIF AGC detector is related to the SIF input signals (average level of FM carriers) and controls the SIF amplifier to provide a constant SIF signal to the single reference QSS mixer.

### Single reference QSS mixer

The single reference QSS mixer is realized by a multiplier. The SIF amplifier output signal is fed to the single reference QSS mixer and converted to intercarrier frequency by the regenerated picture carrier (VCO). The mixer output signal is fed via a high-pass for attenuation of the video signal components to the output pin 17. With this system a high performance hi-fi stereo sound processing can be achieved.

### FM detectors

Each FM detector consists of a limiter, an FM-PLL and an AF amplifier. The limiter provides the amplification and limitation of the FM sound intercarrier signal before demodulation. The result is high sensitivity and AM suppression. The amplifier consists of 7 stages which are internally AC-coupled in order to minimize the DC offset and to save pins for DC decoupling.

The second limiter is extended with an additional level detector consisting of a rectifier and a comparator. By means of this the AF2 signal is set to mute and the PLL VCO is switched off, if the intercarrier signal at pin 14 is below 1 mV (RMS) in order to avoid false identification of a stereo decoder. Note that noise at pin 14 disables the mute state (at low SIF input signal), but this will not lead to false identification. This 'auto-mute' function can be disabled by connecting a 5.6 kΩ resistor from pin 14 to $+V_P$ (see Fig.11).

Furthermore the AF output signals can be muted by connecting a resistor between the limiter inputs pin 14 or pin 15 and ground.

The FM-PLL consists of an integrated relaxation oscillator, an integrated loop filter and a phase detector. The oscillator is locked to the FM intercarrier signal, output from the limiter. As a result of locking, the oscillator frequency tracks with the modulation of the input signal and the oscillator control voltage is superimposed by the AF voltage. The FM-PLL operates as an FM-demodulator.

The AF amplifier consists of two parts:

1. The AF preamplifier for FM sound is an operational amplifier with internal feedback, high gain and high common mode rejection. The AF voltage from the PLL demodulator, by principle a small output signal, is amplified by approximately 33 dB. The low-pass characteristic of the amplifier reduces the harmonics of the intercarrier signal at the sound output terminal. An additional DC control circuit is implemented to keep the DC level constant, independent of process spread.
2. The AF output amplifier (10 dB) provides the required output level by a rail-to-rail output stage. This amplifier makes use of an input selector for switching to FM or mute state, controlled by the mute switching voltage.

### Internal voltage stabilizer and $\frac{1}{2}V_P$-reference

The bandgap circuit internally generates a voltage of approximately 1.25 V, independent of supply voltage and temperature. A voltage regulator circuit, connected to this voltage, produces a constant voltage of 3.6 V which is used as an internal reference voltage.

For all audio output signals the constant reference voltage cannot be used because large output signals are required. Therefore these signals refer to half the supply voltage to achieve a symmetrical headroom, especially for the rail-to-rail output stage. For ripple and noise attenuation the $\frac{1}{2}V_P$ voltage has to be filtered via a low-pass filter by using an external capacitor together with an integrated resistor ($f_g$ = 5 Hz). For a fast setting to $\frac{1}{2}V_P$ an internal start-up circuit is added.

## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_P$ | supply voltage (pin 26) | maximum chip temperature of 125 °C; note 1 | 0 | 5.5 | V |
| $V_i$ | voltage at pins 1 to 7, 9 to 16, 19, 20 and 23 to 28 | | 0 | $V_P$ | V |
| $t_{s(max)}$ | maximum short-circuit time | | – | 10 | s |
| $V_{19}$ | tuner AGC output voltage | | 0 | 13.2 | V |
| $T_{stg}$ | storage temperature | | –25 | +150 | °C |
| $T_{amb}$ | operating ambient temperature | | –20 | +70 | °C |
| $V_{es}$ | electrostatic handling voltage | note 2 | –300 | +300 | V |

**Notes**

1. $I_P$ = 125 mA; $T_{amb}$ = 70 °C; $R_{th\ j\text{-}a}$ = 80 K/W.
2. Machine model class B.

## THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | VALUE | UNIT |
|---|---|---|---|
| $R_{th\ j\text{-}a}$ | thermal resistance from junction to ambient in free air | 80 | K/W |

## CHARACTERISTICS

$V_P$ = 5 V; $T_{amb}$ = 25 °C; see Table 1 for input frequencies and level; input level $V_{i\ IF\ 1,\ 2}$ = 10 mV RMS value (sync-level); video modulation DSB; residual carrier: 10%; video signal in accordance with *"CCIR, line 17"*; measurements taken in Fig.11; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Supply (pin 26)** | | | | | | |
| $V_P$ | supply voltage | note 1 | 4.5 | 5 | 5.5 | V |
| $I_P$ | supply current | | 93 | 109 | 125 | mA |
| **Vision IF amplifier (pins 1 and 2)** | | | | | | |
| $V_{i\ VIF(rms)}$ | input signal voltage sensitivity (RMS value) | B/G standard; −1 dB video at output | – | 60 | 100 | µV |
| $V_{i\ max(rms)}$ | maximum input signal voltage (RMS value) | B/G standard; +1 dB video at output | 120 | 200 | – | mV |
| $\Delta V_{o(int)}$ | internal IF amplitude difference between picture and sound carrier | within AGC range; B/G standard; $\Delta f$ = 5.5 MHz | – | 0.7 | 1 | dB |
| $G_{IFcr}$ | IF gain control range | see Fig.3 | 65 | 70 | – | dB |
| $R_{i(diff)}$ | differential input resistance | note 2 | 1.7 | 2.2 | 2.7 | kΩ |
| $C_{i(diff)}$ | differential input capacitance | | 1.2 | 1.7 | 2.5 | pF |
| $V_{1,\ 2}$ | DC input voltage | | – | 3.4 | – | V |
| **True synchronous video demodulator;** note 3 | | | | | | |
| $f_{VCO(max)}$ | maximum oscillator frequency for carrier regeneration | $f = 2f_{PC}$ | 125 | 130 | – | MHz |
| $\Delta f_{osc}/\Delta T$ | oscillator drift as a function of temperature | oscillator is free-running; $I_{AFC}$ = 0; note 4 | – | – | ±20 | ppm/K |
| $V_{0\ ref(rms)}$ | oscillator voltage swing at pins 21 and 22 (RMS value) | B/G standard | 70 | 100 | 130 | mV |
| $f_{pcCR}$ | picture carrier capture frequency range | B/G standard | ±1.5 | ±2.0 | – | MHz |
| $t_{acq}$ | acquisition time | BL = 180 kHz; note 5 | – | – | 30 | ms |
| $V_{i\ VIF(rms)}$ | VIF input signal voltage sensitivity for PLL to be locked (RMS value; pins 1 and 2) | maximum IF gain; note 6 | – | 30 | 70 | µV |
| $I_{FPLL(offset)}$ | FPLL offset current at pin 5 | note 7 | – | – | ±4.5 | µA |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Composite video amplifier (pin 18; sound carrier off)** | | | | | | |
| $V_{o\ video(p-p)}$ | output signal voltage (peak-to-peak value) | see Fig.8 | 0.88 | 1.0 | 1.12 | V |
| $V_{18(sync)}$ | sync voltage level | B/G standard | – | 1.5 | – | V |
| $V_{18(clu)}$ | upper video clipping voltage level | | $V_P - 1.1$ | $V_P - 1$ | – | V |
| $V_{18(cll)}$ | lower video clipping voltage level | | – | 0.3 | 0.4 | V |
| $R_{o,18}$ | output resistance | note 2 | – | – | 10 | Ω |
| $I_{int\ 18}$ | internal DC bias current for emitter-follower | | 2.2 | 3.0 | – | mA |
| $I_{18\ max(sink)}$ | maximum AC and DC output sink current | | 1.6 | – | – | mA |
| $I_{18\ max(source)}$ | maximum AC and DC output source current | | 2.9 | – | – | mA |
| $B_{-1}$ | –1 dB video bandwidth | B/G standard; $C_L < 50$ pF; $R_L > 1$ kΩ; AC load | 5 | 6 | – | MHz |
| $B_{-3}$ | –3 dB video bandwidth | B/G standard; $C_L < 50$ pF; $R_L > 1$ kΩ; AC load | 7 | 8 | – | MHz |
| $\alpha_H$ | suppression of video signal harmonics | $C_L < 50$ pF; $R_L > 1$ kΩ; AC load; note 8a | 35 | 40 | – | dB |
| PSRR | power supply ripple rejection at pin 18 | video signal; grey level; see Fig.9; B/G standard | 32 | 35 | – | dB |
| **CVBS buffer amplifier (only) and noise clipper (pins 8 and 19)** | | | | | | |
| $R_{i,19}$ | input resistance | note 2 | 2.6 | 3.3 | 4.0 | kΩ |
| $C_{i,19}$ | input capacitance | note 2 | 1.4 | 2 | 3.0 | pF |
| $V_{I,19}$ | DC input voltage | | 1.4 | 1.7 | 2.0 | V |
| $G_v$ | voltage gain | B/G standard; note 9 | 6.5 | 7 | 7.5 | dB |
| $V_{8(clu)}$ | upper video clipping voltage level | | 3.9 | 4.0 | – | V |
| $V_{8(cll)}$ | lower video clipping voltage level | | – | 1.0 | 1.1 | V |
| $R_{o,8}$ | output resistance | note 2 | – | – | 10 | Ω |
| $I_{int\ 8}$ | DC internal bias current for emitter-follower | | 2.0 | 2.5 | – | mA |
| $I_{o,8\ max(sink)}$ | maximum AC and DC output sink current | | 1.4 | – | – | mA |
| $I_{o,8\ max(source)}$ | maximum AC and DC output source current | | 2.4 | – | – | mA |
| $B_{-1}$ | –1 dB video bandwidth | B/G standard; $C_L < 20$ pF; $R_L > 1$ kΩ; AC load | 8.4 | 11 | – | MHz |
| $B_{-3}$ | –3 dB video bandwidth | B/G standard; $C_L < 20$ pF; $R_L > 1$ kΩ; AC load | 11 | 14 | – | MHz |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Measurements from IF input to CVBS output (pin 8; 330 Ω between pins 18 and 19, sound carrier off)** | | | | | | |
| $V_{o\ CVBS(p-p)}$ | CVBS output signal voltage on pin 10 (peak-to-peak value) | note 9 | 1.7 | 2.0 | 2.3 | V |
| $V_{o\ CVBS(sync)}$ | sync voltage level | B/G standard | – | 1.35 | – | V |
| $\Delta V_o$ | deviation of CVBS output signal voltage | 50 dB gain control | – | – | 0.5 | dB |
| | | 30 dB gain control | – | – | 0.1 | dB |
| $\Delta V_{o(blBG)}$ | black level tilt in B/G standard | gain variation; note 10 | – | – | 1 | % |
| $G_{diff}$ | differential gain | *"CCIR, line 330"* | – | 2 | 5 | % |
| $\varphi_{diff}$ | differential phase | *"CCIR, line 330"* | – | 1 | 2 | deg |
| $B_{-1}$ | –1 dB video bandwidth | B/G standard; $C_L < 20$ pF; $R_L > 1$ kΩ; AC load | 5 | 6 | – | MHz |
| $B_{-3}$ | –3 dB video bandwidth | B/G standard; $C_L < 20$ pF; $R_L > 1$ kΩ; AC load | 7 | 8 | – | MHz |
| S/N (W) | weighted signal-to-noise ratio | see Fig.5 and note 11 | 56 | 60 | – | dB |
| S/N | unweighted signal-to-noise ratio | see Fig.5 and note 11 | 49 | 53 | – | dB |
| $IM\alpha_{1.1}$ | intermodulation attenuation at 'blue' | f = 1.1 MHz; see Fig.6 and note 12 | 58 | 64 | – | dB |
| | intermodulation attenuation at 'yellow' | f = 1.1 MHz; see Fig.6 and note 12 | 60 | 66 | – | dB |
| $IM\alpha_{3.3}$ | intermodulation attenuation at 'blue' | f = 3.3 MHz; see Fig.6 and note 12 | 58 | 64 | – | dB |
| | intermodulation attenuation at 'yellow' | f = 3.3 MHz; see Fig.6 and note 12 | 59 | 65 | – | dB |
| $\alpha_{c(rms)}$ | residual vision carrier (RMS value) | fundamental wave and harmonics; B/G standard | – | 2 | 5 | mV |
| $\alpha_{H(sup)}$ | suppression of video signal harmonics | note 8a | 35 | 40 | – | dB |
| $\alpha_{H(spur)}$ | spurious elements | note 8b | 40 | – | – | dB |
| PSRR | power supply ripple rejection at pin 8 | video signal; grey level; see Fig.9; B/G standard | 25 | 28 | – | dB |
| **VIF-AGC detector (pin 25)** | | | | | | |
| $I_{25}$ | charging current | B/G standard; note 10 | 0.75 | 1 | 1.25 | mA |
| | discharging current | B/G standard | 15 | 20 | 25 | μA |
| $t_{resp}$ | AGC response to an increasing VIF step | B/G standard; note 13 | – | 0.05 | 0.1 | ms/dB |
| | AGC response to a decreasing VIF step | B/G standard | – | 2.2 | 3.5 | ms/dB |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Tuner AGC (pin 16)** | | | | | | |
| $V_{i(rms)}$ | IF input signal voltage for minimum starting point of tuner takeover (RMS value) | input at pins 1 and 2; $R_{TOP}$ = 22 kΩ; $I_{16}$ = 0.4 mA | – | 2 | 5 | mV |
| | IF input signal voltage for maximum starting point of tuner takeover (RMS value) | input at pins 1 and 2; $R_{TOP}$ = 0 Ω; $I_{16}$ = 0.4 mA | 50 | 100 | 5 | mV |
| $V_{o,16}$ | permissible output voltage | from external source; note 2 | – | – | 13.2 | V |
| $V_{sat,16}$ | saturation voltage | $I_{16}$ = 1.5 mA | – | – | 0.2 | V |
| $\Delta V_{TOP,16}/\Delta T$ | variation of takeover point by temperature | $I_{16}$ = 0.4 mA | – | 0.03 | 0.07 | dB/K |
| $I_{16(sink)}$ | sink current | see Fig.3 | | | | |
| | | no tuner gain reduction; $V_{16}$ = 13.2 V | – | – | 5 | μA |
| | | maximum tuner gain reduction | 1.5 | 2 | 2.6 | mA |
| $\Delta G_{IF}$ | IF slip by automatic gain control | tuner gain current from 20 to 80% | – | 6 | 8 | dB |
| **AFC circuit (pin 20);** see Fig.7 and note 14 | | | | | | |
| S | control steepness $\Delta I_{23}/\Delta f$ | note 15 | 0.5 | 0.72 | 1.0 | μA/kHz |
| $\Delta f_{IF}/\Delta T$ | frequency variation by temperature | $I_{AFC}$ = 0; note 4 | – | – | ±20 | ppm/K |
| $V_{o,20}$ | output voltage upper limit | see Fig.7 | $V_P$ – 0.6 | $V_P$ – 0.3 | – | V |
| | output voltage lower limit | see Fig.7 | – | 0.3 | 0.6 | V |
| $I_{o,20(source)}$ | output source current | | 150 | 200 | 250 | μA |
| $I_{o,20(sink)}$ | output sink current | | 150 | 200 | 250 | μA |
| $\Delta I_{20(p-p)}$ | residual video modulation current (peak-to-peak value) | B/G standard | – | 20 | 30 | μA |
| **Sound IF amplifier (pins 27 and 28)** | | | | | | |
| $V_{i\ SIF(rms)}$ | input signal voltage sensitivity (RMS value) | –3 dB at intercarrier output pin 17 | – | 30 | 70 | μV |
| $V_{i\ max(rms)}$ | maximum input signal voltage (RMS value) | +1 dB at intercarrier output pin 17 | 50 | 70 | – | mV |
| $G_{SIF}$ | SIF gain control range | see Fig.4 | 60 | 67 | – | dB |
| $R_{i(diff)}$ | differential input resistance | note 2 | 1.7 | 2.2 | 2.7 | kΩ |
| $C_{i(diff)}$ | differential input capacitance | note 2 | 1.2 | 1.7 | 2.5 | pF |
| $V_{27/28}$ | DC input voltage | | – | 3.4 | – | V |
| $\alpha_{SIF/VIF}$ | crosstalk attenuation between SIF and VIF input | between pins 1 and 2 and pins 27 and 28; note 16 | 50 | – | – | dB |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **SIF-AGC detector (pin 6)** | | | | | | |
| $I_6$ | charging current | | 8 | 12 | 16 | μA |
| | discharging current | | 8 | 12 | 16 | μA |
| **Single reference QSS intercarrier mixer (B/G standard; pin 17)** | | | | | | |
| $V_{o(rms)}$ | IF intercarrier level (RMS value) | $SC_1$; sound carrier 2 off | 75 | 100 | 125 | mV |
| $B_{-3}$ | –3 dB intercarrier bandwidth | upper limit | 7.5 | 9 | – | MHz |
| $\alpha_{c(rms)}$ | residual sound carrier (RMS value) | fundamental wave and harmonics | – | 2 | – | mV |
| $R_{o,17}$ | output resistance | note 2 | – | – | 25 | Ω |
| $V_{O,17}$ | DC output voltage | | – | 2.0 | – | V |
| $I_{int\ 17}$ | DC internal bias current for emitter-follower | | 1.5 | 1.9 | – | mA |
| $I_{17\ max(sink)}$ | maximum AC and DC output sink current | | 1.1 | 1.5 | – | mA |
| $I_{17\ max(source)}$ | maximum AC and DC output source current | | 3.0 | 3.5 | – | mA |
| **Limiter amplifier 1 (pin 15);** note 17 | | | | | | |
| $V_{i\ FM(rms)}$ | input signal voltage for lock-in (RMS value) | | – | – | 100 | μV |
| $V_{i\ FM(rms)}$ | input signal voltage (RMS value) | $\left(\frac{S+N}{N}\right) = 40$ dB | – | 300 | 400 | μV |
| | allowed input signal voltage (RMS value) | | 200 | – | – | mV |
| $R_{i,15}$ | input resistance | note 2 | 480 | 600 | 720 | Ω |
| $V_{I,15}$ | DC input voltage | | – | 2.8 | – | V |
| **Limiter amplifier 2 (pin 14);** note 17 | | | | | | |
| $V_{i\ FM(rms)}$ | input signal voltage for lock-in (RMS value) | | – | – | 100 | μV |
| $V_{i\ FM(rms)}$ | input signal voltage (RMS value) | $\left(\frac{S+N}{N}\right) = 40$ dB PLL1 has to be in locked mode; auto mute off | – | 300 | 400 | μV |
| | allowed input signal voltage (RMS value) | | 200 | – | – | mV |
| | input signal voltage for no auto mute; PLL enabled (RMS value) | | 0.7 | 1 | 1.5 | mV |
| $HYS_{14}$ | hysteresis of level detector for auto mute | | –3 | –6 | –8 | dB |
| $R_{i,14}$ | input resistance | note 2 | 480 | 600 | 720 | Ω |
| $V_{I,14}$ | DC input voltage | | – | 2.0 | – | V |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **FM-PLL detectors** | | | | | | |
| $f_{i\ FM(catch)}$ | catching range of PLL | upper limit | 7.0 | – | – | MHz |
| | | lower limit | – | – | 4.0 | MHz |
| $f_{i\ FM(hold)}$ | holding range of PLL | upper limit | 9.0 | – | – | MHz |
| | | lower limit | – | – | 3.5 | MHz |
| $t_{acq}$ | acquisition time | | – | – | 4 | µs |
| **FM operation (B/G standard; pins 10 and 11);** notes 17 and 17a | | | | | | |
| $V_{o\ AF10,11(rms)}$ | AF output signal voltage (RMS value) | 27 kHz (54% FM deviation); see Fig.11 and note 18 | | | | |
| | | $R_x = R_y = 470\ \Omega$ | 200 | 250 | 300 | mV |
| | | $R_x = R_y = 0\ \Omega$ | 400 | 500 | 600 | mV |
| $V_{o\ AF10,11(cl)}$ | AF output clipping signal voltage level | THD <1.5% | 1.3 | 1.4 | – | V |
| $\Delta f_{AF}$ | frequency deviation | THD <1.5%; note 18 | – | – | 53 | kHz |
| $\Delta V_o/\Delta T$ | temperature drift of AF output signal voltage | | – | $3 \times 10^{-3}$ | $7 \times 10^{-3}$ | dB/K |
| $V_{12,13}$ | DC voltage at decoupling capacitor | voltage dependent on VCO frequency; note 19 | 1.2 | – | 3.0 | V |
| $R_{10,11}$ | output resistance | note 2 | – | – | 100 | Ω |
| $V_{10,11}$ | DC output voltage | tracked with supply voltage | – | $\frac{1}{2}V_P$ | – | V |
| $I_{10,11\ max(sink)}$ | maximum AC and DC output sink current | | – | – | 1.1 | mA |
| $I_{10,11\ max(source)}$ | maximum AC and DC output source current | | – | – | 1.1 | mA |
| $B_{-3}$ | –3 dB video bandwidth | | 100 | 125 | – | kHz |
| THD | total harmonic distortion | | – | 0.15 | 0.5 | % |
| S/N (W) | weighted signal-to-noise ratio | FM-PLL only; with 50 µs de-emphasis; 27 kHz (54% FM deviation); *"CCIR 468-4"* | 55 | 60 | – | dB |
| $\alpha_{c(rms)}$ | residual sound carrier (RMS value) | fundamental wave and harmonics | – | – | 75 | mV |
| $\alpha_{AM}$ | AM suppression | 50 µs de-emphasis; AM: f = 1 kHz; m = 0.3 refer to 27 kHz (54% FM deviation) | 46 | 50 | – | dB |
| $\alpha_{10,11}$ | mute attenuation of AF signals | B/G standard | 70 | 80 | – | dB |
| $\Delta V_{10,11}$ | DC jump voltage of AF output terminals for switching AF output to mute state and vice versa | FM-PLLs in lock mode; note 20 | – | ±50 | ±150 | mV |
| PSRR | power supply ripple rejection at pins 10 and 11 | $R_x = R_y = 470\ \Omega$; see Figs 9 and 11 | 26 | 30 | – | dB |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Single reference QSS AF performance for FM operation (B/G standard);** notes 21, 22 and 23; see Table 1 | | | | | | |
| S/N (W) | weighted signal-to-noise ratio ($SC_1/SC_2$) | PC/$SC_1$ ratio at pins 1 and 2; 27 kHz (54% FM deviation); *"CCIR 468-4"* | 40 | – | – | dB |
| | | black picture | 53/48 | 58/55 | – | dB |
| | | white picture | 52/46 | 55/52 | – | dB |
| | | 6 kHz sine wave (black to white modulation) | 44/42 | 48/46 | – | dB |
| | | 250 kHz square wave (black to white modulation) | 35/25 | 41/30 | – | dB |
| | | sound carrier subharmonics; f = 2.75 MHz ±3 kHz | 45/44 | 51/50 | – | dB |
| | | sound carrier subharmonics; f = 2.87 MHz ±3 kHz | 46/45 | 52/51 | – | dB |

**Notes to the characteristics**

1. Values of video and sound parameters are decreased at $V_P$ = 4.5 V.
2. This parameter is not tested during production and is only given as application information for designing the television receiver.
3. Loop bandwidth BL = 180 kHz (natural frequency $f_n$ = 15 kHz; damping factor d ≈ 5; calculated with sync level within gain control range). Resonance circuit of VCO: $Q_0$ > 50; $C_{ext}$ = 8.2 pF ±0.25 pF; $C_{int}$ ≈ 8.5 pF (loop voltage approximately 2.7 V).
4. Temperature coefficient of external LC-circuit is equal to zero.
5. $V_{i\,IF}$ = 10 mV (RMS); Δf = 1 MHz (VCO frequency offset related to picture carrier frequency); white picture video modulation.
6. $V_{i\,IF}$ signal for nominal video signal.
7. Offset current measured between pin 5 and half of supply voltage ($V_P$ = 2.5 V) under the following conditions: no input signal at VIF input (pins 1 and 2) and VIF amplifier gain at minimum ($V_{25} = V_P$).
8. Measurements taken with SAW filter G3962 (sound carrier suppression: 40 dB); loop bandwidth BL = 180 kHz:
   a) Modulation VSB; sound carrier **off**; $f_{video}$ > 0.5 MHz.
   b) Ssound carrier **on**; SIF SAW filter L9453; $f_{video}$ = 10 kHz to 10 MHz.
9. The 7 dB buffer gain accounts for 1 dB loss in the sound trap. Buffer output signal is typical 2 V (p-p), in event of CVBS video amplifier output typical 1 V (p-p). If no sound trap is applied a 330 Ω resistor must be connected from output to input (from pin 18 to pin 19).
10. The leakage current of the AGC capacitor should not exceed 1 μA. Larger currents will increase the tilt.
11. S/N is the ratio of black-to-white amplitude to the black level noise voltage (RMS value, pin 8). B = 5 MHz weighted in accordance with *"CCIR 567"*.

12. The intermodulation figures are defined:

$$\alpha_{1.1} = 20 \log\left(\frac{V_0 \text{ at } 4.4 \text{ MHz}}{V_0 \text{ at } 1.1 \text{ MHz}}\right) + 3.6\,\text{dB}$$; $\alpha_{1.1}$ value at 1.1 MHz referenced to black/white signal;

$$\alpha_{3.3} = 20 \log\left(\frac{V_0 \text{ at } 4.4 \text{ MHz}}{V_0 \text{ at } 3.3 \text{ MHz}}\right)$$; $\alpha_{3.3}$ value at 3.3 MHz referenced to colour carrier.

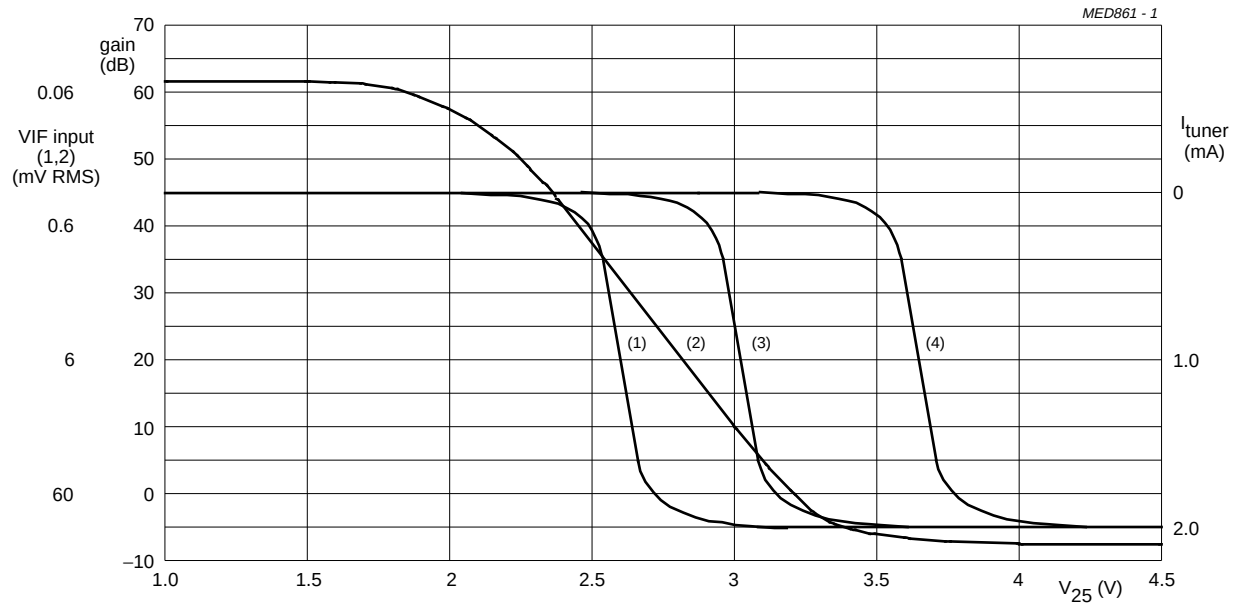
13. Response speed valid for a VIF input level range of 200 μV up to 70 mV.
14. To match the AFC output signal to different tuning systems a current source output is provided. The test circuit is given in Fig.7. The AFC-steepness can be changed by the resistors at pin 20.
15. Depending on the ratio $\Delta C/C_0$ of the LC resonant circuit of VCO ($Q_0 > 50$; see note 3; $C_0 = C_{int} + C_{ext}$).
16. Source impedance: 2.3 kΩ in parallel to 12 pF (SAW filter); $f_{IF}$ = 38.9 MHz.
17. Input level for second IF from an external generator with 50 Ω source impedance. AC-coupled with 10 nF capacitor, $f_{mod}$ = 1 kHz, 27 kHz (54% FM deviation) of audio references. A VIF/SIF input signal is not permitted. Pins 6 and 25 have to be connected to positive supply voltage for minimum IF gain. S/N and THD measurements are taken at 50 μs de-emphasis. The not tested FM-PLL has to be locked to an unmodulated carrier.

    a) Second IF input level 10 mV (RMS).

18. Measured with an FM deviation of 27 kHz the typical AF output signal is 500 mV RMS ($R_x = R_y = 0$ Ω; see Fig.11). By using $R_x = R_y = 470$ Ω the AF output signal is attenuated by 6 dB (250 mV RMS) and adapted to the stereo decoder family TDA9840. For handling an FM deviation of more than 53 kHz the AF output signal has to be reduced by using $R_x$ and $R_y$ in order to avoid clipping (THD < 1.5%). For an FM deviation up to 100 kHz an attenuation of 6 dB is recommended with $R_x = R_y = 470$ Ω.
19. The leakage current of the decoupling capacitor (2.2 μF) should not exceed 1 μA.
20. In the event of activated auto mute state the second FM-PLL oscillator is switched off, if the input signal at pin 14 is missing or too weak (see Fig.11). In the event of switching the second FM-PLL oscillator on by the auto mute stage an increased DC jump is the consequence. Note, that noise at pin 14 disables the mute state (at low SIF input signal), but this will not lead to false identification of the used stereo decoder family TDA9840.
21. For all S/N measurements the used vision IF modulator has to meet the following specifications:
    a) Incidental phase modulation for black-to-white jump less than 0.5 degrees.
    b) QSS AF performance, measured with the television-demodulator AMF2 (audio output, weighted S/N ratio) better than 60 dB (deviation 27 kHz) for 6 kHz sinewave black-to-white video modulation.
    c) Picture-to-sound carrier ratio; $PC/SC_1$ = 13 dB; (transmitter).
22. Measurements taken with SAW filter G3962 (Siemens) for vision IF (suppressed sound carrier) and G9350 (Siemens) for sound IF (suppressed picture carrier). Input level $V_{i\,SIF}$ = 10 mV (RMS), 27 kHz (54% FM deviation).
23. The PC/SC ratio at pins 1 and 2 is calculated as the addition of TV transmitter PC/SC ratio and SAW filter PC/SC ratio. This PC/SC ratio is necessary to achieve the S/N(W) values as noted. A different PC/SC ratio will change these values.

**Table 1** Input frequencies and carrier ratios

| DESCRIPTION | SYMBOL | B/G STANDARD | UNIT |
|---|---|---|---|
| Picture carrier | $f_{PC}$ | 38.9 | MHz |
| Sound carrier | $f_{SC1}$ | 33.4 | MHz |
| | $f_{SC2}$ | 33.158 | MHz |
| Picture-to-sound carrier ratio | $SC_1$ | 13 | dB |
| | $SC_2$ | 20 | dB |




(1) $I_{tuner}$; $R_{TOP}$ = 22 kΩ.
(2) Gain.
(3) $I_{tuner}$; $R_{TOP}$ = 11 kΩ.
(4) $I_{tuner}$; $R_{TOP}$ = 0 Ω.

Fig.3 Typical VIF and tuner AGC characteristic.

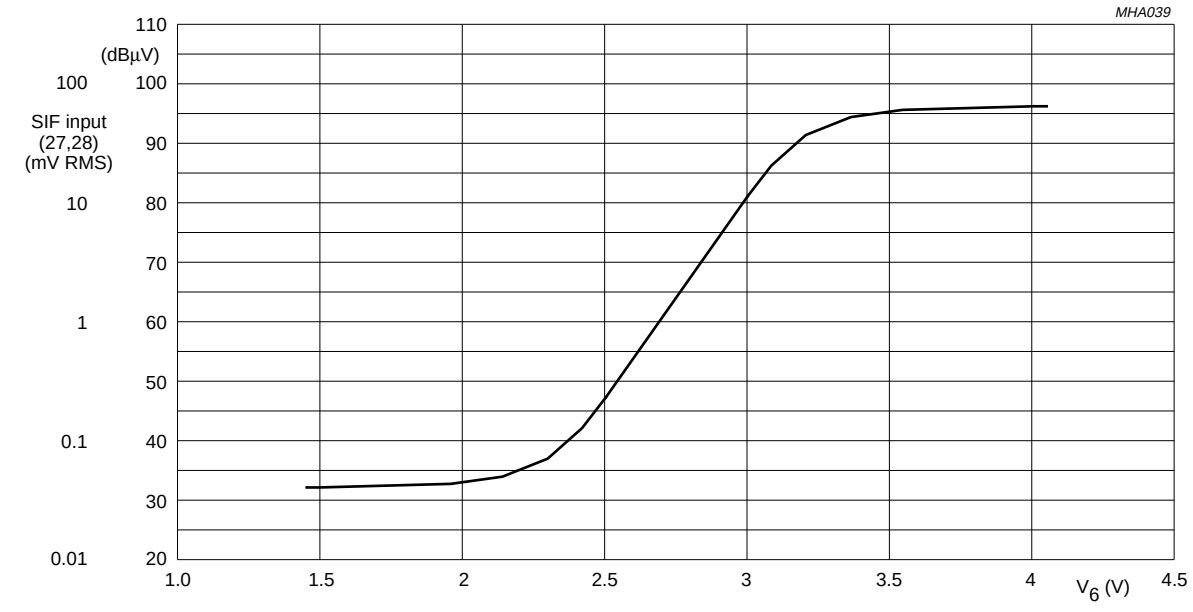



Fig.4 Typical SIF AGC characteristic.

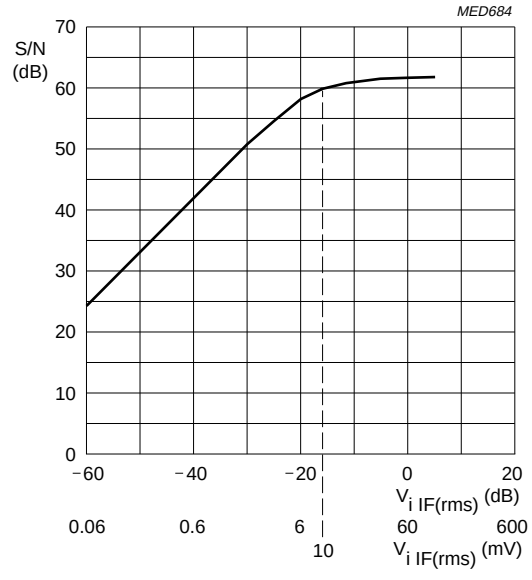
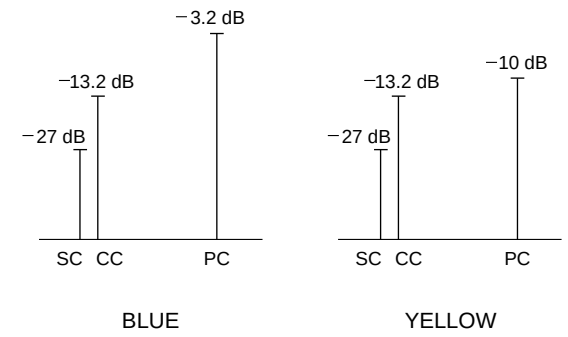



Fig.5 Typical signal-to-noise ratio as a function of IF input voltage.




SC = sound carrier, with respect to sync level.
CC = chrominance carrier, with respect to sync level.
PC = picture carrier, with respect to sync level.
The sound carrier levels are taking into account a sound shelf attenuation of 20 dB (SWIF G1962).

Fig.6 Input signal conditions.

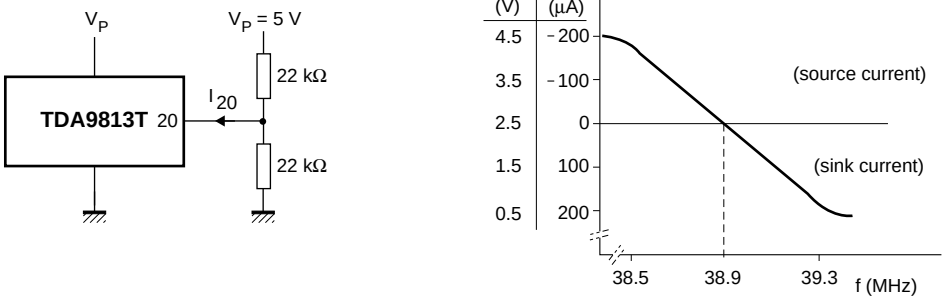



Fig.7 Measurement conditions and typical AFC characteristic.

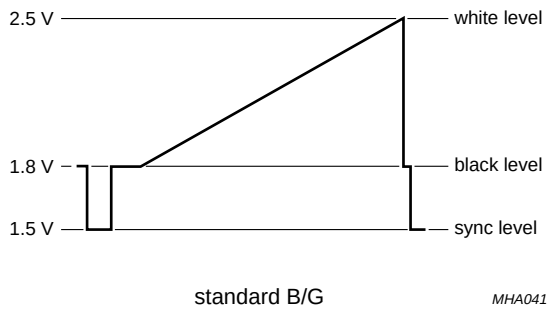



Fig.8 Typical video signal levels on output pin 18 (sound carrier **off**).

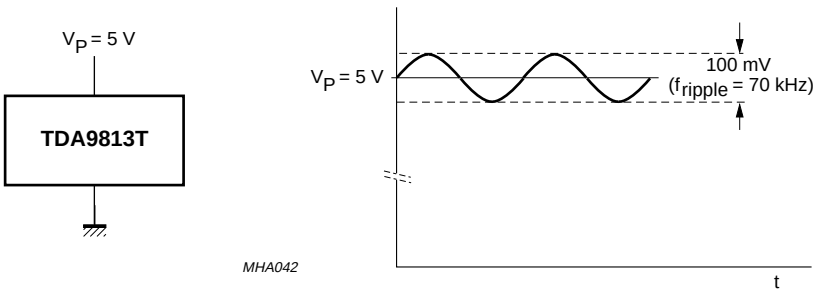



Fig.9 Ripple rejection condition.

**INTERNAL PIN CONFIGURATION**

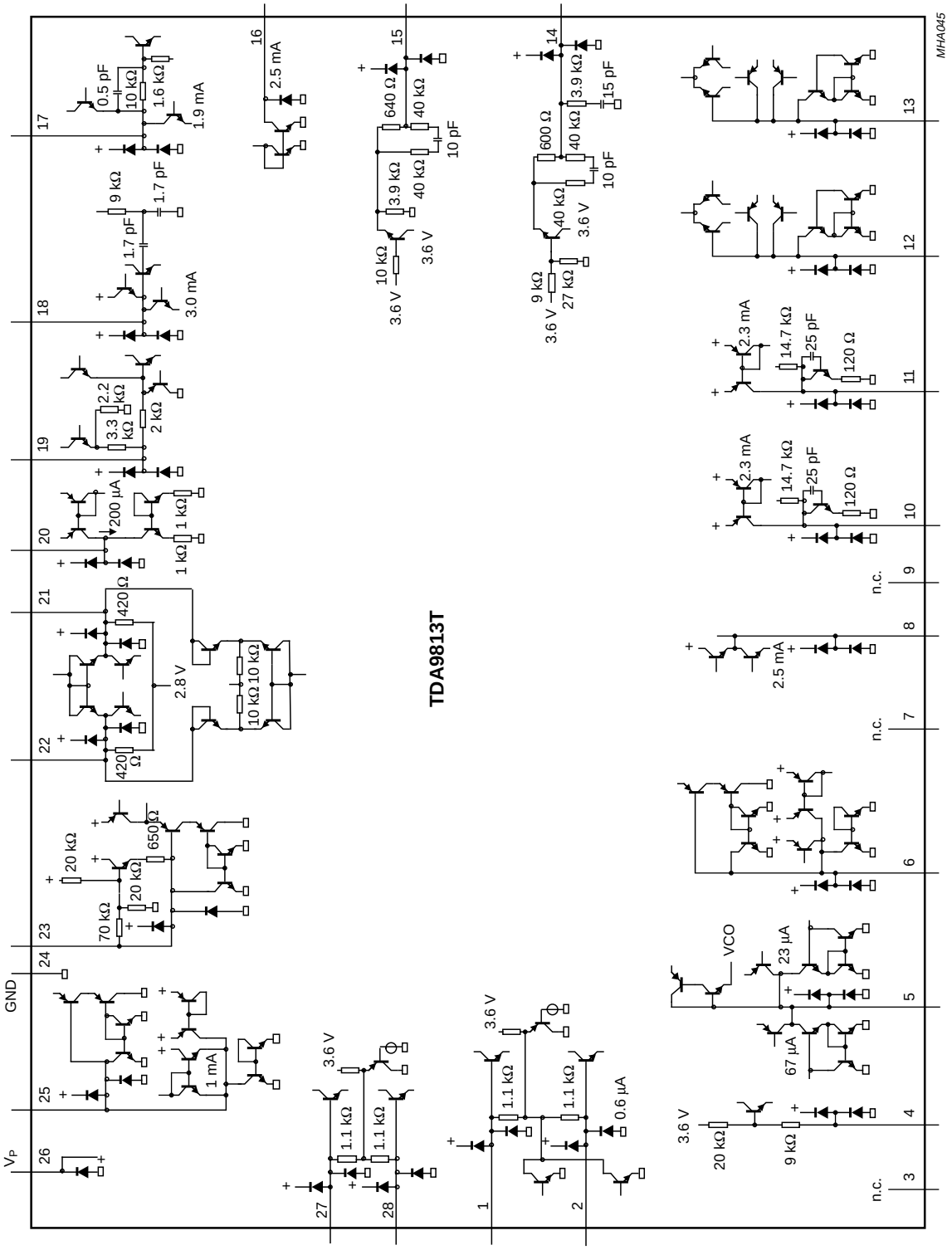



Fig.10 Internal circuitry.

**TEST AND APPLICATION INFORMATION**

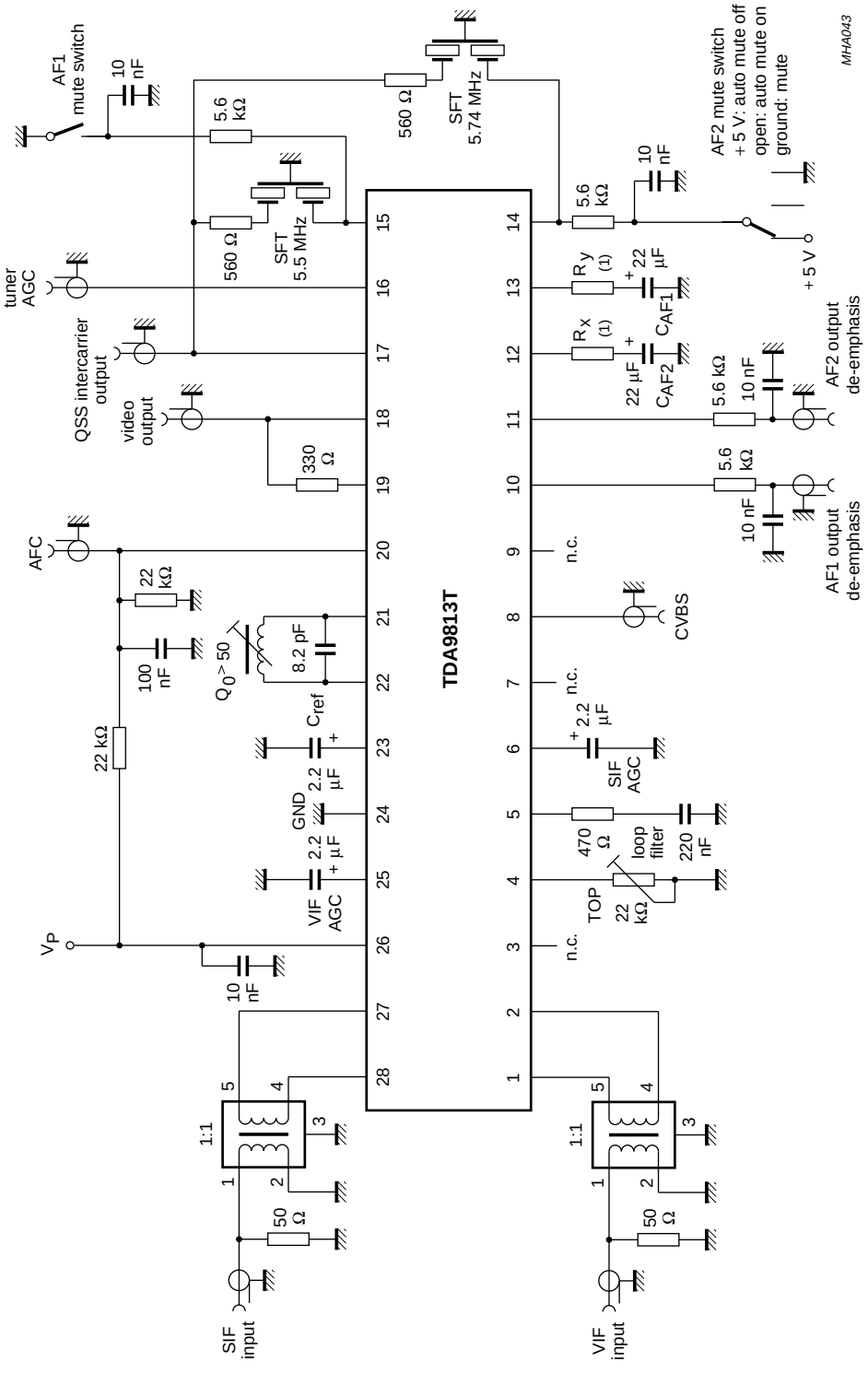



Fig.11 Test circuit.

(1) See note 18 of Chapter "Characteristics".

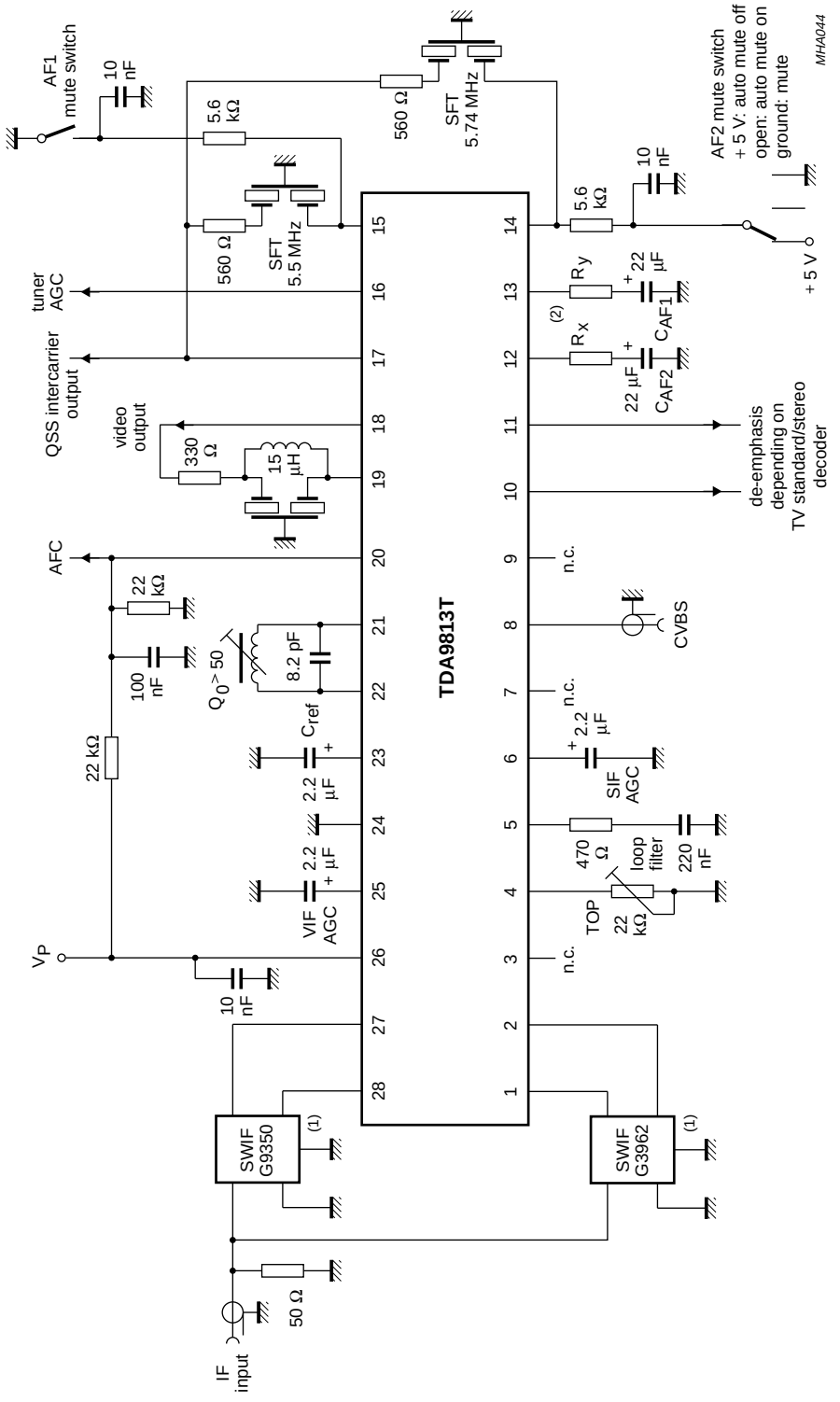
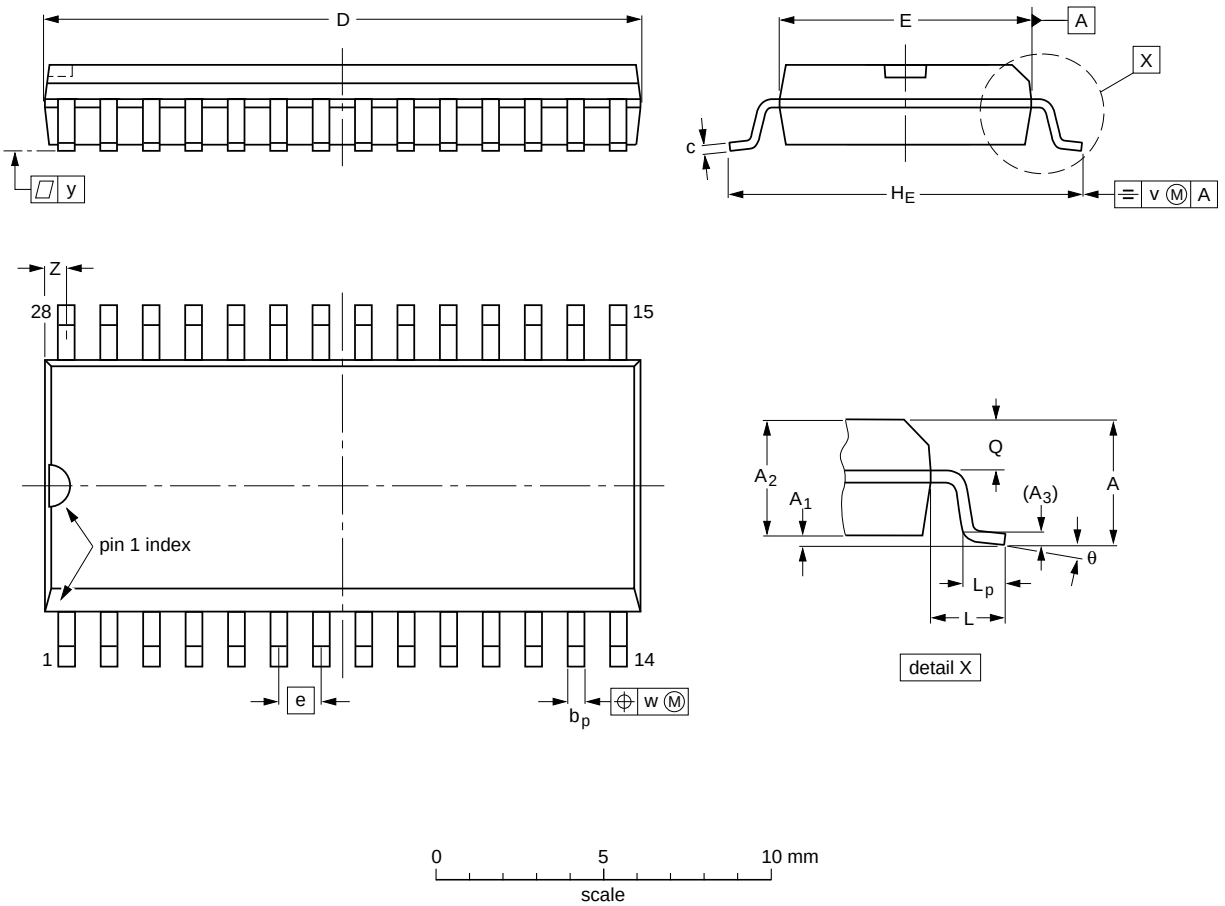



Fig.12 Application circuit.

(1) Depends on standard.
(2) See note 18 of Chapter "Characteristics".

## PACKAGE OUTLINE

**SO28: plastic small outline package; 28 leads; body width 7.5 mm** **SOT136-1**




**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) | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 2.65 | 0.30<br>0.10 | 2.45<br>2.25 | 0.25 | 0.49<br>0.36 | 0.32<br>0.23 | 18.1<br>17.7 | 7.6<br>7.4 | 1.27 | 10.65<br>10.00 | 1.4 | 1.1<br>0.4 | 1.1<br>1.0 | 0.25 | 0.25 | 0.1 | 0.9<br>0.4 | $8^o$<br>$0^o$ |
| inches | 0.10 | 0.012<br>0.004 | 0.096<br>0.089 | 0.01 | 0.019<br>0.014 | 0.013<br>0.009 | 0.71<br>0.69 | 0.30<br>0.29 | 0.050 | 0.42<br>0.39 | 0.055 | 0.043<br>0.016 | 0.043<br>0.039 | 0.01 | 0.01 | 0.004 | 0.035<br>0.016 | |

**Note**

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

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT136-1 | 075E06 | MS-013AE | | | | ~~91-08-13~~<br>95-01-24 |

## SOLDERING

### Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

### Reflow soldering

Reflow soldering techniques are suitable for all SO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

### Wave soldering

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

### Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

## DEFINITIONS

| **Data sheet status** | |
|---|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| **Limiting values** | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| **Application information** | |
| Where application information is given, it is advisory and does not form part of the specification. | |

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**NOTES**

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