DATA SHEET

TDA9801
Single standard VIF-PLL demodulator and FM-PLL detector

Preliminary specification
File under Integrated Circuits, IC02

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Philips Semiconductors

PHILIPS

FEATURES

- Suitable for negative vision modulation
- Applicable for IF frequencies of 38.9 MHz, 45.75 MHz and 58.75 MHz
- Gain controlled wide band VIF-amplifier (AC-coupled)
- True synchronous demodulation with active carrier regeneration (ultra-linear demodulation, good intermodulation figures, reduced harmonics and excellent pulse response)
- Peak sync AGC
- Video amplifier to match sound trap and sound filter
- AGC output voltage for tuner; takeover point setting with fixed resistor (TOP)
- AFC detector without extra reference circuit
- Alignment-free FM-PLL detector with high linearity
- Stabilizer circuit for ripple rejection and to achieve constant output signals
- 5 to 9 V positive supply voltage range, low power consumption (300 mW at 5 V supply voltage).

GENERAL DESCRIPTION

The TDA9801 is a monolithic integrated circuit for vision and sound IF signal processing in TV-VTR sets and for multimedia front ends.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA9801	DIP20	plastic dual in-line package; 20 leads (300 mil)	SOT146-1
TDA9801T	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 (pin 20)		4.5	5.0	9.9	V
I_P	supply current	$V_P = 9$ V	52	61	70	mA
$V_{i\ VIF(rms)}$	vision IF input signal voltage sensitivity (RMS value; pins 1 and 2)		–	50	90	μV
	maximum vision IF input signal voltage (RMS value; pins 1 and 2)		70	150	–	mV
G_{IF}	IF gain control		64	70		dB
$V_{o\ CVBS(p\text{-}p)}$	CVBS output signal voltage on pin 7 (peak-to-peak value)		1.7	2.0	2.3	V
B_{-3}	−3 dB video bandwidth on pin 7		6	8	–	MHz
S/N (W)	weighted signal-to-noise ratio for video		56	60	–	dB
$\alpha_{IM(0.92/1.1)}$	intermodulation attenuation at 'blue'	f = 0.92 or 1.1 MHz	56	62	–	dB
$\alpha_{IM(2.76/3.3)}$	intermodulation attenuation at 'blue'	f = 2.76 or 3.3 MHz	56	62	–	dB
$\alpha_{H(sup)}$	harmonics suppression in video signal		35	40	–	dB
$V_{o\ AF(max)(rms)}$	maximum output signal handling voltage (RMS value)	THD < 1.5%	0.8	–	–	V
T_{amb}	operating ambient temperature		−20	–	+70	°C

BLOCK DIAGRAM

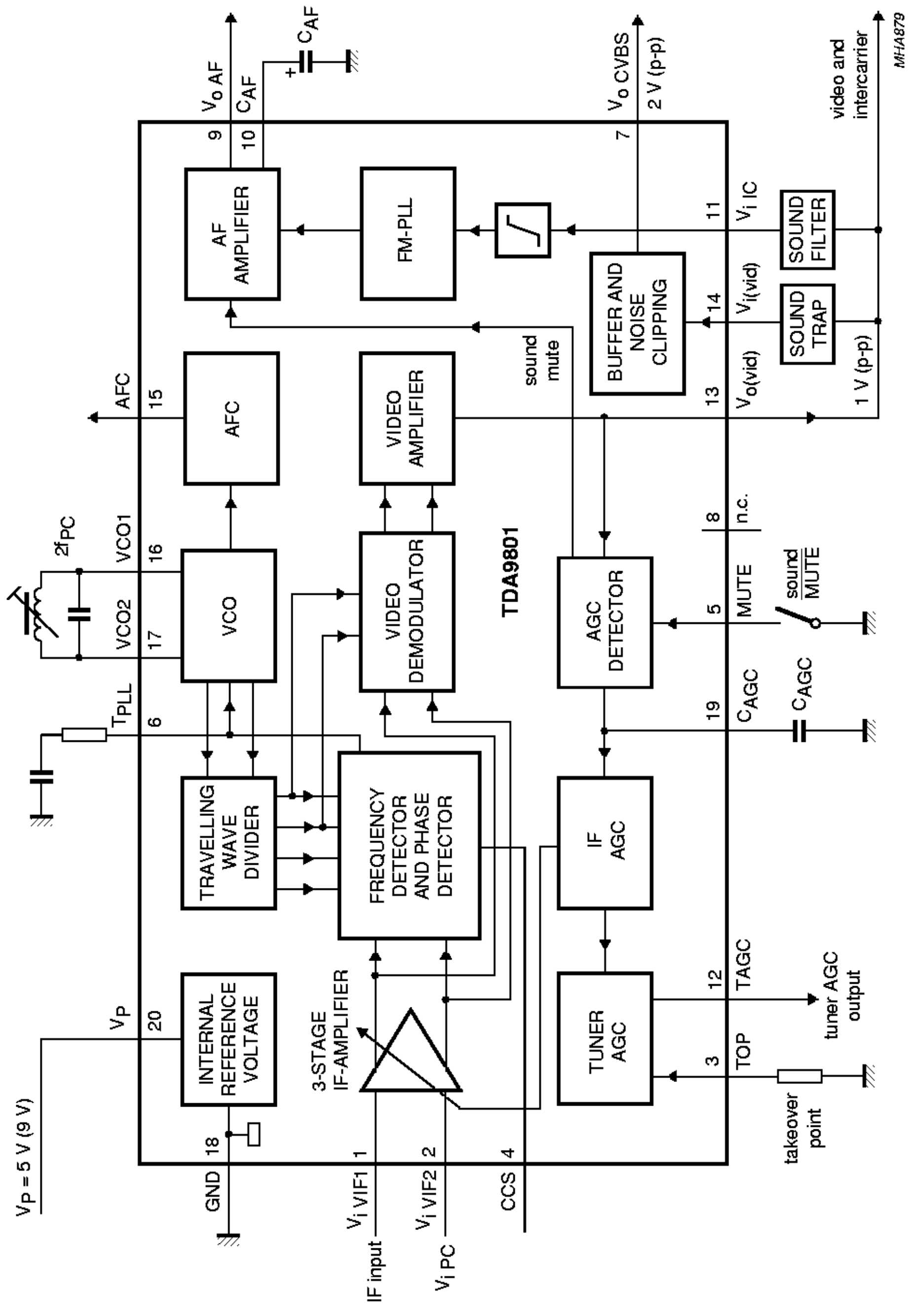


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
$V_{i\ VIF1}$	1	VIF differential input signal voltage 1
$V_{i\ VIF2}$	2	VIF differential input signal voltage 2
TOP	3	tuner AGC takeover point
CCS	4	controlled current source
MUTE	5	sound mute switch
T_{PLL}	6	PLL time constant of phase detector
$V_{o\ CVBS}$	7	CVBS (positive) output signal voltage
n.c.	8	not connected
$V_{o\ AF}$	9	audio frequency output signal voltage
C_{AF}	10	decoupling capacitor of audio frequency amplifier
$V_{i\ IC}$	11	sound intercarrier input voltage
TAGC	12	tuner AGC output
$V_{o(vid)}$	13	video and sound intercarrier output signal voltage
$V_{i(vid)}$	14	video input signal voltage to buffer amplifier
AFC	15	automatic frequency control output
VCO1	16	VCO1 reference circuit for $2f_{PC}$
VCO2	17	VCO2 reference circuit for $2f_{PC}$
GND	18	ground (0 V)
C_{AGC}	19	AGC capacitor
V_P	20	supply voltage

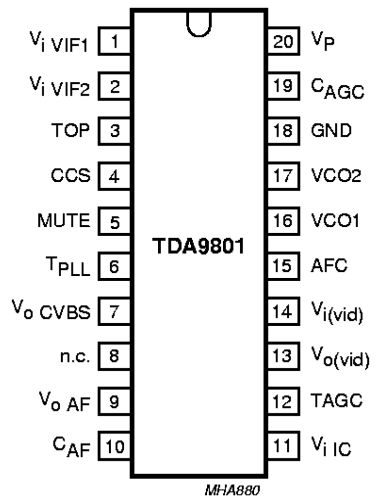


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

Vision IF amplifier

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

IF and tuner AGC

The automatic control voltage to maintain the video output signal at a constant level is generated in accordance with the transmission standard. Since the TDA9801 is suitable for negative modulation only the peak-sync level is detected. The AGC detector charges and discharges the capacitor on pin 19 to set the IF and tuner gain. The AGC capacitor voltage is transferred to an internal IF control signal, and is fed to the tuner AGC to generate the tuner AGC output current on pin 12 (open-collector output). The tuner AGC takeover point level is set at pin 3. This allows the tuner and the SAW filter to be matched to achieve the optimum IF input level.

Frequency detector, phase detector and video demodulator

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

The video demodulator is a linear multiplier, designed for low distortion and wide bandwidth. The vision IF input signal is multiplied by the in-phase component of the VCO output. The demodulated output signal is fed via an integrated low-pass filter (f_g = 12 MHz) to the video amplifier for suppression of the carrier harmonics.

VCO and travelling wave divider

The VCO operates with a symmetrically-connected reference LC-circuit, operating at double vision carrier frequency. Frequency control is performed by an internal variable capacitor diode. The voltage to set the VCO frequency to the actual frequency of double vision carrier frequency, is also amplified and converted for the AFC output current.

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

Video amplifier, buffer and noise clipping

The video amplifier is a wide bandwidth operational amplifier with internal feedback. A nominal positive video signal of 1 V (p-p) is present on the composite video output (pin 13). The input impedance of the 7 dB wideband buffer amplifier (with internal feedback) is suitable for ceramic sound trap filters.

The CVBS output (pin 7) provides a positive video signal of 2 V (p-p). Noise clipping is provided internally.

Sound demodulation

The FM sound intercarrier signal is fed to pin 11 and through a limiter amplifier before it is demodulated. The result is high sensitivity and AM suppression. The limiter amplifier consists of 7 stages which are internally AC-coupled in order to minimizing the DC offset.

The FM-PLL demodulator consists of an RC-oscillator, loop filter and phase detector. The oscillator frequency is locked on the FM intercarrier signal from the limiter amplifier. As a result of this locking, the RC-oscillator is frequency-modulated.

The modulating signal voltage (AF signal) is used to control the oscillator frequency. By this, the FM-PLL operates as an FM demodulator.

The audio frequency amplifier with internal feedback is designed for high gain and high common mode rejection. The LOW-level AF signal output from the FM-PLL demodulator is amplified and buffered in a low-ohmic audio signal output stage (pin 9). An external decoupling capacitor on pin 10 removes the DC voltage from the audio amplifier input.

By using the sound mute switch (pin 5) the AF amplifier is set to mute state.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage (pin 20)	maximum chip temperature; note 1			
		SOT146-1 at 125 °C	0	9.9	V
		SOT163-1 at 128 °C	0	9.9	V
V_n	voltage at pins 1, 2, 15 and 19		0	V_P	V
$t_{sc(max)}$	maximum short-circuit time		–	10	s
V_{12}	tuner AGC output voltage		–	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. Supply current I_P = 70 mA at 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		
	SOT146-1		73	K/W
	SOT163-1		85	K/W

CHARACTERISTICS (V_P = 9 V)

V_P = 9 V; T_{amb} = 25 °C; see Table 1 for input frequencies and picture-to-sound ratios; input level $V_{i\,IF\,1,\,2}$ = 10 mV RMS value (sync-level); IF input from 50 Ω via broadband transformer 1:1; video modulation DSB; residual carrier: 10%; video signal in accordance with *"CCIR, line 17"* or *"NTC-7 Composite"*; measurements taken in Fig.12; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (pin 20)						
V_P	supply voltage	note 1	4.5	5.0	9.9	V
I_P	supply current		52	61	70	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	–	50	90	μV
Composite video amplifier (pin 13; sound carrier OFF)						
$V_{o\,video(p-p)}$	output signal voltage (peak-to-peak value)	see Fig.5	0.95	1.1	1.25	V
Measurements from IF input to CVBS output (pin 7; 330 Ω between pins 13 and 14, sound carrier OFF)						
$V_{o\,CVBS(p-p)}$	CVBS output signal voltage on pin 7 (peak-to-peak value)		1.8	2.2	2.6	V
S/N (W)	weighted signal-to-noise ratio	see Fig.3 and note 4	55	59	–	dB
RR	ripple rejection at pin 7	see Fig.7	25	28	–	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 15); see Fig.8 and note 5						
S	control steepness $\Delta I_{15}/\Delta f$	see Table 3				
		f_{PC} = 38.9 MHz	−0.5	−0.75	−1.0	μA/kHz
		f_{PC} = 45.75 MHz	−0.4	−0.65	−0.9	μA/kHz
		f_{PC} = 58.75 MHz	−0.3	−0.55	−0.8	μA/kHz
$\Delta f_{IF}/\Delta T$	frequency variation by temperature	I_{AFC} = 0; note 6	–	–	$\pm 20 \times 10^{-6}$	K^{-1}
FM-PLL sound demodulator and AF output (pin 9); note 7						
$V_{o\,AF(rms)}$	AF output signal voltage (RMS value)	Δf_{AF} = ±27 kHz; see Fig.10	400	500	600	mV
S/N (W)	weighted signal-to-noise ratio	*"CCIR 468-4"*; see Fig.10	50	55	–	dB
α_{mute}	mute attenuation	V_5 = 0 V	70	80	–	dB
ΔV_5	DC offset voltage at switching (plop)	switching to MUTE-ON	–	100	500	mV

Notes

1. Values of video and sound parameters are decreased at $V_P = 4.5$ V.
2. Loop bandwidth BL = 60 kHz (natural frequency $f_n = 15$ kHz; damping factor d = 2; calculated with grey level and FPLL input signal level). Resonance circuit of VCO: $Q_0 > 50$; C_{ext} see Table 3; $C_{int} \approx 8.5$ pF (loop voltage approximately 2.7 V).
3. $V_{i\ IF}$ 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 7). 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.8).
6. Temperature coefficient of external LC-circuit is equal to zero.
7. Input level for second IF from an external generator with 50 Ω source impedance. AC-coupled with 10 nF capacitor, $f_{mod} = 1$ kHz, 27 kHz (54% FM deviation) of audio reference. A VIF input signal is not permitted. Pin 19 has to be connected to positive supply voltage. Measurements are taken at 50 μs de-emphasis.

CHARACTERISTICS (V_P = 5 V)

V_P = 5 V; T_{amb} = 25 °C; see Table 1 for input frequencies and picture-to-sound carrier ratios; input level $V_{i\,IF\,1,\,2}$ = 10 mV RMS value (sync-level); IF input from 50 Ω via broadband transformer 1:1; video modulation DSB; residual carrier: 10%; video signal in accordance with *"CCIR, line 17"* or *"NTC-7 Composite"*; measurements taken in Fig.12; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (pin 20)						
V_P	supply voltage	note 1	4.5	5.0	5.5	V
I_P	supply current		51	60	70	mA
Vision IF input (pins 1 and 2)						
$V_{i(VIF)(rms)}$	input signal voltage sensitivity (RMS value)	f_{PC} = 38.9 or 45.75 MHz; −1 dB video at output	–	50	90	μV
		f_{PC} = 58.75 MHz; −1 dB video at output	–	60	100	μV
$V_{i(max)(rms)}$	maximum input signal voltage (RMS value)	f_{PC} = 38.9 or 45.75 MHz; +1 dB video at output	70	150	–	mV
		f_{PC} = 58.75 MHz; +1 dB video at output	80	160	–	mV
$\Delta V_{o(int)}$	internal IF amplitude difference between picture and sound carrier	within AGC range	–	0.7	1	dB
G_{IF}	IF gain control	see Fig.6				
		f_{PC} = 38.9 or 45.75 MHz	64	70	–	dB
		f_{PC} = 58.75 MHz	62	68	–	dB
B_{-3}	−3 dB IF bandwidth	upper cut-off frequency	70	100	–	MHz
$R_{i(diff)}$	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
$V_{1/2}$	DC input voltage		3.0	3.4	3.8	V
True synchronous video demodulator; note 3						
$f_{VCO(max)}$	maximum oscillator frequency for carrier regeneration	$f = 2f_{PC}$	125	130	–	MHz
$\Delta f_{VCO}/\Delta T$	oscillator drift (free-running) as a function of temperature	I_{AFC} = 0; note 4	–	–	$\pm 20 \times 10^{-6}$	K^{-1}
$V_{0\,ref(rms)}$	oscillator voltage swing at pins 16 and 17 (RMS value)	f_{PC} = 38.9 MHz	–	120	–	mV
		f_{PC} = 45.75 MHz	–	100	–	mV
		f_{PC} = 58.75 MHz	–	80	–	mV
$\Delta f_{PC(capt)}$	vision carrier capture frequency range (negative)		1.4	1.8	–	MHz
	vision carrier capture frequency range (positive)		1.4	1.8	–	MHz
t_{acqu}	acquisition time	BL = 60 kHz; note 5	–	–	30	ms
$V_{i\,(VIF)(rms)}$	VIF input signal voltage sensitivity (RMS value; pins 1 and 2)	PLL still locked; maximum IF gain; note 6	–	50	90	μV
		C/N = 10 dB; note 7	–	100	140	μV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{PLL(os)}$	FPLL offset current at pin 6	note 8	–	–	±2.0	μA
Composite video amplifier (pin 13; sound carrier OFF)						
$V_{o\ video(p\text{-}p)}$	output signal voltage (peak-to-peak value)	see Fig.5	0.9	1.0	1.1	V
$V_{13(sync)}$	sync voltage level		1.35	1.5	1.6	V
$V_{13(clu)}$	upper video clipping voltage level		$V_P - 1.1$	$V_P - 1$	–	V
$V_{13(cll)}$	lower video clipping voltage level		–	0.7	0.9	V
$V_{0\ FM(rms)}$	IF intercarrier voltage level (RMS value)	sound carrier ON	–	note 9	–	mV
R_{13}	output resistance	note 2	–	–	10	Ω
$I_{int\ 13}$	internal DC bias current for emitter-follower		1.8	2.5	–	mA
$I_{13(max)(sink)}$	maximum AC and DC output sink current		1.4	–	–	mA
$I_{13(max)(source)}$	maximum AC and DC output source current		2.0	–	–	mA
B_{-3}	–3 dB video bandwidth	$C_L < 50$ pF; $R_L > 1$ kΩ	7	10	–	MHz
$\alpha_{H(sup)}$	harmonics suppression in video signal	$C_L < 50$ pF; $R_L > 1$ kΩ; note 10	35	40	–	dB
RR	ripple rejection at pin 13	see Fig.7	32	35	–	dB
CVBS buffer amplifier and noise clipper (pins 7 and 14)						
R_{14}	input resistance		2.6	3.3	4.0	kΩ
C_{14}	input capacitance		1.4	2	3.0	pF
V_{14}	DC input voltage	pin 14 not connected	1.5	1.8	2.1	V
G_v	voltage gain	note 11	6	7	7.5	dB
$V_{o\ CVBS(p\text{-}p)}$	CVBS output signal voltage at pin 7 (peak-to-peak value)	sound carrier OFF; see Fig.12	1.7	2.0	2.3	V
$V_{o\ CVBS(clu)}$	upper video clipping CVBS output voltage level		3.9	4.0	–	V
$V_{o\ CVBS(cll)}$	lower video clipping CVBS output voltage level		–	1.0	1.1	V
$V_{o\ CVBS(sync)}$	sync CVBS output voltage level		–	1.35	–	V
R_7	output resistance		–	–	10	Ω
$I_{int\ 7}$	DC internal bias current for emitter-follower		1.8	2.5	–	mA
$I_{7(max)(sink)}$	maximum AC and DC output sink current		1.4	–	–	mA
$I_{7(max)(source)}$	maximum AC and DC output source current		2.4	–	–	mA
B_{-3}	–3 dB video bandwidth	$C_L < 20$ pF; $R_L > 1$ kΩ	8	11	–	MHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Measurements from IF input to CVBS output (pin 7; 330 Ω between pins 13 and 14, sound carrier OFF)						
$V_{o\ CVBS(p\text{-}p)}$	CVBS output signal voltage on pin 7 (peak-to-peak value)		1.7	2.0	2.3	V
ΔV_o	deviation of CVBS output signal voltage at B/G standard	50 dB gain control	–	–	0.5	dB
		30 dB gain control	–	–	0.1	dB
$\Delta V_{o(bl)}$	black level tilt	gain variation; note 12	–	–	1	%
ΔG_{diff}	differential gain	*“CCIR, line 330”* or *“NTC-7 Composite”*	–	2	5	%
$\Delta \varphi_{diff}$	differential phase	*“CCIR, line 330”* or *“NTC-7 Composite”*	–	2	4	deg
B_{-3}	–3 dB video bandwidth	C_L < 20 pF; R_L > 1 kΩ	6	8	–	MHz
S/N (W)	weighted signal-to-noise ratio	see Fig.3 and note 13	56	60	–	dB
$\alpha_{IM(0.92/1.1)}$	intermodulation attenuation at ‘blue’	f = 0.92 or 1.1 MHz; see Fig.4 and note 14	56	62	–	dB
	intermodulation attenuation at ‘yellow’	f = 0.92 or 1.1 MHz; see Fig.4 and note 14	58	64	–	dB
$\alpha_{IM(2.76/3.3)}$	intermodulation attenuation at ‘blue’	f = 2.76 or 3.3 MHz; see Fig.4 and note 14	56	62	–	dB
	intermodulation attenuation at ‘yellow’	f = 2.76 or 3.3 MHz; see Fig.4 and note 14	57	63	–	dB
$\alpha_{c(rms)}$	residual vision carrier (RMS value)	fundamental wave	–	1	10	mV
		harmonics	–	1	10	mV
$\alpha_{H(sup)}$	harmonics suppression in video signal	note 10	35	40	–	dB
RR	ripple rejection at pin 7	see Fig.7	25	28	–	dB
AGC detector (pin 19)						
t_{resp}	response to an increasing amplitude step of 50 dB in input signal		–	1	10	ms
	response to a decreasing amplitude step of 50 dB in input signal		–	50	100	ms
I_{19}	charging current	note 12	0.82	1.1	1.38	mA
	discharging current		16	22	28	μA
V_{19}	AGC voltage	maximum gain	0	see Fig.6	–	V
		minimum gain	–	see Fig.6	V_P – 0.7	V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Tuner AGC (pin 12)						
$V_{i(rms)}$	IF input signal voltage for minimum onset of tuner takeover point (RMS value)	input at pins 1 and 2; R_{TOP} = 22 kΩ	–	–	5	mV
	IF input signal voltage for maximum onset of tuner takeover point (RMS value)	input at pins 1 and 2; R_{TOP} = 0 Ω	50	–	–	mV
	tuner takeover point accuracy	R_{TOP} = 13 kΩ; I_{12} = 0.4 mA	7	–	14	mV
V_{12}	permissible output voltage	from external source; note 2	–	–	13.2	V
	saturation voltage	I_{12} = 1.7 mA	–	–	0.2	V
$\Delta V_{12}/\Delta T$	variation of takeover point by temperature	I_{12} = 0.4 mA	–	0.02	0.06	dB/K
$I_{12(sink)}$	sink current	see Fig.6				
		no tuner gain reduction	–	0.1	0.3	μA
		maximum tuner gain reduction	1.7	2.0	2.6	mA
ΔG_{IF}	IF slip by automatic gain control	tuner gain current from 20 to 80%	–	6	8	dB
AFC circuit (pin 15); see Fig.8 and note 15						
S	control steepness $\Delta I_{15}/\Delta f$	see Table 3				
		f_{PC} = 38.9 MHz	−0.5	−0.75	−1.0	μA/kHz
		f_{PC} = 45.75 MHz	−0.4	−0.65	−0.9	μA/kHz
		f_{PC} = 58.75 MHz	−0.3	−0.55	−0.8	μA/kHz
$\Delta f_{IF}/\Delta T$	frequency variation by temperature	I_{AFC} = 0; note 4	–	–	$\pm 20 \times 10^{-6}$	K^{-1}
V_{15}	output voltage upper limit	see Fig.8; without external components	$V_P - 0.5$	$V_P - 0.3$	–	V
	output voltage lower limit		–	0.3	0.5	V
$I_{15(source)}$	output source current	see Fig.8	150	200	250	μA
$I_{15(sink)}$	output sink current		150	200	250	μA
$\Delta I_{15(p-p)}$	residual video modulation current (peak-to-peak value)		–	20	30	μA
Sound mute switch (pin 5); note 16						
V_{IL}	input voltage for MUTE-ON		0	–	0.8	V
V_{IH}	input voltage for MUTE-OFF		1.5	–	V_P	V
I_{IL}	LOW-level input current	V_5 = 0 V	–	−300	−360	μA
α_{mute}	mute attenuation	V_5 = 0 V	70	80	–	dB
ΔV_5	DC offset voltage at switching (plop)	switching to MUTE-ON	–	100	500	mV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
FM sound limiter amplifier (pin 11); note 17						
$V_{i\ FM(rms)}$	input signal voltage (RMS value)	*"CCIR468-4"*				
		S/N = 40 dB; see Fig.10	–	200	300	μV
		α_{AM} = 40 dB; f = 1 kHz; m = 0.3	–	1	–	mV
$V_{i\ FM(max)(rms)}$	maximum input signal handling voltage (RMS value)		200	–	–	mV
α_{AM}	AM suppression	AM: f = 1 kHz; m = 0.3; see Fig.9	46	50	–	dB
R_{11}	input resistance	note 2	480	600	720	Ω
B_{-3}	−3 dB IF frequency response of sound IF	lower and upper cut-off frequency	3.5	–	10	MHz
V_{11}	DC input voltage		2.3	2.6	2.9	V
FM-PLL sound demodulator and AF output (pin 9); note 17						
$f_{i\ FM(catch)}$	catching range of PLL	upper limit	7	–	–	MHz
		lower limit	–	–	4	MHz
$f_{i\ FM(hold)}$	holding range of PLL	upper limit	8	–	–	MHz
		lower limit	–	–	3.5	MHz
t_{acqu}	acquisition time		–	–	4	μs
$V_{o\ AF(rms)}$	AF output signal voltage (RMS value)	$\Delta f_{AF} = \pm 27$ kHz; B/G standard; see Fig.10	400	500	600	mV
		$\Delta f_{AF} = \pm 25$ kHz; M standard; see Fig.10	370	460	550	mV
$V_{o\ AF(max)(rms)}$	maximum output signal handling voltage (RMS value)	THD < 1.5%	0.8	–	–	V
$\Delta V_o/\Delta T$	temperature drift of AF output signal voltage		–	3×10^{-3}	7×10^{-3}	dB/K
Δf_{AF}	frequency deviation	THD < 1.5%; note 18	–	–	±50	kHz
V_{10}	DC voltage at decoupling capacitor	voltage dependent on VCO frequency; note 19	1.5	–	3.3	V
R_9	output resistance	note 2	–	200	–	Ω
R_L	load resistance (pin 9)	AC-coupled	2.2	–	–	kΩ
$I_{9(max)}$	maximum sink or source output current	AC and DC	–	–	1.5	mA
V_9	DC output voltage		2.1	2.5	2.9	V
B_{-3}	−3 dB audio frequency bandwidth		95	120	–	kHz
THD	total harmonic distortion	27 kHz FM deviation; $R_x = 0\ \Omega$	–	0.25	0.5	%
S/N (W)	weighted signal-to-noise ratio	*"CCIR 468-4"*; see Fig.10	50	55	–	dB
$\alpha_{c(rms)}$	residual sound carrier (RMS value)	fundamental wave and harmonics	–	–	75	mV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
RR	ripple rejection at pin 9	$R_x = 0\ \Omega$; see Figs 7 and 13	24	30	–	dB
Measurements from IF input to audio output (pin 9); notes 20 and 21; see Fig.13						
S/N (W)	weighted signal-to-noise ratio	*"CCIR 468-4"*				
		black picture (sync only)	46	52	–	dB
		white picture	42	48	–	dB
		colour bar	40	46	–	dB

Notes

1. Values of video and sound parameters are decreased at $V_P = 4.5$ V.
2. This parameter is not tested during production and is only given as application information for designing the television receiver.
3. Loop bandwidth BL = 60 kHz (natural frequency $f_n = 15$ kHz; damping factor d = 2; calculated with grey level and FPLL input signal level). Resonance circuit of VCO: $Q_0 > 50$; C_{ext} see Table 3; $C_{int} \approx 8.5$ pF (loop voltage approximately 2.6 V).
4. Temperature coefficient of external LC-circuit is equal to zero.
5. $V_{i\,IF} = 10$ mV RMS value; $\Delta f = 1$ MHz (VCO frequency offset related to picture carrier frequency); white picture video modulation.
6. $V_{i\,IF}$ signal for nominal video signal.
7. Transformer at IF input (Fig.12). The C/N ratio at IF input for 'lock-in' is defined as the vision IF input signal (sync level, RMS value) in relation to a superimposed, 5 MHz band-limited white noise signal (RMS value); video modulation: white picture.
8. Offset current measured between pin 6 and half of supply voltage ($V_P = 2.5$ V) under the following conditions: no input signal at VIF input (pins 1 and 2) and VIF amplifier gain at minimum ($V_{19} = V_P$), pin 4 open-circuit.
9. The intercarrier output signal is superimposed to the video signal at pin 13 and can be calculated by the following formula taking into account the video output signal at pin 13 ($V_{o\,video} = 1$ V typical) as a reference:

$$V_{o(rms)} = 1.0\ \text{V (p-p)} \times \frac{1}{2\sqrt{2}} \times 10^{\frac{\frac{V_{i\,SC}}{V_{i\,PC}}(\text{dB}) + 6\ \text{dB} \pm 2\ \text{dB}}{20}}$$

with $\frac{1}{2\sqrt{2}}$ = 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 ±2 dB = tolerance of video output and intercarrier output amplitude $V_{o(rms)}$.

Example: SAW filter G1962 (sound shelf: 20 dB) $\Rightarrow \frac{V_{i\,SC}}{V_{i\,PC}} = -27\ \text{dB} \Rightarrow V_{o(rms)} = 32$ mV typical

10. Measurements taken with SAW filter G1962; modulation: VSB, $f_{video} > 0.5$ MHz, loop bandwidth BL = 60 kHz.
11. The 7 dB buffer gain accounts for 1 dB loss in the sound trap. Buffer output signal is typical 2 V (p-p). If no sound trap is applied a 330 Ω resistor must be connected from output to input (from pin 13 to pin 14).
12. The leakage current of the AGC capacitor should not exceed 1 µA. Larger currents will increase the tilt.

13. S/N is the ratio of black-to-white amplitude to the black level noise voltage (RMS value, pin 7). B = 5 MHz weighted in accordance with *"CCIR 567"* at a source impedance of 50 Ω.
14. The intermodulation figures are defined:

$$\alpha_{0.92/1.1} = 20\ \log\left(\frac{V_o \text{ at } 4.4\ (3.58)\ \text{MHz}}{V_o \text{ at } 0.92\ (1.1)\ \text{MHz}}\right) + 3.6\ \text{dB}$$

; $\alpha_{0.92/1.1}$ value at 0.92 (1.1) MHz referenced to black or white signal;

$$\alpha_{2.76/3.3} = 20\ \log\left(\frac{V_o \text{ at } 4.4\ (3.58)\ \text{MHz}}{V_o \text{ at } 2.76\ (3.3)\ \text{MHz}}\right)$$

; $\alpha_{2.76/3.3}$ value at 2.76 (3.3) MHz referenced to colour carrier.

15. To match the AFC output signal to different tuning systems a current source output is provided (Fig.8).
16. No mute state is also valid for pin not connected.
17. Input level for second IF from an external generator with 50 Ω source impedance. AC-coupled with 10 nF capacitor, f_{mod} = 1 kHz, 27 kHz (54% FM deviation) of audio reference. A VIF input signal is not permitted. Pin 19 has to be connected to positive supply voltage. Measurements are taken at 50 μs (75 μs at M standard) de-emphasis.
18. To allow higher frequency deviation, the resistor R_x on pin 10 (see Fig.13) has to be increased to a value which does not exceed the AF output signal of nominally 0.50 V for THD = 0.2% (R_x = 4.7 kΩ provides −6 dB amplification).
19. The leakage current of the decoupling capacitor (2.2 μF) should not exceed 100 nA.
20. For all S/N measurements the used vision IF modulator has to meet the following specification:
    a) Incidental phase modulation for black-to-white jump less than 0.5 degrees.
    b) AF performance, measured with the television demodulator AMF2 (audio output, weighted S/N ratio) better than 60 dB (deviation 27 kHz) for white picture video modulation.
21. Input signal according to Table 1, B/G standard; input level $V_{i\ IF\ 1,\ 2}$ = 10 mV RMS value; modulation VSB mode with 10% residual carrier. Reference: 27 kHz FM deviation, measurements are taken at 50 μs de-emphasis.

Table 1 Input frequencies and carrier ratios

SYMBOL	DESCRIPTION	B/G STANDARD	M/N STANDARD	M STANDARD	UNIT
f_{PC}	picture carrier frequency	38.9	45.75	58.75	MHz
f_{SC}	sound carrier frequency	33.4	41.25	54.25	MHz
PC/SC	picture-to-sound carrier ratio	13	7	7	dB

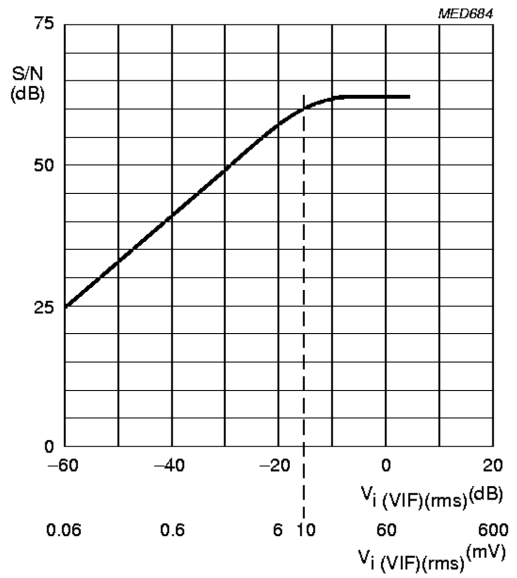
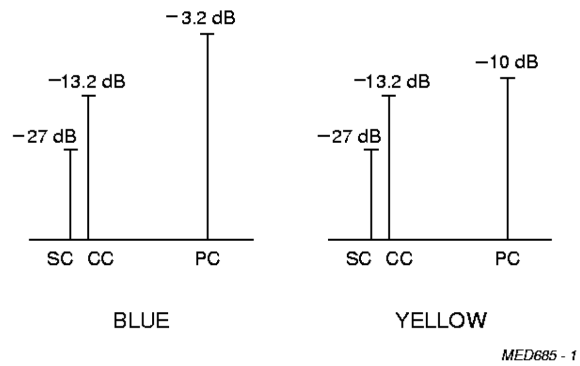


Fig.3 Typical signal-to-noise ratio as a function of IF input signal.



SC = Sound Carrier level, with respect to TOP sync level.
CC = Chrominance Carrier level, with respect to TOP sync level.
PC = Picture Carrier level, with respect to TOP sync level.
Sound shelf attenuation: 20 dB.

Fig.4 Input conditions for intermodulation measurements.

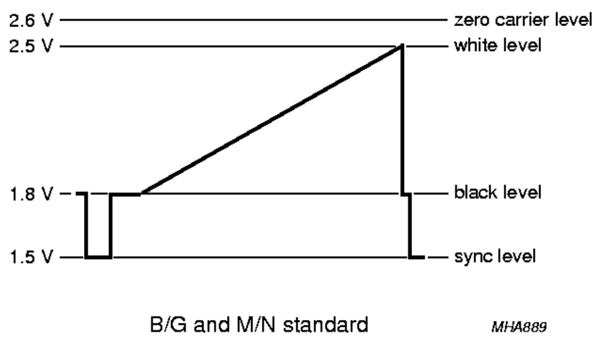
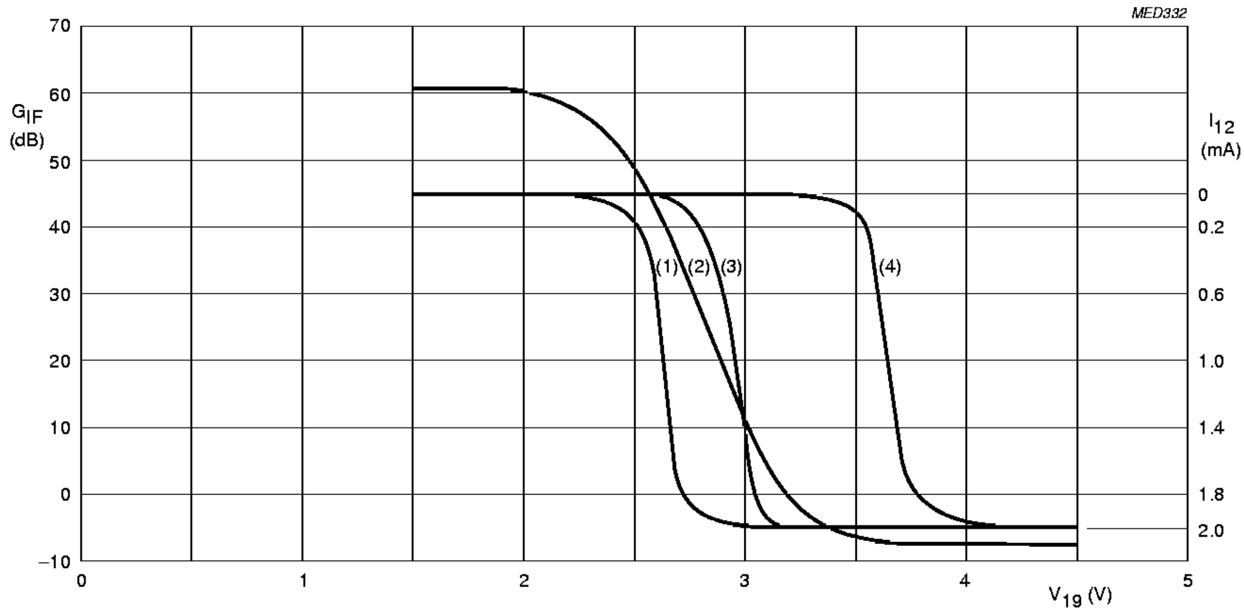


Fig.5 Video signal levels on output pin 13.



(1) R3 = 22 kΩ.
(2) G_{IF}.
(3) R3 = 13 kΩ.
(4) R3 = 0 Ω.

Fig.6 IF AGC (2) and characteristic of tuner AGC current (typically).

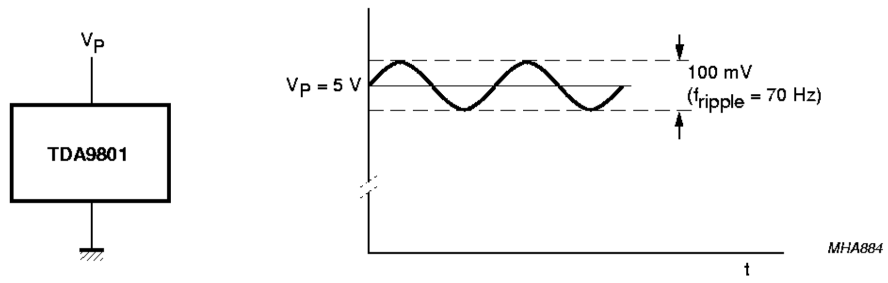
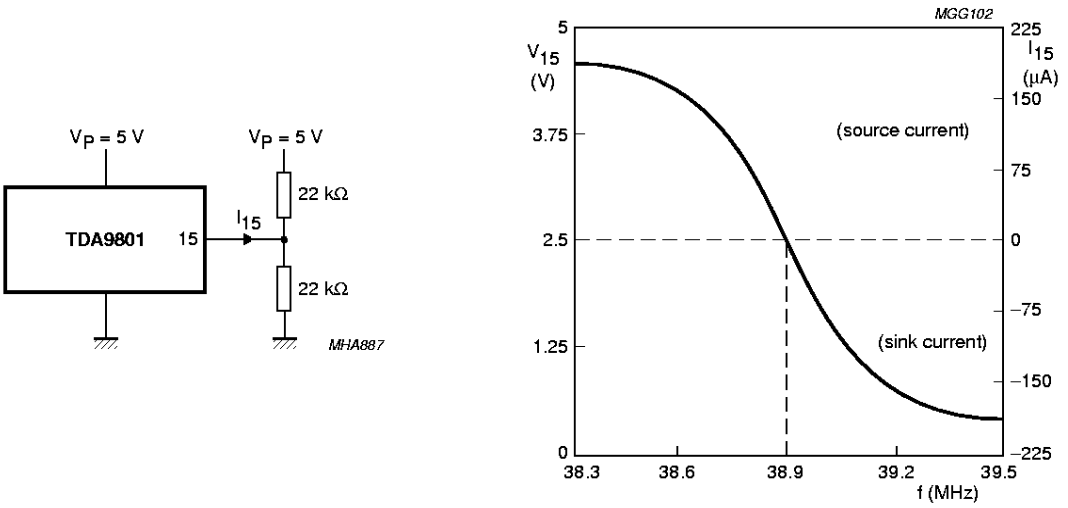
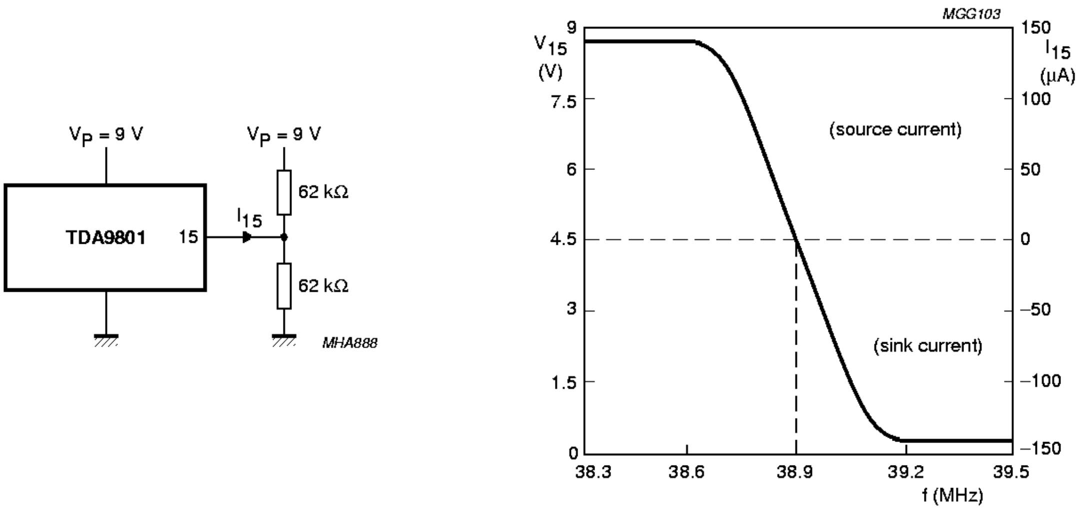


Fig.7 Ripple rejection condition.



a. $V_P = 5$ V.



b. $V_P = 9$ V.

Fig.8 Measurement conditions and typical AFC characteristic.

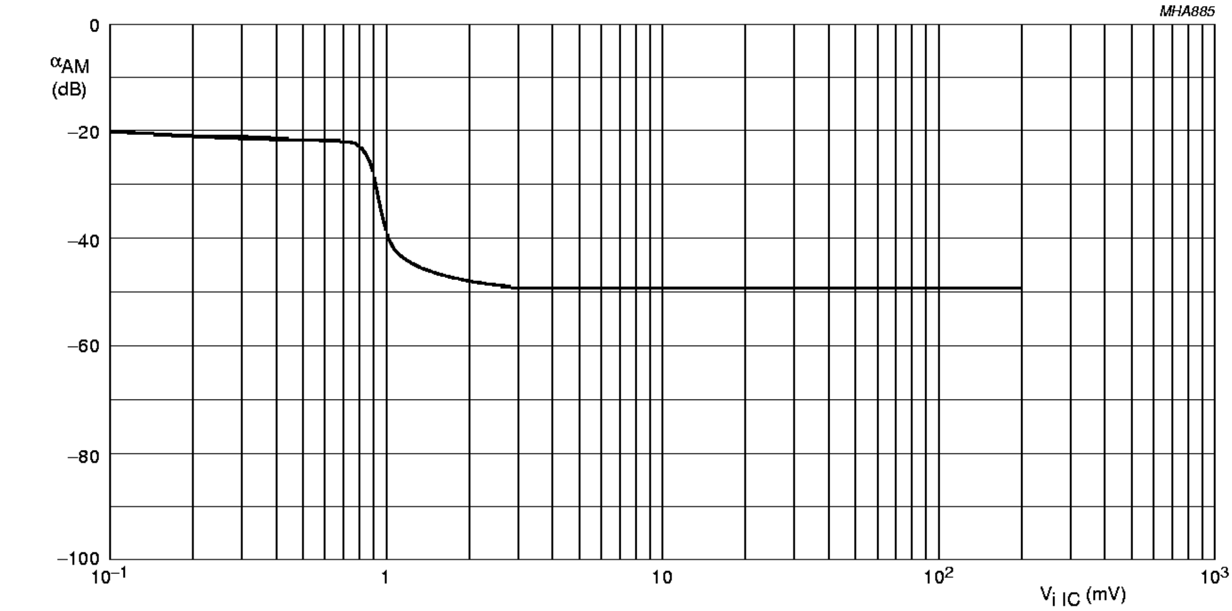
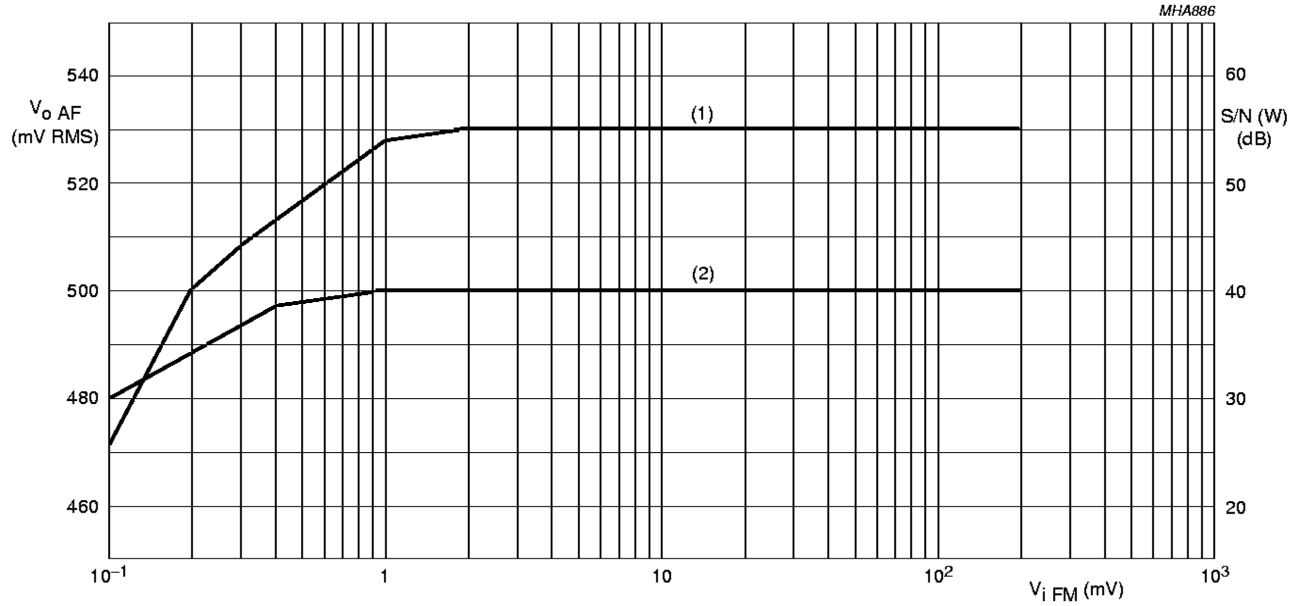
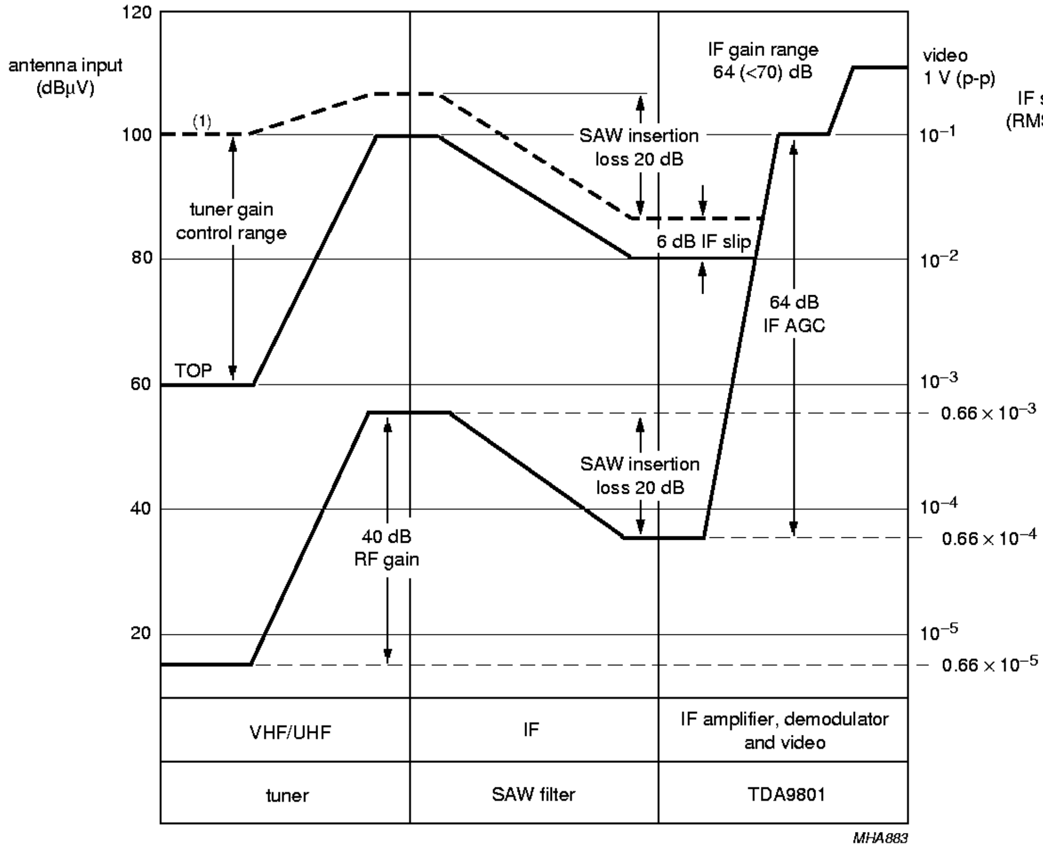


Fig.9 Typical AM suppression of FM sound demodulator.



(1) Signal-to-noise ratio.
(2) AF output signal.

Fig.10 Typical AF output signal and signal-to-noise ratio.

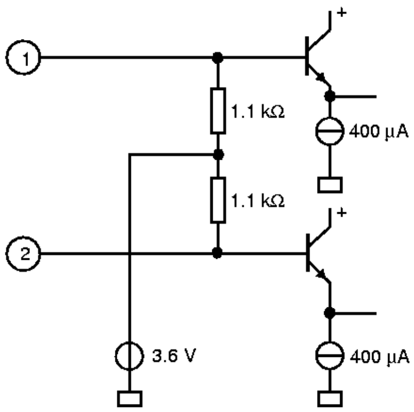
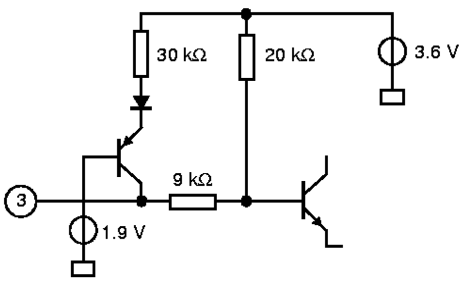
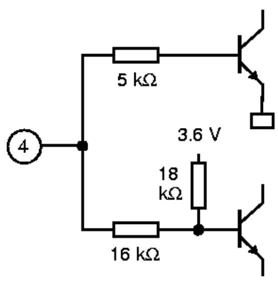


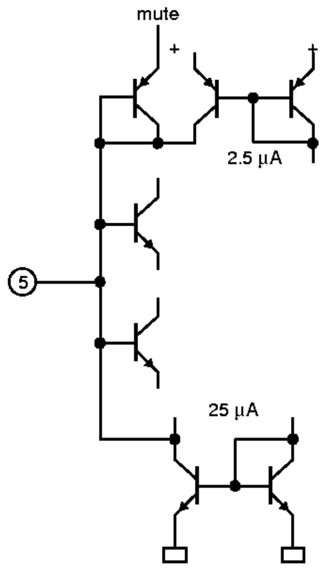
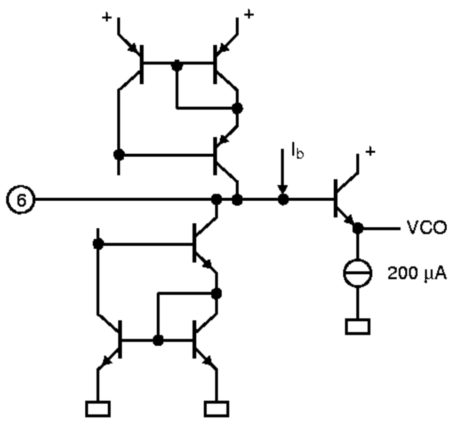
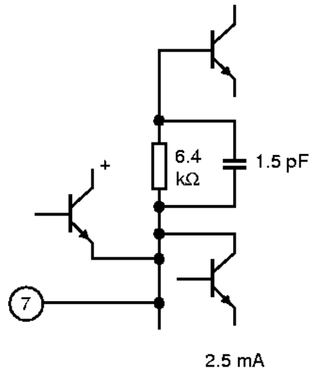
(1) Depends on TOP.

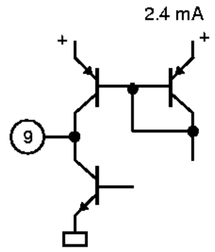
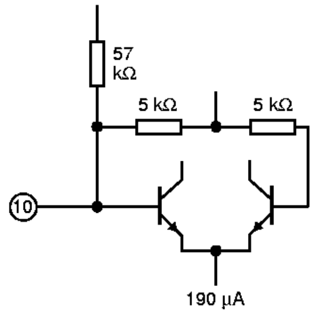
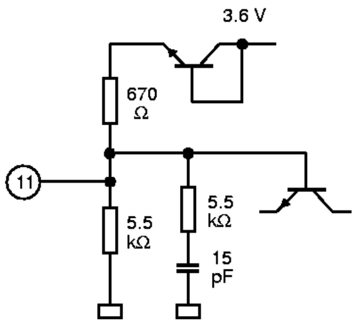
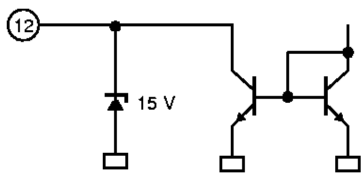
Fig.11 Front end level diagram.

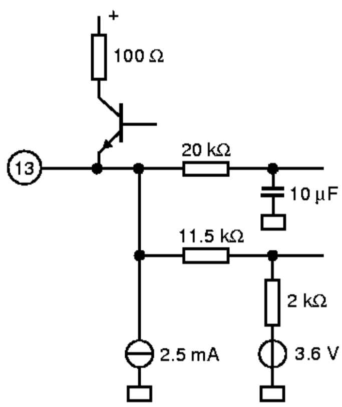
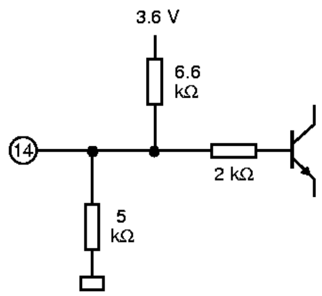
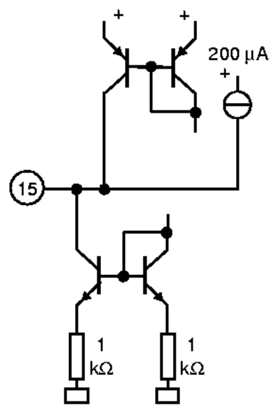
INTERNAL CIRCUITRY

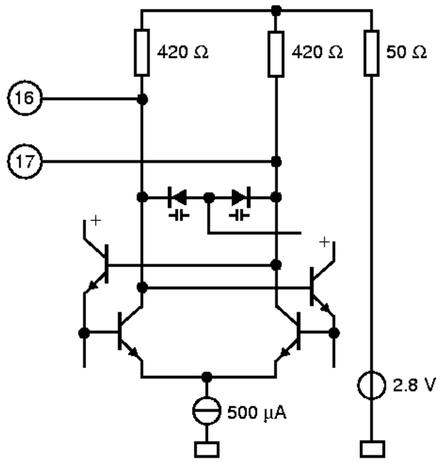
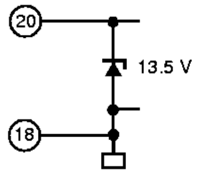
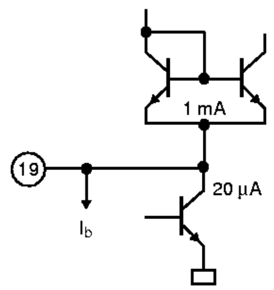
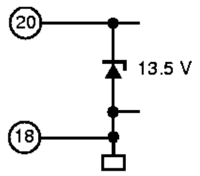
Table 2 Equivalent pin circuits and pin voltages

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	TOP	0 to 1.9	
4	CCS	0 to 0.4	

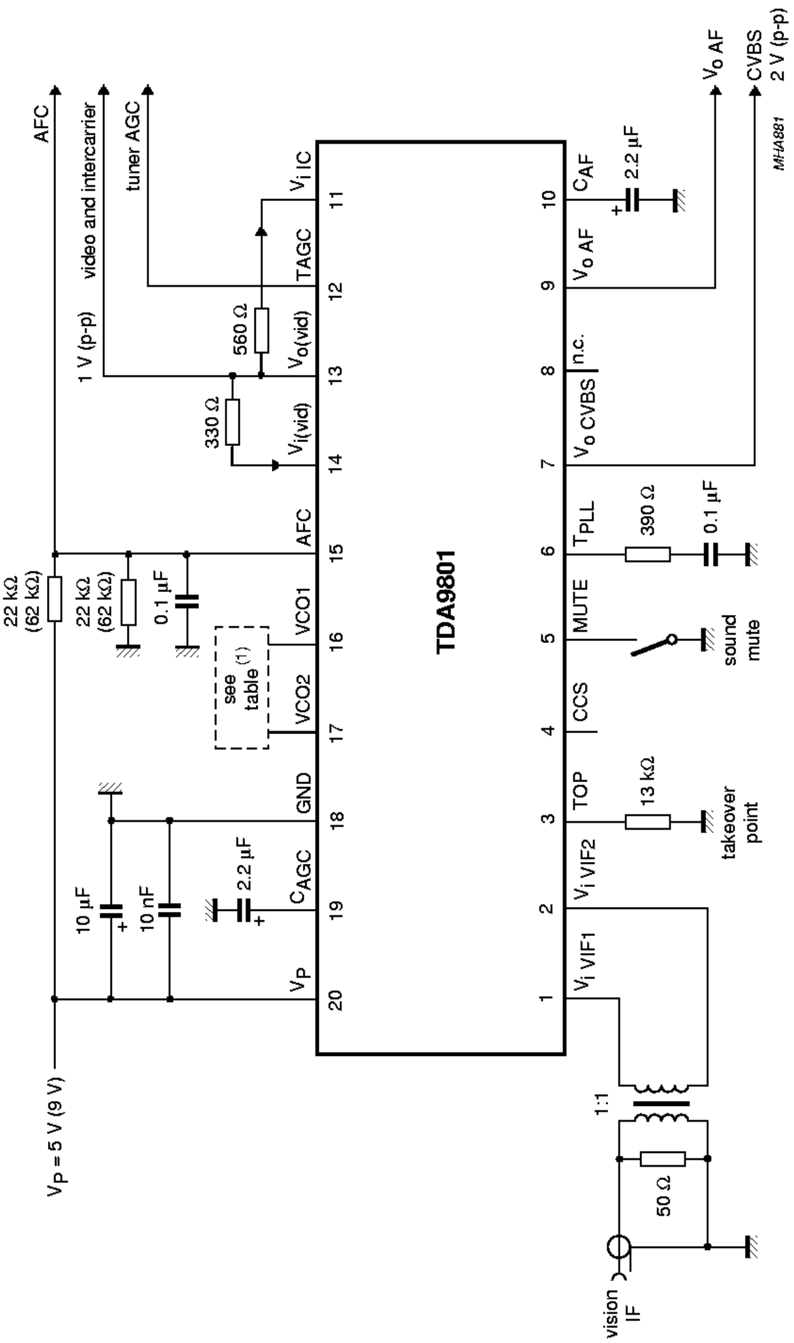
PIN NO.	PIN SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
5	MUTE	0 to V_P	
6	T_{PLL}	1.5 to 4.0	
7	$V_{o\,CVBS}$	sync level: 1.35	

PIN NO.	PIN SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
8	n.c.		
9	$V_{o\ AF}$	2.5	
10	C_{AF}	1.5 to 3.3	
11	$V_{i\ IC}$	2.6	
12	TAGC	0 to 13.2	

PIN NO.	PIN SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
13	$V_{o(vid)}$	sync level: 1.5	
14	$V_{i(vid)}$	1.8	
15	AFC	0.3 to $V_P - 0.3$	

PIN NO.	PIN SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
16	VCO1	2.7	
17	VCO2	2.7	
18	GND		
19	C_{AGC}	1.5 to 4.0	
20	V_P		

TEST AND APPLICATION INFORMATION



(1) See Table 3.

Fig.12 Test circuit.

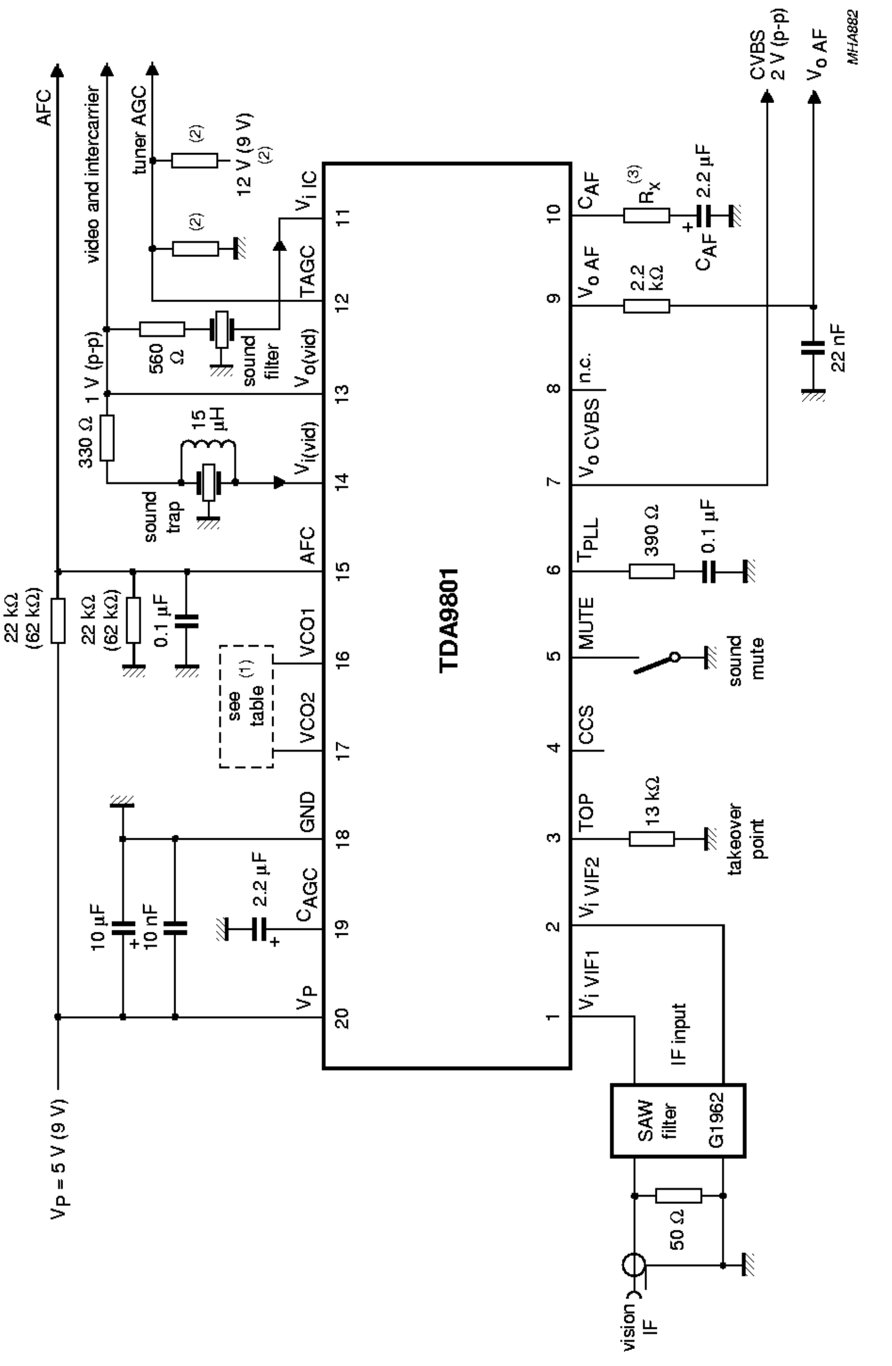
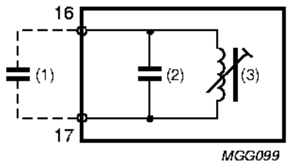
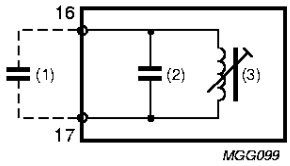
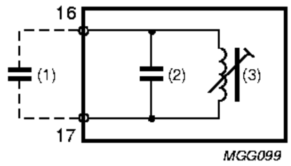


Fig.13 Application circuit.

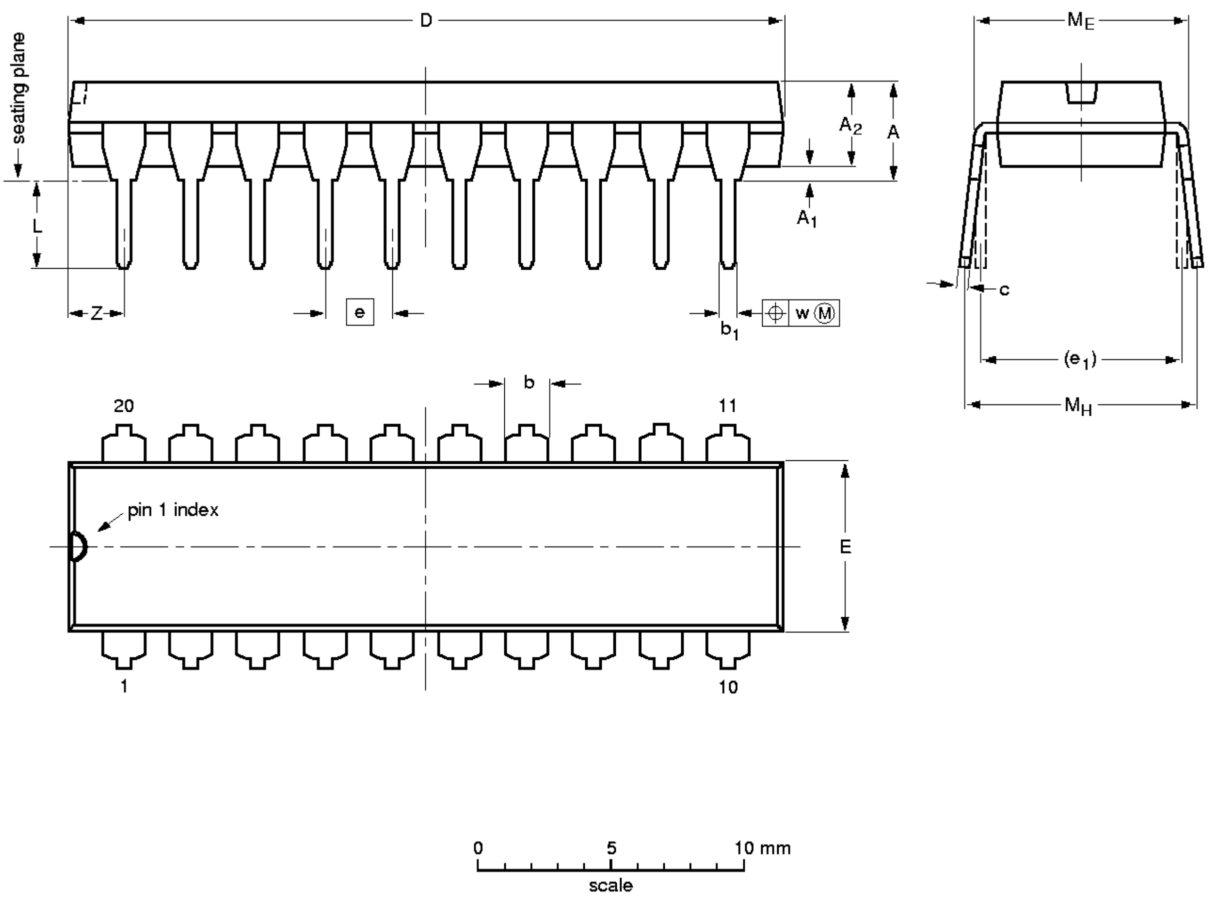
(1) See Table 3.
(2) Depends on tuner.
(3) See note 18 of Chapter “Characteristics (V_P = 5 V)”.

Table 3 Oscillator circuit for 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.
Toko coil	5KM 369SNS-2010Z	5KMC V369SCS-2370Z	MC139 NE545SNAS100108
Philips ceramic capacitor	2222 632 51828	inside 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)

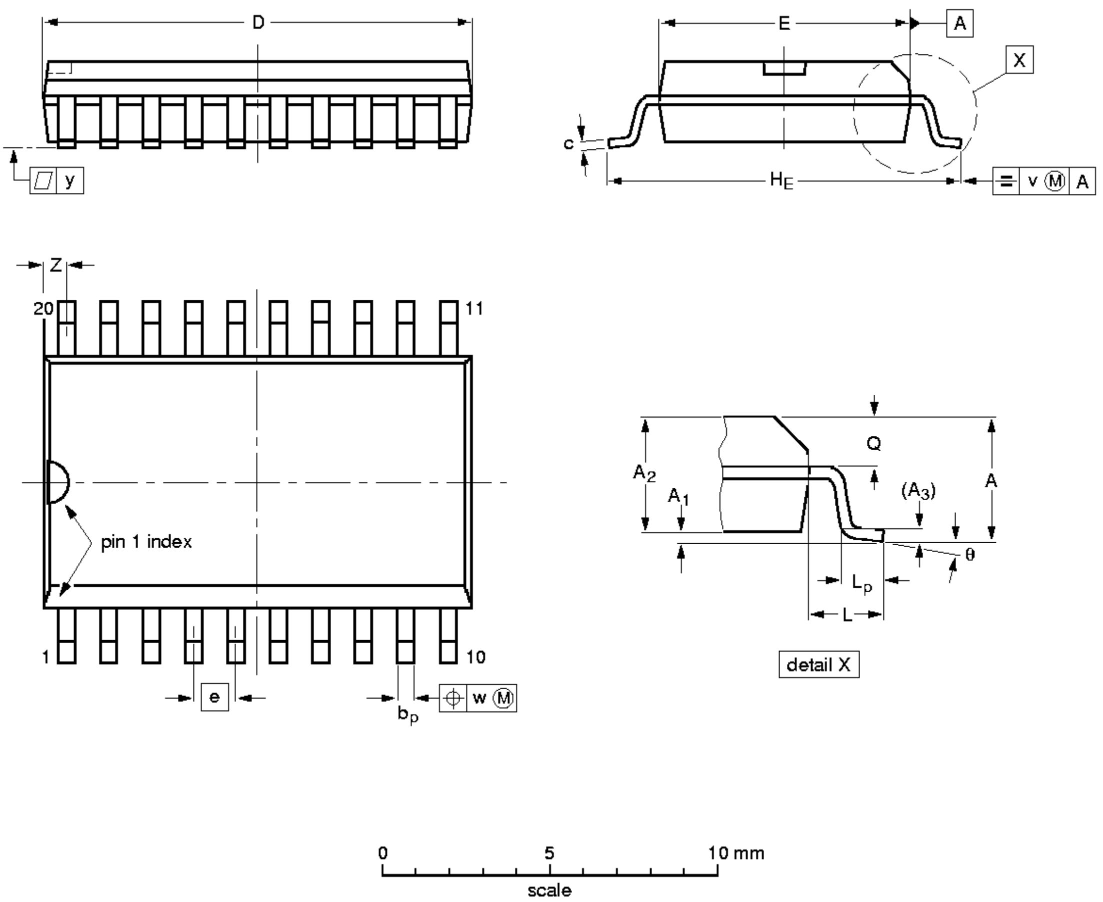
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D[(1)]	E[(1)]	e	e_1	L	M_E	M_H	w	Z[(1)] max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	0.36 0.23	26.92 26.54	6.40 6.22	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.0
inches	0.17	0.020	0.13	0.068 0.051	0.021 0.015	0.014 0.009	1.060 1.045	0.25 0.24	0.10	0.30	0.14 0.12	0.32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

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.	

LIFE SUPPORT APPLICATIONS

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.

NOTES

NOTES

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