

INTEGRATED CIRCUITS

DATA SHEET

TDA9880

Alignment-free multistandard vision
and FM sound IF-PLL demodulator

Product specification
Supersedes data of 1998 Aug 12
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Alignment-free multistandard vision and FM sound IF-PLL demodulator

TDA9880

FEATURES

- 5 V supply voltage
- Gain controlled wide-band Vision Intermediate Frequency (VIF) amplifier (AC-coupled)
- True synchronous demodulation with active carrier regeneration (very linear demodulation, good intermodulation figures, reduced harmonics and excellent pulse response)
- Fully integrated VIF Voltage Controlled Oscillator (VCO), alignment-free
- Digital acquisition help, VIF frequencies of 38.0, 38.9, 45.75 and 58.75 MHz
- 4 MHz reference frequency input [signal from Phase-Locked Loop (PLL) tuning system] or operating as crystal oscillator
- VIF Automatic Gain Control (AGC) detector for gain control, operating as peak sync detector, fast reaction time

- Precise fully digital Automatic Frequency Control (AFC) detector with 4-bit digital-to-analog converter
- Fully integrated sound carrier trap for 4.5, 5.5, 6.0 and 6.5 MHz, controlled by reference signal
- Alignment-free selective FM-PLL demodulator with high linearity and low noise
- Digital frequency control, sound carrier frequencies 4.5, 5.5, 6.0 and 6.5 MHz
- Stabilizer circuit for ripple rejection and to achieve constant output signals
- Electrostatic discharge (ESD) protection for all pins.

GENERAL DESCRIPTION

The TDA9880(T) is an integrated circuit for multistandard vision IF signal processing and FM demodulation in TV and VTR sets.

ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | |
|-------------|---------|--|----------|
| | NAME | DESCRIPTION | VERSION |
| TDA9880 | SDIP20 | plastic shrink dual in-line package; 20 leads (300 mil) | SOT325-1 |
| TDA9880T | SO20 | plastic small outline package; 20 leads; body width 7.5 mm | SOT163-1 |

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QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-------------------------|--|--|------|------------|------|-------------|
| V_P | supply voltage | note 1 | 4.5 | 5 | 5.5 | V |
| I_P | supply current | | 85 | 100 | 115 | mA |
| $V_{i(sens)(VIF)(rms)}$ | VIF input voltage sensitivity (RMS value) | -1 dB video at output | - | 50 | 100 | μ V |
| $G_{VIF(cr)}$ | VIF gain control range | see Fig.4 | 65 | 69 | - | dB |
| f_{VIF} | VIF frequencies | see Table 2 | - | 38.0 | - | MHz |
| | | | - | 38.9 | - | MHz |
| | | | - | 45.75 | - | MHz |
| | | | - | 58.75 | - | MHz |
| Δf_{VIF} | VIF frequency window of digital acquisition help | referenced to f_{VIF} | - | ± 2.38 | - | MHz |
| $V_{o(v)(p-p)}$ | video output signal voltage (peak-to-peak value) | sound carrier off; see Fig.10 | 1.7 | 2.0 | 2.3 | V |
| | | trap bypass mode; see Fig.10 | 0.95 | 1.10 | 1.25 | V |
| G_{dif} | differential gain | "NTC-7 Composite" | - | 2 | 5 | % |
| Φ_{dif} | differential phase | "NTC-7 Composite" | - | 2 | 4 | deg |
| $B_{v(-3dB)(trap)}$ | -3 dB video bandwidth including sound carrier trap | $C_L < 20$ pF; $R_L > 1$ k Ω ; AC load; note 2 $f_{trap} = 4.5$ MHz (M/N standard) | 3.95 | 4.05 | - | MHz |
| | | $f_{trap} = 5.5$ MHz (B/G standard) | 4.90 | 5.00 | - | MHz |
| α_{SC1} | trap attenuation at first sound carrier | M/N standard | 30 | 36 | - | dB |
| | | B/G standard | 30 | 36 | - | dB |
| S/N_W | weighted signal-to-noise ratio of video signal | see Fig.6; note 3 | 56 | 60 | - | dB |
| $PSRR_{13}$ | power supply ripple rejection at pin 13 | $f_{ripple} = 70$ Hz; video signal; grey level; see Fig.9 | 25 | 28 | - | dB |
| $B_{v(-1dB)}$ | -1 dB video bandwidth | $C_L < 20$ pF; $R_L > 1$ k Ω ; AC load; trap bypass mode | 5 | 6 | - | MHz |
| $I_{ch(max)(20)}$ | AGC maximum charge current at pin 20 | | 6 | 8 | 10 | μ A |
| $I_{dch(max)(20)}$ | AGC maximum discharge current at pin 20 | | 7.5 | 10 | 12.5 | μ A |
| $I_{sink(14)}$ | sink current of tuner AGC at pin 14 | maximum tuner gain reduction; $V_{14} = 1$ V; see Fig.4 | 450 | 600 | 750 | μ A |
| AFC_{stps} | AFC steepness $\Delta I_{1g}/\Delta f$ | | 0.85 | 1.05 | 1.25 | μ A/kHz |
| $I_{o(source)(19)}$ | AFC output source current at pin 19 | | 160 | 200 | 240 | μ A |
| $I_{o(sink)(19)}$ | AFC output sink current at pin 19 | | 160 | 200 | 240 | μ A |
| $V_{o(intc)(rms)}$ | intercarrier output voltage (RMS value) | $\frac{V_{i(SC)}}{V_{i(PC)}} = -24$ dB ; note 4 | - | 49 | - | mV |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|------|-----------|------|------|
| $B_{\text{intc}(-3\text{dB})(\text{ul})}$ | upper limit -3 dB intercarrier bandwidth | | 7.5 | 9 | – | MHz |
| $V_{\text{o(AF)}(8)(\text{rms})}$ | audio output signal voltage at pin 8 (RMS value) | 25 kHz FM deviation; 75 μs de-emphasis | 400 | 500 | 600 | mV |
| THD_8 | total harmonic distortion at pin 8 | | – | 0.15 | 0.5 | % |
| $B_{\text{AF}(-3\text{dB})}$ | -3 dB audio frequency bandwidth | without de-emphasis; dependent on loop filter at pin 4 | 100 | 120 | – | kHz |
| $\text{S/N}_{\text{W(AF)}}$ | weighted signal-to-noise ratio of audio signal | black picture | 50 | 56 | – | dB |
| | | white picture | 45 | 51 | – | dB |
| | | 6 kHz sine wave (black-to-white modulation) | 40 | 46 | – | dB |
| | | sound carrier subharmonics; $f = 2.25 \text{ MHz} \pm 3 \text{ kHz}$ | 35 | 40 | – | dB |
| $\alpha_{\text{AM}(\text{sup})}$ | AM suppression of FM demodulator | 75 μs de-emphasis; AM: $f = 1 \text{ kHz}$; $m = 0.3$ referenced to 25 kHz FM deviation | 40 | 46 | – | dB |
| PSRR_8 | power supply ripple rejection at pin 8 | $f_{\text{ripple}} = 70 \text{ Hz}$; see Fig.9 | 14 | 20 | – | dB |
| Δf_{FM} | frequency window of digital acquisition help for FM demodulator | | – | ± 225 | – | kHz |
| $f_{\text{ref}(15)}$ | frequency of reference signal at pin 15 | | – | 4.0 | – | MHz |
| $V_{\text{ref}(15)(\text{rms})}$ | amplitude of reference signal source at pin 15 (RMS value) | operation as input terminal | 80 | – | 400 | mV |

Notes

- Values of video and sound parameters can be decreased at $V_P = 4.5 \text{ V}$.
- The sound carrier frequencies (depending on TV standard) are attenuated by the integrated sound carrier traps (see Figs 13 to 18); $|H(s)|$ is the absolute value of transfer function.
- S/N is the ratio of black-to-white amplitude to the black level noise voltage (RMS value, pin 13). $B = 4.2 \text{ MHz}$ (M/N standard) or $B = 5.0 \text{ MHz}$ (B/G, I and D/K standard) weighted in accordance with "CCIR 567".
- The intercarrier output signal at pin 11 can be calculated by the following formula taking into account the internal video signal with 1.1 V (p-p) as a reference:

$$V_{\text{o(intc)}(\text{rms})} = 1.1 \text{ V (p-p)} \times \frac{1}{2\sqrt{2}} \times 10^{\frac{V_{\text{i(SC)}}(\text{dB}) + 6 \text{ dB} \pm 3 \text{ dB}}{20}}$$

where:

$\frac{1}{2\sqrt{2}}$ = correction term for RMS value, $\frac{V_{\text{i(SC)}}(\text{dB})}{V_{\text{i(PC)}}(\text{dB})}$ = sound-to-picture carrier ratio at VIF input (pins 1 and 2) in dB,

6 dB = correction term of internal circuitry and $\pm 3 \text{ dB}$ = tolerance of video output and intercarrier output amplitude $V_{\text{o(intc)}(\text{rms})}$.

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BLOCK DIAGRAM

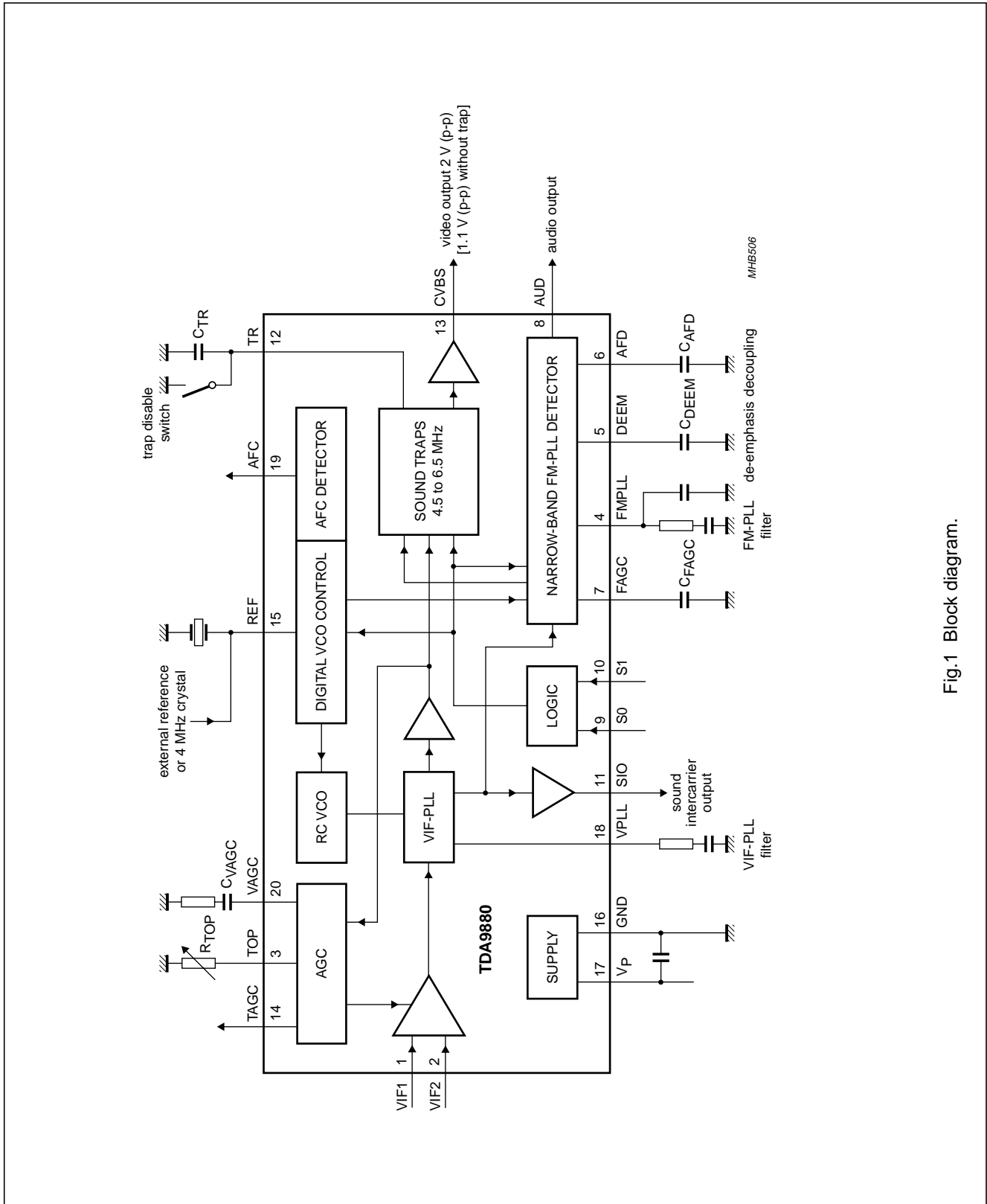


Fig.1 Block diagram.

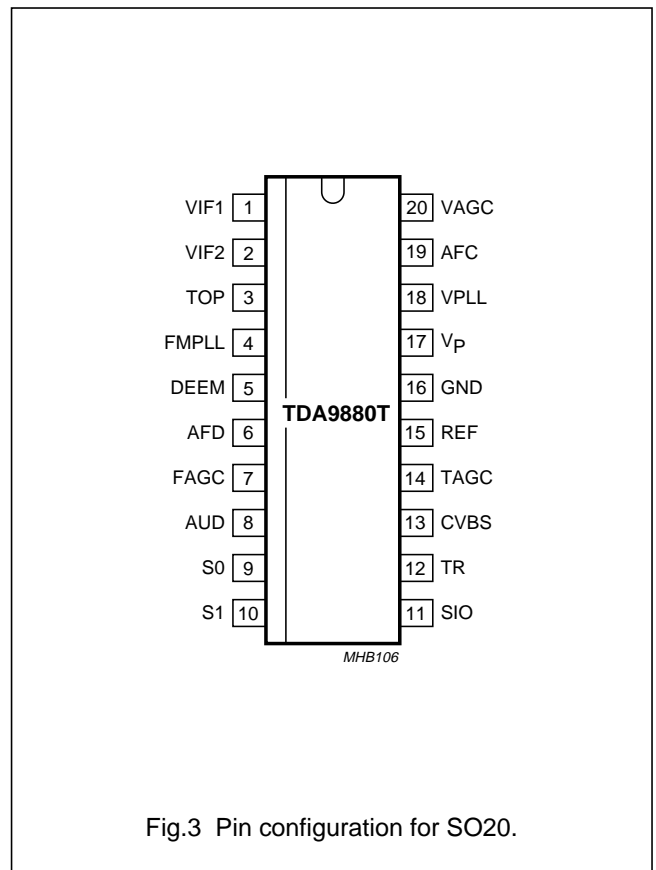
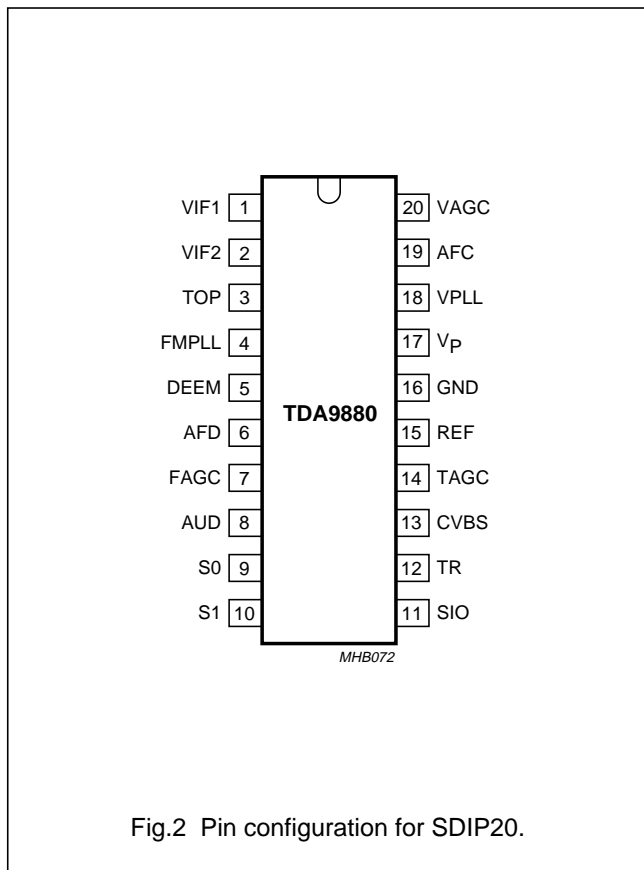
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PINNING

| SYMBOL | PIN | DESCRIPTION |
|--------|-----|--------------------------------|
| VIF1 | 1 | VIF differential input 1 |
| VIF2 | 2 | VIF differential input 2 |
| TOP | 3 | tuner AGC TakeOver Point (TOP) |
| FMPLL | 4 | FM-PLL filter |
| DEEM | 5 | de-emphasis capacitor |
| AFD | 6 | AF decoupling capacitor |
| FAGC | 7 | FM-PLL AGC capacitor |
| AUD | 8 | audio output |
| S0 | 9 | switch input S0 |
| S1 | 10 | switch input S1 |

| SYMBOL | PIN | DESCRIPTION |
|----------------|-----|----------------------------------|
| SIO | 11 | sound intercarrier output |
| TR | 12 | trap control |
| CVBS | 13 | video output |
| TAGC | 14 | tuner AGC output |
| REF | 15 | 4 MHz crystal or reference input |
| GND | 16 | ground supply |
| V _P | 17 | supply voltage (+5 V) |
| VPLL | 18 | VIF-PLL filter |
| AFC | 19 | AFC output |
| VAGC | 20 | VIF-AGC capacitor |



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FUNCTIONAL DESCRIPTION

Figure 1 shows the simplified block diagram of the integrated circuit. The integrated circuit comprises the following functional blocks:

1. VIF amplifier
2. Tuner-AGC and VIF-AGC
3. VIF-AGC detector
4. Frequency Phase-Locked Loop (FPLL) detector
5. VCO and Travelling Wave Divider (TWD)
6. Digital acquisition help and AFC
7. Video demodulator and amplifier
8. Sound carrier trap
9. Intercarrier mixer
10. FM demodulator and acquisition help
11. Audio amplifier
12. Internal voltage stabilizer.

VIF amplifier

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

Tuner-AGC and VIF-AGC

The AGC capacitor voltage is converted to an internal VIF gain control signal, and is fed to the tuner AGC to generate the tuner AGC output current at pin TAGC (open-collector output). The tuner AGC takeover point can be adjusted with R_{TOP} . This allows the tuner to be matched to the SAW filter in order to achieve the optimum IF input level.

VIF-AGC detector

The AGC detector generates the required VIF gain control voltage for constant video output by charging or discharging the AGC capacitor. Gain control is performed by sync level detection. The newly developed AGC circuit provides fast reaction time to cope with 'aeroplane fluttering'. The time constants for decreasing or increasing gain are nearly equal.

Frequency Phase-Locked Loop (FPLL) detector

The VIF amplifier output signal is fed into a Frequency Detector (FD) and into a Phase Detector (PD) 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 the frequency detector or the phase detector is converted into a DC voltage via the VIF-PLL filter, which controls the VCO frequency.

VCO and Travelling Wave Divider (TWD)

The Resistor Capacitor (RC) VCO operates as an integrated relaxation oscillator at double the picture carrier frequency. The control voltage required to tune the VCO to actually double the picture carrier frequency is generated by the FPLL detector and fed via the loop filter to the VCO control input terminal.

The oscillator signal is divided-by-two with a TWD which generates two differential output signals with a 90 degrees phase difference independent of the frequency.

Digital acquisition help and AFC

The integrated relaxation oscillator has a very wide frequency range from approximately 30 to 70 MHz (after the TWD). To prevent false locking of the FPLL and with respect to the catching range of the frequency detector of maximum ± 2.5 MHz, the Digital Acquisition Help (DAH) provides current into the loop filter until the VCO is in a frequency window of ± 2.3 MHz around the wanted VIF frequency. In this case the analog operating FPLL will lock the VCO to the VIF carrier and the acquisition help does not provide any current to the loop filter.

The principle of the digital acquisition help is as follows: the VCO is connected to a downcounter, which is preset depending on the required VIF frequency. The counting time, as well as the counter control, is derived from a 4 MHz reference signal. This signal can be supplied from the internal 4 MHz crystal oscillator or from the 4 MHz reference oscillator of an external tuning system. The counting result after a counting cycle corresponds to the actual VCO frequency.

The digital AFC is also derived from the counting result after a counting cycle by digital-to-analog converting the last four bits of the counter.

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.

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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 signal of 1.1 V (p-p) for nominal vision IF modulation is fed internally to the integrated sound carrier trap as well as to the VIF-AGC detector. The second stage of the video amplifier converts and amplifies the differential output signal from the sound carrier trap to the single-ended CVBS output signal at pin 13 with a 2 V (p-p) amplitude.

Noise clipping is provided. Furthermore the trap can be bypassed by the implemented input switch of the second amplifier stage, forced by connecting pin 12 to ground.

Sound carrier trap

The sound carrier trap consists of a reference filter, a phase detector and the sound trap itself.

A sound carrier reference signal is fed into the reference low-pass filter and is shifted by a nominal 90 degrees. The phase detector compares the original reference signal with the signal shifted by the reference filter and produces, at the external capacitor C_{TR} , a DC voltage by charging or discharging the capacitor with a current proportional to the phase difference between both signals, respectively to the frequency error of the integrated filters. The DC voltage is converted to currents which control the frequency position of the reference filter and the sound trap.

The sound trap itself is constructed of three separate traps to realize sufficient suppression of the first and second sound carrier. The right frequency position of the different standards is set by the sound carrier reference signal.

Intercarrier mixer

The intercarrier mixer is realized by a multiplier, operating in quadrature mode for suppression of low frequency video signals. The VIF amplifier output signal is fed to the intercarrier mixer and converted to an intercarrier frequency by the regenerated 90 degree picture carrier from the VCO. The mixer output signal is fed via a band-pass filter and amplifier for attenuation of the high frequency video signal components and carrier harmonics to the output pin 11. The intercarrier signal is fed also to the integrated FM demodulator.

FM demodulator and acquisition help

The FM demodulator is realized as a narrow-band PLL with external loop filter, which provides the necessary selectivity. To achieve good selectivity, a linear phase detector and constant input level are required.

The intercarrier signal from the intercarrier mixer is fed via a gain controlled amplifier to the phase detector and its output signal controls (via the loop filter) the integrated relaxation oscillator. The possible frequency range is from 4 to 7 MHz. As a result of locking the oscillator frequency tracks with the FM modulation of the input signal; therefore, the oscillator control voltage is superimposed by the AF voltage. In this way the FM-PLL operates as an FM demodulator. The AF voltage is present at the loop filter and is fed via a buffer with 0 dB gain to the audio amplifier.

The digital acquisition help operates in the same way as described in Section "Digital acquisition help and AFC".

Audio amplifier

The audio amplifier consists of two parts:

1. The AF preamplifier 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 30 dB. A DC operating point control circuit (pin 6) decouples the AF amplifier from the DC voltage of the PLL. The low-pass characteristic of the amplifier reduces the harmonics of the intercarrier signal at the sound output terminal. If required, a de-emphasis network can be realized by the amplifier output resistance and an external capacitor.
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 mute state, automatically controlled by the mute switching voltage from the digital acquisition help in order to avoid lock-in noise. During normal operation the automatic audio mute function is not active. Application of a 2.2 k Ω resistor between the intercarrier output (pin 11) and ground will activate the automatic audio mute function.

Internal voltage stabilizer

The band gap circuit internally generates a voltage of approximately 2.4 V, independent of the supply voltage and the temperature. A voltage regulator circuit, controlled by this voltage, produces a constant voltage of 3.55 V which is used as an internal reference voltage.

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LIMITING VALUES

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

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|------------------|--|---|--------|---------------|------------------|
| V_P | supply voltage | $I_P = 115 \text{ mA}$; $T_{\text{amb}} = 70 \text{ }^\circ\text{C}$; at maximum chip temperature of $125 \text{ }^\circ\text{C}$ | – | 5.5 | V |
| V_n | voltage at pins 1 to 4, 6 to 10, 12 and 17 to 20 pin 14 | | 0 0 | V_P 13.2 | V V |
| t_{sc} | short-circuit time to ground or V_P | | – | 10 | s |
| T_{stg} | storage temperature | | –25 | +150 | $^\circ\text{C}$ |
| T_{amb} | ambient temperature | | –20 | +70 | $^\circ\text{C}$ |
| V_{es} | electrostatic handling voltage for all pins | note 1 | –250 | +250 | V |
| | | note 2 | –3000 | +3000 | V |

Notes

1. Charge device model class A; machine model: discharging a 200 pF capacitor via a 0.75 μH inductance.
2. Charge device model class B; human body model: discharging a 100 pF capacitor via a 1.5 k Ω series resistor.

THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|----------------------|--|-------------|----------|------------|
| $R_{\text{th(j-a)}}$ | thermal resistance from junction to ambient TDA9880 (SDIP20) TDA9880T (SO20) | in free air | 85 85 | K/W K/W |

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CHARACTERISTICS

$V_P = 5\text{ V}$; $T_{\text{amb}} = 25\text{ °C}$; see Table 2 for input frequencies; M standard ($f_{\text{PC}} = 45.75\text{ MHz}$; $f_{\text{SC}} = 41.25\text{ MHz}$; PC/SC = 10 dB) is used for specification; $V_{i(\text{VIF})(\text{rms})} = 10\text{ mV}$ (sync level); IF input from 50 Ω via broadband transformer 1 : 1; DSB video modulation; 10% residual carrier; video signal in accordance with "NTC-7 Composite"; measurements taken in test circuit of Fig.19; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--|--|---|------|------------|------|------------------|
| Supply (pin 17) | | | | | | |
| V_P | supply voltage | note 1 | 4.5 | 5 | 5.5 | V |
| I_P | supply current | | 85 | 100 | 115 | mA |
| P_{tot} | total power dissipation | | – | 500 | 633 | mW |
| VIF amplifier (pins 1 and 2) | | | | | | |
| $V_{i(\text{sens})(\text{VIF})(\text{rms})}$ | VIF input voltage sensitivity (RMS value) | –1 dB video at output | – | 50 | 100 | μV |
| $V_{i(\text{max})(\text{rms})}$ | maximum input signal voltage (RMS value) | 1 dB video at output; note 2 | 110 | – | – | mV |
| ΔV_{int} | internal IF amplitude difference between picture and sound carrier | within AGC range; $\Delta f = 4.5\text{ MHz}$ | – | 0.7 | 1 | dB |
| $G_{\text{VIF}(\text{cr})}$ | VIF gain control range | see Fig.4 | 65 | 69 | – | dB |
| $B_{\text{VIF}(-3\text{dB})(\text{ll})}$ | lower limit –3 dB VIF bandwidth | | – | 15 | 25 | MHz |
| $B_{\text{VIF}(-3\text{dB})(\text{ul})}$ | upper limit –3 dB VIF bandwidth | | 70 | 100 | – | MHz |
| $R_{i(\text{dif})}$ | differential input resistance | note 3 | 1.7 | 2.2 | 2.7 | $\text{k}\Omega$ |
| $C_{i(\text{dif})}$ | differential input capacitance | note 3 | 1.2 | 1.7 | 2.5 | pF |
| V_I | DC input voltage | | – | 3.35 | – | V |
| FPLL and true synchronous video demodulator; note 4 | | | | | | |
| $f_{\text{VCO}(\text{max})}$ | maximum oscillator frequency for carrier regeneration | $f = 2f_{\text{PC}}$ | 120 | 140 | – | MHz |
| f_{VIF} | vision carrier operating frequencies | see Table 2 | – | 38.0 | – | MHz |
| | | | – | 38.9 | – | MHz |
| | | | – | 45.75 | – | MHz |
| | | | – | 58.75 | – | MHz |
| Δf_{VIF} | VIF frequency window of digital acquisition help | referenced to f_{VIF} | – | ± 2.38 | – | MHz |
| t_{acq} | acquisition time | BL = 70 kHz; note 5 | – | – | 30 | ms |
| $V_{i(\text{sens})(\text{VIF})(\text{rms})}$ | VIF input voltage sensitivity at pins 1 and 2 (RMS value) for PLL to be locked for C/N = 10 dB | maximum IF gain notes 6 and 7 | – | 30 | 70 | μV |
| | | | – | 100 | 140 | μV |
| SIGNAL AT PIN 18 | | | | | | |
| $I_{o(\text{source})(\text{PD})(\text{max})}$ | maximum source current of phase detector output | | – | 17 | – | μA |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|--|--|-------------|-----------|------|--------------------------|
| $I_{o(sink)(PD)(max)}$ | maximum sink current of phase detector output | | – | 17 | – | μA |
| $I_{o(source)(DAH)}$ | output source current of digital acquisition help | | – | 23 | – | μA |
| $I_{o(sink)(DAH)}$ | output sink current of digital acquisition help | | – | 23 | – | μA |
| $t_{W(min)(DAH)}$ | minimum pulse width of digital acquisition help current | | – | 64 | – | μs |
| $K_{O(VIF)}$ | VCO steepness $\Delta f_{VIF}/\Delta V_{18}$ | | – | 20 | – | MHz/V |
| $K_{D(VIF)}$ | phase detector steepness $\Delta I_{18}/\Delta \phi_{VIF}$ | | – | 23 | – | $\mu\text{A}/\text{rad}$ |
| Video output signal and sound carrier trap (pin 13; sound carrier off) | | | | | | |
| $V_{o(v)(p-p)}$ | video output signal voltage (peak-to-peak value) | see Fig.10 | 1.7 | 2.0 | 2.3 | V |
| V_{sync} | sync pulse voltage level | see Fig.10 | 1.15 | 1.35 | 1.55 | V |
| V_{zc} | zero carrier voltage level | see Fig.10 | 3.27 | 3.57 | 3.87 | V |
| $V_{v(clu)}$ | upper video clipping voltage level | | $V_P - 1.1$ | $V_P - 1$ | – | V |
| $V_{v(cll)}$ | lower video clipping voltage level | | – | 0.7 | 1.0 | V |
| R_o | output resistance | note 3 | – | – | 30 | Ω |
| $I_{bias(int)}$ | internal DC bias current for emitter-follower | | 2.0 | 2.5 | – | mA |
| $I_{o(source)(max)}$ | maximum AC and DC output source current | | 2.4 | – | – | mA |
| $I_{o(sink)(max)}$ | maximum AC and DC output sink current | | 1.4 | – | – | mA |
| ΔV_o | deviation of CVBS output signal voltage | 50 dB gain control | – | – | 0.5 | dB |
| | | 30 dB gain control | – | – | 0.1 | dB |
| $\Delta V_{o(bl)}$ | black level tilt | | – | – | 1 | % |
| G_{dif} | differential gain | "NTC-7 Composite" | – | 2 | 5 | % |
| ϕ_{dif} | differential phase | "NTC-7 Composite" | – | 2 | 4 | deg |
| $B_{v(-3dB)(trap)}$ | –3 dB video bandwidth including sound carrier trap | $C_L < 20 \text{ pF}; R_L > 1 \text{ k}\Omega;$ AC load; note 8 | | | | |
| | | $f_{trap} = 4.5 \text{ MHz}$ (M/N standard) | 3.95 | 4.05 | – | MHz |
| | | $f_{trap} = 5.5 \text{ MHz}$ (B/G standard) | 4.90 | 5.00 | – | MHz |
| | | $f_{trap} = 6.0 \text{ MHz}$ (I standard) | 5.2 | 5.50 | – | MHz |
| | | $f_{trap} = 6.5 \text{ MHz}$ (D/K standard) | 5.5 | 5.95 | – | MHz |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-------------------------------|--|--|------|------|------|------|
| α_{SC1} | trap attenuation at first sound carrier | M/N standard | 30 | 36 | – | dB |
| | | B/G standard | 30 | 36 | – | dB |
| | | I standard | 26 | 32 | – | dB |
| | | D/K standard | 26 | 32 | – | dB |
| $\alpha_{SC1(60\text{ kHz})}$ | trap attenuation at first sound carrier $f_{SC1} \pm 60\text{ kHz}$ | M/N standard | 21 | 27 | – | dB |
| | | B/G standard | 24 | 30 | – | dB |
| | | I standard | 20 | 26 | – | dB |
| | | D/K standard | 20 | 26 | – | dB |
| α_{SC2} | trap attenuation at second sound carrier | M/N standard | 21 | 27 | – | dB |
| | | B/G standard | 21 | 27 | – | dB |
| | | I standard | 12 | 18 | – | dB |
| | | D/K standard | 18 | 24 | – | dB |
| $\alpha_{SC2(60\text{ kHz})}$ | trap attenuation at second sound carrier $f_{SC2} \pm 60\text{ kHz}$ | M/N standard | 15 | 21 | – | dB |
| | | B/G standard | 15 | 21 | – | dB |
| | | I standard | 10 | 15 | – | dB |
| | | D/K standard | 13 | 18 | – | dB |
| $t_{d(g)(CC)}$ | group delay at chrominance carrier frequency | 3.58 MHz at M/N standard | 110 | 180 | 250 | ns |
| | | 4.43 MHz at B/G standard | 110 | 180 | 250 | ns |
| | | 4.43 MHz at I standard | – | 90 | 160 | ns |
| | | 4.28 MHz at D/K standard | – | 60 | 130 | ns |
| S/N_W | weighted signal-to-noise ratio | weighted in accordance with "CCIR 567"; see Fig.6; note 9 | 56 | 60 | – | dB |
| S/N_{UW} | unweighted signal-to-noise ratio | note 9 | 47 | 51 | – | dB |
| $\alpha_{d\text{blue}}$ | intermodulation attenuation at 'blue' | $f = 0.92\text{ MHz}$; see Fig.7; note 10 | 58 | 64 | – | dB |
| | | $f = 2.76\text{ MHz}$; see Fig.7; note 10 | 58 | 64 | – | dB |
| $\alpha_{d\text{yellow}}$ | intermodulation attenuation at 'yellow' | $f = 0.92\text{ MHz}$; see Fig.7; note 10 | 60 | 66 | – | dB |
| | | $f = 2.76\text{ MHz}$; see Fig.7; note 10 | 59 | 65 | – | dB |
| $\Delta V_{r(vc)(rms)}$ | residual vision carrier (RMS value) | fundamental wave and harmonics | – | 2 | 5 | mV |
| $\alpha_{H(sup)}$ | harmonics suppression in video signal | $C_L < 20\text{ pF}$; $R_L > 1\text{ k}\Omega$; AC load; note 11a | 35 | 40 | – | dB |
| $\alpha_{H(spur)}$ | spurious elements suppression in video signal | note 11b | 40 | – | – | dB |
| $PSRR_{13}$ | power supply ripple rejection at pin 13 | $f_{\text{ripple}} = 70\text{ Hz}$; video signal; grey level; see Fig.9 | 25 | 28 | – | dB |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|--|---|------|------|----------|-------------|
| Video output signal (pin 13; trap bypass mode; $V_{12} < 0.8$ V; sound carrier off); see Fig.10; note 12 | | | | | | |
| $V_{o(v)(p-p)}$ | video output signal voltage (peak-to-peak value) | see Fig.10 | 0.95 | 1.10 | 1.25 | V |
| V_{sync} | sync pulse voltage level | | 1.4 | 1.5 | 1.6 | V |
| V_{zc} | zero carrier voltage level | | 2.57 | 2.72 | 2.87 | V |
| $V_{v(clu)}$ | upper video clipping voltage level | | 3.1 | 3.25 | – | V |
| $V_{v(cll)}$ | lower video clipping voltage level | | – | 1.15 | 1.3 | V |
| $B_{v(-1dB)}$ | –1 dB video bandwidth | $C_L < 20$ pF; $R_L > 1$ k Ω ; AC load | 5 | 6 | – | MHz |
| $B_{v(-3dB)}$ | –3 dB video bandwidth | $C_L < 20$ pF; $R_L > 1$ k Ω ; AC load | 7 | 8 | – | MHz |
| S/N_W | weighted signal-to-noise ratio | weighted in accordance with "CCIR 567"; see Fig.6; note 9 | 56 | 60 | – | dB |
| S/N_{UW} | unweighted signal-to-noise ratio | note 9 | 49 | 53 | – | dB |
| Trap control (pin 12) | | | | | | |
| $I_{o(source)(max)}$ | maximum output source current | | 5 | 9 | 13 | μ A |
| $I_{o(sink)(max)}$ | maximum output sink current | | 9 | 13 | 17 | μ A |
| $K_{D(trap)}$ | frequency detector steepness $\Delta I_{12}/\Delta f_{trap}$ | $f_{trap} = 4.5$ MHz (M/N standard) | – | –8 | – | μ A/MHz |
| | | $f_{trap} = 6.5$ MHz (D/K standard) | – | –5.5 | – | μ A/MHz |
| V_{12} | operating voltage range of trap frequency control at pin 12 | | 1.5 | – | 3.5 | V |
| $I_{L(12)}$ | leakage current at pin 12 | $\Delta f_{trap} < \pm 25$ kHz | – | – | ± 80 | nA |
| CR_{stps} | control steepness $\Delta f_{trap}/\Delta V_{12}$ | $f_{trap} = 4.5$ MHz (M/N standard) | – | 4.5 | – | MHz/V |
| | | $f_{trap} = 6.5$ MHz (D/K standard) | – | 9 | – | MHz/V |
| V_{sw} | switching voltage | trap bypass mode active | – | – | 0.8 | V |
| I_{source} | source current | trap bypass mode active; $V_{12} \leq 0.8$ V | – | 185 | – | μ A |
| VIF-AGC detector (pin 20) | | | | | | |
| $I_{ch(max)(20)}$ | maximum charge current | | 6 | 8 | 10 | μ A |
| $I_{dch(max)(20)}$ | maximum discharge current | | 7.5 | 10 | 12.5 | μ A |
| $t_{res(inc)}$ | AGC response time to an increasing VIF step | 6 dB; note 13 | – | 2.0 | – | ms |
| | | 20 dB; note 13 | – | 2.5 | – | ms |
| | | 40 dB; note 13 | – | 4.0 | – | ms |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--|---|--|-------------|-------------|------|-------------|
| $t_{\text{res(dec)}}$ | AGC response time to a decreasing VIF step | -6 dB; note 13 | - | 1.0 | - | ms |
| | | -20 dB; note 13 | - | 1.5 | - | ms |
| | | -40 dB; note 13 | - | 2.5 | - | ms |
| V_{20} | gain control voltage range at pin 20 | | 1.7 | - | 3.6 | V |
| CR_{stps} | control steepness $\Delta G_{\text{IF}}/\Delta V_{20}$ | $V_{20} = 2.2$ to 3.2 V | - | -40 | - | dB/V |
| Tuner AGC (pin 14); see Figs 4 and 5 | | | | | | |
| $V_{i(\text{VIF})(\text{min})(\text{rms})}$ | VIF input signal voltage for minimum starting point of tuner takeover at pins 1 and 2 (RMS value) | $R_{\text{TOP}} = 22$ k Ω ; $I_{14} = 120$ μ A | - | 2 | 5 | mV |
| $V_{i(\text{VIF})(\text{max})(\text{rms})}$ | VIF input signal voltage for maximum starting point of tuner takeover at pins 1 and 2 (RMS value) | $R_{\text{TOP}} = 0$ Ω ; $I_{14} = 120$ μ A | 45 | 90 | - | mV |
| $QV_{i(\text{VIF})(\text{rms})}$ | tuner takeover point accuracy (RMS value) | $R_{\text{TOP}} = 12$ k Ω ; $I_{14} = 120$ μ A | 5 | 10 | 20 | mV |
| V_o | permissible output voltage | from external source | - | - | 13.2 | V |
| V_{sat} | saturation voltage | $I_{14} = 450$ μ A | - | - | 0.2 | V |
| $V_{i(\text{VIF})(\text{rms})}/\Delta T$ | variation of takeover point with temperature | $I_{14} = 120$ μ A | - | 0.03 | 0.07 | dB/K |
| I_{sink} | sink current | no tuner gain reduction; see Fig.4 $V_{14} = 12$ V | - | - | 0.75 | μ A |
| | | $V_{14} = 13.2$ V | - | - | 1.5 | μ A |
| | | maximum tuner gain reduction; $V_{14} = 1$ V; see Fig.4 | 450 | 600 | 750 | μ A |
| ΔG_{IF} | IF slip by automatic gain control | tuner gain current from 20% to 80% | - | 5 | 8 | dB |
| AFC circuit (pin 19); notes 14 and 15 | | | | | | |
| AFC_{stps} | AFC steepness $\Delta I_{19}/\Delta f_{\text{VIF}}$ | | 0.85 | 1.05 | 1.25 | μ A/kHz |
| Qf_{VIF} | accuracy of AFC circuit | $I_{o(19)} = 0$; $f_{15} = 4.0$ MHz | -20 | - | +20 | kHz |
| $V_{\text{sat(ul)}}$ | upper limit saturation voltage | see Fig.8 | $V_P - 0.6$ | $V_P - 0.3$ | - | V |
| $V_{\text{sat(ll)}}$ | lower limit saturation voltage | see Fig.8 | - | 0.3 | 0.6 | V |
| $I_{o(\text{source})}$ | output source current | | 160 | 200 | 240 | μ A |
| $I_{o(\text{sink})}$ | output sink current | | 160 | 200 | 240 | μ A |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--|---|---|------|-----------|------|---------------|
| Intercarrier mixer (pin 11) | | | | | | |
| $V_{o(intc)(rms)}$ | intercarrier output voltage (RMS value) | $\frac{V_{i(SC)}}{V_{i(PC)}} = -24 \text{ dB}$; note 16 | – | 49 | – | mV |
| $B_{intc(-3dB)(ul)}$ | upper limit –3 dB intercarrier bandwidth | | 7.5 | 9 | – | MHz |
| $\Delta V_{r(SC)(rms)}$ | residual sound carrier (RMS value) | fundamental wave and harmonics | – | 2 | – | mV |
| R_o | output resistance | note 3 | – | – | 70 | Ω |
| V_o | DC output voltage | | 1.85 | 2.05 | 2.35 | V |
| $I_{bias(int)}$ | internal DC bias current for emitter-follower | | 0.9 | 1.15 | – | mA |
| $I_{o(source)(max)}$ | maximum AC output source current | note 17 | 0.6 | 0.8 | – | mA |
| $I_{o(sink)(max)}$ | maximum AC output sink current | note 17 | 0.6 | 0.8 | – | mA |
| $I_{O(source)}$ | DC output source current | automatic audio mute function activated; note 17 | 0.75 | 0.93 | 1.20 | mA |
| FM-PLL demodulator; notes 15 and 18 to 21 | | | | | | |
| f_{intc} | sound intercarrier operating frequencies | see Table 2 | – | 4.5 | – | MHz |
| | | | – | 5.5 | – | MHz |
| | | | – | 6.0 | – | MHz |
| | | | – | 6.5 | – | MHz |
| Δf_{FM} | frequency window of digital acquisition help for FM demodulator | | – | ± 225 | – | kHz |
| $V_{FM(rms)}$ | IF intercarrier level for gain controlled operation of FM-PLL (RMS value) | corresponding PC/SC ratio at input pins 1 and 2 is 7 to 40 dB | 6 | – | 320 | mV |
| $V_{FM(lock)(rms)}$ | IF intercarrier level for lock-in of PLL (RMS value) | | – | – | 3 | mV |
| G_{FM} | IF intercarrier gain control range | | 30 | 34 | – | dB |
| SIGNAL AT PIN 7 | | | | | | |
| V_7 | gain control voltage range at pin 7 | | 1.5 | – | 3.5 | V |
| $I_{ch(max)(7)}$ | maximum charge current | | 1.5 | 2.2 | 2.9 | μA |
| $I_{dch(max)(7)}$ | maximum discharge current | | 1.5 | 2.2 | 2.9 | μA |
| CR_{stps} | control steepness $\Delta G_{FM}/\Delta V_7$ | $V_7 = 2.2 \text{ to } 2.7 \text{ V}$ | – | –30 | – | dB/V |
| SIGNAL AT PIN 8 | | | | | | |
| $V_{o(AF)(rms)}$ | audio output signal voltage (RMS value) | 25 kHz FM deviation | 400 | 500 | 600 | mV |
| | | 27 kHz FM deviation | 432 | 540 | 648 | mV |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-----------------------------|--|---|------|--------------------|--------------------|-------------|
| $V_{o(AF)(cl)(rms)}$ | audio output clipping signal voltage level (RMS value) | THD < 1.5% | 1.3 | 1.4 | – | V |
| THD | total harmonic distortion | | – | 0.15 | 0.5 | % |
| $\Delta V_{o(AF)}/\Delta T$ | temperature drift of AF output signal voltage | | – | 3×10^{-3} | 7×10^{-3} | dB/K |
| Δf_{AF} | audio frequency deviation | THD < 1.5%; note 22 | – | – | ± 55 | kHz |
| $B_{AF(-3dB)}$ | –3 dB audio frequency bandwidth | without de-emphasis; dependent on loop filter at pin 4; measured in accordance with Fig.19 | 80 | 100 | – | kHz |
| S/N_W | weighted signal-to-noise ratio of audio signal | black picture | 50 | 56 | – | dB |
| | | white picture | 45 | 51 | – | dB |
| | | 6 kHz sine wave (black-to-white modulation) | 40 | 46 | – | dB |
| | | sound carrier subharmonics; $f = 2.25 \text{ MHz} \pm 3 \text{ kHz}$ | 35 | 40 | – | dB |
| $\Delta V_{r(SC)(rms)}$ | residual sound carrier (RMS value) | fundamental wave and harmonics; without de-emphasis | – | – | 2 | mV |
| $\alpha_{AM(sup)}$ | AM suppression of FM demodulator | 75 μ s de-emphasis; AM: $f = 1 \text{ kHz}$; $m = 0.3$ referenced to 25 kHz FM deviation | 40 | 46 | – | dB |
| $PSRR_8$ | power supply ripple rejection at pin 8 | $f_{ripple} = 70 \text{ Hz}$; see Fig.9 | 14 | 20 | – | dB |
| SIGNAL AT PIN 4 | | | | | | |
| $I_{o(source)(PD)(max)}$ | maximum phase detector output source current | | – | 86 | – | μ A |
| $I_{o(sink)(PD)(max)}$ | maximum phase detector output sink current | | – | 80 | – | μ A |
| $I_{o(source)(DAH)}$ | output source current of digital acquisition help | | – | 110 | – | μ A |
| $I_{o(sink)(DAH)}$ | output sink current of digital acquisition help | | – | 110 | – | μ A |
| $t_W(DAH)$ | pulse width of digital acquisition help current | | – | 16 | – | μ s |
| $T_{cy}(DAH)$ | cycle time of digital acquisition help | | – | 64 | – | μ s |
| $K_{O(FM)}$ | VCO steepness $\Delta f_{FM}/\Delta V_4$ | | – | 3.3 | – | MHz/V |
| $K_{D(FM)}$ | phase detector steepness $\Delta I_4/\Delta \phi_{FM}$ | | – | 9 | – | μ A/rad |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|--|------|----------|-----------|------------|
| Audio amplifier (pins 5, 6 and 8) | | | | | | |
| $R_{O(5)}$ | output resistance at pin 5 | note 23 | 4.4 | 5.0 | 5.6 | k Ω |
| $V_{AF(5)(rms)}$ | audio signal (RMS value) at pin 5 | | – | 170 | – | mV |
| $V_{O(5)}$ | DC output voltage at pin 5 | | – | 2.37 | – | V |
| $R_{O(8)}$ | output resistance at pin 8 | note 3 | – | – | 200 | Ω |
| $V_{O(8)}$ | DC output voltage at pin 8 | | – | 2.37 | – | V |
| $I_{O(source)(max)(8)}$ | maximum AC and DC output source current at pin 8 | | – | – | 0.5 | mA |
| $I_{O(sink)(max)(8)}$ | maximum AC and DC output sink current at pin 8 | | – | – | 0.5 | mA |
| V_6 | DC decoupling voltage at pin 6 | dependent on intercarrier frequency f_{FM} | 1.5 | – | 3.3 | V |
| $I_{L(6)}$ | leakage current at pin 6 | $\Delta V_{O(8)} < \pm 50$ mV | – | – | ± 25 | nA |
| $I_{ch(max)(6)}$ | maximum charge current at pin 6 | | 1.15 | 1.5 | 1.85 | μ A |
| $I_{dch(max)(6)}$ | maximum discharge current at pin 6 | | 1.15 | 1.5 | 1.85 | μ A |
| $B_{AF(-3dB)}$ | –3 dB audio frequency bandwidth of audio amplifier | upper limit | 150 | – | – | kHz |
| | | lower limit; note 24 | – | – | 20 | Hz |
| $\alpha_{mute(8)}$ | mute attenuation of AF signal at pin 8 | note 17 | 70 | 75 | – | dB |
| ΔV_8 | DC jump voltage at pin 8 for switching AF output to mute state and vice versa | activated by digital acquisition help; note 17 | – | ± 50 | ± 150 | mV |
| Standard switch (pins 9 and 10); see Table 2 | | | | | | |
| V_i | input voltage | pin open-circuit; $I_{i(9,10)} < 0.1$ μ A | 2.8 | 3.0 | 3.6 | V |
| | | for LOW | 0 | – | 0.8 | V |
| | | for MID | 1.3 | 1.8 | 2.3 | V |
| | | for HIGH | 2.8 | – | V_P | V |
| $I_{i(source)}$ | input source current | $V_{i(9,10)} = 0$ V | 87 | 105 | 122 | μ A |
| | | $V_{i(9,10)} = 1.8$ V | 33 | 39 | 45 | μ A |
| Reference input (pin 15); note 25 | | | | | | |
| V_I | DC input voltage | | 2.3 | 2.6 | 2.9 | V |
| R_i | input resistance | | 2.5 | 3.0 | 3.5 | k Ω |
| R_{xtal} | resonance resistance of crystal | operation as crystal oscillator | – | – | 200 | Ω |
| C_x | pull-up/down capacitance | note 26 | – | – | – | pF |
| f_{ref} | frequency of reference signal | | – | 4.0 | – | MHz |
| Δf_{ref} | tolerance of reference frequency | note 15 | – | – | ± 0.1 | % |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-----------------------|---|-----------------------------|------|------|------|------------|
| $V_{\text{ref(rms)}}$ | amplitude of reference signal source (RMS value) | operation as input terminal | 80 | – | 400 | mV |
| $R_{\text{O(ref)}}$ | output resistance of reference source | | – | – | 4.7 | k Ω |
| C_K | decoupling capacitance to external reference source | operation as input terminal | 22 | 100 | – | pF |

Notes

- Values of video and sound parameters can be decreased at $V_P = 4.5$ V.
- This parameter is tested with 110 mV to ensure maximum input level.
- This parameter is not tested during production and is only given as application information for designing the television receiver.
- Loop bandwidth $BL = 70$ kHz (damping factor $d = 1.9$; calculated with sync level within gain control range). Calculation of the VIF-PLL filter can be done by use of the following formulae:

$$BL_{-3\text{ dB}} = \frac{1}{2\pi} K_O K_D R, \text{ valid for } d \geq 1.2$$

$$d = \frac{1}{2} R \sqrt{K_O K_D C},$$

where:

$$K_O = \text{VCO steepness} \left(\frac{\text{rad}}{\text{V}} \right) \text{ or } \left(2\pi \frac{\text{Hz}}{\text{V}} \right); K_D = \text{phase detector steepness} \left(\frac{\mu\text{A}}{\text{rad}} \right);$$

R = loop resistor; C = loop capacitor; $BL_{-3\text{ dB}}$ = loop bandwidth for -3 dB; d = damping factor.

- $V_{i(\text{VIF})\text{(rms)}}$ = 10 mV; $\Delta f = 1$ MHz (VCO frequency offset related to picture carrier frequency); white picture video modulation.
- $V_{i(\text{VIF})}$ signal for nominal video signal.
- Broadband transformer at VIF input. The C/N ratio at VIF input is defined as the VIF input signal (sync level, RMS value) related to a superimposed 4.2 MHz band-limited white noise signal (RMS value); white picture video modulation.
- The sound carrier frequencies (depending on TV standard) are attenuated by the integrated sound carrier traps (see Figs 13 to 18); $|H(s)|$ is the absolute value of transfer function.
- S/N is the ratio of black-to-white amplitude to the black level noise voltage (RMS value, pin 13).
 $B = 4.2$ MHz (M/N standard) or $B = 5.0$ MHz (B/G, I and D/K standard).
- The intermodulation figures are defined:

$$\alpha d_{0.92} = 20 \log \left(\frac{V_0 \text{ at } 3.58 \text{ MHz}}{V_0 \text{ at } 0.92 \text{ MHz}} \right) + 3.6 \text{ dB}; \alpha d_{0.92} \text{ value at } 0.92 \text{ MHz referenced to black or white signal};$$

$$\alpha d_{2.76} = 20 \log \left(\frac{V_0 \text{ at } 3.58 \text{ MHz}}{V_0 \text{ at } 2.76 \text{ MHz}} \right); \alpha d_{2.76} \text{ value at } 2.76 \text{ MHz referenced to chrominance carrier}.$$

- Measurements taken with SAW filter M1963M (sound shelf: 20 dB); loop bandwidth $BL = 70$ kHz.
 - Modulation Vestigial Side-Band (VSB); sound carrier off; $f_{\text{video}} > 0.5$ MHz.
 - Sound carrier on; $f_{\text{video}} = 10$ kHz to 10 MHz.
- The sound carrier trap can be disabled by switching pin 12 to ground (< 0.8 V). In this way the full composite video spectrum appears at pin 13. The amplitude is 1.1 V (p-p).
- Response time valid for a VIF input level range of 200 μ V to 70 mV.

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14. To match the AFC output signal to different tuning systems a current source output is provided. The test circuit is given in Fig.8. The AFC steepness can be changed by resistors R1 and R2.
15. The tolerance of the reference frequency determines the accuracy of the VIF AFC, FM demodulator centre frequency and maximum FM deviation.
16. The intercarrier output signal at pin 11 can be calculated by the following formula taking into account the internal video signal with 1.1 V (p-p) as a reference:

$$V_{o(intc)(rms)} = 1.1 \text{ V (p-p)} \times \frac{1}{2\sqrt{2}} \times 10^{\frac{V_{i(SC)}(dB) + 6 \text{ dB} \pm 3 \text{ dB}}{20} - \frac{V_{i(PC)}}{20}}$$

where:

$\frac{1}{2\sqrt{2}}$ = correction term for RMS value, $\frac{V_{i(SC)}}{V_{i(PC)}}(dB)$ = sound-to-picture carrier ratio at VIF input (pins 1 and 2) in dB,

6 dB = correction term of internal circuitry and $\pm 3 \text{ dB}$ = tolerance of video output and intercarrier output amplitude $V_{o(intc)(rms)}$.

17. For normal operation no DC load at pin 11 is allowed, so the automatic audio mute function is not active. By connecting a 2.2 k Ω resistor between pin 11 and ground the automatic audio mute function will be activated. With this application also the series capacitor C_S of the loop filter at pin 4 should be changed from 33 nF to 4.7 nF.
18. Calculation of the FM-PLL filter can be done approximately by use of the following formulae:

$$f_o = \frac{1}{2\pi} \sqrt{\frac{K_O K_D}{C_P}}$$

$$\vartheta = \frac{1}{2R \sqrt{K_O K_D C_P}}$$

$$BL_{-3 \text{ dB}} = f_o (1.55 - \vartheta^2)$$

The formulae are only valid under the following conditions:

$\vartheta \leq 1$ and $C_S > 5C_P$

where:

K_O = VCO steepness $\left(\frac{\text{rad}}{\text{V}}\right)$ or $\left(2\pi \frac{\text{Hz}}{\text{V}}\right)$; K_D = phase detector steepness $\left(\frac{\mu\text{A}}{\text{rad}}\right)$;

R_S = loop resistor; C_S = series capacitor; C_P = parallel capacitor; f_o = natural frequency of PLL;

$BL_{-3 \text{ dB}}$ = loop bandwidth for -3 dB ; ϑ = damping factor. For examples see Table 1.

19. For all S/N measurements the used vision IF modulator requires an incidental phase modulation for black-to-white jump of less than 0.5 degrees.
20. Measurements taken with SAW filter M1963M (Siemens) for vision and sound IF (sound shelf: 20 dB). Picture-to-sound carrier ratio of transmitter: PC/SC = 10 dB. Input level (at pins 1 and 2) $V_{i(VIF)(rms)} = 10 \text{ mV}$ (sync level), 25 kHz FM deviation for sound carrier, $f_{AF} = 400 \text{ Hz}$. Measurement in accordance with "CCIR 468-4". De-emphasis = 75 μs .
21. The PC/SC ratio 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.
22. Measured with an FM deviation of 25 kHz, the typical AF output signal is 500 mV (RMS). By using $R_x = 20 \text{ k}\Omega$ the AF output signal is attenuated by 6 dB, so 250 mV (RMS). For handling an FM deviation of more than 55 kHz the AF output signal has to be reduced by using R_x in order to avoid clipping (THD < 1.5%). For an FM deviation up to 100 kHz an attenuation of 6 dB is recommended.
23. $C_{DEEM} = 10 \text{ nF}$ results in $\tau = 50 \mu\text{s}$ and $C_{DEEM} = 15 \text{ nF}$ results in $\tau = 75 \mu\text{s}$.

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24. The lower limit of audio bandwidth depends on the value of the capacitor at pin 6. A value of $C_{AFD} = 470$ nF leads to $f_{AF(-3\text{ dB})} \approx 20$ Hz and $C_{AFD} = 220$ nF leads to $f_{AF(-3\text{ dB})} \approx 40$ Hz.
25. The reference input pin 15 is able to operate as a 1-pin crystal oscillator as well as an input terminal with external reference signal, e.g. from the tuning system.
26. The value of C_x determines the accuracy of the resonance frequency of the crystal. It depends on the type of crystal used.

Table 1 Examples to note 18 of Chapter "Characteristics"

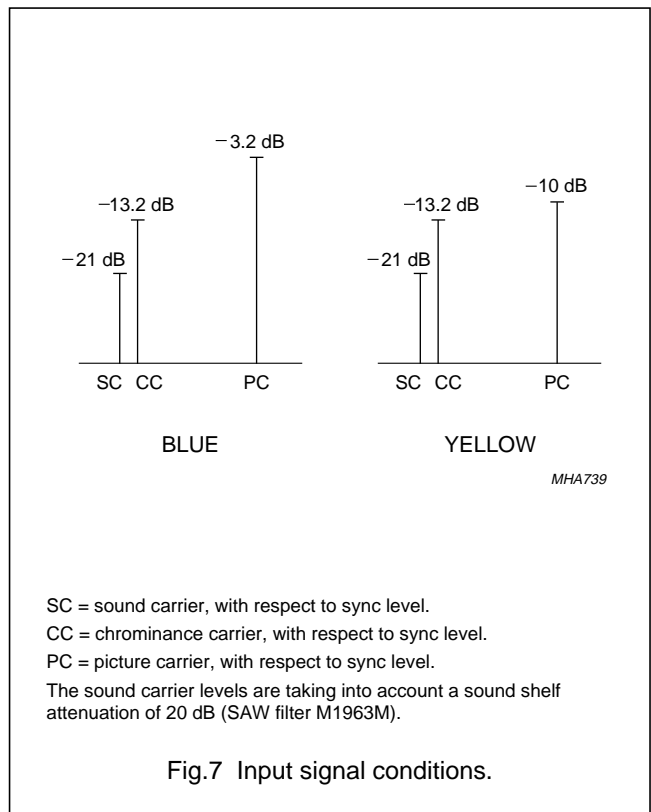
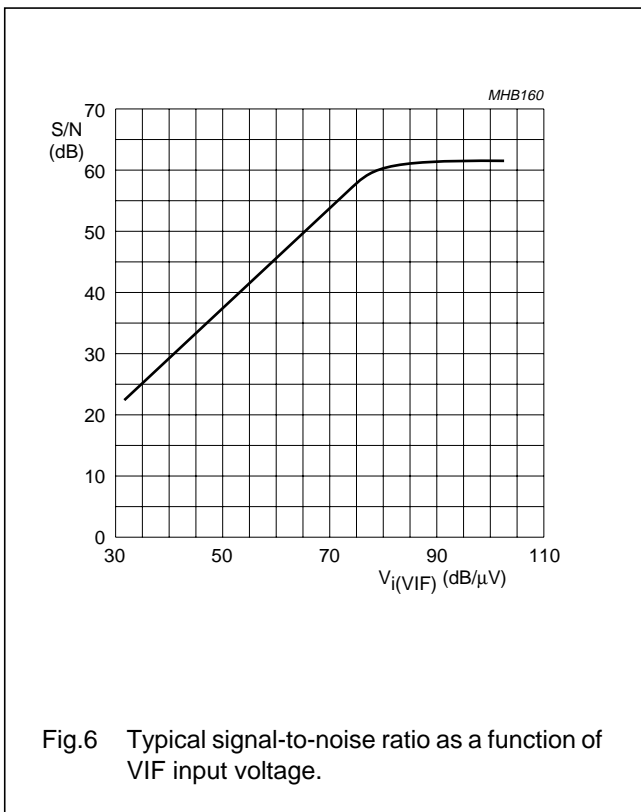
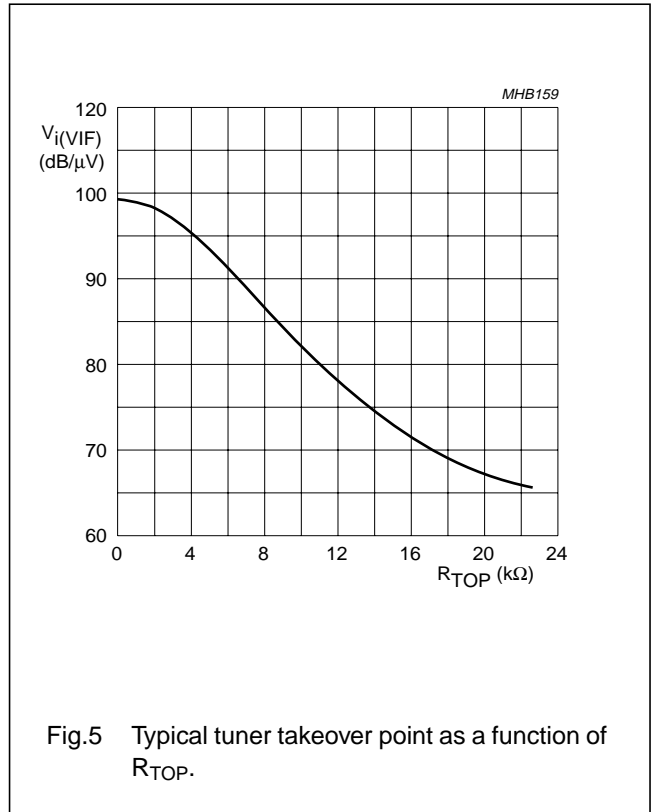
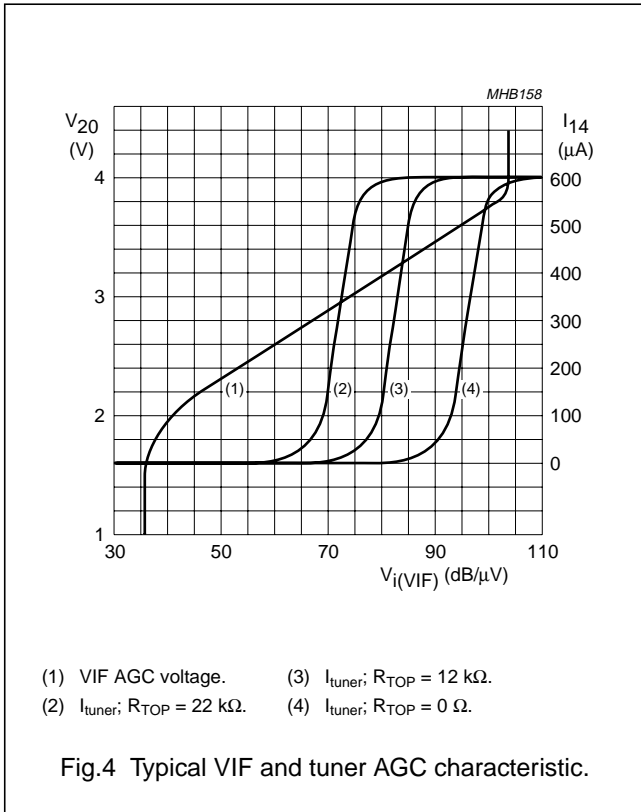
| BL _{-3 dB} (kHz) | C _S (nF) | C _P (pF) | R (kΩ) | ϑ |
|---------------------------|---------------------|---------------------|--------|-----|
| 100 | 33 | 820 | 2.7 | 0.5 |
| 160 | 33 | 330 | 3.9 | 0.5 |

Table 2 Standard switch settings

| S0 | S1 | f _{VIF} (MHz) | f _{intc} (MHz) | STANDARD | REMARK |
|------|------|------------------------|-------------------------|----------|----------------|
| LOW | LOW | 38.9 | 5.5 | B/G | Europe |
| LOW | MID | 38.9 | 6.5 | D/K | |
| LOW | HIGH | 38.9 | 6.0 | I | United Kingdom |
| MID | LOW | 38.0 | 5.5 | B/G | |
| MID | MID | 38.0 | 6.0 | I | |
| MID | HIGH | 38.0 | 6.5 | D/K | |
| HIGH | LOW | 45.75 | 4.5 | M/N | USA |
| HIGH | MID | 38.0 | 4.5 | M | |
| HIGH | HIGH | 58.75 | 4.5 | M | Japan |

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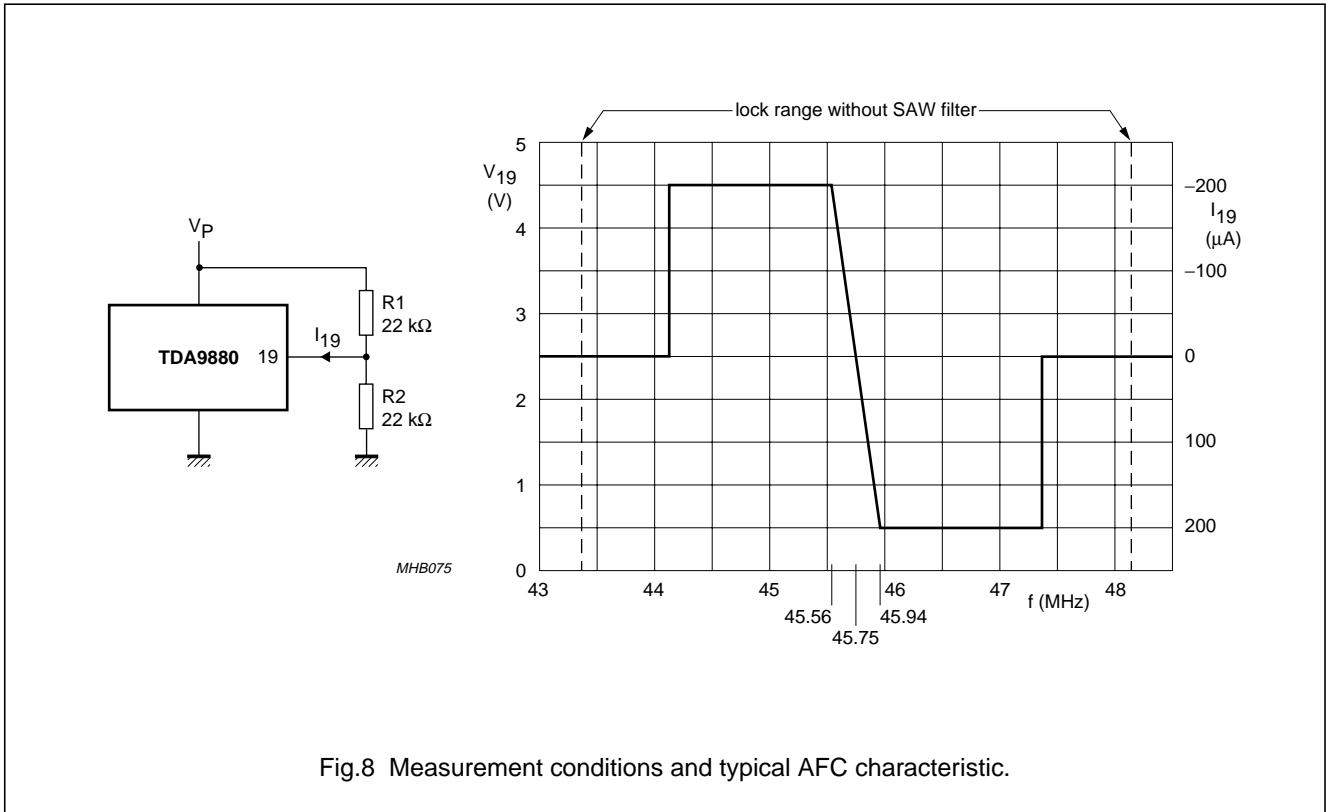


Fig.8 Measurement conditions and typical AFC characteristic.

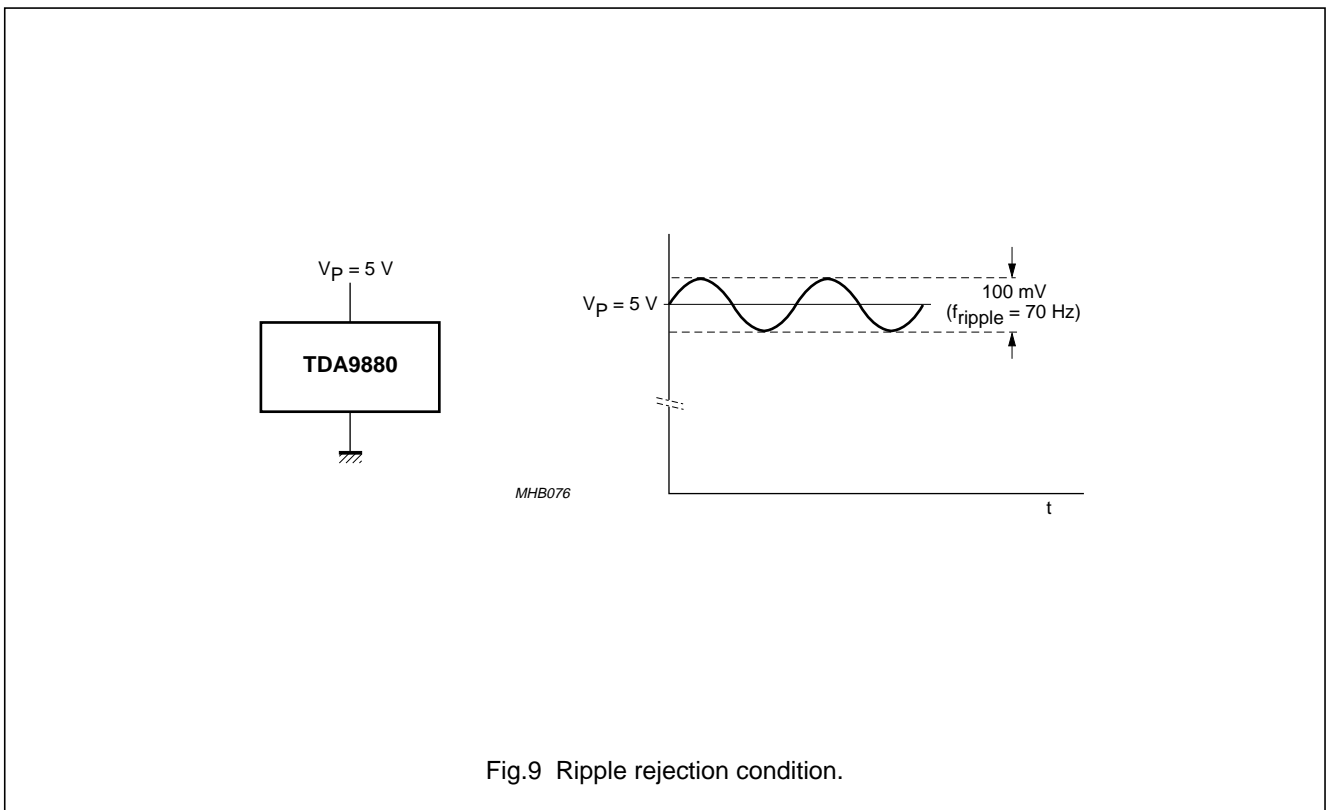


Fig.9 Ripple rejection condition.

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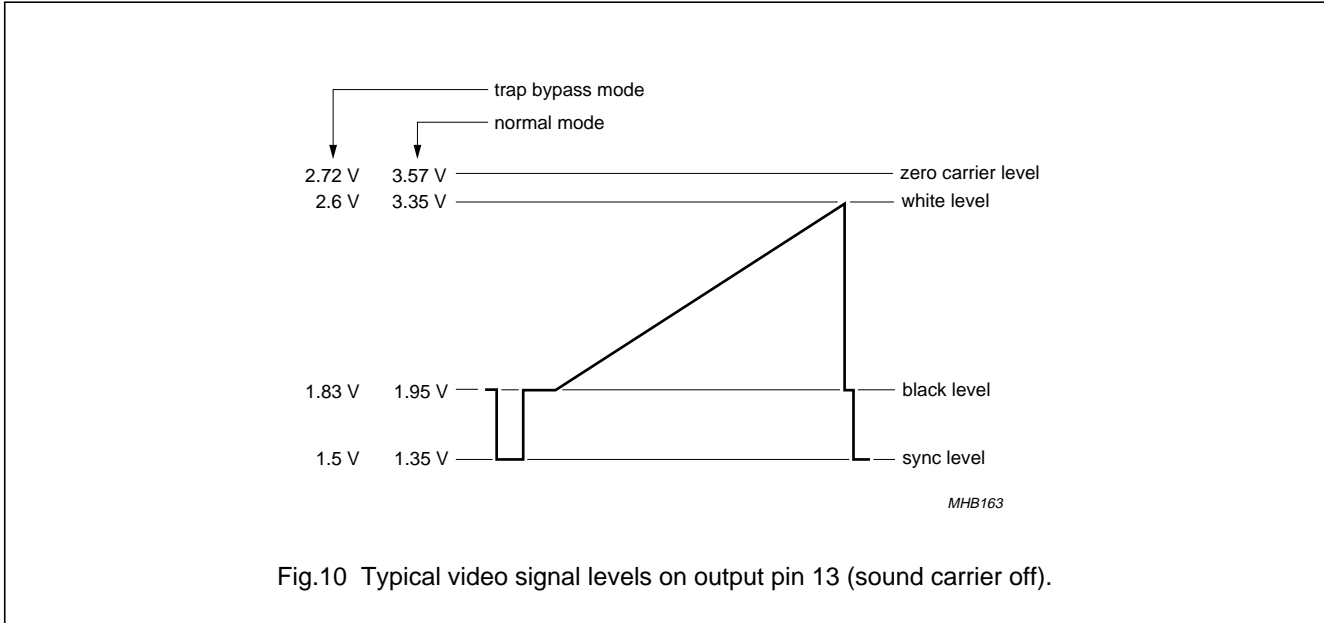


Fig.10 Typical video signal levels on output pin 13 (sound carrier off).

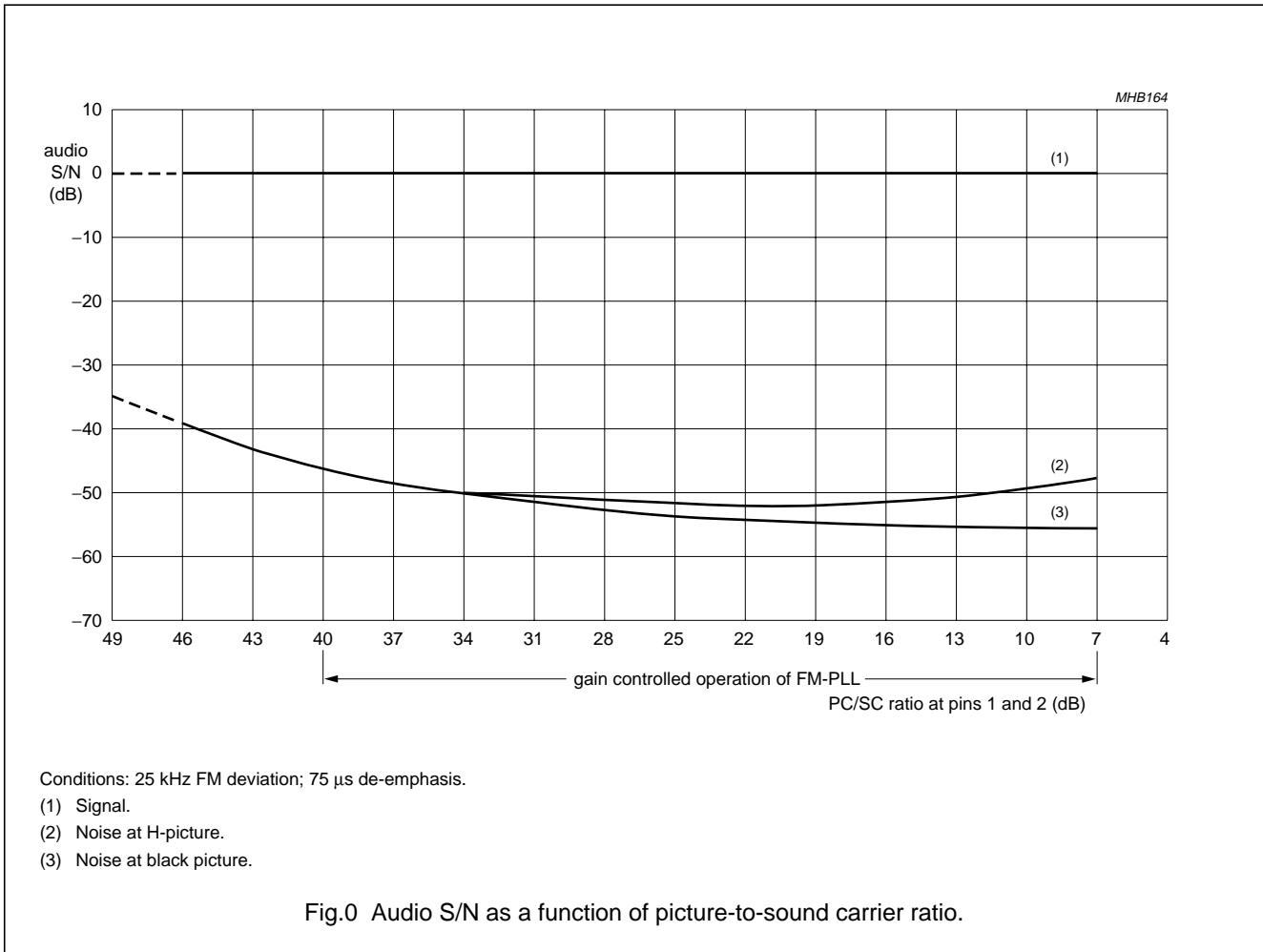
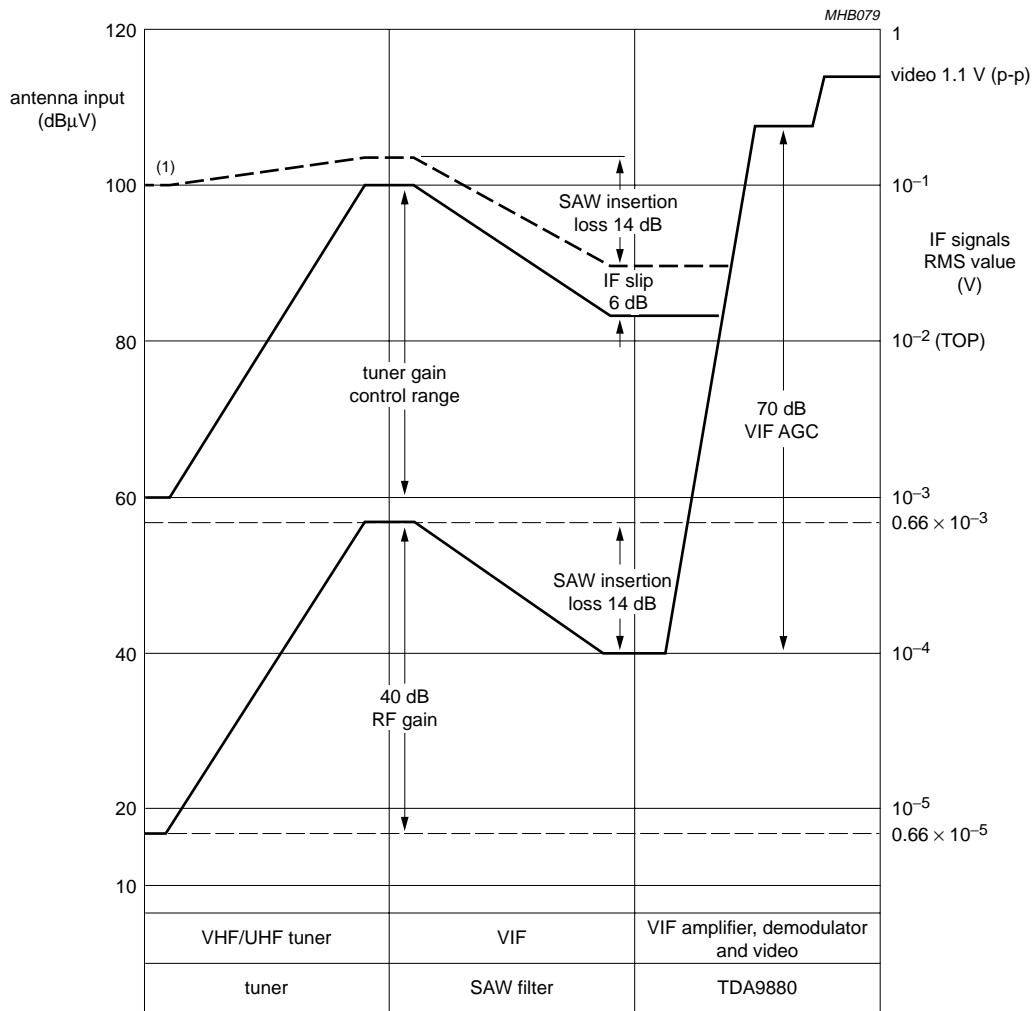


Fig.0 Audio S/N as a function of picture-to-sound carrier ratio.

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(1) Depends on TOP.

Fig.12 Front-end level diagram.

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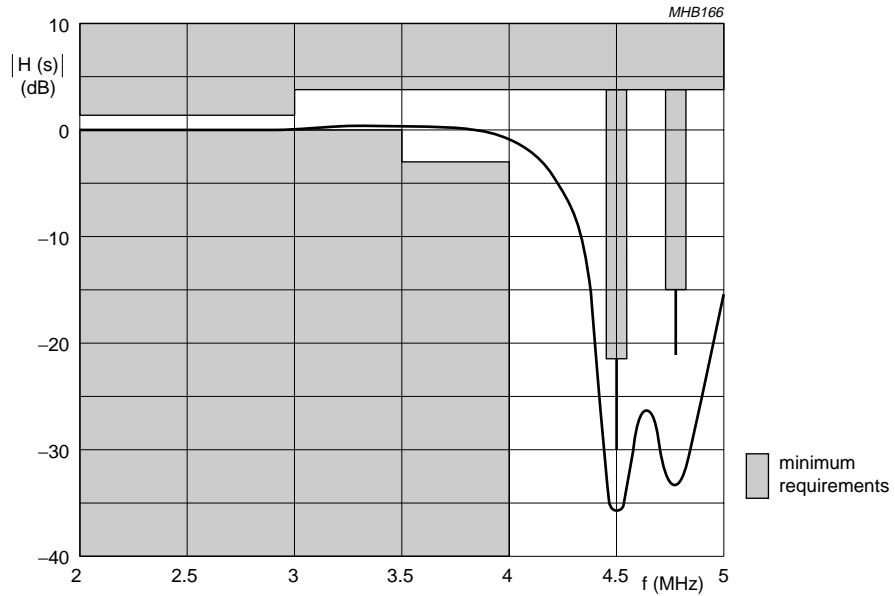
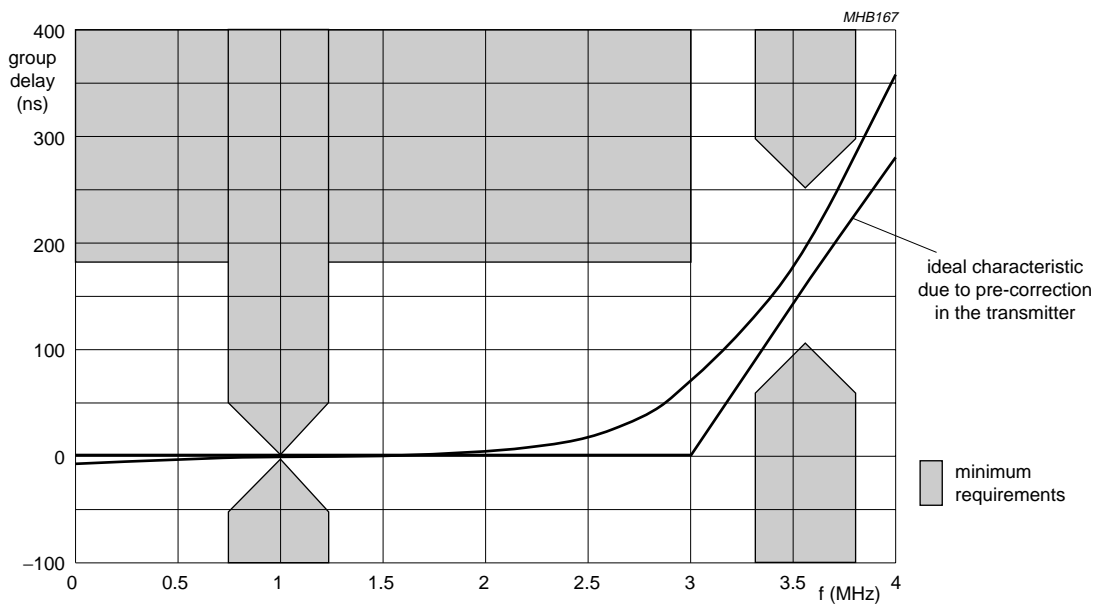


Fig.13 Typical amplitude response for sound trap at M/N standard (including Korea).



Remark: overall delay is not shown, here the maximum ripple is specified.

Fig.14 Typical group delay for sound trap at M/N standard.

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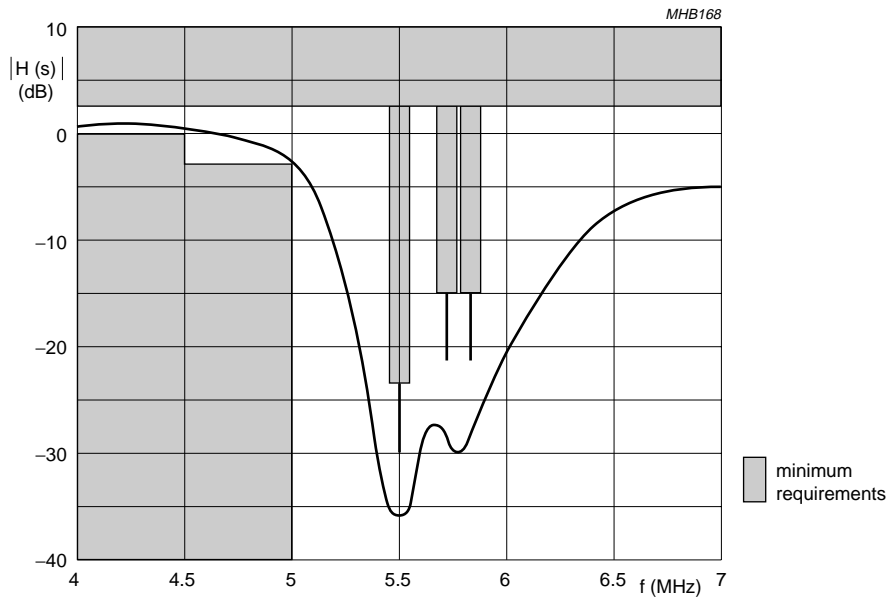
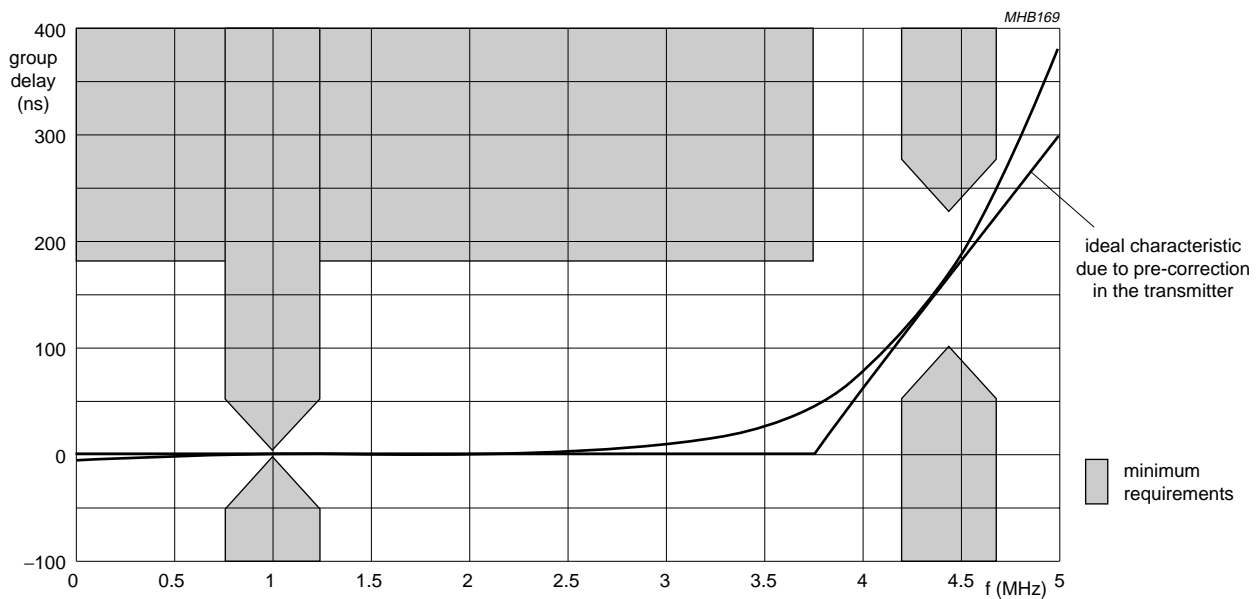


Fig.15 Typical amplitude response for sound trap at B/G standard.



Remark: Overall delay is not shown, here the maximum ripple is specified.

Fig.16 Typical group delay for sound trap at B/G standard.

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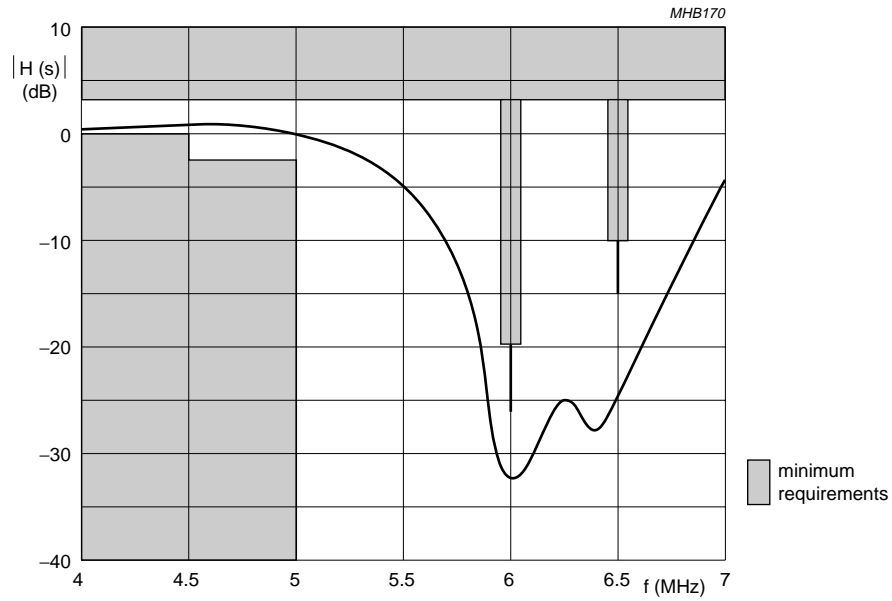


Fig.17 Typical amplitude response for sound trap at I standard.

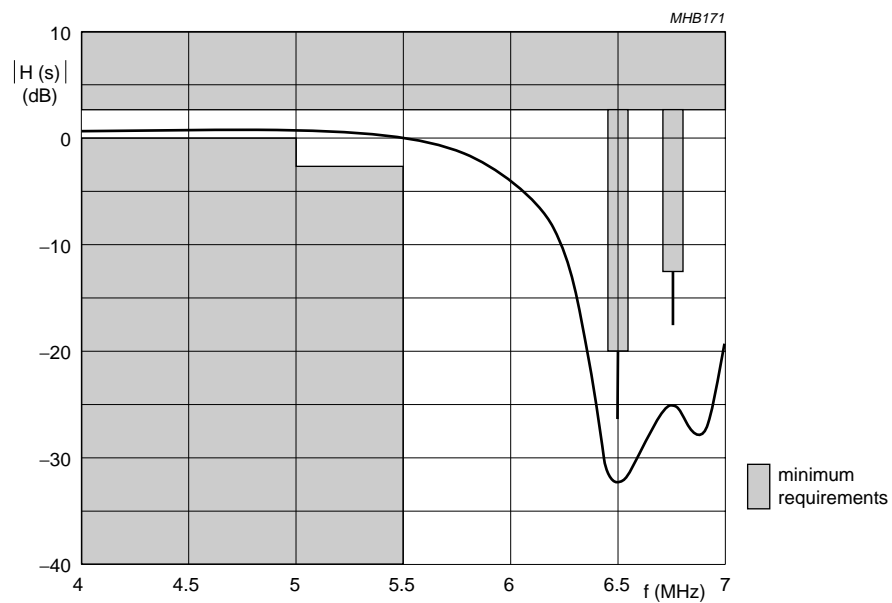


Fig.18 Typical amplitude response for sound trap at D/K standard.

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TEST CIRCUIT

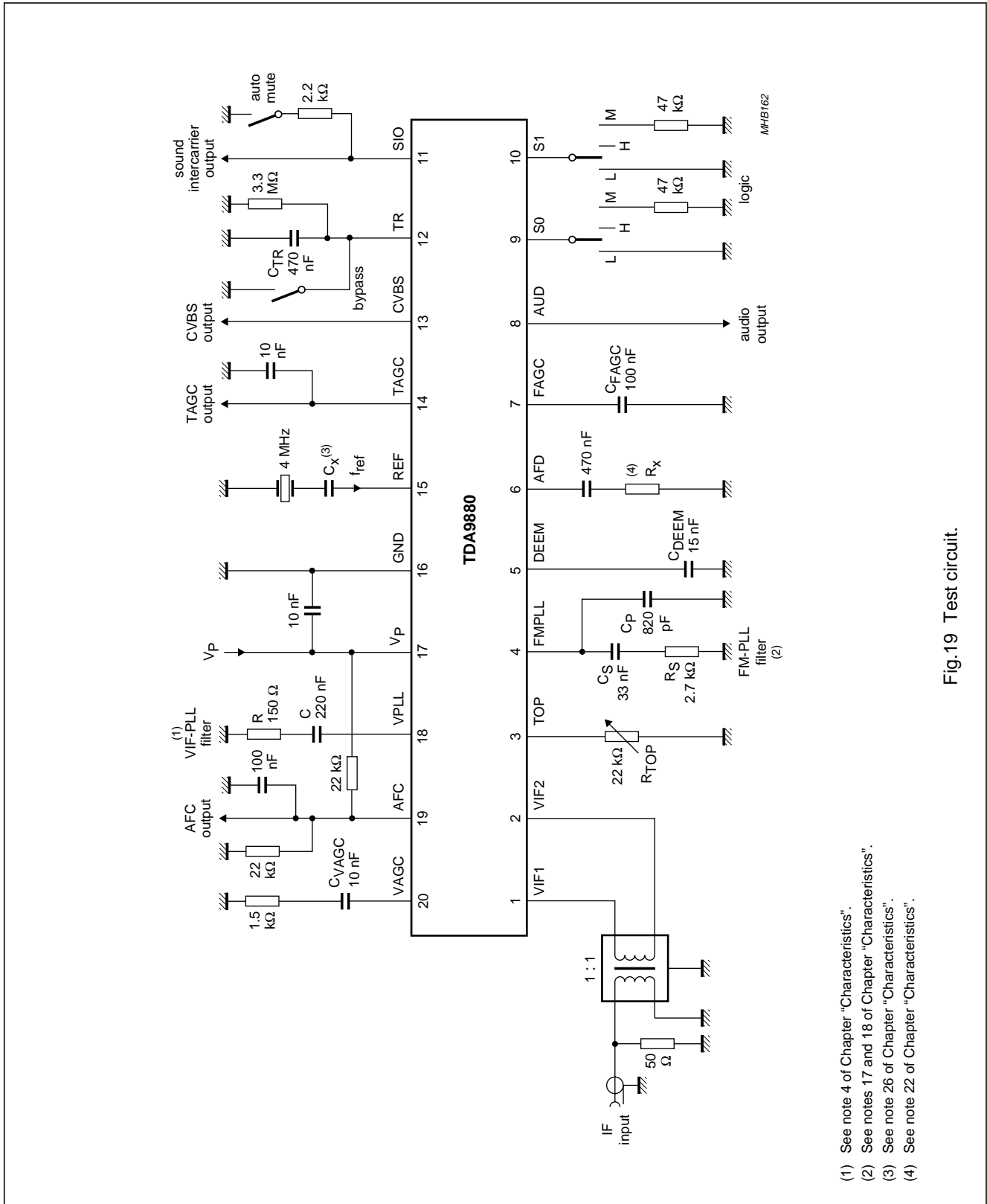


Fig. 19 Test circuit.

- (1) See note 4 of Chapter "Characteristics".
- (2) See notes 17 and 18 of Chapter "Characteristics".
- (3) See note 26 of Chapter "Characteristics".
- (4) See note 22 of Chapter "Characteristics".

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INTERNAL PIN CONFIGURATIONS

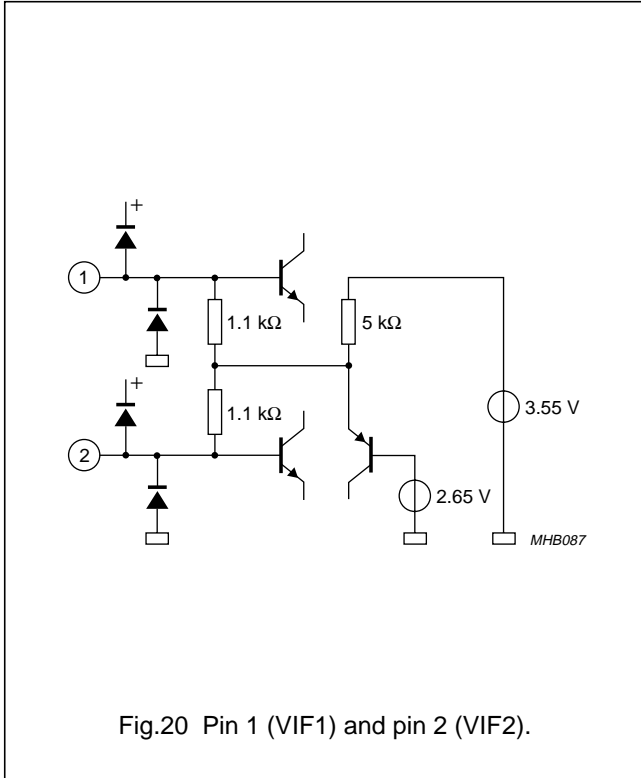


Fig.20 Pin 1 (VIF1) and pin 2 (VIF2).

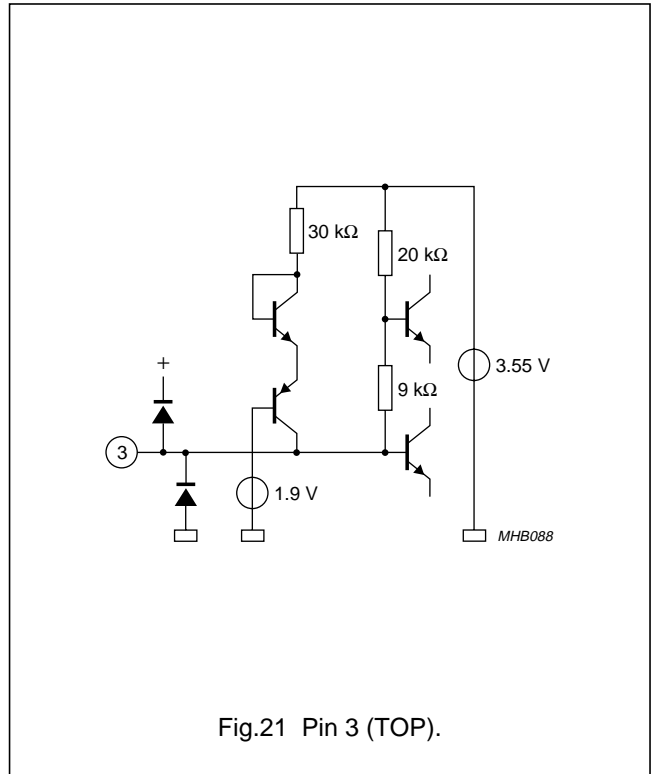


Fig.21 Pin 3 (TOP).

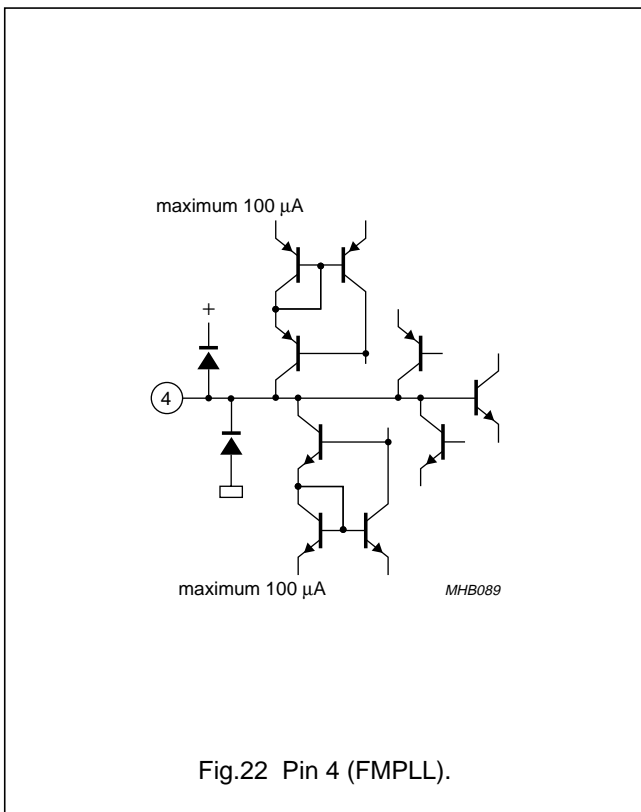


Fig.22 Pin 4 (FMPLL).

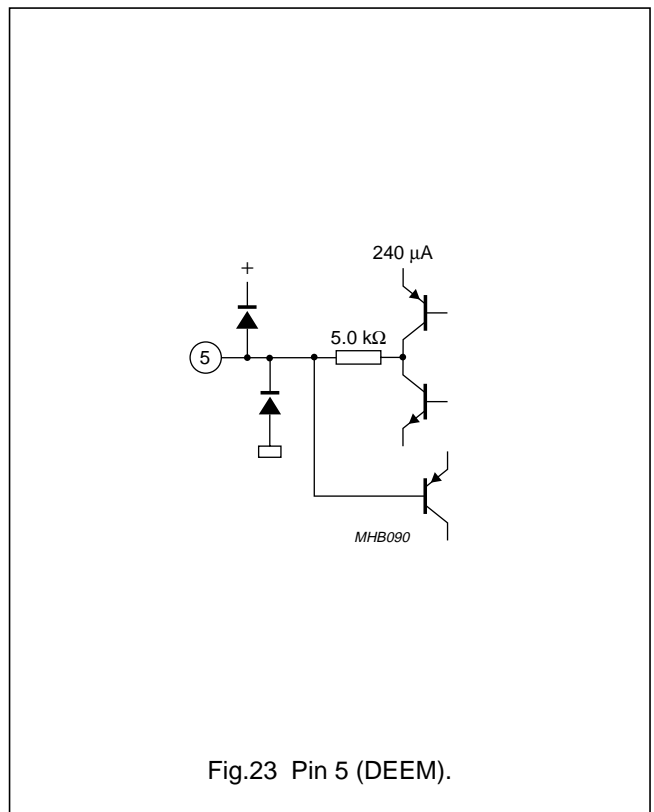


Fig.23 Pin 5 (DEEM).

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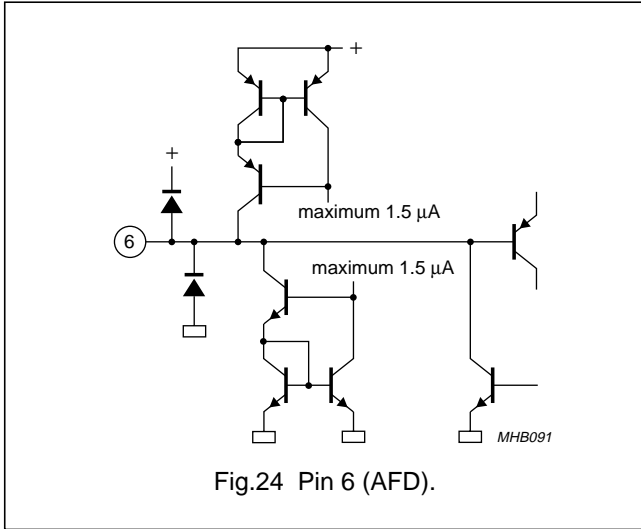


Fig.24 Pin 6 (AFD).

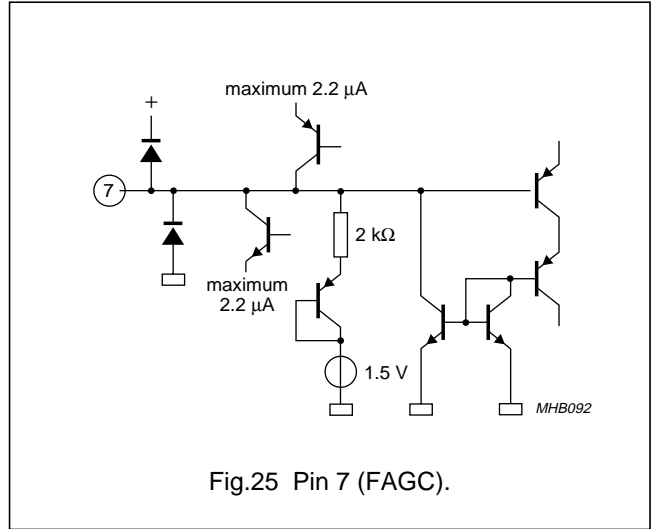


Fig.25 Pin 7 (FAGC).

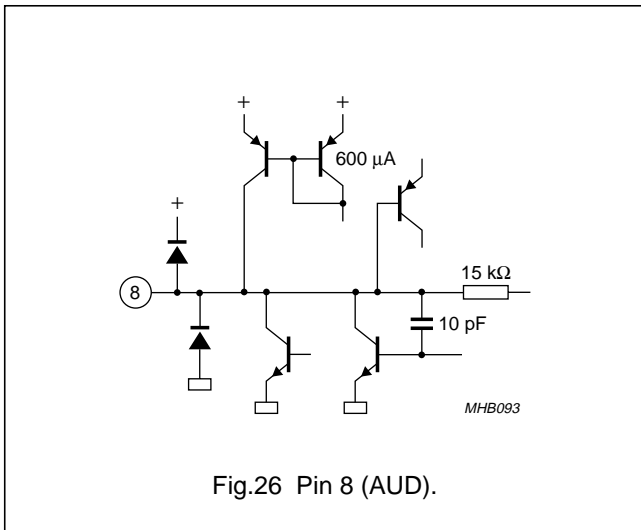


Fig.26 Pin 8 (AUD).

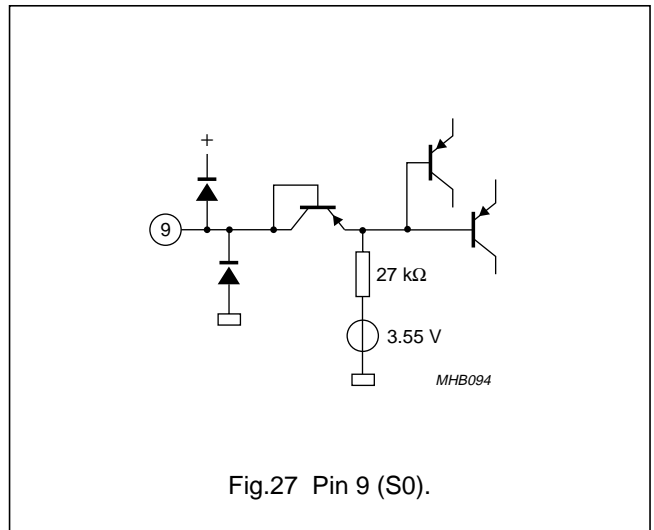


Fig.27 Pin 9 (S0).

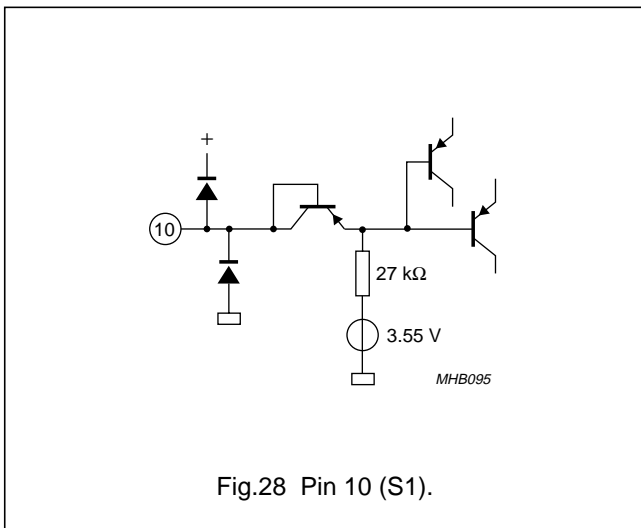


Fig.28 Pin 10 (S1).

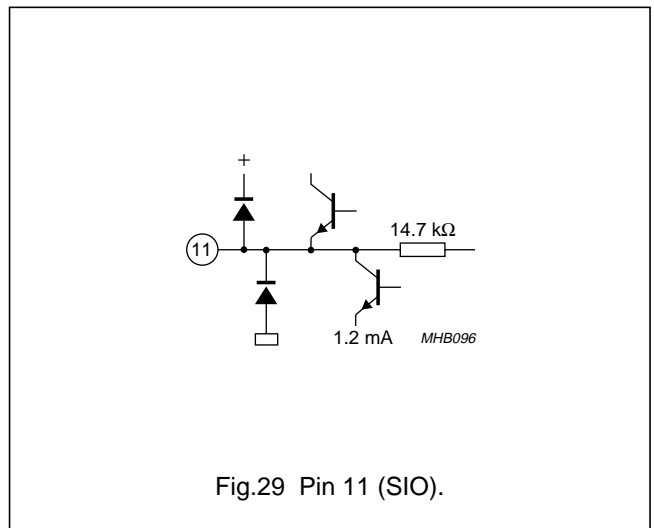
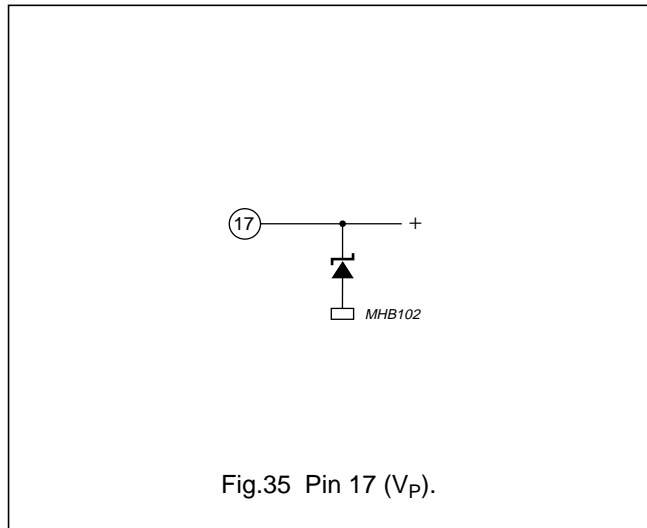
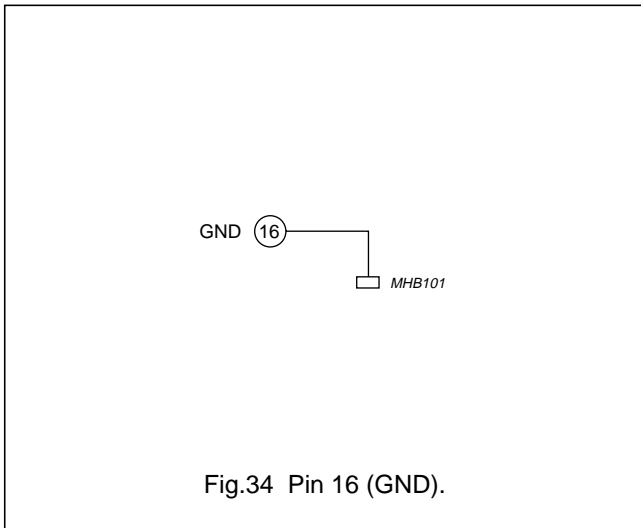
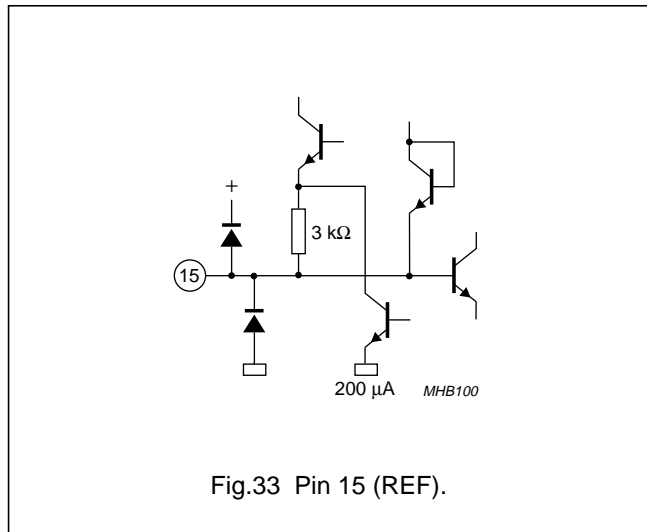
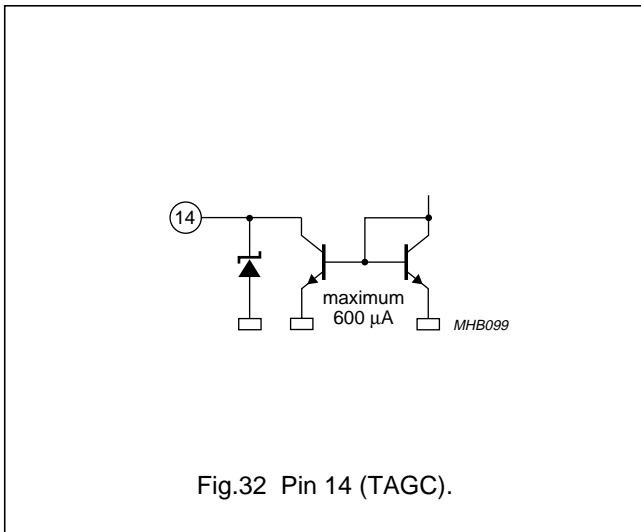
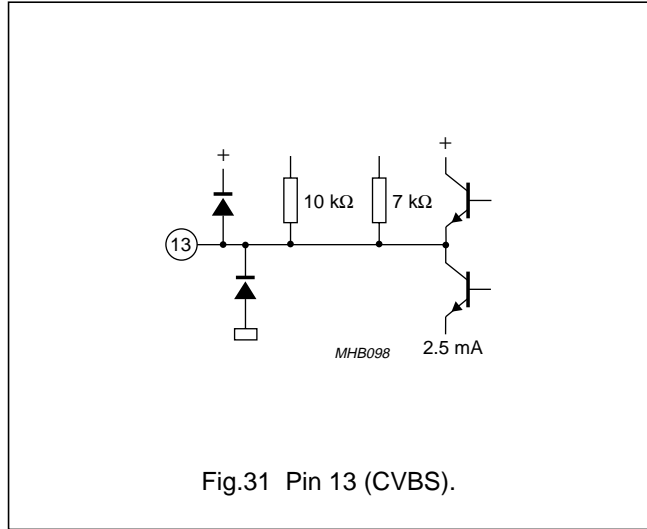
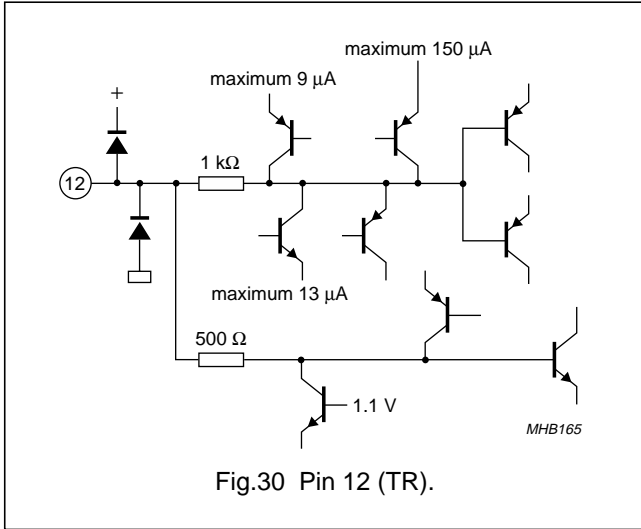


Fig.29 Pin 11 (SIO).

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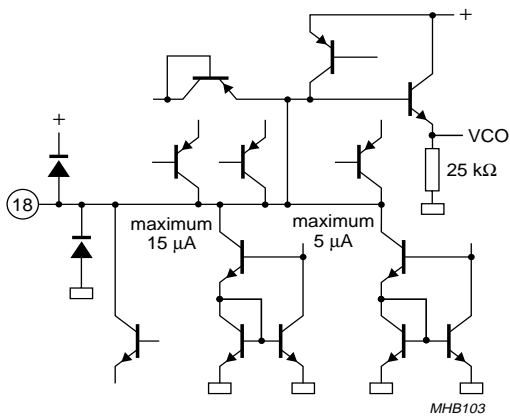


Fig.36 Pin 18 (VPLL).

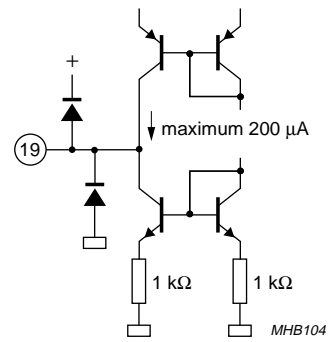


Fig.37 Pin 19 (AFC).

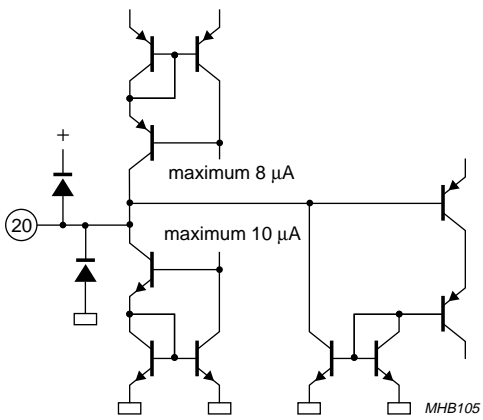


Fig.38 Pin 20 (VAGC).

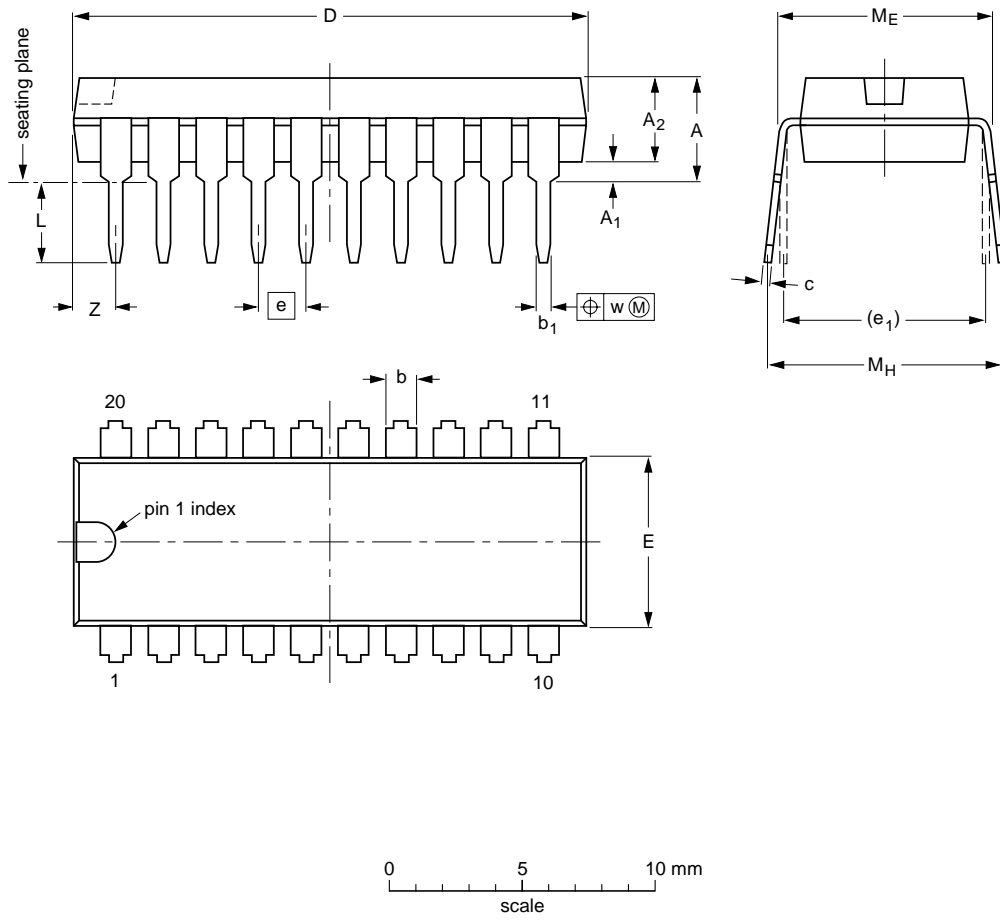
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PACKAGE OUTLINES

SDIP20: plastic shrink dual in-line package; 20 leads (300 mil)

SOT325-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ min. | A ₂ max. | b | b ₁ | c | D ⁽¹⁾ | E ⁽¹⁾ | e | e ₁ | L | M _E | M _H | w | Z ⁽¹⁾ max. |
|------|--------|---------------------|---------------------|------------|----------------|--------------|------------------|------------------|-------|----------------|------------|----------------|----------------|------|-----------------------|
| mm | 4.2 | 0.51 | 3.2 | 1.3 1.0 | 0.53 0.38 | 0.32 0.20 | 19.50 18.55 | 6.48 6.14 | 1.778 | 7.62 | 3.2 2.8 | 8.25 7.80 | 10.0 8.3 | 0.18 | 1.9 |

Note

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

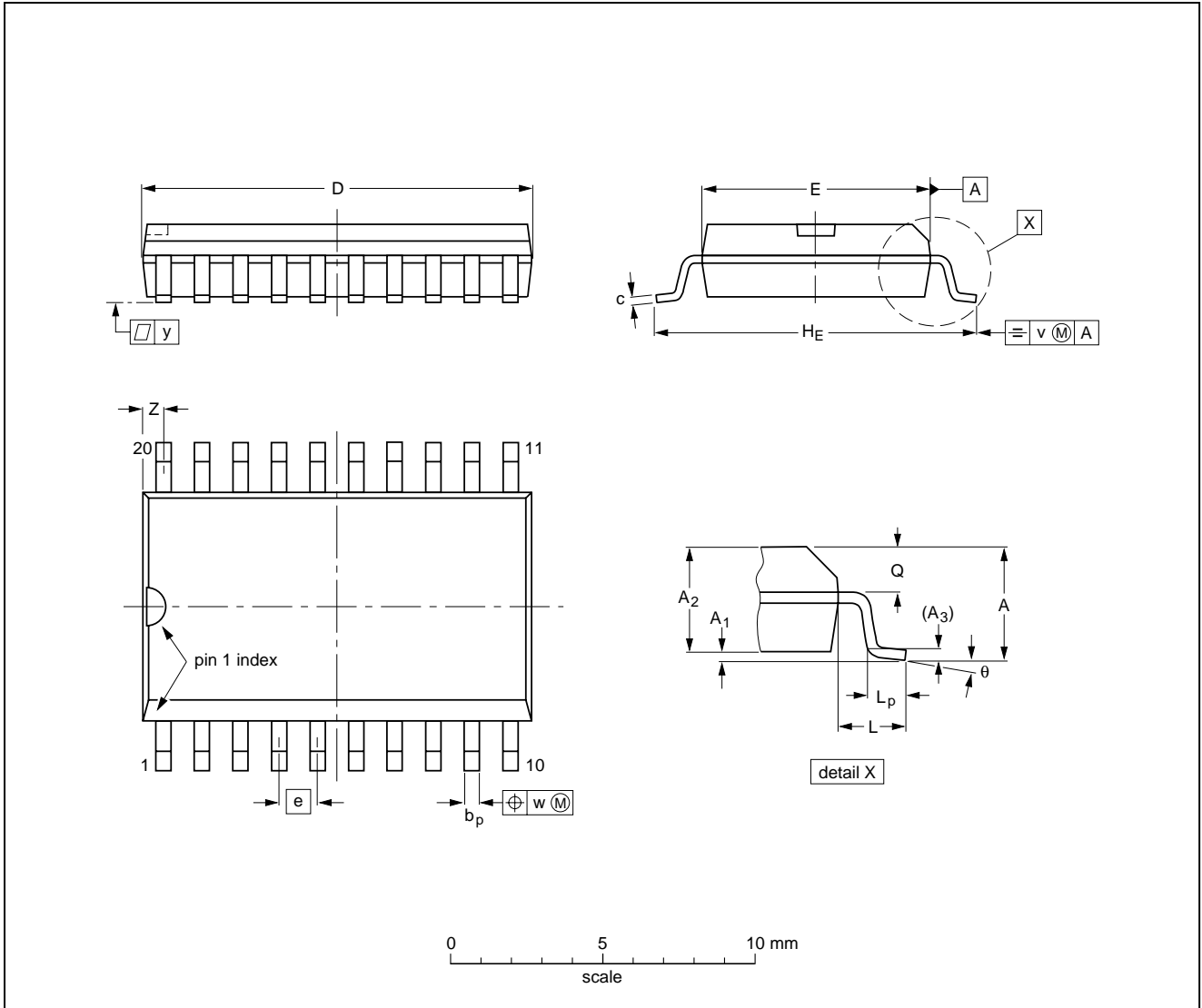
| OUTLINE VERSION | REFERENCES | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|-------|------|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | |
| SOT325-1 | | | | | 92-10-13 95-02-04 |

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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⁾ | θ |
|--------|--------|----------------|----------------|----------------|----------------|----------------|------------------|------------------|-------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm | 2.65 | 0.30 0.10 | 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° 0° |
| inches | 0.10 | 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 | 0.050 | 0.419 0.394 | 0.055 | 0.043 0.016 | 0.043 0.039 | 0.01 | 0.01 | 0.004 | 0.035 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 | | | |
| SOT163-1 | 075E04 | MS-013AC | | | | 95-01-24 97-05-22 |

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SOLDERING

Introduction

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "Data Handbook IC26; Integrated Circuit Packages" (document order number 9398 652 90011).

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

Through-hole mount packages

SOLDERING BY DIPPING OR BY SOLDER WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joints for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg(max)}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

MANUAL SOLDERING

Apply the soldering iron (24 V or less) to the lead(s) of the package, either below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

Surface mount packages

REFLOW SOLDERING

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 methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

WAVE SOLDERING

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
 - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
 - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

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.

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.

MANUAL SOLDERING

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron 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.

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Suitability of IC packages for wave, reflow and dipping soldering methods

| MOUNTING | PACKAGE | SOLDERING METHOD | | |
|--------------------|---------------------------------|-----------------------------------|-----------------------|----------|
| | | WAVE | REFLOW ⁽¹⁾ | DIPPING |
| Through-hole mount | DBS, DIP, HDIP, SDIP, SIL | suitable ⁽²⁾ | – | suitable |
| Surface mount | BGA, SQFP | not suitable | suitable | – |
| | HLQFP, HSQFP, HSOP, HTSSOP, SMS | not suitable ⁽³⁾ | suitable | – |
| | PLCC ⁽⁴⁾ , SO, SOJ | suitable | suitable | – |
| | LQFP, QFP, TQFP | not recommended ⁽⁴⁾⁽⁵⁾ | suitable | – |
| | SSOP, TSSOP, VSO | not recommended ⁽⁶⁾ | suitable | – |

Notes

- All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the “*Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods*”.
- For SDIP packages, the longitudinal axis must be parallel to the transport direction of the printed-circuit board.
- These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
- If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
- Wave soldering is only suitable for LQFP, QFP and TQFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

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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These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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NOTES

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NOTES

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