Single standard VIF-PLL with QSS-IF and FM-PLL demodulator

TDA9808

FEATURES

- 5 V supply voltage (9 V supply voltage for TDA9808 (DIP20) only)
- Applicable for IFs (Intermediate Frequencies) of 38.9 MHz, 45.75 MHz and 58.75 MHz
- Gain controlled wide band Video IF (VIF)-amplifier (AC-coupled)
- True synchronous demodulation with active carrier regeneration (very linear demodulation, good intermodulation figures, reduced harmonics, excellent pulse response)
- Robustness for over-modulation better than 105% due to Phase Locked Loop (PLL)-bandwidth control at negative modulated standards
- VIF Automatic Gain Control (AGC) detector for gain control, operating as peak sync detector
- Tuner AGC with adjustable TakeOver Point (TOP)
- Automatic Frequency Control (AFC) detector without extra reference circuit
- AC-coupled limiter amplifier for sound intercarrier signal
- Alignment-free FM-PLL demodulator with high linearity
- Sound IF (SIF) input for single reference Quasi Split Sound (QSS) mode (PLL controlled); SIF AGC detector for gain controlled SIF amplifier; single reference QSS mixer for high performance
- Electrostatic Discharge (ESD) protection for all pins.

GENERAL DESCRIPTION

The TDA9808 is an integrated circuit for single standard (negative modulated) vision IF signal processing and FM demodulation, with single reference QSS-IF in TV and VTR sets.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA9808	DIP20	plastic dual in-line package; 20 leads (300 mil)	SOT146-1
TDA9808T	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	supply voltage	V_P = 9 V for TDA9808 (DIP20) only	4.5	5	9.9	V
I_P	supply current		71	83	95	mA
$V_{i(VIF)(rms)}$	VIF input signal voltage sensitivity (RMS value)	–1 dB video at output	–	60	100	μV
$V_{o(video)(p-p)}$	video output signal voltage (peak-to-peak value)		1.2	1.35	1.5	V
B_{-3}	–3 dB video bandwidth on pin 9	C_L < 30 pF; R_L > 1.5 kΩ; AC load	7	8	–	MHz
$S/N_{W(video)}$	weighted signal-to-noise ratio for video		56	60	–	dB
$\alpha_{IM(0.92)}$	intermodulation attenuation at 'blue'	f = 0.92 MHz	58	64	–	dB
$\alpha_{IM(2.76)}$	intermodulation attenuation at 'blue'	f = 2.76 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	–	50	100	μV
$V_{o(rms)}$	audio output signal voltage for FM (RMS value)	M, N standard; 25 kHz modulation	0.4	0.5	0.6	V
THD	total harmonic distortion	25 kHz modulation	–	0.15	1.0	%
$S/N_{W(audio)}$	weighted signal-to-noise ratio	25 kHz modulation; τ = 75 μs	55	60	–	dB

BLOCK DIAGRAM

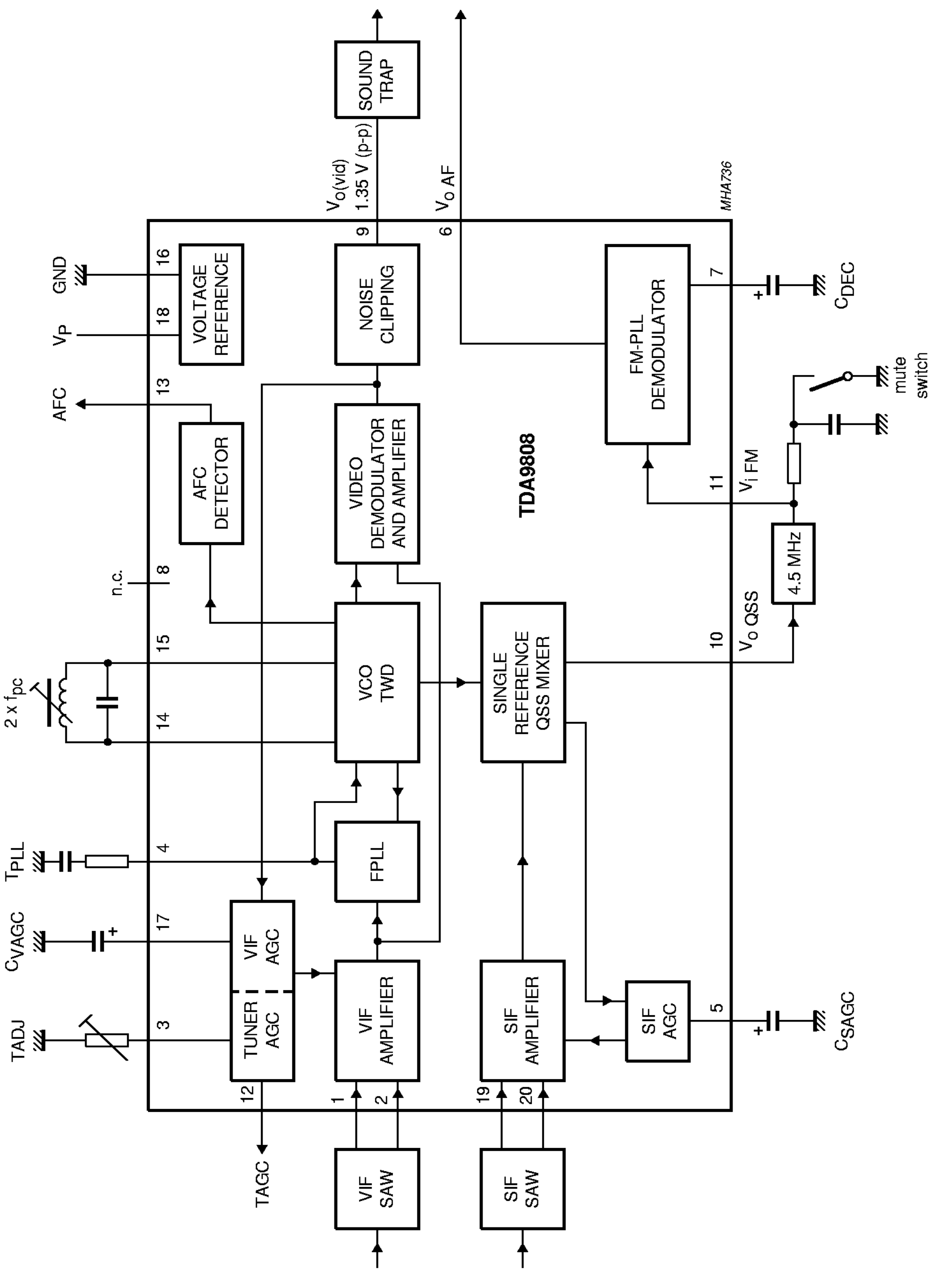


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
$V_{i\ VIF1}$	1	VIF differential input signal voltage 1
$V_{i\ VIF2}$	2	VIF differential input signal voltage 2
TADJ	3	tuner AGC takeover point adjust
T_{PLL}	4	PLL loop filter
C_{SAGC}	5	SIF AGC capacitor
$V_{o\ AF}$	6	audio output
C_{DEC}	7	decoupling capacitor
n.c.	8	not connected
$V_{o(vid)}$	9	composite video output voltage
$V_{o\ QSS}$	10	single reference QSS output voltage
$V_{i\ FM}$	11	sound intercarrier input voltage
TAGC	12	tuner AGC output
AFC	13	AFC output
VCO1	14	VCO1 resonance circuit
VCO2	15	VCO2 resonance circuit
GND	16	ground
C_{VAGC}	17	VIF AGC capacitor
V_P	18	supply voltage
$V_{i\ SIF1}$	19	SIF differential input signal voltage 1
$V_{i\ SIF2}$	20	SIF differential input signal voltage 2

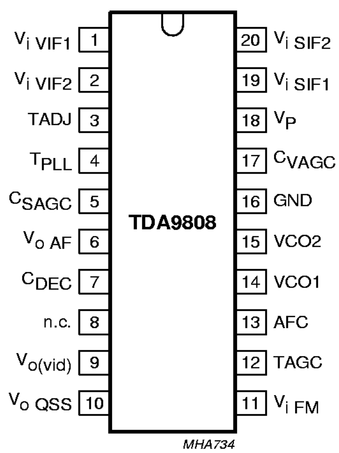


Fig.2 Pin configuration DIP20.

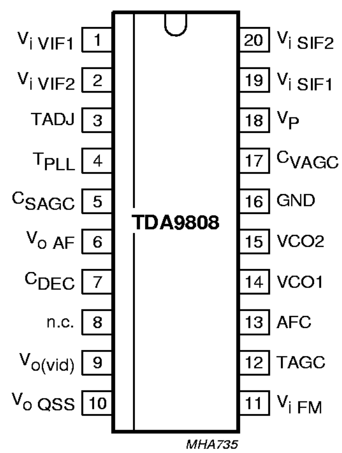


Fig.3 Pin configuration SO20.

FUNCTIONAL DESCRIPTION

The integrated circuit comprises the functional blocks as shown in Fig.1:

1. Vision IF amplifier and VIF AGC detector
2. Tuner AGC
3. Frequency Phase Locked Loop (FPLL) detector
4. Voltage Controlled Oscillator (VCO), Travelling Wave Divider (TWD) and AFC
5. Video demodulator and amplifier
6. SIF amplifier and SIF AGC
7. Single reference QSS mixer
8. FM-PLL demodulator
9. Audio Frequency (AF) signal processing
10. Internal voltage stabilizer.

Vision IF amplifier and VIF AGC detector

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

The AGC detector generates the required VIF gain control voltage for constant video output by charging/discharging the AGC capacitor. Therefore, for negative video modulation the synchronisation level of the video signal is detected.

Tuner AGC

The AGC capacitor voltage is converted to an internal IF 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 at pin TADJ. This allows to match the tuner to the SAW filter in order to achieve the optimum IF input level.

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 the frequency detector or the phase detector is converted to a DC voltage via the loop filter, which controls the VCO frequency.

VCO, Travelling Wave Divider (TWD) and AFC

The VCO operates with a resonance circuit (with L and C in parallel) at double the Picture Carrier (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 double the PC frequency is generated by the frequency-phase detector of the FPLL and fed via the loop filter to the first variable capacitor. This control voltage is amplified and additionally converted into a current which represents the AFC output signal. At the centre frequency the AFC output current is equal to zero.

The oscillator signal is divided-by-two with a 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 to the video amplifier via an integrated low-pass filter for attenuation of the carrier harmonics. 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 at pin $V_{o(vid)}$ is 1.35 V (p-p) for nominal vision IF modulation. Noise clipping is provided.

SIF amplifier and SIF 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 signal (average level of FM carrier) 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 filter for attenuation of the video signal components to the output pin 10. With this system a high performance hi-fi stereo sound processing can be achieved.

FM-PLL demodulator

The FM-PLL demodulator consists of a limiter and an FM-PLL. The limiter provides the amplification and limitation of the FM sound intercarrier signal. 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.

Furthermore the AF output signal can be muted by connecting a resistor between the limiter input pin 11 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.

AF signal processing

The AF amplifier consists of two parts:

1. The AF pre-amplifier 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 pin 10. 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

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.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage	note 1			
		$T_{j(max)}$ = 125 °C; TDA9808 (DIP20)	–	9.9	V
		$T_{j(max)}$ = 115 °C; TDA9808T (SO20)	–	5.5	V
V_i	voltage at pins 1, 2, 5, 13, 17, 19 and 20		0	V_P	V
$t_{s(max)}$	maximum short-circuit time to ground or V_P		–	10	s
V_{12}	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 = 95 mA; T_{amb} = 70 °C.
2. Machine model class B (L = 2.5 µH).

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air		
	TDA9808 (DIP20)		62	K/W
	TDA9808T (SO20)		85	K/W

CHARACTERISTICS (9 V SUPPLY, TDA9808; DIP20 only)

V_P = 9 V; T_{amb} = 25 °C; see Table 1 for input frequencies and carrier ratios; input level $V_{i(VIF)(rms)}$ = 10 mV (pins 1 and 2) (sync-level); $V_{i(SIF)(rms)}$ = 4.5 mV (pins 19 and 20) (sound carrier); IF input from 50 Ω via broadband transformer 1 : 1; video modulation DSB; residual carrier: 10%; video signal in accordance with *"NTC-7 Composite"*; measurements taken in Fig.13; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (pin 18)						
V_P	supply voltage	note 1	4.5	5.0	9.9	V
I_P	supply current		72	85	98	mA
True synchronous video demodulator; note 2						
$V_{i(VIF)(rms)}$	VIF input signal voltage sensitivity (RMS value)	PLL still locked; maximum IF gain; note 3	–	60	90	μV
Composite video amplifier (pin 9; sound carrier off)						
$V_{o(video)(p-p)}$	video output signal voltage (peak-to-peak value)	see Fig.8	1.27	1.45	1.63	V
$S/N_{W(video)}$	weighted signal-to-noise ratio	see Fig.6 and note 4	56	60	–	dB
PSRR	power supply ripple rejection at pin 9	see Fig.11	25	30	–	dB
Tuner AGC (pin 12)						
ΔG_{IF}	IF slip by automatic gain control	tuner gain current from 20 to 80%	–	6	8	dB
AFC circuit (pin 13); see Fig.10 and note 5						
S	control steepness $\Delta I_{13}/\Delta f$	note 6				
		f_{pc} = 38.9 MHz	0.35	0.55	0.75	μA/kHz
		f_{pc} = 45.75 MHz	0.35	0.55	0.75	μA/kHz
		f_{pc} = 58.75 MHz	0.35	0.55	0.75	μA/kHz
$\Delta f_{IF}/\Delta T$	frequency variation by temperature	I_{AFC} = 0; note 7	–	–	$\pm 20 \times 10^{-6}$	K^{-1}
FM-PLL sound demodulator and AF output (pin 6); note 8						
$V_{o(AF)(6)(rms)}$	AF output signal voltage (RMS value)	±25 kHz (50% FM deviation); see Fig.13	375	500	625	mV
$S/N_{W(audio)}$	weighted signal-to-noise ratio	*"CCIR 468-4"*; see Fig.13	55	60	–	dB
α_6	mute attenuation		70	75	–	dB
ΔV_5	DC jump voltage of AF output terminal	FM-PLL in lock mode	–	±50	±175	mV

Notes to the characteristics

1. Values of video and sound parameters are decreased at V_P = 4.5 V.
2. Loop bandwidth BL = 70 kHz (natural frequency f_n = 12 kHz; damping factor d ≈ 3; calculated with sync level within gain control range). Resonance circuit of VCO: Q_0 > 50; C_{ext}: see Table 3; C_{int} ≈ 8.5 pF (loop voltage approximately 2.7 V).
3. $V_{i(VIF)}$ signal for nominal video signal.
4. S/N is the ratio of black to white amplitude to the black level noise voltage (RMS value, pin 9). B = 5 MHz weighted in accordance with *"CCIR 567"* at a source impedance of 50 Ω.
5. To match the AFC output signal to different tuning systems a current source output is provided (Fig.10).
6. Depending on the ratio $\Delta C/C_0$ of the LC resonant circuit of VCO (Q_0 > 50; see note 2; $C_0 = C_{int} + C_{ext}$).
7. Temperature coefficient of external LC-circuit is equal to zero.
8. Input level for second IF from an external generator with 50 Ω source impedance. AC-coupled with 10 nF capacitor, f_{mod} = 1 kHz, 25 kHz (50% FM deviation) of audio reference. A VIF/SIF input signal is not permitted. Pin 17 has to be connected to positive supply voltage. S/N and THD measurements are taken at 50 µs (75 µs at M standard) de-emphasis.

CHARACTERISTICS (5 V SUPPLY)

V_P = 5 V; T_{amb} = 25 °C; see Table 1 for input frequencies and carrier ratios; input level $V_{i(VIF)(rms)}$ = 10 mV (pins 1 and 2) (sync-level); $V_{i(SIF)(rms)}$ = 4.5 mV (pins 19 and 20) (sound carrier); IF input from 50 Ω via broadband transformer 1 : 1; video modulation DSB; residual carrier: 10%; video signal in accordance with *"NTC-7 Composite"*; measurements taken in Fig.13; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (pin 18)						
V_P	supply voltage	note 1	4.5	5	5.5	V
I_P	supply current		71	83	95	mA
Vision IF amplifier (pins 1 and 2)						
$V_{i(VIF)(rms)}$	VIF input signal voltage sensitivity (RMS value)	−1 dB video at output	–	60	100	μV
$V_{i(max)(rms)}$	maximum input signal voltage (RMS value)	+1 dB video at output	140	300	–	mV
$\Delta V_{o(int)}$	internal IF amplitude difference between picture and sound carrier	within AGC range; M standard; Δf = 4.5 MHz	–	0.7	1	dB
G_{IFcr}	IF gain control range	see Fig.4	65	70	–	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
$V_{I(1,2)}$	DC input voltage	note 2	–	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	–	–	$\pm 20 \times 10^{-6}$	K^{-1}
$\Delta f_{osc}/\Delta V_P$	oscillator shift as a function of supply voltage	oscillator is free-running; note 4	–	–	$\pm 1500 \times 10^{-6}$	V^{-1}
$V_{VCO(rms)}$	oscillator voltage swing at pins 14 and 15 (RMS value)		50	80	110	mV
$f_{cr(pc)}$	picture carrier capture range		±1.4	±1.8	–	MHz
t_{acq}	acquisition time	BL = 70 kHz; note 5	–	–	30	ms
$V_{i(IF)(rms)}$	IF input signal voltage sensitivity for PLL to be locked (RMS value; pins 1 and 2)	maximum IF gain; note 6	–	60	90	μV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Composite video amplifier (pin 9; sound carrier off)						
$V_{o(video)(p-p)}$	output signal voltage (peak-to-peak value)	see Fig.8	1.2	1.35	1.5	V
V/S	ratio between video (black-to-white) and sync level		2.0	2.5	3.0	
$V_{sync(9)}$	sync voltage level		1.4	1.5	1.6	V
$V_{clu(9)}$	upper video clipping voltage level		3.3	3.45	–	V
$V_{cll(9)}$	lower video clipping voltage level		–	1.1	1.25	V
$R_{o(9)}$	output resistance	note 2	–	–	10	Ω
$I_{int(9)}$	internal DC bias current for emitter-follower		1.6	2.0	–	mA
$I_{o(sink)(9)(max)}$	maximum AC and DC output sink current		1.0	–	–	mA
$I_{o(source)(9)(max)}$	maximum AC and DC output source current		2.0	–	–	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	gain variation; note 7	–	–	1	%
G_{diff}	differential gain	*“NTC-7 Composite”*	–	2	5	%
φ_{diff}	differential phase	*“NTC-7 Composite”*	–	2	4	deg
B_{-1}	–1 dB video bandwidth	C_L < 30 pF; R_L > 1.5 kΩ; AC load	5	6	–	MHz
B_{-3}	–3 dB video bandwidth	C_L < 30 pF; R_L > 1.5 kΩ; AC load	7	8	–	MHz
$S/N_{W(video)}$	weighted signal-to-noise ratio for video	see Fig.6 and note 8	56	60	–	dB
$S/N_{(video)}$	unweighted signal-to-noise ratio for video	see Fig.6 and note 8	49	53	–	dB
$\alpha_{IM(0.92)}$	intermodulation attenuation at	f = 0.92 MHz; see Fig.7 and note 9				
	‘blue’		58	64	–	dB
	‘yellow’		60	66	–	dB
$\alpha_{IM(2.76)}$	intermodulation attenuation at	f = 2.76 MHz; see Fig.7 and note 9				
	‘blue’		58	64	–	dB
	‘yellow’		59	65	–	dB
$V_{VC(rms)}$	residual vision carrier (RMS value)	fundamental wave and harmonics	–	2	10	mV
$\alpha_{H(sup)}$	suppression of video signal harmonics	note 10a	35	40	–	dB
$\alpha_{H(spur)}$	spurious elements	note 10b	40	–	–	dB
PSRR	power supply ripple rejection at pin 9	video signal; grey level; see Fig.11	25	30	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
VIF-AGC detector (pin 17)						
I_{17}	charging current		55	75	95	μA
	discharging current	note 7	1.0	1.4	1.8	μA
t_{resp}	AGC response to an increasing VIF step	note 11	–	0.05	0.1	ms/dB
	AGC response to a decreasing VIF step		–	2.2	3.5	ms/dB
Tuner AGC (pin 12)						
$V_{i(rms)}$	IF input signal voltage for minimum starting point of tuner takeover (RMS value)	input at pins 1 and 2; R_{TOP} = 22 kΩ; I_{12} = 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_{12} = 0.4 mA	50	100	–	mV
$V_{o(12)}$	permissible output voltage	from external source; note 2	–	–	13.2	V
$V_{sat(12)}$	saturation voltage	I_{12} = 1.6 mA	–	–	0.2	V
$\Delta V_{TOP(12)}/\Delta T$	variation of takeover point by temperature	I_{12} = 0.4 mA	–	0.03	0.07	dB/K
$I_{12(sink)}$	sink current	see Fig.4				
		no tuner gain reduction; V_{12} = 13.2 V	–	–	5	μA
		maximum tuner gain reduction	1.5	2	2.6	mA
ΔG_{IF}	IF slip by automatic gain control	tuner gain current from 20 to 80%	–	6	8	dB
AFC circuit (pin 13); see Fig.10 and note 12						
S	control steepness $\Delta I_{13}/\Delta f$	note 13				
		f_{pc} = 38.9 MHz	0.35	0.55	0.75	μA/kHz
		f_{pc} = 45.75 MHz	0.35	0.55	0.75	μA/kHz
		f_{pc} = 58.75 MHz	0.35	0.55	0.75	μA/kHz
$\Delta f_{IF}/\Delta T$	frequency variation by temperature	I_{AFC} = 0; note 4	–	–	$\pm 20 \times 10^{-6}$	K^{-1}
$V_{o(13)}$	output voltage upper limit	see Fig.10	$V_P - 0.7$	$V_P - 0.3$	–	V
	output voltage lower limit	see Fig.10	–	0.3	0.7	V
$I_{o(source)(13)}$	output source current		150	200	250	μA
$I_{o(sink)(13)}$	output sink current		150	200	250	μA
$\Delta I_{13(p-p)}$	residual video modulation current (peak-to-peak value)		–	20	30	μA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Sound IF amplifier (pins 19 and 20)						
$V_{i(SIF)(rms)}$	input signal voltage sensitivity (RMS value)	−1 dB at intercarrier output pin 10	–	50	100	μV
$V_{i(max)(rms)}$	maximum input signal voltage (RMS value)	+1 dB at intercarrier output pin 10	40	110	–	mV
$G_{cr(SIF)}$	SIF gain control range	see Fig.5	60	66	–	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
$V_{I(19,20)}$	DC input voltage		–	3.4	–	V
$\alpha_{SIF,VIF}$	crosstalk attenuation between SIF and VIF input	between pins 1 and 2 and pins 19 and 20; note 14	50	–	–	dB
SIF AGC detector (pin 5)						
$I_{ch(5)}$	charging current		3.5	5	6.5	μA
$I_{dch(5)}$	discharging current		4.5	6	7.5	μA
Single reference QSS intercarrier mixer (pin 10)						
$V_{o(rms)}$	IF intercarrier output level (RMS value)	SC_1; sound carrier 2 off	75	100	125	mV
$V_{o(peak)}$	IF intercarrier output level (peak value)		141	198	225	mV
B_{-3}	−3 dB intercarrier bandwidth	upper limit	7.5	9	–	MHz
$V_{SC(rms)}$	residual sound carrier (RMS value)	fundamental wave and harmonics	–	2	5	mV
$V_{VC(rms)}$	residual vision carrier (RMS value)	fundamental wave and harmonics	–	2	5	mV
$R_{o(10)}$	output resistance	note 2	–	–	25	Ω
$V_{O(10)}$	DC output voltage		–	2.0	–	V
$I_{int(10)}$	DC internal bias current for emitter-follower		1.5	1.9	–	mA
$I_{sink(max)(10)}$	maximum AC and DC output sink current		1.2	1.6	–	mA
$I_{source(max)(10)}$	maximum AC and DC output source current		2.0	2.5	–	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Limiter amplifier (pin 11); note 15						
$V_{i(FM)(rms)}$	input signal voltage for lock-in (RMS value)		–	–	100	μV
$V_{i(FM)(rms)}$	input signal voltage (RMS value)		–	300	400	μV
	allowed input signal voltage (RMS value)	$\left(\frac{S+N}{N}\right)$weighted = 40 dB	200	–	–	mV
α_{AM}	AM suppression	50 μs de-emphasis; AM: f = 1 kHz; m = 0.3 refer to 25 kHz (50% FM deviation)	46	50	–	dB
$R_{i(11)}$	input resistance	note 2	480	600	720	Ω
$V_{I(11)}$	DC input voltage		–	2.8	–	V
FM-PLL demodulator						
f_{cr}	catching range of PLL	upper limit	7.0	–	–	MHz
		lower limit	–	–	4.0	MHz
f_{hr}	holding range of PLL	upper limit	9.0	–	–	MHz
		lower limit	–	–	3.5	MHz
t_{acq}	acquisition time		–	–	4	μs
FM operation (M, N standard; pin 6); notes 15 and 15a						
$V_{o(AF)(6)(rms)}$	AF output signal voltage (RMS value)	25 kHz (50% FM deviation); R_x = 0 Ω; see Fig.13 and note 16	400	500	600	mV
$V_{o(AF)(6)(cl)}$	AF output clipping signal voltage level	THD < 1.5%	1.0	–	1.2	V
Δf_{AF}	frequency deviation	THD < 1.5%; R_x = 0 Ω; note 16	–	–	±53	kHz
$\Delta V_o/\Delta T$	temperature drift of AF output signal voltage		–	3×10^{-3}	7×10^{-3}	dB/K
V_7	DC voltage at decoupling capacitor	voltage dependent on VCO frequency; note 17	1.2	–	3.0	V
$R_{o(6)}$	output resistance	note 2	–	–	100	Ω
$V_{O(6)}$	DC output voltage		–	2.3	–	V
$I_{sink(max)(6)}$	maximum AC and DC output sink current		–	–	1.1	mA
$I_{source(max)(6)}$	maximum AC and DC output source current		–	–	1.1	mA
B_{-3}	–3 dB audio frequency bandwidth	without de-emphasis capacitor	100	125	–	kHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
THD	total harmonic distortion	25 kHz (50% FM deviation)	–	0.15	0.5	%
$S/N_{W(audio)}$	weighted signal-to-noise ratio for audio	FM-PLL only; with 75 μs de-emphasis; 25 kHz (50% FM deviation); *"CCIR 468-4"*	55	60	–	dB
$V_{SC(rms)}$	residual sound carrier (RMS value)	fundamental wave and harmonics	–	–	75	mV
α_6	mute attenuation of AF signal		70	75	–	dB
ΔV_6	DC jump voltage of AF output terminal for switching AF output to mute state and vice versa	FM-PLL in lock mode	–	±50	±150	mV
PSRR	power supply ripple rejection at pin 6	$R_x = 0\ \Omega$; f = 70 Hz; see Figs 11 and 13	20	26	–	dB
Single reference QSS AF performance for FM operation (M standard); notes 18, 19 and 20; see Table 1						
$S/N_{W(audio)}$	weighted signal-to-noise ratio for audio	black picture	50	56	–	dB
		white picture	47	53	–	dB
		colour bar	45	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 an application information for designing the television receiver.
3. Loop bandwidth BL = 70 kHz (natural frequency $f_n = 12$ kHz; damping factor d ≈ 3; calculated with sync level within gain control range). Resonance circuit of VCO: $Q_0 > 50$; C_{ext} see Table 3; $C_{int} \approx 8.5$ pF (loop voltage approximately 2.7 V).
4. Temperature coefficient of external LC-circuit is equal to zero.
5. $V_{i(IF)(rms)} = 10$ mV; Δf = 1 MHz (VCO frequency offset related to picture carrier frequency); white picture video modulation.
6. $V_{i(VIF)}$ signal for nominal video signal.
7. The leakage current of the AGC capacitor should not exceed 100 nA at M, N standard. Larger currents will increase the tilt.
8. S/N is the ratio of black-to-white amplitude to the black level noise voltage (RMS value, pin 9). B = 5 MHz weighted in accordance with *"CCIR 567"*.
9. The intermodulation figures are defined:

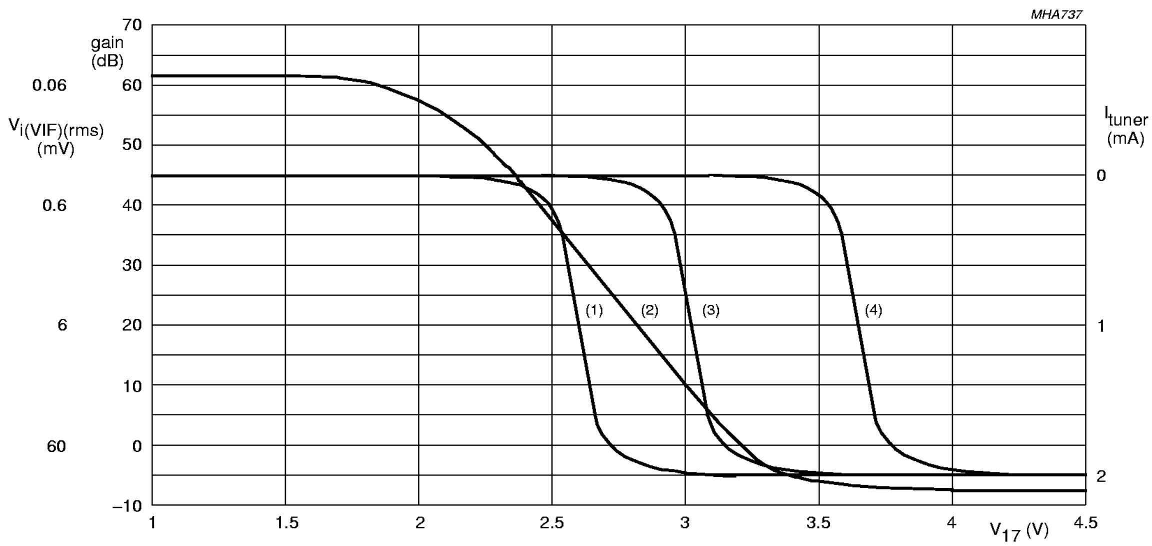
$$\alpha_{0.92} = 20\ \log\left(\frac{V_o \text{ at } 3.58\text{ MHz}}{V_o \text{ at } 0.92\text{ MHz}}\right) + 3.6\text{ dB}$$; $\alpha_{0.92}$ value at 0.92 MHz referenced to black/white signal;

$$\alpha_{2.76} = 20\ \log\left(\frac{V_o \text{ at } 3.58\text{ MHz}}{V_o \text{ at } 2.76\text{ MHz}}\right)$$; $\alpha_{2.76}$ value at 2.76 MHz referenced to colour carrier.

10. Measurements taken with SAW filter M3951 (sound carrier suppression: 32 dB); loop bandwidth BL = 70 kHz:
    a) Modulation VSB; sound carrier off; f_{video} > 0.5 MHz.
    b) Sound carrier on; SIF SAW filter M9352; f_{video} = 10 kHz to 10 MHz.
11. Response speed valid for a VIF input level range of 200 μV up to 70 mV.
12. To match the AFC output signal to different tuning systems a current source output is provided. The test circuit is given in Fig.10. The AFC-steepness can be changed by the resistors at pin 13.
13. Depending on the ratio $\Delta C/C_0$ of the LC resonant circuit of VCO (Q_0 > 50; see note 3; $C_0 = C_{int} + C_{ext}$).
14. Source impedance: 2.3 kΩ in parallel to 12 pF (SAW filter); f_{IF} = 38.9 MHz.
15. Input level for second IF from an external generator with 50 Ω source impedance, AC-coupled with 10 nF capacitor, f_{mod} = 400 Hz, 25 kHz (50% FM deviation) of audio reference. A VIF/SIF input signal is not permitted. Pins 5 and 17 have to be connected to positive supply voltage for minimum IF gain. S/N and THD measurements are taken at 75 μs de-emphasis (modulator pre-emphasis has to be activated). The FM demodulator steepness $\Delta V_{o(AF)}/\Delta f_{AF}$ is positive.
    a) Second IF input level 10 mV RMS.
16. Measured at de-emphasis circuitry with an FM deviation of 25 kHz (f_{mod} = 400 Hz) the typical AF output signal is 500 mV RMS (R_x = 0 Ω). By using R_x = 470 Ω the AF output signal is attenuated by 6 dB (250 mV RMS). For handling a frequency deviation of more than 53 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 with R_x = 470 Ω.
17. The leakage current of the decoupling capacitor (22 μF) should not exceed 1 μA.
18. 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 25 kHz) for 6 kHz sine wave black-to-white video modulation.
    c) Picture-to-sound carrier ratio; PC/SC_1 = 7 dB (transmitter).
19. The PC/SC_1 ratio is calculated as the addition to TV transmitter PC/SC_1 ratio and SAW filter PC/SC_1 ratio. This PC/SC_1 ratio is necessary to achieve the $S/N_{W(audio)}$ values as noted. A different PC/SC_1 ratio will change these values.
20. Measurements taken with SAW filter M3951 for vision IF (suppressed sound carrier, minimum 25 dB) and M9352 for sound IF (suppressed picture carrier). Input level $V_{i(SIF)(rms)}$ = 10 mV, 25 kHz (50% FM deviation). Measurements in accordance with *"CCIR 468-4"*.

Table 1 Input frequencies and carrier ratios

SYMBOL	DESCRIPTION	B/G STANDARD	M, N STANDARD	UNIT
f_{pc} or f_{IF}	picture/IF carrier	38.9	45.75/58.75	MHz
f_{SC1}	sound carrier	33.4	41.25/54.25	MHz
f_{SC2}		33.158	–	MHz
SC_1	picture-to-sound carrier	13	7	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.4 Typical VIF (pins 1 and 2) and tuner AGC characteristic.

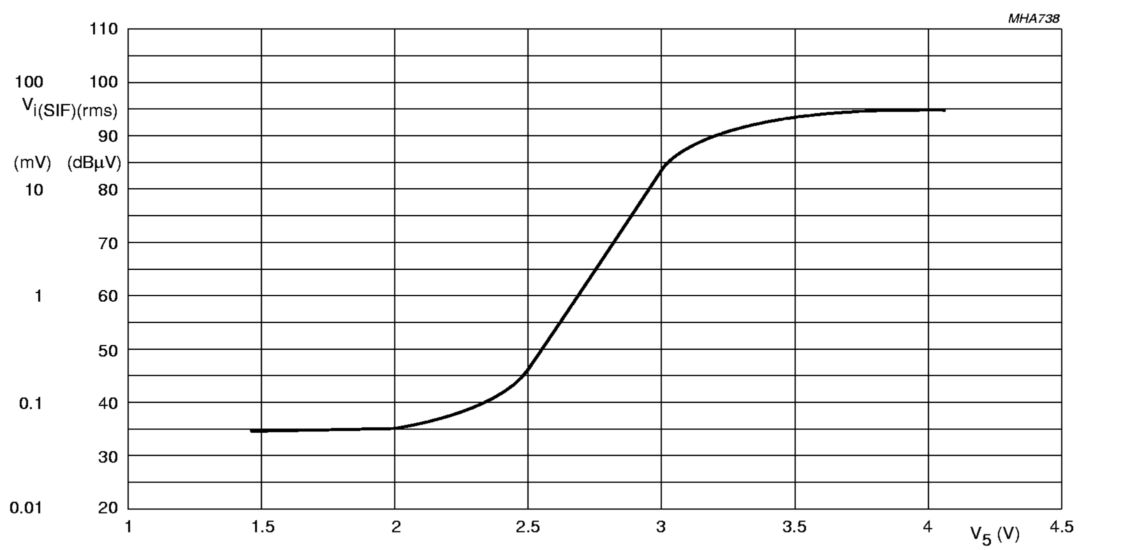


Fig.5 Typical SIF (pins 19 and 20) AGC characteristic.

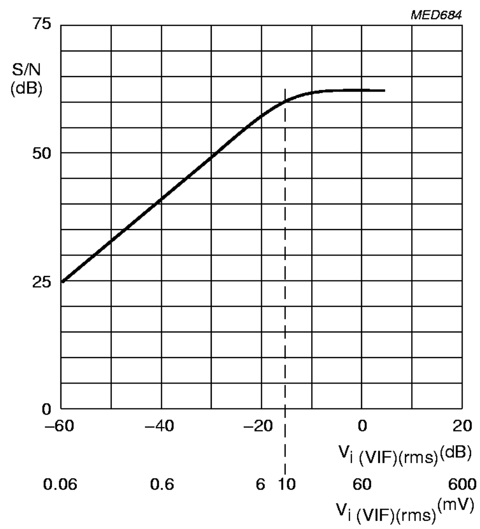
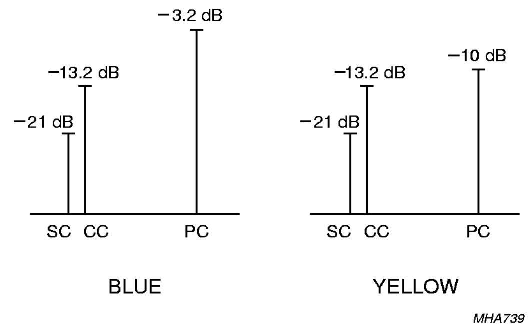


Fig.6 Typical signal-to-noise ratio as a function of IF input voltage.



SC = sound carrier, with respect to sync level.
CC = chrominance carrier, with respect to sync level.
PC = picture carrier, with respect to sync level.

Fig.7 Input signal conditions.

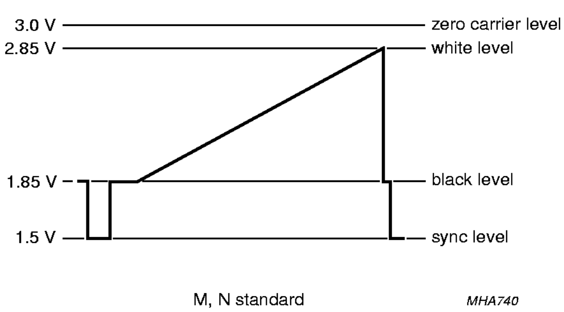
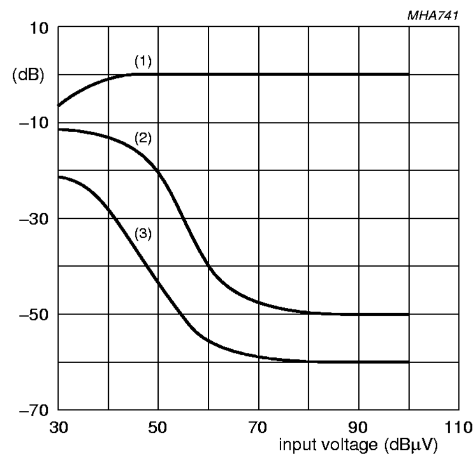
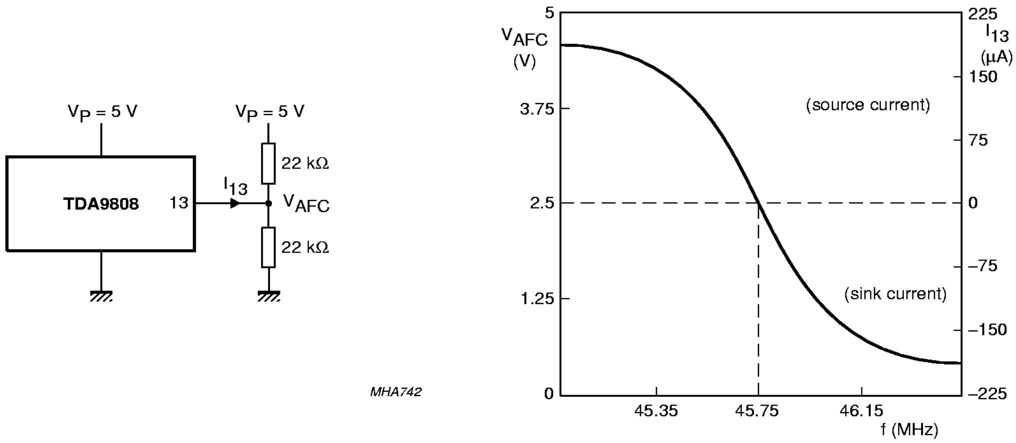


Fig.8 Typical video signal levels on output pin 9 (sound carrier off).

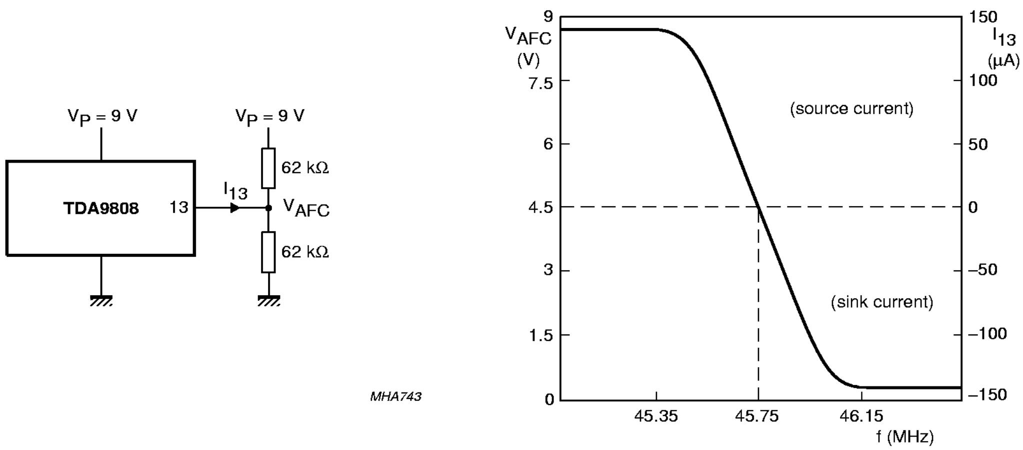


(1) Signal.
(2) AM rejection.
(3) Noise.

Fig.9 Typical audio level, noise and AM rejection (50% FM deviation).



a. $V_P = 5$ V.



b. $V_P = 9$ V.

Fig.10 Measurement conditions and typical AFC characteristic.

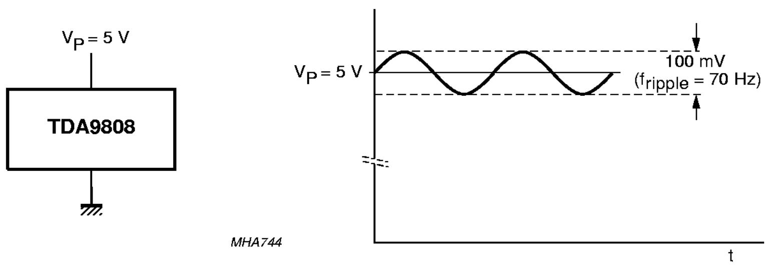
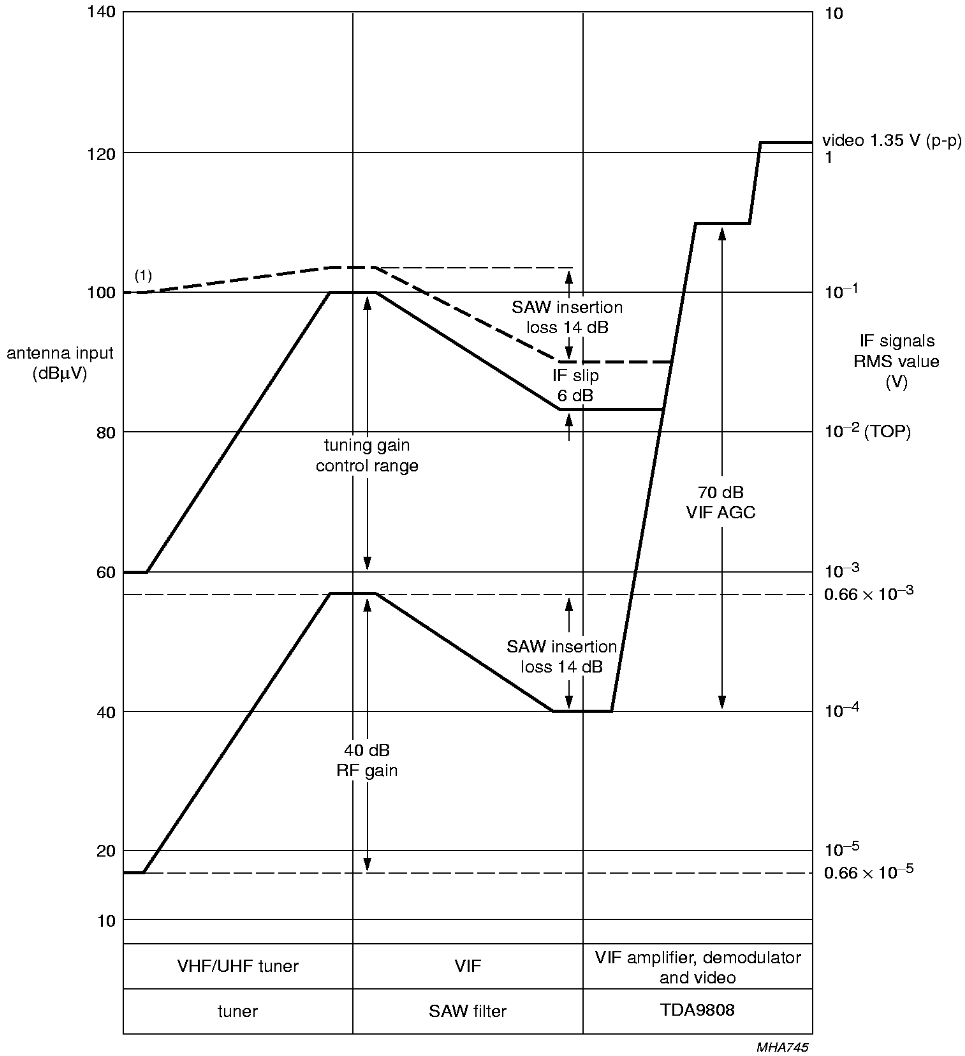


Fig.11 Ripple rejection condition.

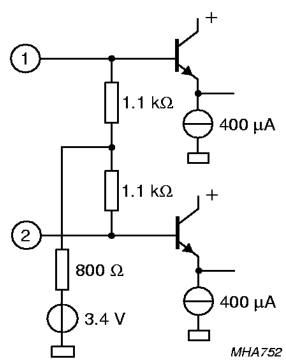
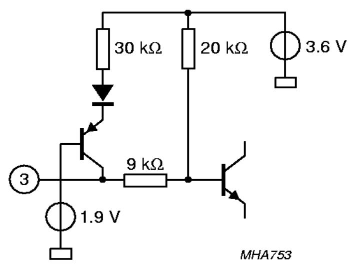
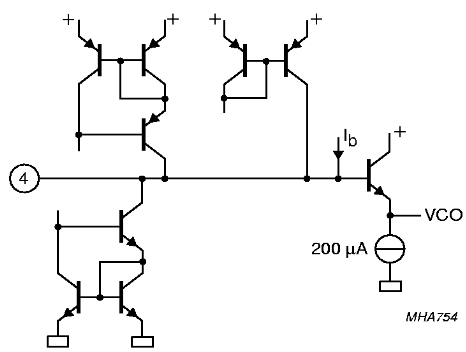


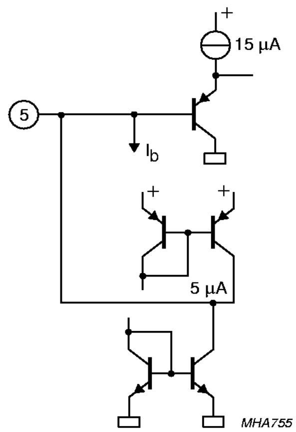
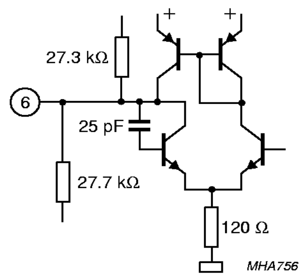
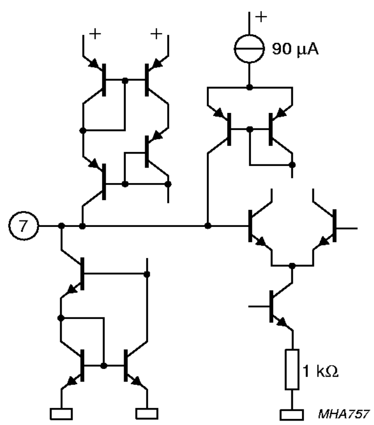
(1) Depends on TOP.

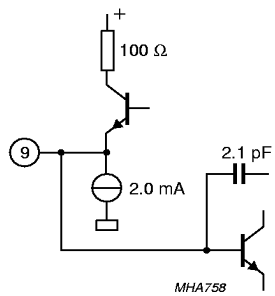
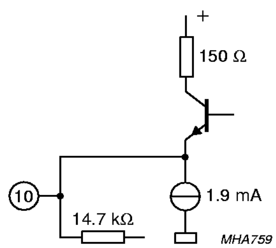
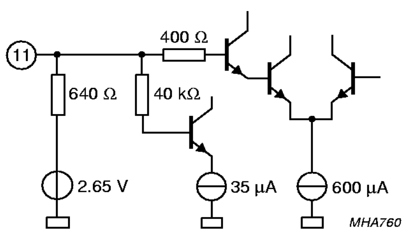
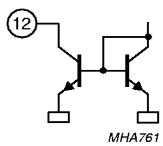
Fig.12 Front end level diagram.

INTERNAL CIRCUITRY

Table 2 Equivalent pin circuits and pin voltages

PIN NO.	PIN SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
1	$V_{i\ VIF1}$	3.4	
2	$V_{i\ VIF2}$	3.4	
3	TADJ (TOP)	0 to 1.9	
4	T_{PLL}	1.5 to 4.0	

PIN NO.	PIN SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
5	C_{SAGC}	1.5 to 4.0	
6	$V_{o\ AF}$	2.3	
7	C_{DEC}	1.2 to 3.0	
8	n.c.		

<table>
<tr><th>PIN NO.</th><th>PIN SYMBOL</th><th>DC VOLTAGE (V)</th><th>EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)</th></tr>
<tr><td>9</td><td>$V_{o(vid)}$</td><td>sync level: 1.5</td><td>
</td></tr>
<tr><td>10</td><td>$V_{o\ QSS}$</td><td>2.0</td><td>
</td></tr>
<tr><td>11</td><td>$V_{i\ FM}$</td><td>2.65</td><td>
</td></tr>
<tr><td>12</td><td>TAGC</td><td>0 to 13.2</td><td>
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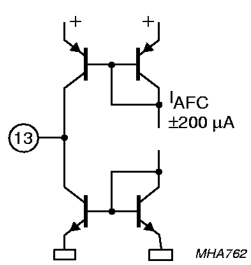
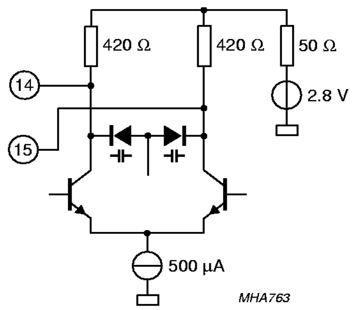
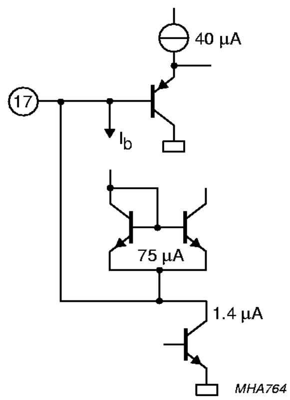
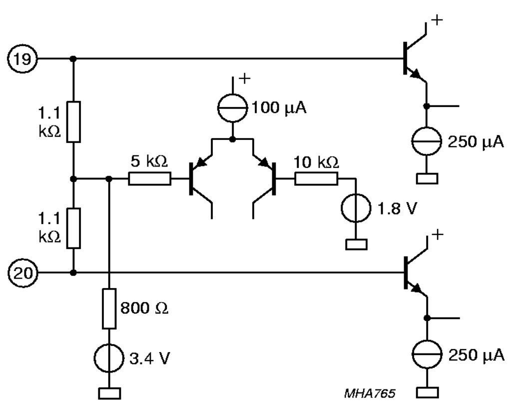
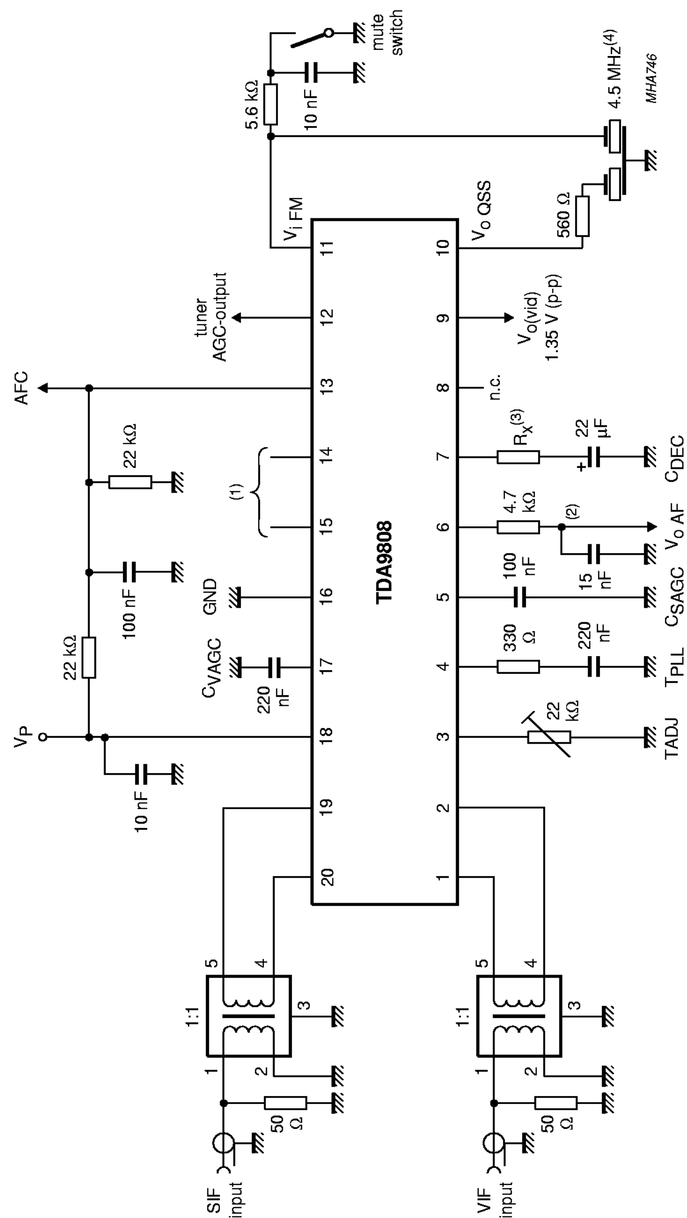
<tr><td>13</td><td>AFC</td><td>0.3 to $V_P - 0.3$</td><td>
</td></tr>
</table>

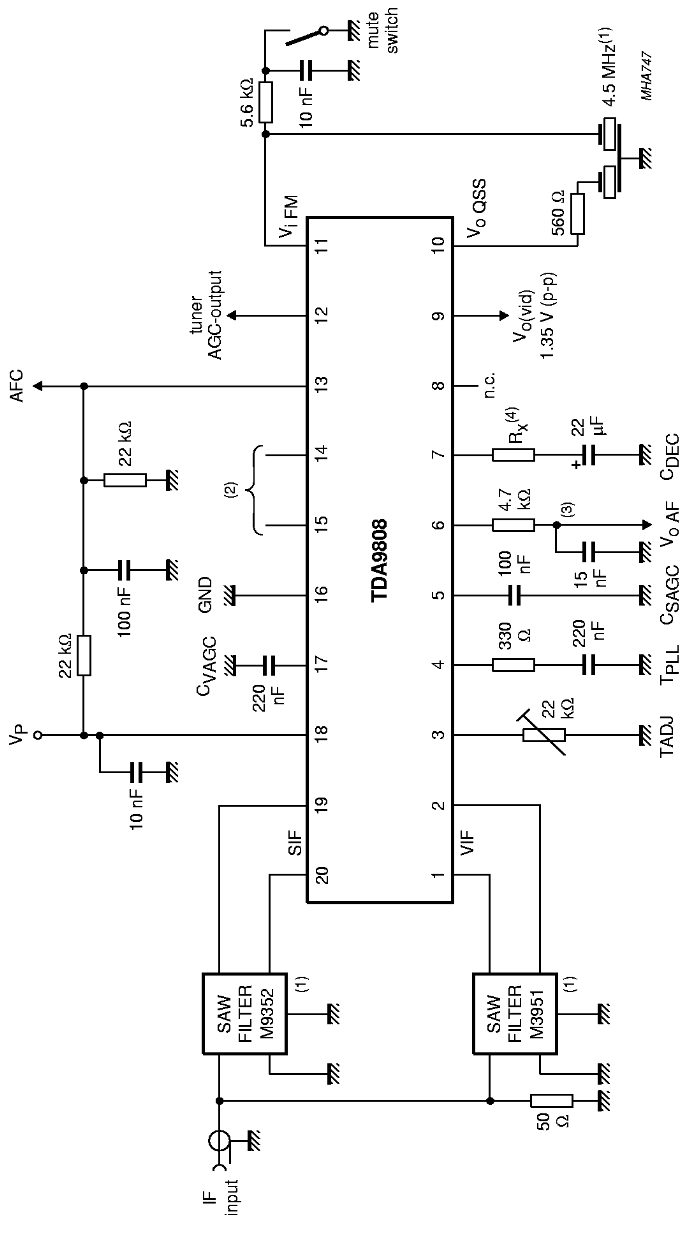
PIN NO.	PIN SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
14	VCO1	2.7	
15	VCO2	2.7	
16	GND	0	
17	C_{VAGC}	1.5 to 4.0	
18	V_P	V_P	
19	$V_{i\ SIF1}$	3.4	
20	$V_{i\ SIF2}$	3.4	

TEST AND APPLICATION INFORMATION



(1) See Table 3.
(2) De-emphasis circuitry for 75 μs.
(3) See note 16 of Chapter “Characteristics (5 V supply)”.
(4) Depends on TV standard.

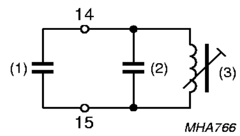
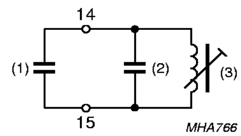
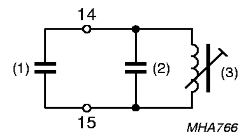
Fig.13 Test circuit.



(1) Depends on TV standard.
(2) See Table 3.
(3) De-emphasis circuitry for 75 µs.
(4) See note 16 of Chapter "Characteristics (5 V supply)".

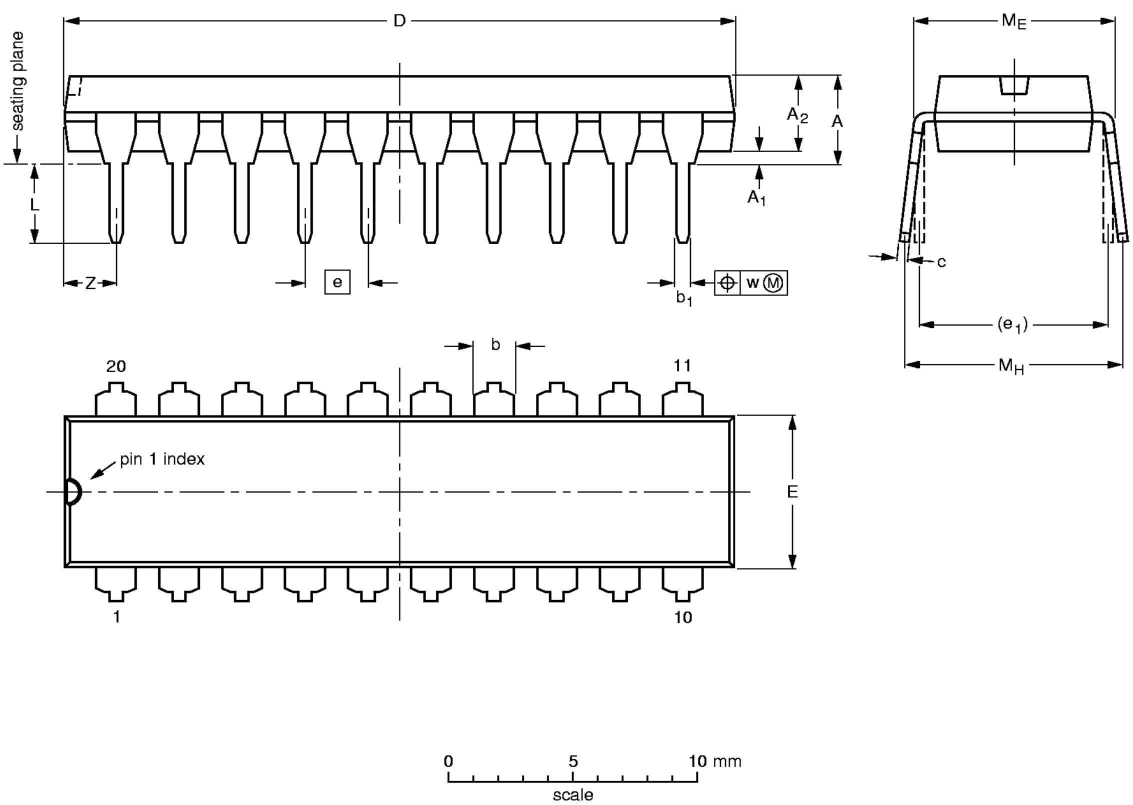
Fig.14 Application circuit.

Table 3 Oscillator circuit for the different TV standards

PARAMETER	EUROPE	USA	JAPAN
IF frequency	38.9 MHz	45.75 MHz	58.75 MHz
VCO frequency	77.8 MHz	91.5 MHz	117.5 MHz
Oscillator circuit	 (1) C_{VCO} = 8.5 pF. (2) C = 8.2 ±0.25 pF. (3) L = 251 nH.	 (1) C_{VCO} = 8.5 pF. (2) C = 10 ±0.25 pF. (3) L = 163 nH.	 (1) C_{VCO} = 8.5 pF. (2) C = 15 ±0.25 pF. (3) L = 78 nH.
e.g. Toko coil	5KM 369SNS-2010Z	5KMC V369SCS-2370Z	MC139 NE545SNAS100108
Philips ceramic capacitor	2222 632 51828	inside of coil	15 pF SMD; size = 0805

PACKAGE OUTLINES

DIP20: plastic dual in-line package; 20 leads (300 mil) **SOT146-1**

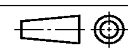


DIMENSIONS (inch dimensions are derived from the original mm dimensions)

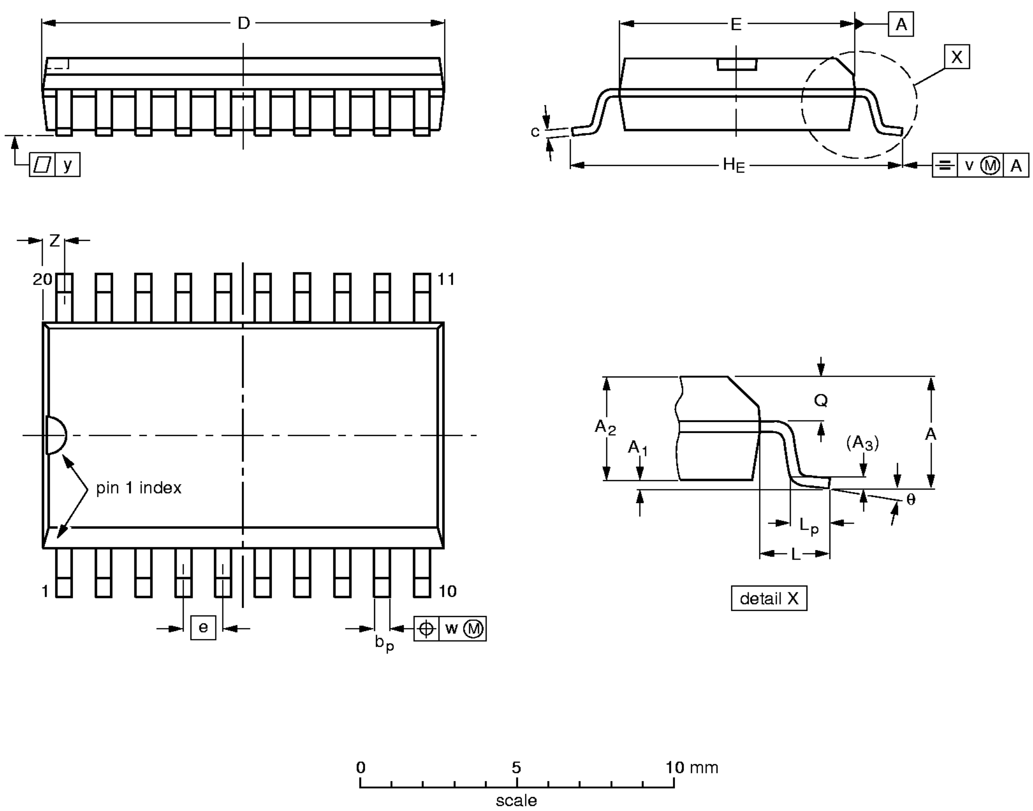
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	0.36 0.23	26.92 26.54	6.40 6.22	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.0
inches	0.17	0.020	0.13	0.068 0.051	0.021 0.015	0.014 0.009	1.060 1.045	0.25 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.078

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			
SOT146-1			SC603			~~92-11-17~~ 95-05-24

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

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 *"Data Handbook IC26; Integrated Circuit Packages"* (order code 9398 652 90011).

DIP

SOLDERING BY DIPPING OR BY WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint 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.

REPAIRING SOLDERED JOINTS

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, 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.

SO

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.