DATA SHEET

TDA9816M
Multistandard multimedia IF-PLL and FM radio demodulator

Preliminary specification
File under Integrated Circuits, IC02

1997 Nov 19

Philips Semiconductors

PHILIPS

Multistandard multimedia IF-PLL and FM radio demodulator

TDA9816M

FEATURES

- 5 V supply voltage
- Gain controlled wideband 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 gated phase detector at L/L accent standard and PLL bandwidth control for negative modulation standards
- VCO (Voltage Controlled Oscillator) frequency can be switched between L and L accent (alignment external) picture carrier frequency
- VIF AGC (Automatic Gain Control) detector for gain control, operating as peak sync detector for B/G and peak white detector for L; signal controlled reaction time for L
- Tuner AGC with adjustable TakeOver Point (TOP)
- AFC (Automatic Frequency Control) detector without extra reference circuit
- AC-coupled limiting amplifier for sound intercarrier signal
- Alignment-free FM PLL (Phase-Locked Loop) demodulator with high linearity; integrated de-emphasis resistor
- Integrated level detector
- Alignment-free FM radio AFC detector with external resonator
- RIF (Radio IF) amplifier for 10.7 MHz
- SIF (Sound IF) input for single reference QSS (Quasi Split Sound) mode (PLL controlled); SIF AGC detector for gain controlled SIF amplifier; single reference QSS mixer able to operate in high performance single reference QSS mode
- AM demodulator without extra reference circuit
- Stabilizer circuit for ripple rejection and to achieve constant output signals
- ESD (Electrostatic Discharge) protection for all pins.

GENERAL DESCRIPTION

The TDA9816M is an integrated circuit for multistandard vision IF signal processing, sound AM and FM demodulation and FM radio demodulation in multimedia sets.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA9816M	SSOP28	plastic shrink small outline package; 28 leads; body width 5.3 mm	SOT341-1

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (pin 25)						
V_P	supply voltage		4.5	5	5.5	V
I_P	supply current	TV mode (B/G standard)	76	89	102	mA
		radio mode	29	35	41	mA
		power-down mode	5	8	11	mA
Television mode						
$V_{i(VIF)(rms)}$	minimum vision IF input signal voltage (RMS value)	–1 dB video at output	–	60	100	μV
$V_{o(video)(p-p)}$	video output signal voltage (peak-to-peak value)		0.97	1.1	1.23	V
B_{-3dB}	–3 dB video bandwidth on pin 18	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		54	58	–	dB
$\alpha_{IM(1.1)}$	intermodulation attenuation at ‘blue’	f = 1.1 MHz	52	58	–	dB
$\alpha_{IM(3.3)}$	intermodulation attenuation at ‘blue’	f = 3.3 MHz	52	58	–	dB
$\alpha_{H(sup)}$	suppression of harmonics in video signal		35	40	–	dB
$V_{i(SIF)(rms)}$	minimum sound IF input signal voltage (RMS value)	–3 dB at intercarrier output	–	30	70	μV
$V_{o(audio)(rms)}$	audio output signal voltage for FM (RMS value)	B/G standard; 27 kHz modulation	0.4	0.5	0.6	V
THD_{video}	total harmonic distortion for video	27 kHz modulation	–	0.5	1.0	%
$S/N_{W(audio)}$	weighted signal-to-noise ratio for audio	27 kHz modulation; t = 50 μs	50	55	–	dB
Radio mode						
$V_{i(RIF)(rms)}$	minimum radio IF input signal voltage (RMS value)	d_3 < 60 dB intermodulation; note 1	–	–	20	mV
$V_{i(FM)(rms)}$	minimum FM limiter input signal voltage (RMS value)	$\frac{S+N}{N}$ unweighted = 26 dB	–	100	–	μV
$\Delta V_{LD}/\log\Delta V_i$	output voltage slope according to FM limiter input voltage		–	50	–	mV/dBμV
$V_{o(audio)(rms)}$	audio output signal voltage for radio (peak-to-peak value)	22.5 kHz modulation	200	250	300	mV
THD_{audio}	total harmonic distortion for audio	22.5 kHz modulation	–	0.5	1.0	%
$S/N_{W(audio)}$	weighted signal-to-noise ratio for audio	22.5 kHz modulation; 15 kHz bandwidth	59	64	–	dB

Note

1. d_3 is the ratio of the intermodulation product at 10.3 MHz to the level of $V_{i(4)(max)(rms)}$.

BLOCK DIAGRAM

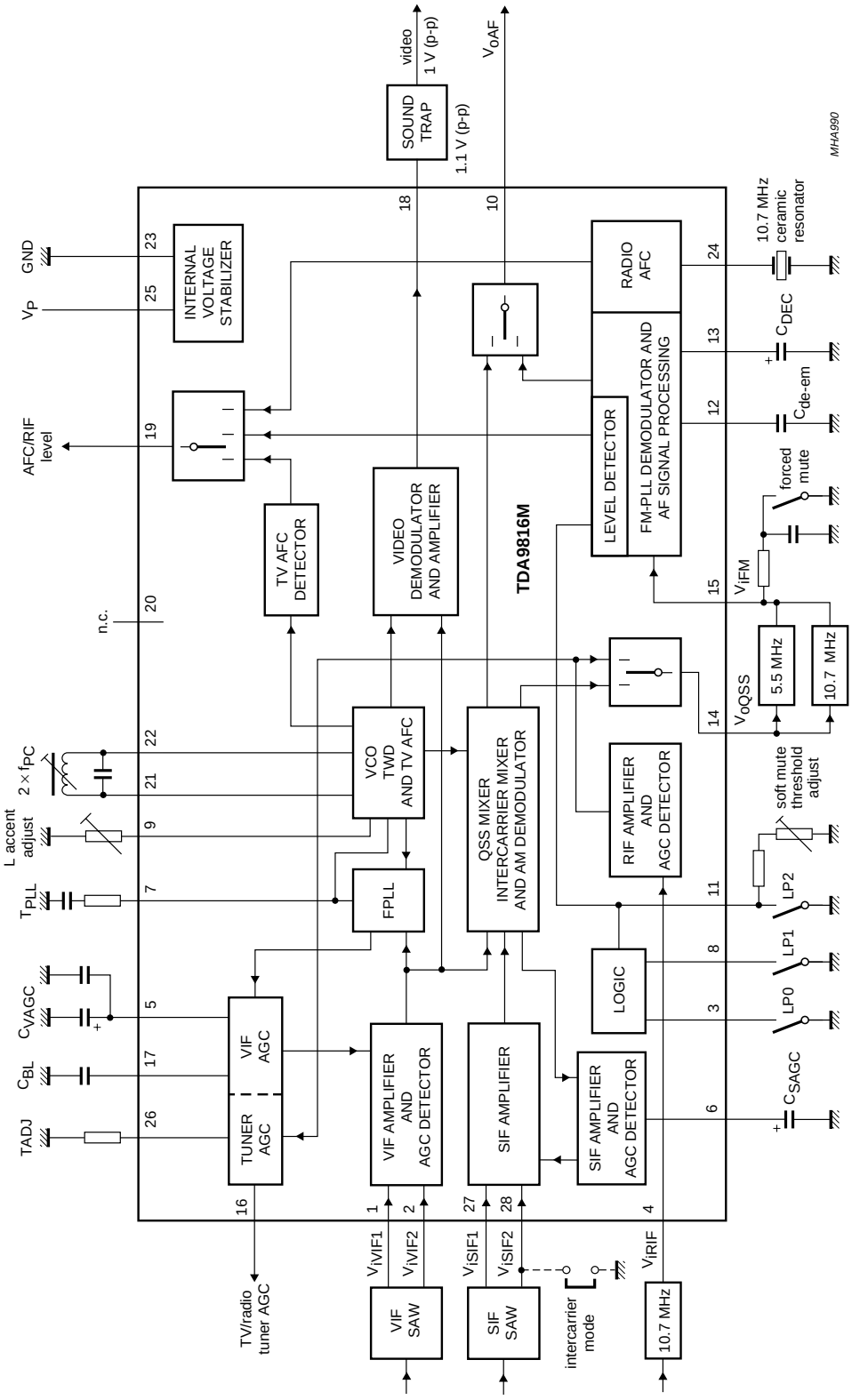


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
V_{iVIF1}	1	VIF differential input signal voltage 1
V_{iVIF2}	2	VIF differential input signal voltage 2
LP0	3	logic port 0
V_{iRIF}	4	RIF input
C_{VAGC}	5	VIF AGC capacitor
C_{SAGC}	6	SIF AGC capacitor
T_{PLL}	7	PLL loop filter
LP1	8	logic port 1
LADJ	9	L/L accent switch and adjustment
V_{oAF}	10	audio output
LP2	11	logic port 2 and soft mute threshold adjustment
$C_{de\text{-}em}$	12	de-emphasis capacitor
C_{DEC}	13	decoupling capacitor
V_{oQSS}	14	single reference QSS/intercarrier output voltage
V_{iFM}	15	sound intercarrier input voltage
TAGC	16	TV/radio tuner AGC output
C_{BL}	17	black level detector
$V_{o(vid)}$	18	composite video output voltage
AFC	19	AFC/RIF level output
n.c.	20	not connected
VCO1	21	VCO1 resonance circuit
VCO2	22	VCO2 resonance circuit
GND	23	ground
CERRES	24	ceramic resonator 10.7 MHz
V_P	25	supply voltage
TADJ	26	tuner AGC takeover point adjustment
V_{iSIF1}	27	SIF differential input signal voltage 1
V_{iSIF2}	28	SIF differential input signal voltage 2

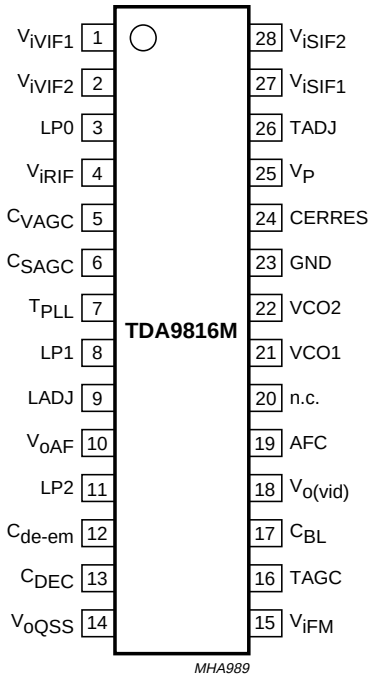


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA9816M is comprised of the functional blocks shown in Fig.1:

- Vision IF amplifier and AGC detector
- Tuner (TV/radio) and VIF AGC
- Frequency Phase Locked Loop (FPLL) detector
- VCO, Travelling Wave Divider (TWD) and TV AFC
- Video demodulator and amplifier
- SIF amplifier and AGC detector
- Single reference QSS mixer
- AM demodulator
- RIF amplifier and AGC detector
- FM-PLL demodulator, level detector and radio AFC
- AF (Audio Frequency) signal processing
- Internal voltage stabilizer
- Logic.

Vision IF amplifier and AGC detector

The vision IF amplifier contains three AC-coupled differential amplifier stages. Each differential stage includes 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. The sync level of the video signal is therefore detected for negative video modulation, while the peak white level is detected for positive video modulation. In order to reduce the reaction time for positive modulation, where a very large time constant is needed, an additional level detector is used to increase the discharge current of the AGC capacitor (fast mode) in the event of a decreasing VIF amplitude step. The additional level information is given by the black-level detector voltage.

Tuner (TV/radio) and VIF AGC

For TV operation, the AGC capacitor voltage is converted to an internal IF control signal and then 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 the tuner to be matched to the SAW filter in order to achieve the optimum IF input level.

For FM radio operation, an AGC detector is provided to obtain some adjacent channel protection.

Frequency Phase-Locked Loop detector (FPLL)

The VIF amplifier output signal is fed, via a limiting amplifier, to a frequency and phase detector. During acquisition, the frequency detector generates a DC current proportional to the difference in frequency between the input signal and the VCO signal. After frequency lock-in, the phase detector generates a DC current proportional to the phase difference between the input signal and the VCO signal. The DC current generated by the frequency or phase detector is converted to a DC voltage via the loop filter, which controls the VCO frequency. For positively modulated signals, the phase detector is gated by composite sync in order to avoid signal distortion with overmodulated VIF signals.

VCO, TWD and TV 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 FPLL and fed via the loop filter to the first variable capacitor. This control voltage is amplified and converted into a current which represents the AFC output signal.

The VCO centre frequency can be decreased (required for L accent standard) by activating an additional internal capacitor using logic ports LP0 and LP1. A variable resistor connected to LADJ can be used in conjunction with the second variable capacitor to set the VCO centre frequency to the required L accent value. At the centre frequency, the AFC output current is zero.

The TWD divides the oscillator signal by 2 and generates two differential output signals with a 90° phase difference independent of frequency.

Video demodulator and amplifier

Video demodulation is realized by a multiplier designed for low distortion and wide bandwidth. The vision IF input signal and the ‘in-phase’ signal of the travelling wave divider output are multiplied together. The video signal polarity can be switched in the demodulator stage in accordance with the relevant TV standard.

The demodulated output signal is fed to the video amplifier via an integrated low-pass filter used to attenuate the carrier harmonics. This is an operational amplifier with internal feedback and wide bandwidth. A low-pass filter is integrated to attenuate the carrier harmonics for B/G and L standard.

The standard-dependent level shift in this stage delivers the same sync level for positive and negative modulation. The video output signal at $V_{o(vid)}$ is 1.1 V (p-p) for nominal vision IF modulation, in order to achieve 1 V (p-p) at the sound trap output.

SIF amplifier and AGC

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

The SIF AGC detector is related to the SIF input signal (average level of AM or FM carrier). It controls the SIF amplifier to provide a constant SIF signal to the AM demodulator and single reference QSS mixer. The AGC reaction time is set to 'slow' for nominal video conditions. But with a decreasing VIF amplitude step the SIF AGC is set to 'fast' mode, controlled by the VIF AGC detector. In FM mode this reaction time is also set to 'fast' mode according to the TV standard.

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 the intercarrier frequency by the regenerated picture carrier (VCO). The mixer output signal is fed, via a high-pass filter used to attenuate the video signal components, to output pin 14. High performance hi-fi stereo sound processing can be achieved with this system.

For a simplified application without a sound IF SAW filter, the single reference QSS mixer can be switched to the intercarrier mode by connecting pin 27 and/or pin 28 to ground. In this mode, the sound IF signal passes through the vision IF SAW filter and the composite IF signal is then fed to the single reference QSS mixer. Here, the IF signal is multiplied by the 90° TWD output signal to convert the sound IF to the intercarrier frequency. By using this quadrature detection, the low frequency video signals are removed.

AM demodulator

A multiplier is used for AM demodulation. The modulated SIF amplifier output signal and the 'in-phase' limited (AM is removed) SIF amplifier output signal are multiplied together. The demodulated output signal is fed, via an integrated low-pass filter used to attenuate the carrier harmonics, to the AF amplifier.

RIF amplifier and AGC

The radio IF amplifier amplifies the 10.7 MHz radio IF signal. This signal is supplied by the tuner and is fed to the RIF input (pin 4) via a matching circuit and a ceramic band-pass filter. This amplifier contains two stages. The first stage, a conventional 0 dB differential amplifier designed for optimal dynamic range, is followed by a switchable differential amplifier stage with a gain of 10 dB. Either the radio IF or to the TV IF signal can be selected at the output (pin 14).

The RIF output signal is fed via ceramic band-pass filters to the FM-PLL demodulator and the radio IF AGC detector. The AGC threshold is very high and is designed to obtain some adjacent channel protection. The AGC detector output is fed to the tuner AGC output stage (pin 16) to control the tuner.

FM-PLL demodulator level detector and radio AFC

The FM-PLL demodulator consists of a limiter and an FM phase-locked loop. The 8-stage internally AC-coupled limiter amplifies and limits the TV FM sound intercarrier or the radio FM intermediate frequency signal prior to demodulation. The limiter is designed for high sensitivity and AM suppression with low DC offset and needs no external pins for DC coupling.

Furthermore, the AF output signal can be force muted by connecting a resistor between pin 15 and ground. The soft mute function can be disabled by connecting a resistor between pin 15 and the power supply. See the application circuit in Fig.18.

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 on the AF voltage. The FM-PLL operates as an FM demodulator.

The level detector detects, rectifies and amplifies the output signals from the first 5 limiter stages. These signals are then summed and the composite signal passed through a low-pass filter, followed by a 6 dB output amplifier. A DC voltage dependent on the limiter input level is generated for controlling the behaviour of the AF soft mute. The 6 dB output amplifier can be switched off via the control logic and the level detector output signal fed to pin 19. Furthermore, the steepness of the level detector output signal tracks that of the power supply voltage.

The radio Automatic Frequency Control (AFC) stage is comprised of a 10.7 MHz phase shifting network, a phase detector (quadrature demodulator), a differential amplifier input stage (which receives the limiting amplifier output signal), and a current mode output stage.

A ceramic resonator is used for phase shifting. This permits alignment-free operation.

AF signal processing

The AF signal processing stage consists of a pre-amplifier for the FM-PLL demodulator output signal, an AF source selector, a soft and forced mute stage with an integrated time constant, and an AF post-amplifier.

The FM demodulator output signal is pre-amplified by an operational amplifier (30 dB gain) with internal feedback, high gain and high common mode rejection. The feedback circuit, together with external capacitor C_{DEC} connected to pin 13, keeps the DC level at the pre-amplifier output constant (2.3 V). An external resistor connected in series with C_{DEC} provides a gain-reduction capability.
The low-pass filter characteristic (130 kHz bandwidth) of the amplifier reduces the harmonics of the IF signal at the sound signal output.

The source selector operational amplifier selects and amplifies the appropriate AF source signal by means of the control logic: AM from the AM demodulator in TV L/L accent mode, FM from the FM demodulator via de-emphasis (internal resistor, external capacitor $C_{de\text{-}em}$ at pin 12) in TV B/G mode or FM direct from the FM demodulator in radio mode.

Soft mute occurs when the internal level detector output voltage is lower than the mute threshold voltage at pin 11 (provided an external resistor is not connected between the limiter input, pin 15, and the supply voltage). The mute stage reduces the AF signal by 25 dB, with an internal time constant of approximately 7 ms.

If forced mute is active (see Table 2), or a resistor is connected between pin 15 and ground, the mute stage will reduce the AF signal level by more than 70 dB, with the same time constant.

Otherwise, the AF signal level will not be reduced.

The AF post-amplifier, which was designed to include a rail-to-rail output stage, provides the required AF output level at pin 10.

Internal voltage stabilizer

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

Logic

The logic circuit detects the logic levels and threshold voltages at ports LP0, LP1 and LP2 and controls the internal functions as described in Table 2.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage (pin 25)	maximum chip temperature of 125 °C; note 1	–	5.5	V
V_n	input voltage at pins 1 to 13, 15 to 17, 19 and 23 to 28		0	V_P	V
t_{sc}	short-circuit time		–	10	s
V_{TAGC}	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 = 102 mA; T_{amb} = 70 °C; $R_{th(j-a)}$ = 110 K/W.
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	110	K/W

CHARACTERISTICS

V_P = 5 V; T_{amb} = 25 °C; see Table 1 for input frequencies; input level $V_{i(VIF)(rms)}$ = 10 mV (sync-level for B/G, peak white level for L); $V_{i(FM)(rms)}$ = 10 mV; IF input from 50 Ω via broadband transformer 1 : 1; video modulation DSB; residual carrier B/G: 10%; L = 3%; video signal in accordance with *"CCIR, line 17"*; measured in test circuit of Fig.17; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (pin 25)						
V_P	supply voltage	note 1	4.5	5	5.5	V
I_P	supply current	TV mode (B/G standard)	76	89	102	mA
		radio mode	29	35	41	mA
		power-down mode	5	8	11	mA
Television mode						
VISION IF AMPLIFIER (PINS 1 AND 2)						
$V_{i(VIF)(rms)}$	minimum vision IF input signal voltage (RMS value)	B/G standard; −1 dB video at output	–	60	100	μV
	maximum vision IF input signal voltage (RMS value)	B/G standard; +1 dB video at output	120	200	–	mV
$\Delta V_{o(int)}$	internal IF amplitude difference between picture and sound carrier	within AGC range; B/G standard; Δf = 5.5 MHz	–	0.7	1	dB
$G_{VIF(CR)}$	VIF gain control range	see Fig.3	65	70	–	dB
$B_{VIF(-3dB)}$	−3 dB VIF bandwidth	lower limit	–	15	25	MHz
		upper limit	70	100	–	MHz
$R_{i(dif)}$	differential input resistance	note 2	1.7	2.2	2.7	kΩ
$C_{i(dif)}$	differential input capacitance	note 2	1.2	1.7	2.5	pF
V_I	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}
$V_{VCO(rms)}$	oscillator voltage swing at pins 21 and 22 (RMS value)		50	80	110	mV
$f_{cr(PC)}$	picture carrier capture range	B/G and L standard	±1.4	±1.8	–	MHz
		L accent standard; f_{PC} = 33.9 MHz; R_9 = 5.6 kΩ	±0.9	±1.2	–	MHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\Delta f_{fr(PC)}$	picture carrier free-running frequency accuracy	L accent standard; f_{PC} = 33.9 MHz; R_9 = 5.6 kΩ	–	±200	±400	kHz
$f_{alg(L\ accent)}$	L accent alignment frequency range	L accent standard; I_{AFC} = 0	±400	±600	–	kHz
t_{acq}	acquisition time	Black Level (BL) = 70 kHz note 5	–	–	30	ms
$V_{i(VIF)(rms)}$	minimum vision IF input signal voltage for PLL to be locked (RMS value; pins 1 and 2)	maximum IF gain; note 6	–	30	70	μV
COMPOSITE VIDEO AMPLIFIER (PIN 18; SOUND CARRIER OFF)						
$V_{o(video)(p-p)}$	output signal voltage (peak-to-peak value)	see Fig.8	0.97	1.1	1.23	V
V/S	ratio between video (black-to-white) and sync level		1.9	2.33	3.0	–
$\Delta V_{o(video)}$	output signal voltage difference	difference between B/G and L standard	–	–	±12	%
V_{sync}	sync voltage level	B/G and L standard	1.4	1.5	1.6	V
V_{clu}	upper video clipping voltage level		V_P – 1.1	V_P – 1	–	V
V_{cll}	lower video clipping voltage level		–	0.7	0.9	V
R_o	output resistance	note 2	–	–	10	Ω
$I_{bias(int)}$	internal DC bias current for emitter-follower		2.2	3.0	–	mA
$I_{o(sink)(max)}$	maximum AC and DC output sink current		1.6	–	–	mA
$I_{o(source)(max)}$	maximum AC and DC output source current		2.9	–	–	mA
$\Delta V_{o(CVBS)}$	deviation of CVBS output signal voltage at B/G	50 dB gain control	–	–	0.5	dB
		30 dB gain control	–	–	0.1	dB
$\Delta V_{o(bl)(BG)}$	black level tilt in B/G standard	gain variation; note 7	–	–	1	%
$\Delta V_{o(bl)(L)}$	vertical black level tilt for worst case in L standard	vision carrier modulated by test line (VITS) only; gain variation; note 7	–	–	1.9	%
G_{dif}	differential gain	*"CCIR, line 330"*	–	2	5	%
φ_{dif}	differential phase	*"CCIR, line 330"*	–	1	2	deg
$B_{v(-1dB)}$	–1 dB video bandwidth	B/G and L standard; C_L < 50 pF; R_L > 1 kΩ; AC load	5	6	–	MHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$B_{v(-3dB)}$	−3 dB video bandwidth	B/G and L standard; C_L < 50 pF; R_L > 1 kΩ; AC load	7	8	–	MHz
S/N_W	weighted signal-to-noise ratio	see Fig.5 and note 8	54	58	–	dB
S/N	unweighted signal-to-noise ratio	see Fig.5 and note 8	47	51	–	dB
$\alpha_{IM(1.1)}$	intermodulation attenuation at 'blue'	f_{IM} = 1.1 MHz; see Fig.6 and note 9	52	58	–	dB
	intermodulation attenuation at 'yellow'	f_{IM} = 1.1 MHz; see Fig.6 and note 9	54	60	–	dB
$\alpha_{IM(3.3)}$	intermodulation attenuation at 'blue'	f_{IM} = 3.3 MHz; see Fig.6 and note 9	52	58	–	dB
	intermodulation attenuation at 'yellow'	f_{IM} = 3.3 MHz; see Fig.6 and note 9	54	60	–	dB
$\alpha_{r(vc)(rms)}$	residual vision carrier (RMS value)	fundamental wave and harmonics; B/G and L standard	–	2	5	mV
$\Delta f_{unwanted(p-p)}$	robustness for unwanted frequency deviation of picture carrier (peak-to-peak value)	L standard; residual carrier: 3%; serration pulses: 50%; note 2	–	–	12	kHz
$\Delta\varphi$	robustness for modulator imbalance	L standard; residual carrier: 0%; serration pulses: 50%; note 2	–	–	3	%
$\alpha_{H(sup)}$	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 18	video signal; grey level; see Fig.11				
		B/G standard	30	35	–	dB
		L standard	25	30	–	dB
VIF AGC DETECTOR (PIN 5)						
I_{ch}	charge current	B/G and L standard; note 7	0.75	1	1.25	mA
	additional charge current	L standard in event of missing VITS pulses and no white video content	1.9	2.5	3.1	µA
I_{dch}	discharge current	B/G standard	15	20	25	µA
		normal mode L standard	225	300	375	nA
		fast mode L standard	30	40	50	µA
$t_{res(AGC)(r)}$	AGC response to a rising VIF step	B/G and L standard; note 11	–	0.05	0.1	ms/dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$t_{res(AGC)(f)}$	AGC response to a falling VIF step	B/G standard	–	2.2	3.5	ms/dB
		fast mode L standard	–	1.1	1.8	ms/dB
		normal mode L standard; note 11	–	150	240	ms/dB
ΔIF	VIF amplitude step for activating fast AGC mode	L standard	–2	–6	–10	dB
$V_{th(17)}$	threshold voltage level additional charging/ discharging current	see Fig.8				
		L standard	1.95	2.0	2.05	V
		L standard; fast mode L	1.6	1.66	1.72	V
TV TUNER AGC (PIN 16)						
$V_{i(rms)}$	IF input signal voltage for minimum starting point of tuner takeover (RMS value)	input at pins 1 and 2; R_{TOP} = 22 kΩ; I_{16} = 0.4 mA	–	2	5	mV
	IF input signal voltage for maximum starting point of tuner takeover (RMS value)	input at pins 1 and 2; R_{TOP} = 0 Ω; I_{16} = 0.4 mA	50	100	–	mV
	tuner takeover point accuracy (RMS value)	R_{TOP} = 13 kΩ; I_{16} = 0.4 mA	5	–	20	mV
$V_{o(max)}$	maximum output voltage	from external source; note 2	–	–	13.2	V
V_{sat}	saturation voltage	I_{16} = 1.5 mA	–	–	0.2	V
$\Delta V_{TOP(T)}$	variation of takeover point with temperature	I_{16} = 0.4 mA	–	0.03	0.07	dB/K
I_{sink}	sink current	see Fig.3				
		no tuner gain reduction; V_{16} = 13.2 V	–	–	1	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
TV AFC DETECTOR (PIN 19); see Fig.7 and note 12						
CR_{stps}	control steepness $\Delta I_{19}/\Delta f$	note 13	0.5	0.75	1.0	μA/kHz
$\Delta f_{IF(T)}$	frequency variation with temperature	I_{AFC} = 0; note 4				
		B/G and L standard	–	–	$\pm 20 \times 10^{-6}$	K^{-1}
		L accent standard	–	–	$\pm 60 \times 10^{-6}$	K^{-1}
$V_{o(max)}$	output voltage upper limit	see Fig.7 without external components	V_P – 0.6	V_P – 0.3	–	V
$V_{o(min)}$	output voltage lower limit		–	0.3	0.6	V
$I_{o(source)}$	output source current		150	200	250	μA
$I_{o(sink)}$	output sink current		150	200	250	μA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\Delta I_{r(mod)(p-p)}$	residual video modulation current (peak-to-peak value)	B/G and L standard	–	20	30	µA
SOUND IF AMPLIFIER (PINS 27 AND 28)						
$V_{i(SIF)(rms)}$	minimum sound IF input signal voltage (RMS value)	FM mode; –3 dB at intercarrier output pin 14	–	30	70	µV
		AM mode; –3 dB at AF output pin 10	–	70	100	µV
$V_{i(max)(rms)}$	maximum sound IF input signal voltage (RMS value)	FM mode; +1 dB at intercarrier output pin 14	50	70	–	mV
		AM mode; +1 dB at AF output pin 10	80	140	–	mV
$G_{cr(SIF)}$	SIF gain control range	FM and AM mode; see Fig.4	60	67	–	dB
$B_{SIF(-3dB)}$	–3 dB SIF bandwidth	lower limit	–	–	25	MHz
		upper limit	60	–	–	MHz
$R_{i(dif)}$	differential input resistance	note 2	1.7	2.2	2.7	kΩ
$C_{i(dif)}$	differential input capacitance	note 2	1.2	1.7	2.5	pF
$V_{I(27,28)}$	DC input voltage		–	3.4	–	V
$\alpha_{ct(SIF-VIF)}$	crosstalk attenuation between SIF and VIF input	between pins 1 and 2 and pins 27 and 28; note 14	50	–	–	dB
SIF-AGC DETECTOR (PIN 6)						
I_{ch}	charge current	FM mode	8	12	16	µA
		AM mode	0.8	1.2	1.6	µA
I_{dch}	discharge current	FM mode	8	12	16	µA
		normal mode AM	1	1.4	1.8	µA
		fast mode AM	60	85	110	µA
SINGLE REFERENCE QSS INTERCARRIER MIXER (PIN 14)						
$V_{o(intercarrier)(rms)}$	IF intercarrier level (RMS value)	QSS mode; SC_1; sound carrier 2 off	100	140	180	mV
		L standard; without modulation	100	140	180	mV
		intercarrier mode; SC_1; sound carrier 2 off; note 15	–	32	–	mV
$B_{ic(-3dB)}$	–3 dB intercarrier bandwidth	upper limit	7.5	9	–	MHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\alpha_{r(SC)(rms)}$	residual sound carrier (RMS value)	QSS mode; fundamental wave and harmonics	–	2	5	mV
		intercarrier mode; fundamental wave and harmonics	–	2	5	mV
$\alpha_{r(VC)(rms)}$	residual vision carrier (RMS value)	QSS mode; fundamental wave and harmonics	–	2	5	mV
		intercarrier mode; fundamental wave and harmonics	–	2	5	mV
$\alpha_{H(sup)}$	suppression of video signal harmonics	intercarrier mode; $f_{video} \leq 5$ MHz	39	–	–	dB
R_o	output resistance	note 2	–	25	–	Ω
V_O	DC output voltage		–	2.0	–	V
$I_{bias(int)}$	DC internal bias current for emitter-follower		2.7	3.4	–	mA
$I_{(sink)(max)}$	maximum AC and DC output sink current		1.5	2.0	–	mA
$I_{(source)(max)}$	maximum AC and DC output source current		2.5	–	–	mA
LIMITER AMPLIFIER (PIN 15); note 16						
$V_{i(FM)(rms)}$	input signal voltage for lock-in (RMS value)		–	–	100	µV
	input signal voltage (RMS value)	$\frac{S+N}{N}$ weighted = 40 dB	–	250	500	µV
	allowed input signal voltage (RMS value)		200	–	–	mV
α_{AM}	AM suppression	50 µs de-emphasis; AM: f_{mod} = 1 kHz; m = 0.3 referenced to 27 kHz (54% FM deviation)	46	50	–	dB
R_i	input resistance	note 2	480	600	720	Ω
V_I	DC input voltage		–	2.65	–	V
FM-PLL DEMODULATOR						
$f_{cr(PLL)}$	catching range of PLL	upper limit	7.0	–	–	MHz
		lower limit	–	–	4.0	MHz
$f_{hr(PLL)}$	holding range of PLL	upper limit	9.0	–	–	MHz
		lower limit	–	–	3.5	MHz
t_{acq}	acquisition time		–	–	4	µs

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
FM OPERATION (B/G STANDARD; PIN 10); notes 16 and 16a						
$V_{o(AF)(rms)}$	AF output signal voltage (RMS value)	27 kHz (54% FM deviation); see Fig.17 and note 17				
		R_x = 470 Ω	200	250	300	mV
		R_x = 0 Ω	400	500	600	mV
$V_{o(AF)(cl)(rms)}$	AF output clipping signal voltage level (RMS value)	THD < 1.5%	1.0	–	1.2	V
Δf_{AF}	frequency deviation	THD < 1.5%; note 17	–	–	±53	kHz
$\Delta V_o/\Delta T$	temperature drift of AF output signal voltage		–	3×10^{-3}	7×10^{-3}	dB/K
V_{13}	DC voltage at decoupling capacitor	voltage dependent on VCO frequency; note 18	1.2	–	3.0	V
R_o	output resistance	note 2	–	–	150	Ω
V_O	DC output voltage		–	2.3	–	V
$I_{o(sink)(max)}$	maximum AC and DC output sink current		–	–	0.5	mA
$I_{o(source)(max)}$	maximum AC and DC output source current		–	–	0.5	mA
$B_{aud(-3dB)}$	−3 dB audio frequency bandwidth	without de-emphasis capacitor	100	125	–	kHz
THD	total harmonic distortion	27 kHz (54% FM deviation)	–	0.5	1.0	%
S/N_W	weighted signal-to-noise ratio	FM-PLL only; with 50 μs de-emphasis; 27 kHz (54% FM deviation); *"CCIR 468-4"*; see Fig.9	50	55	–	dB
$\alpha_{r(SC)(rms)}$	residual sound carrier (RMS value)	fundamental wave and harmonics	–	–	75	mV
$\alpha_{mute(AF)}$	mute attenuation of AF signal	B/G and L standard	70	75	–	dB
ΔV_{10}	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 10	R_x = 0 Ω; f_{mod} = 70 Hz; see Figs 11 and 17	20	26	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
SINGLE REFERENCE QSS AF PERFORMANCE FOR FM OPERATION (B/G STANDARD); notes 19, 20 and 21; see Table 1						
$S/N_{W(SC1)}$	weighted signal-to-noise ratio for SC_1	PC/SC_1 ratio at pins 1 and 2; 27 kHz (54% FM deviation); *"CCIR 468-4"*	40	–	–	dB
		black picture	45	51	–	dB
		white picture	45	51	–	dB
		6 kHz sine wave (black-to-white modulation)	39	43	–	dB
		sound carrier subharmonics; f_{mod} = 2.75 MHz ±3 kHz	35	40	–	dB
INTERCARRIER AF PERFORMANCE FOR FM OPERATION (B/G STANDARD); notes 19, 21 and 22; see Table 1						
$S/N_{W(SC1)}$	weighted signal-to-noise ratio for SC_1	PC/SC_1 ratio at pins 1 and 2; 27 kHz (54% FM deviation); *"CCIR 468-4"*	27	–	–	dB
		black picture	41	47	–	dB
		white picture	41	47	–	dB
		6 kHz sine wave (black-to-white modulation)	35	40	–	dB
		sound carrier subharmonics; f_{mod} = 2.75 MHz ±3 kHz	30	35	–	dB
AM OPERATION (L STANDARD; PIN 8); see note 23 and Fig.10						
$V_{o(AF)(rms)}$	AF output signal voltage (RMS value)	54% modulation	400	500	600	mV
THD	total harmonic distortion	54% modulation	–	0.5	1.0	%
$B_{AF(-3dB)}$	−3 dB AF bandwidth		100	125	–	kHz
S/N_W	weighted signal-to-noise ratio	*"CCIR 468-4"*	45	50	–	dB
V_{10}	DC potential voltage		–	2.3	–	V
PSRR	power supply ripple rejection at pin 10	see Fig.11	20	26	–	dB
Radio mode						
RIF AMPLIFIER (PINS 4 AND 14)						
$V_{i(4)(max)(rms)}$	maximum input signal voltage (RMS value)	d_3 < 60 dB intermodulation; notes 24 and 25	10	20	–	mV
$V_{o(14)(cl)(rms)}$	RF amplifier output clipping signal voltage level (RMS value)	−1 dB gain compression point; note 24	400	–	900	mV
G_{RIF}	RIF gain		10	13	16	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$B_{RIF(-3dB)}$	−3 dB RIF bandwidth	lower limit	–	100	–	kHz
		upper limit	–	25	–	MHz
$R_{i(SE)}$	single-ended input resistance	note 2	240	330	420	Ω
$C_{i(SE)}$	single-ended input capacitance	note 2	1.5	2	2.5	pF
R_o	output resistance	note 2	–	25	–	Ω
$V_{I(4)}$	DC input voltage	note 2	–	2.7	–	V
RADIO TUNER AGC (PIN 16)						
I_{sink}	sink current	maximum tuner gain reduction	1.5	2	2.6	mA
$V_{o(max)}$	maximum output voltage	from external source; note 2	–	–	13.2	V
$V_{o(14)(rms)}$	AGC onset (RMS value)	RIF amplifier output; I_{16} = 0.4 mA	–	180	–	mV
RADIO AFC DETECTOR (PIN 19); see Fig.13 and note 12a						
CR_{stps}	control steepness $\Delta I_{19}/\Delta f$	note 26	0.59	0.9	1.22	μA/kHz
Δf_{IF}	frequency variation by input level	note 2	–	–	50×10^{-6}	$(dB\mu V)^{-1}$
$V_{o(max)}$	output voltage upper limit	see Fig.13 without external components	$V_P - 0.6$	$V_P - 0.3$	–	V
$V_{o(min)}$	output voltage lower limit		–	0.3	0.6	V
$I_{o(source)}$	output source current		150	200	250	μA
$I_{o(sink)}$	output sink current		150	200	250	μA
LIMITER AMPLIFIER (PIN 15); note 16						
$V_{i(FM)(rms)}$	input signal voltage (RMS value)	−3 dB AF signal at pin 10	–	50	–	μV
		Δf = 22.5 kHz; $\frac{S+N}{N}$ unweighted = 26 dB	–	100	–	μV
	allowed input signal voltage (RMS value)		200	–	–	mV
α_{AM}	AM suppression	50 μs de-emphasis; AM: f_{mod} = 1 kHz; m = 0.3 referenced to 22.5 kHz	40	45	–	dB
R_i	input resistance	note 2	240	330	420	Ω
V_I	DC input voltage		–	2.65	–	V
LEVEL DETECTOR (PIN 19); note 12						
$\Delta V_{LD}/\log \Delta V_i$	output voltage slope according to FM limiter input voltage		–	50	–	mV/dBμV
$V_{O(LD)min}$	minimum DC output voltage	$V_{i(15)}$ = 56 μV (35 dBμV)	0	–	1.0	V
$V_{O(LD)}$	DC output voltage	$V_{i(15)}$ = 32 mV (90 dBμV)	–	3.00	–	V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{O(LD)max}$	maximum DC output voltage		–	–	$V_P - 1.0$	V
$\Delta V_O/\Delta V_P$	output voltage variation with supply voltage		0.5	0.7	0.9	V/V
$\Delta V_O/\Delta T$	output voltage variation with temperature		–	–	$\pm 100 \times 10^{-6}$	V/K
FM-PLL DEMODULATORS						
$f_{cr(PLL)}$	catching range of PLL	upper limit	11.5	–	–	MHz
		lower limit	–	–	9.0	MHz
$f_{hr(PLL)}$	holding range of PLL	upper limit	13.0	–	–	MHz
		lower limit	–	–	8.0	MHz
t_{acq}	acquisition time		–	–	4	µs
FM OPERATION (PIN 10); notes 16 and 16a						
$V_{o(AF)(rms)}$	AF output signal voltage (RMS value)	22.5 kHz; $R_x = 0\ \Omega$; see Fig.17 and note 17	200	250	300	mV
$V_{o(AF)(cl)(rms)}$	AF output clipping signal voltage level (RMS value)	THD < 1.5%	1.0	–	1.2	V
Δf_{AF}	frequency deviation	THD < 1.5%; note 17	–	–	±75	kHz
$\Delta V_o/\Delta T$	temperature drift of AF output signal voltage		–	3×10^{-3}	7×10^{-3}	dB/K
V_{13}	DC voltage at decoupling capacitor	voltage dependent on VCO frequency; note 18	1.2	–	3.0	V
R_o	output resistance	note 2	–	–	150	Ω
V_O	DC output voltage		–	2.3	–	V
$I_{o(sink)(max)}$	maximum AC and DC output sink current		–	–	0.5	mA
$I_{o(source)(max)}$	maximum AC and DC output source current		–	–	0.5	mA
$B_{AF(-3dB)}$	–3 dB AF bandwidth	without de-emphasis capacitor; 22.5 kHz	100	125	–	kHz
THD	total harmonic distortion	22.5 kHz	–	0.5	1.0	%
S/N	unweighted signal-to-noise ratio	FM-PLL only; with 50 µs de-emphasis; 22.5 kHz; 15 kHz bandwidth	59	64	–	dB
ΔV_{10}	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 10	$R_x = 0\ \Omega$; f_{mod} 70 Hz; see Figs 11 and 17	20	26	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
MUTE BEHAVIOUR; note 16						
$\alpha_{mute(10)}$	forced mute attenuation	pin 15 at V_P	70	75	–	dB
	soft mute attenuation	RIF level dependent; see Fig.14	20	25	30	dB
$I_{15(forced)}$	forced mute switching current	α_{10} > 70 dB	–	350	–	µA
$I_{15(soft)(dis)}$	current for disabling soft mute	α_{10} > 0 dB	–	–350	–	µA
$V_{th(11)}$	soft mute threshold adjustment voltage	$V_{i(15)}$ = 56 µV	0.8	1.0	1.2	V
		$V_{i(15)}$ = 560 µV	1.2	1.4	1.6	V
t_{mute}	time constant	mute on or off	3	–	7	ms
Switching levels for logic ports 0 and 1; see also Table 2						
V_{logic}	DC potential for logic 1 or pin not connected		2.8	–	V_P	V
	DC potential for logic 0		0	–	0.8	V
I_{IL}	LOW-level input current	$V_{3,8}$ = 0 V	50	70	90	µA
Switching levels for logic port 2; see also Table 2 and Fig.14						
V_{logic}	DC potential for logic 1 or pin not connected		0.8	–	V_P	V
	DC potential for logic 0		0	–	0.8	V
I_{IL}	LOW-level input current	V_{11} = 0 V	110	150	190	µA

Notes

1. Video and sound parameters are degraded 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 = 70 kHz (natural frequency f_n = 12 kHz; damping factor d ≈ 3; calculated for peak level). Resonance circuit of VCO: Q_0 > 50; C_{ext} = 8.2 pF ±0.25 pF; C_{int} ≈ 8.5 pF (loop voltage ≈ 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 1 µA for B/G standard and 10 nA for L 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 18). B = 5 MHz weighted in accordance with *"CCIR 567"*.
9. The intermodulation figures are defined:

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

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

10. Measurements taken with SAW filter K3953 (sound carrier suppression: 40 dB); loop bandwidth = 70 kHz.
    a) Modulation VSB; sound carrier off; $f_{video} > 0.5$ MHz.
    b) Sound carrier on; SIF SAW filter K9453; 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. A current source output is provided to match the AFC output signal to different tuning systems. The test circuit is given in Fig.7 for TV mode and in Fig.13 for radio mode. The AFC steepness can be changed by the resistors at pin 19.
    a) A voltage output is provided to match the AFC output signal to different tuning systems. The DC load current should not exceed 180 μA.
13. Depending on the ratio $\Delta C/C_0$ of the LC resonant circuit of the VCO ($Q_0 > 50$; see note 3; $C_0 = C_{int} + C_{ext}$).
14. Source impedance: 2.3 kΩ in parallel with 12 pF (SAW filter); f_{IF} = 38.9 MHz.
15. Without using an SIF SAW filter the mixer can be switched to intercarrier mode by connecting pin 27 and/or pin 28 to ground. In this mode the SIF passes the VIF SAW filter and IF intercarrier levels are dependant on the sound shelf of the VIF SAW filter. The intercarrier output signal at pin 14 can be calculated with the following formula using the video output signal at pin 18 ($V_{o(video)(p-p)}$ = 1.1 V typical) as a reference:

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

    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 ±3 dB = tolerance of video output and intercarrier output amplitude $V_{o(rms)}$.

    Example: SAW filter G1962 (sound shelf: 20 dB) $\Rightarrow \frac{V_{i(SC)}}{V_{i(PC)}} = -27$ dB $\Rightarrow V_{o(rms)}$ = 32 mV (typ.).
16. 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/SIF input signal is not permitted. Pins 6 and 5 have to be connected to positive supply voltage for minimum IF gain. S/N and THD measurements are taken at 50 μs de-emphasis at pin 14 (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).
17. Measured with an FM deviation of 27 kHz, the typical AF output signal is 500 mV (RMS) (R_x = 0 Ω). By using R_x = 680 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 = 680 Ω.
18. The leakage current of the decoupling capacitor (2.2 μF) should not exceed 1 μA.
19. For all S/N measurements the used vision IF modulator has to meet the following specifications:
    a) Incidental phase modulation for black-to-white jump less than 0.5 degrees.
    b) QSS AF performance, measured with the television-demodulator AMF2 (audio output, weighted S/N ratio) better than 60 dB (deviation ±27 kHz) for 6 kHz sine wave black-to-white video modulation.
    c) Picture-to-sound carrier ratio; PC/SC_1 = 13 dB; (transmitter).

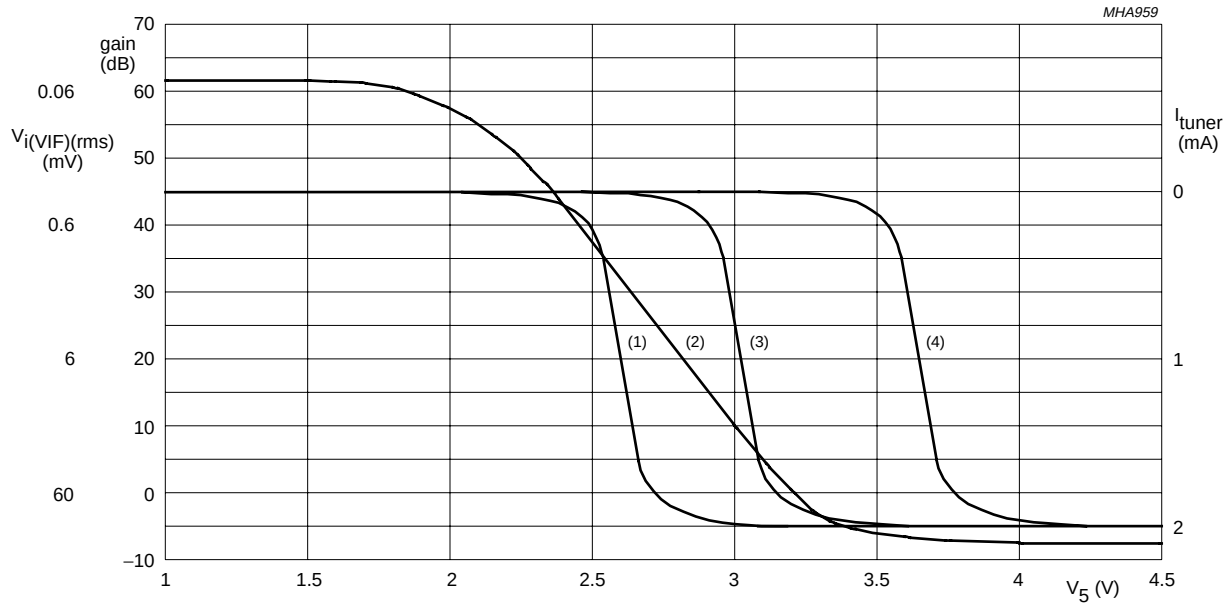
20. Measurements taken with SAW filter K3953 for vision and sound IF (suppressed sound carrier) and K9453 for sound IF (suppressed picture carrier). Input level $V_{i(SIF)(rms)}$ = 10 mV, 27 kHz (54% FM deviation).
21. The PC/SC_1 ratio at pins 1 and 2 is calculated as the addition of TV transmitter PC/SC_1 ratio and SAW filter PC/SC_1 ratio. This PC/SC_1 ratio is necessary to achieve the S/N_W values as noted. A different PC/SC_1 ratio will change these values.
22. Measurements taken with SAW filter G1962 (sound shelf: 20 dB) for vision and sound IF. Pin 27 and/or pin 28 has to be connected to ground for switching the single reference QSS mixer to intercarrier mode.
23. Measurements taken with SAW filter K9453 (Siemens) for AM sound IF (suppressed picture carrier).
24. The RIF amplifier output (pin 14) has to be connected to a multistandard application ceramic filter for 5.5, 6.0 and 10.7 MHz. This total load constitutes an impedance of 250 Ω.
25. d_3 tested by using two signals with frequencies of f_1 = 10.5 MHz and f_2 = 10.7 MHz with a level $V_{i4(max)(rms)}$ for each signal. d_3 is the ratio between intermodulation product at 10.3 MHz and output level of $V_{i4(max)(rms)}$.
26. The control steepness of the radio AFC detector is dependent on the characteristic of the ceramic resonator, pin 24. The figure given here will be obtained when applying a typical resonator of the type CDA 10.7 MC1-A (Murata). The spreading of the control steepness depends on the spreading of the ceramic resonator characteristic (see Fig.13).

Table 1 Input frequencies and carrier ratios

DESCRIPTION	SYMBOL	B/G STANDARD	L STANDARD	L ACCENT STANDARD	FM RADIO	UNIT
Picture/IF carrier	f_{PC} or f_{IF}	38.9	38.9	33.9	10.7	MHz
Sound carrier	f_{SC1}	33.4	32.4	40.4	–	MHz
	f_{SC2}	33.158	–	–	–	MHz
Picture-to-sound carrier	PC/SC_1	13	10	10	–	dB
	PC/SC_2	20	–	–	–	dB

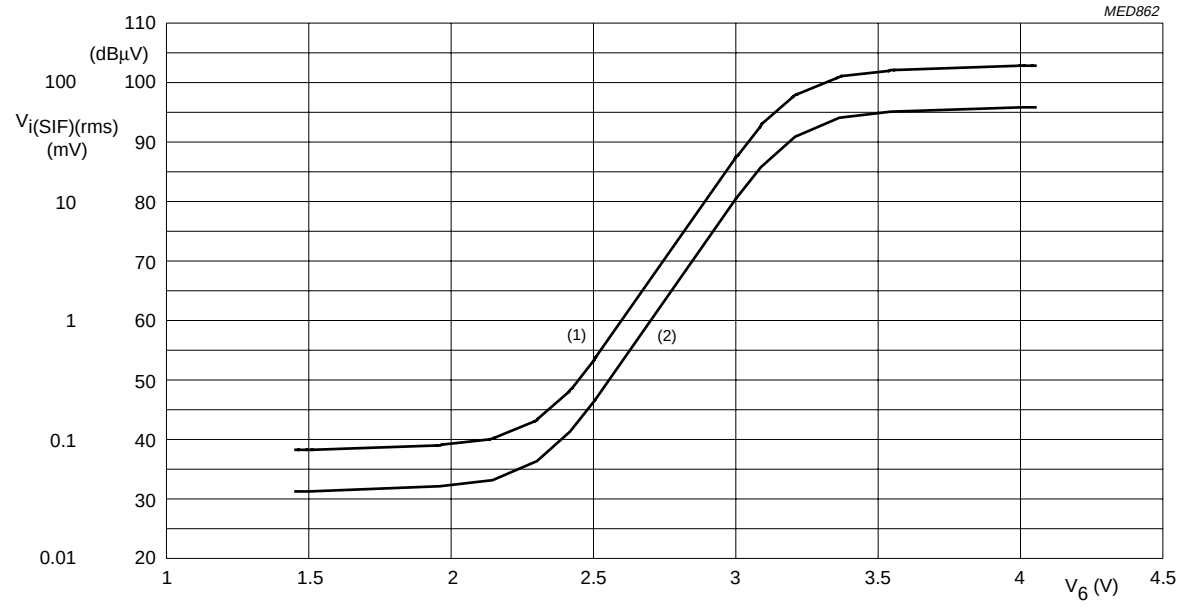
Table 2 Switch logic

FUNCTION			LP2	LP1	LP0	REMARKS
Power-down			0	1	0	
TV mode	B/G standard	negative modulation	0	1	1	
	L accent standard	positive modulation	0	0	0	
	L standard		0	0	1	
Radio mode	AFC	soft mute active	1	1	0	RIF level dependent (25 dB)
	RIF level		1	1	1	
	AFC	forced mute active	1	0	0	forced mute (70 dB)
	RIF level		1	0	1	



(1) I_{tuner}; R_{TOP} = 22 kΩ.
(2) Gain.
(3) I_{tuner}; R_{TOP} = 13 kΩ.
(4) I_{tuner}; R_{TOP} = 0 Ω.

Fig.3 Typical VIF and tuner AGC characteristic.



(1) AM mode.
(2) FM mode.

Fig.4 Typical SIF AGC characteristic.

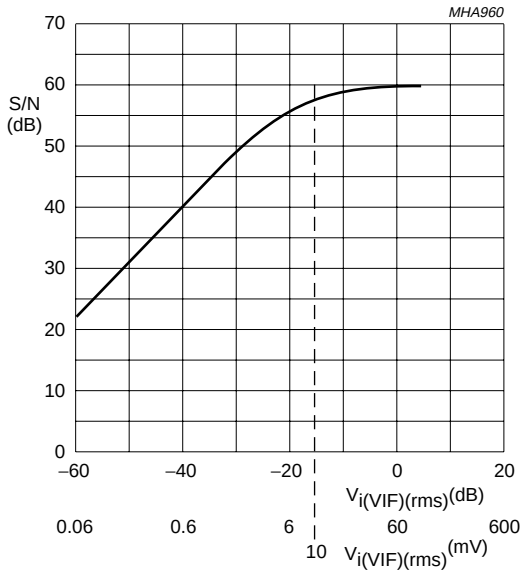
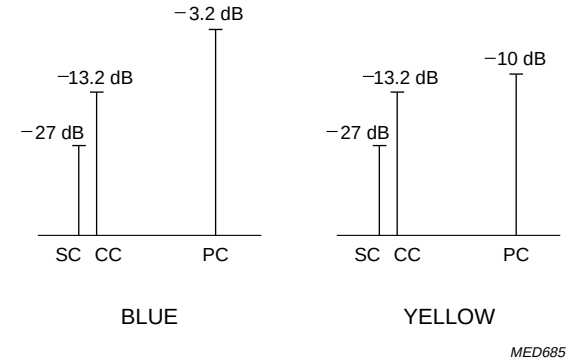


Fig.5 Typical signal-to-noise ratio as a function of IF input voltage.



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

Fig.6 Input signal conditions.

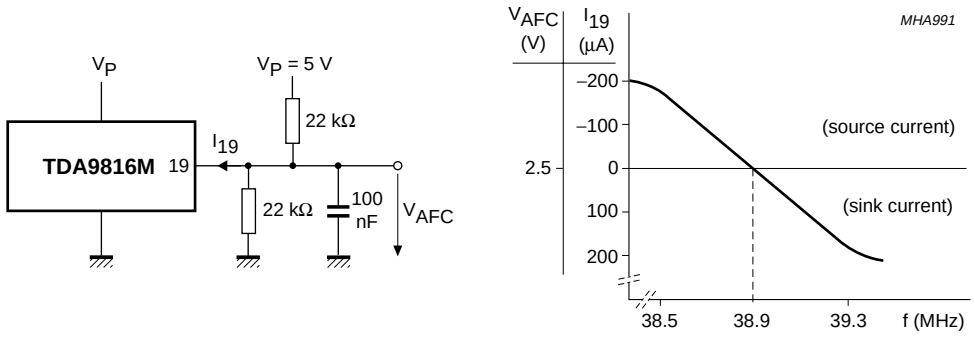


Fig.7 Measurement conditions and typical AFC characteristic at TV operation.

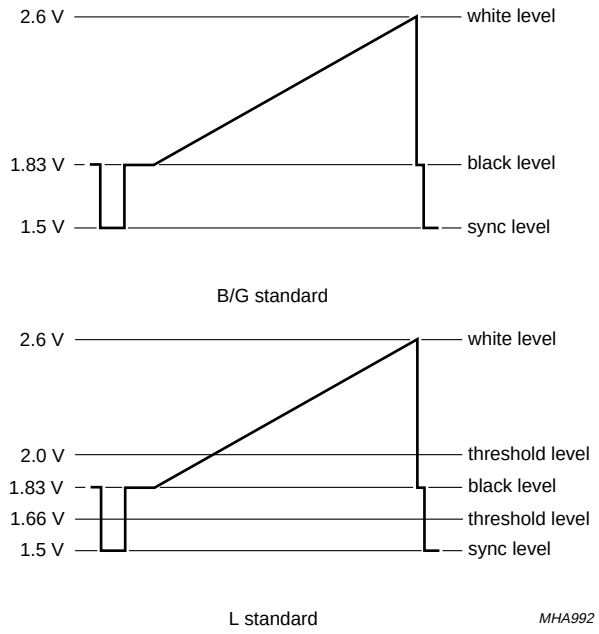
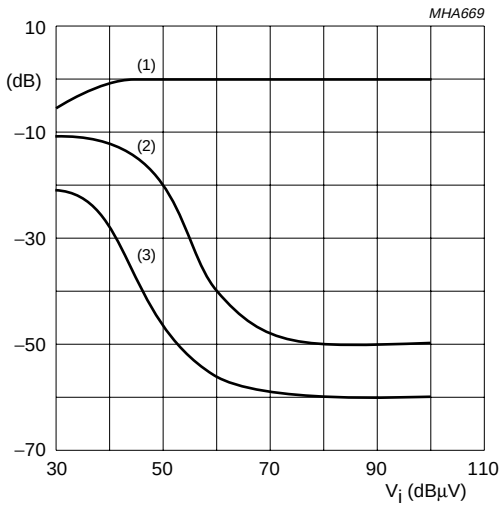
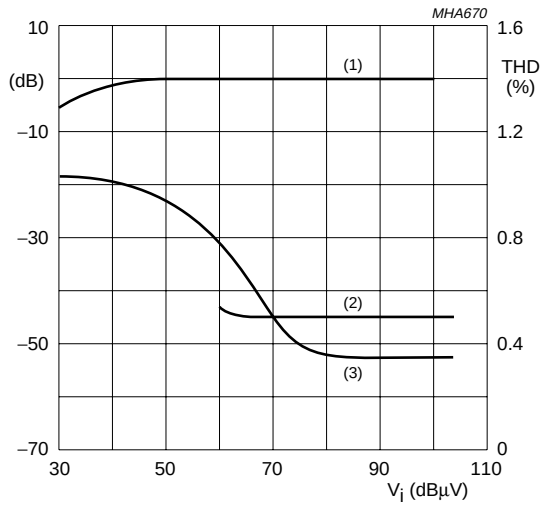


Fig.8 Typical video signal levels on output pin 18 (sound carrier off).



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

Fig.9 Typical audio level, noise and AM rejection (54% FM deviation) for FM (TV).



(1) Signal.
(2) THD.
(3) Noise.

Fig.10 Typical audio level, noise and THD (54% AM modulation) for AM (TV).

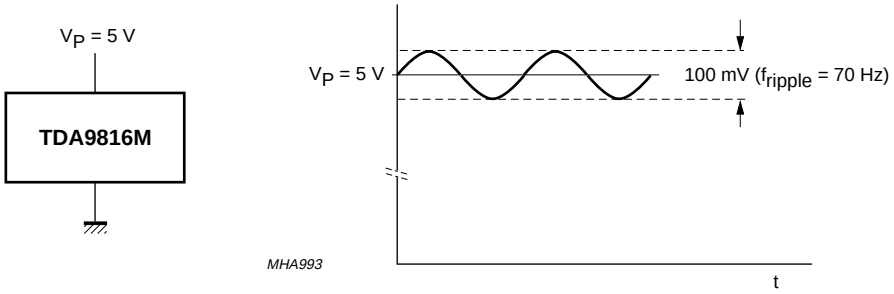
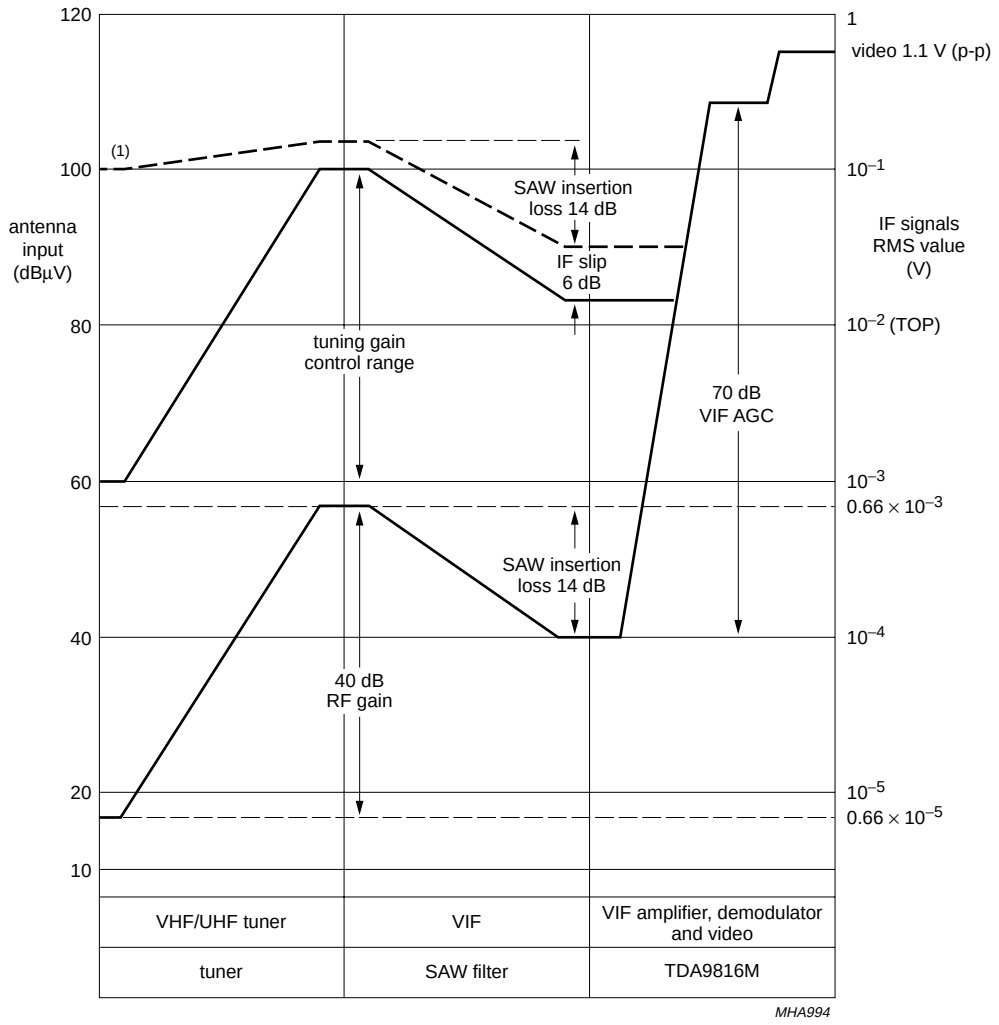
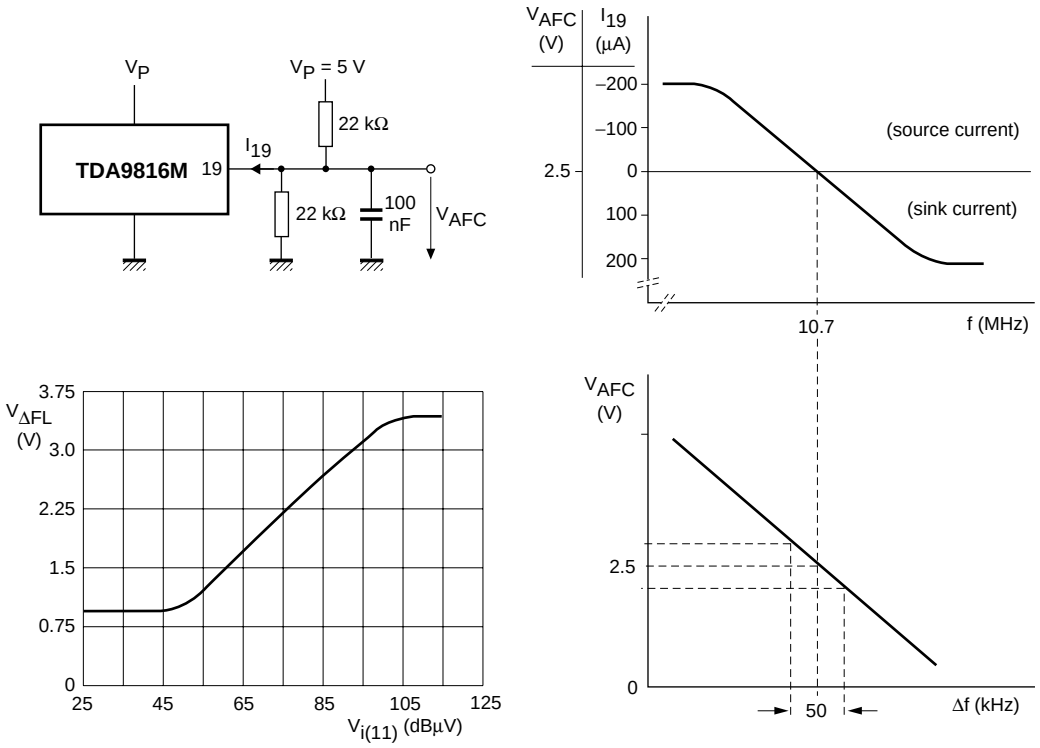


Fig.11 Ripple rejection condition.

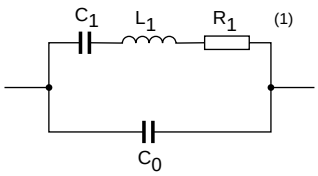


(1) Depends on TOP.

Fig.12 Front-end level diagram for TV operation.



Typical level detector characteristic at radio operation

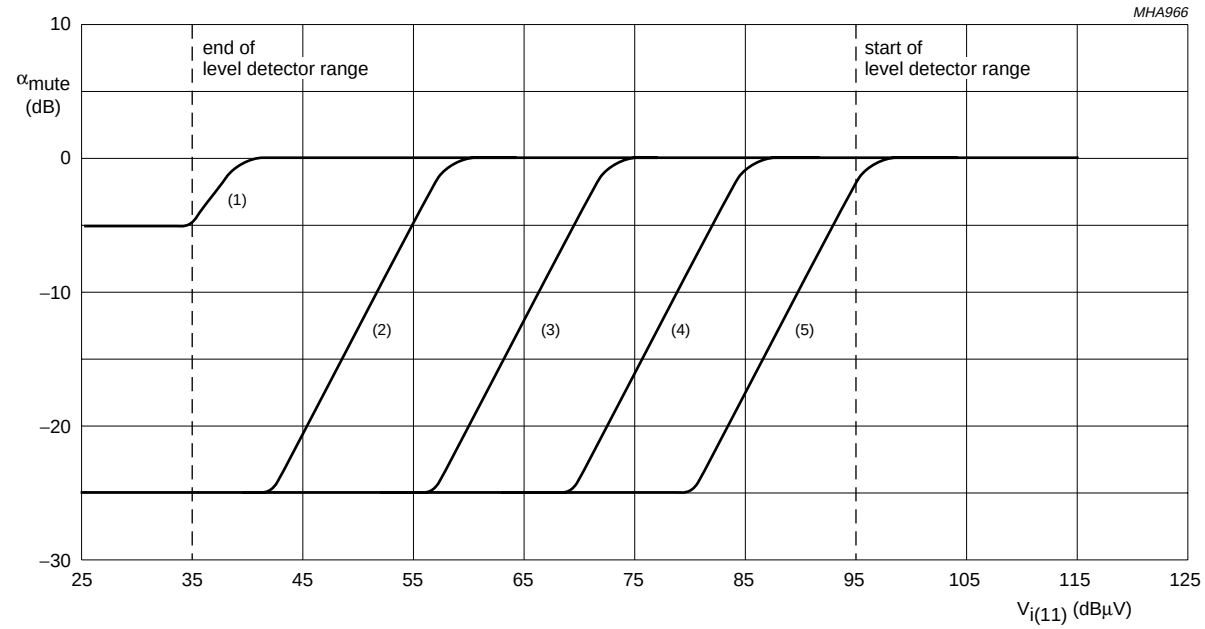


MHA995

2-terminal type equivalent circuit of ceramic resonator

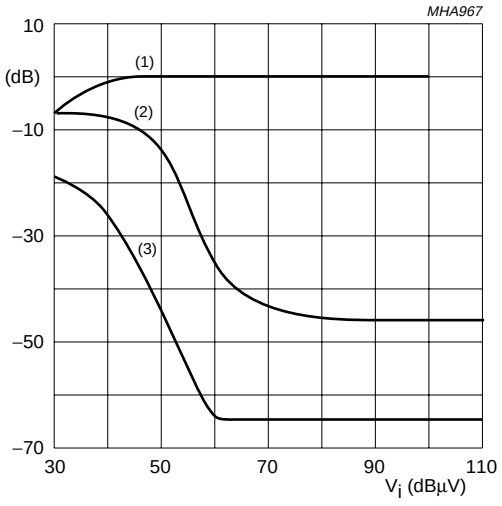
Equivalent compliance C_1 = 2.35 pF.
Equivalent mass L_1 = 101 μH.
Equivalent resistance R_1 = 55 Ω.
Parallel equivalent capacity C_0 = 18 pF.

Fig.13 Measurement conditions and typical AFC characteristic at radio operation.



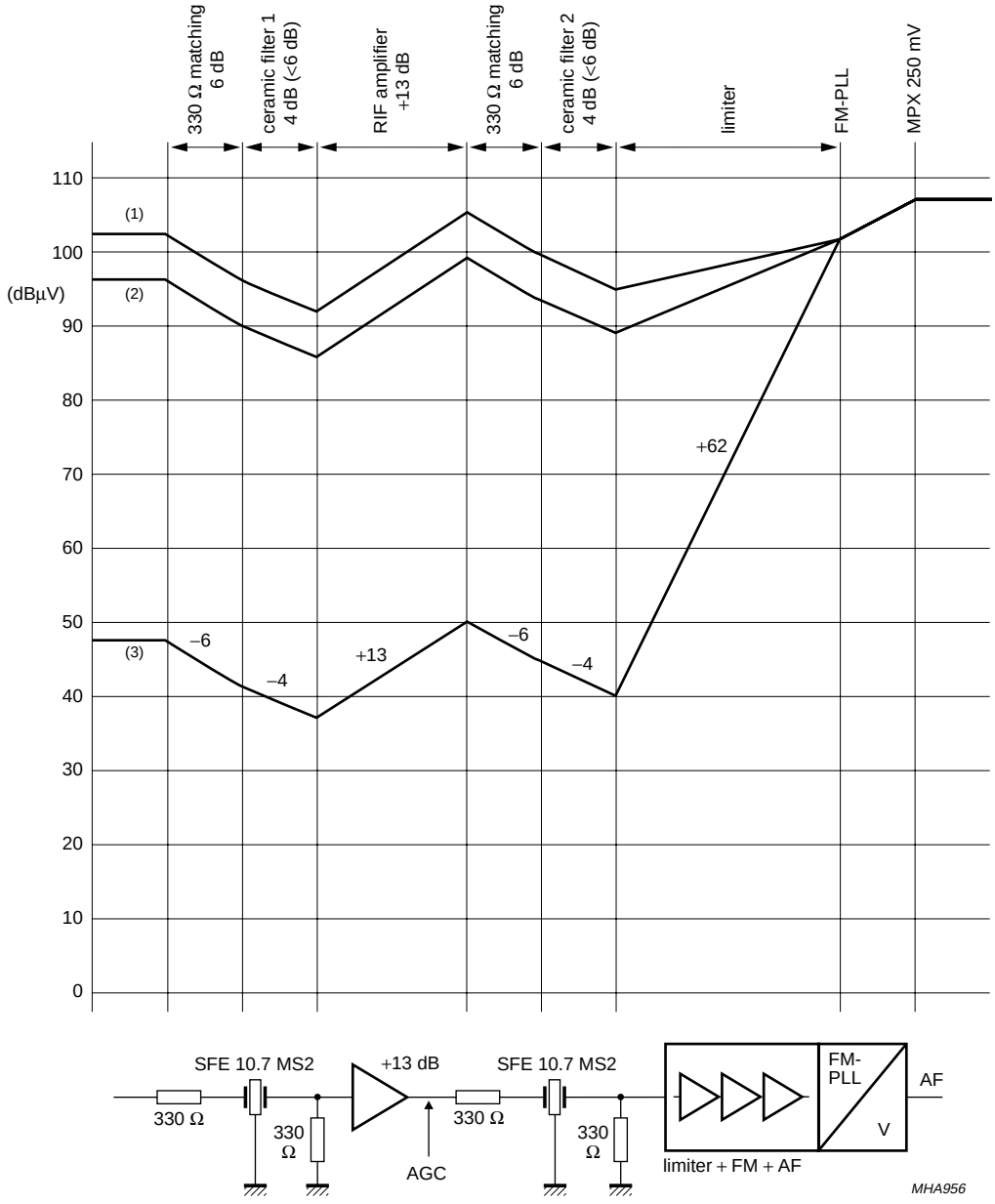
(1) AF level; R_{11} = 0 Ω.
(2) AF level; R_{11} = 5 kΩ.
(3) AF level; R_{11} = 11 kΩ.
(4) AF level; R_{11} = 16 kΩ.
(5) AF level; R_{11} = 22 kΩ.

Fig.14 Typical audio signal-to-noise ratio as a function of input signal at radio operation.



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

Fig.15 Typical audio level, S/N ratio and AM rejection (54% FM deviation) for FM (radio).

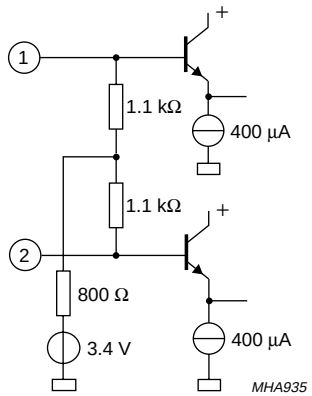
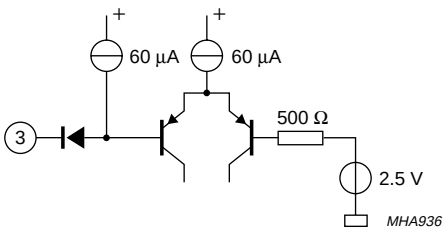
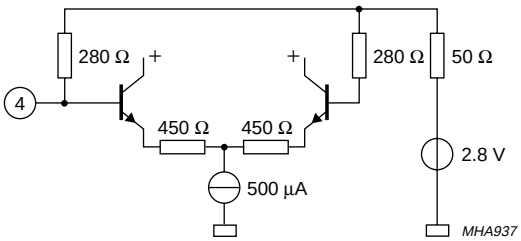
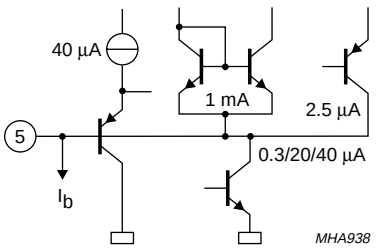


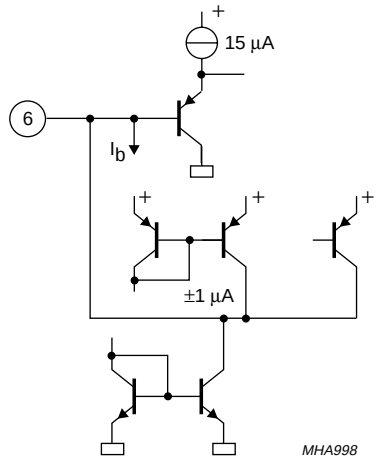
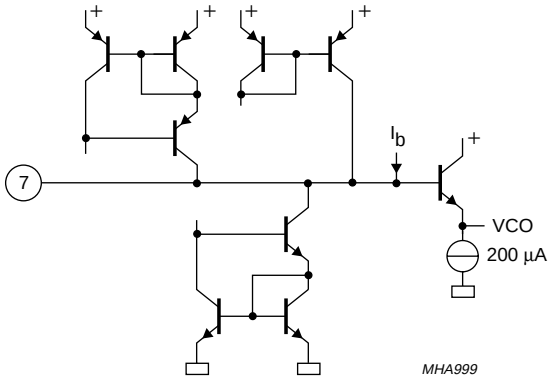
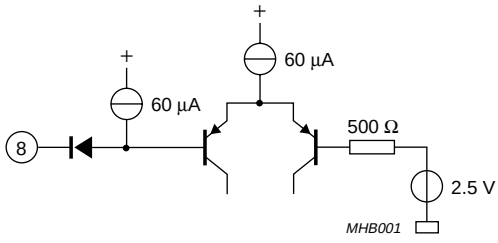
(1) RF input 102 dBμV (onset of tuner AGC).
(2) RF input 96 dBμV (signal condition for d_3 < 60 dB).
(3) RF input 47 dBμV.

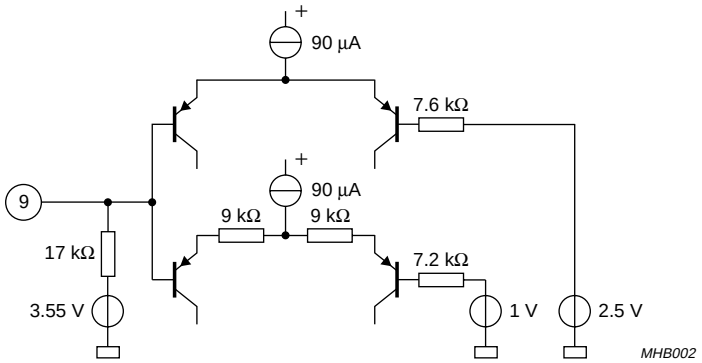
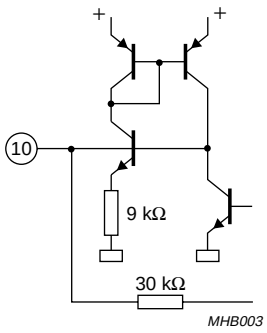
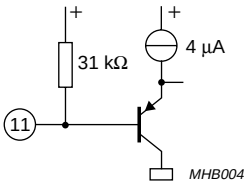
Fig.16 Front-end level diagram for radio operation.

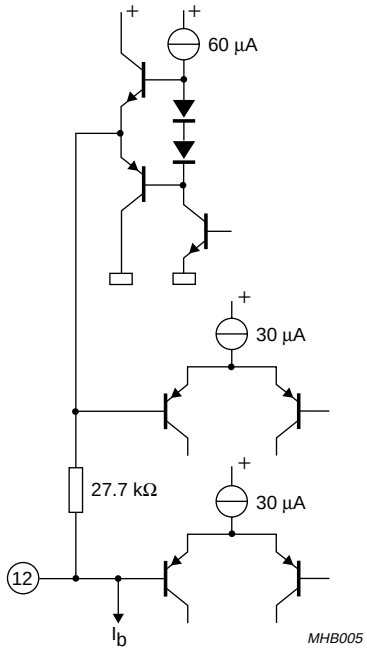
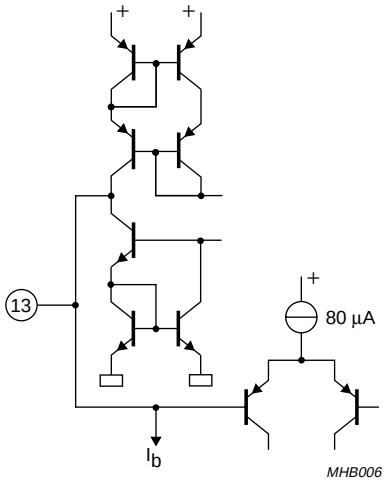
INTERNAL CIRCUITRY

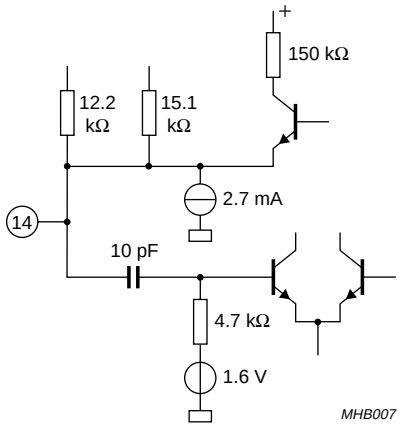
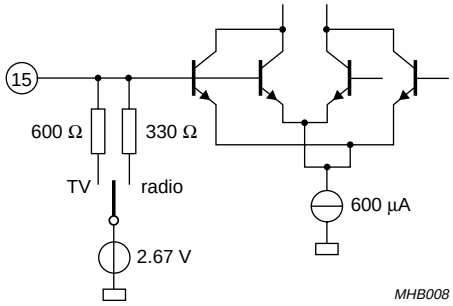
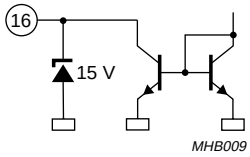
Table 3 Equivalent pin circuits and pin voltages

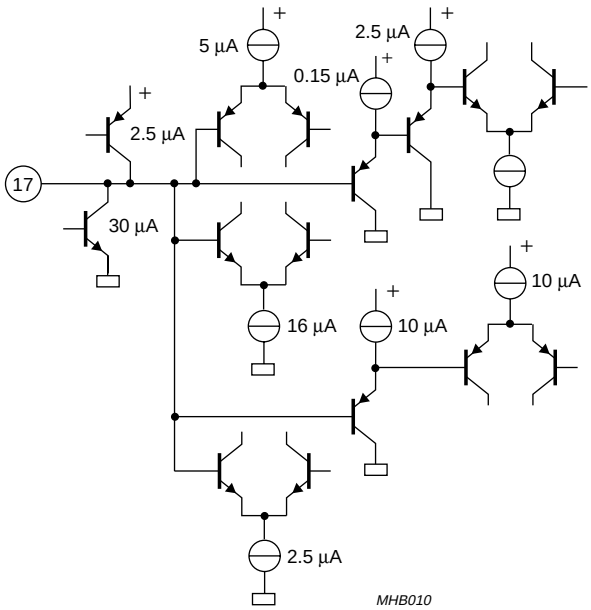
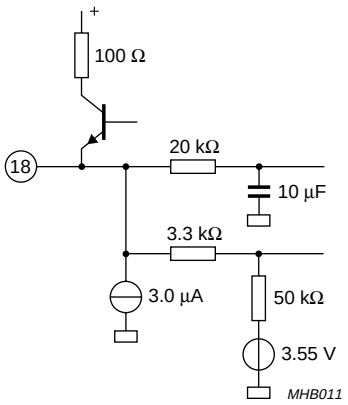
PIN	SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
1	V_{iVIF1}	3.4	
2	V_{iVIF2}	3.4	
3	LP0	0 to V_P	
4	V_{iRIF}	2.7	
5	C_{VAGC}	1.5 to 4.0	

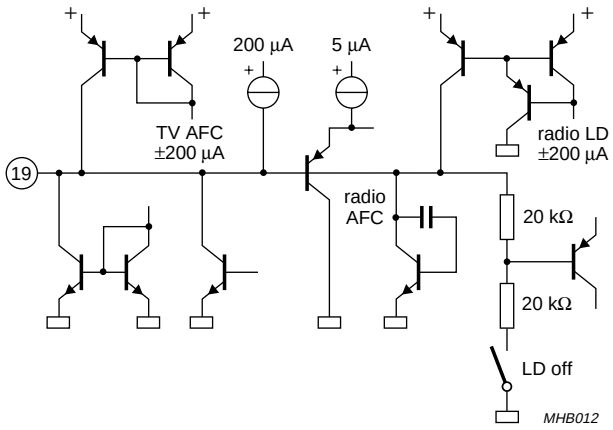
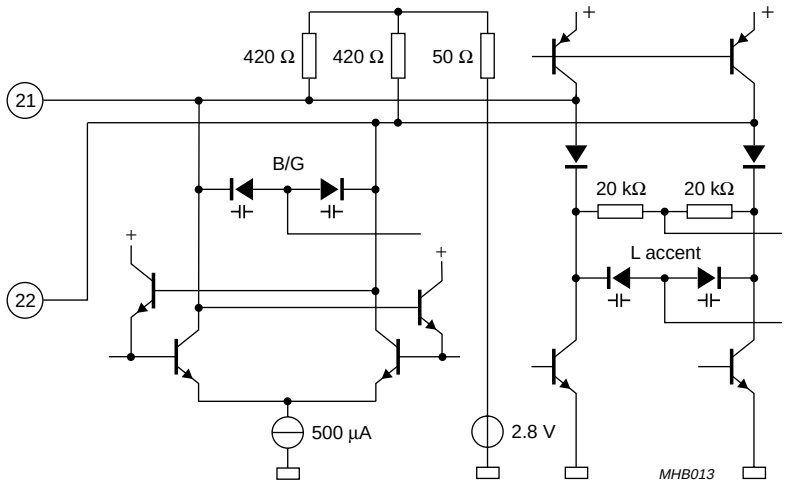
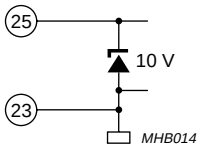
PIN	SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
6	C_{SAGC}	1.5 to 4.0	
7	T_{PLL}	1.5 to 4.0	
8	LP1	0 to V_P	

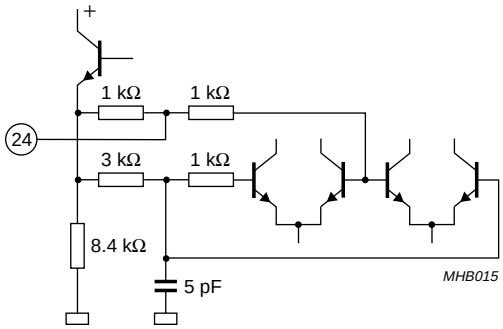
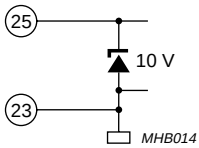
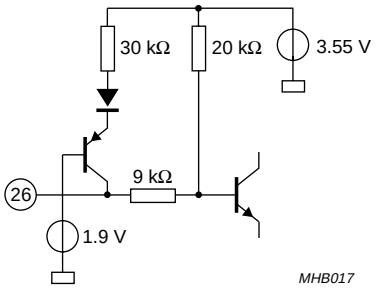
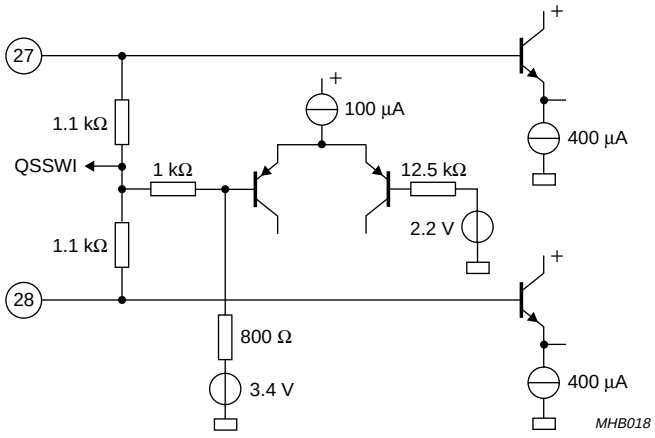
PIN	SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
9	LADJ	0 to V_P	
10	V_{oAF}	2.3	
11	LP2	0 to 3.0	

PIN	SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
12	$C_{de\text{-}em}$	2.3	
13	C_{DEC}	1.2 to 3.0	

PIN	SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
14	V_{oQSS}	2.0	
15	V_{iFM}	2.65	
16	TAGC	0 to 13.2	

PIN	SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
17	C_{BL}	0 to 3.2	
18	$V_{o(vid)}$	sync level: 1.5	

PIN	SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
19	AFC	0.3 to V_P – 0.3	
20	n.c.		
21	VCO1	2.7	
22	VCO2	2.7	
23	GND		

PIN	SYMBOL	DC VOLTAGE (V)	EQUIVALENT CIRCUIT (WITHOUT ESD PROTECTION CIRCUIT)
24	CERRES	4.0	
25	V_P		
26	TADJ	0 to 1.9	
27	V_{iSIF1}	3.4	
28	V_{iSIF2}	3.4	

TEST AND APPLICATION INFORMATION

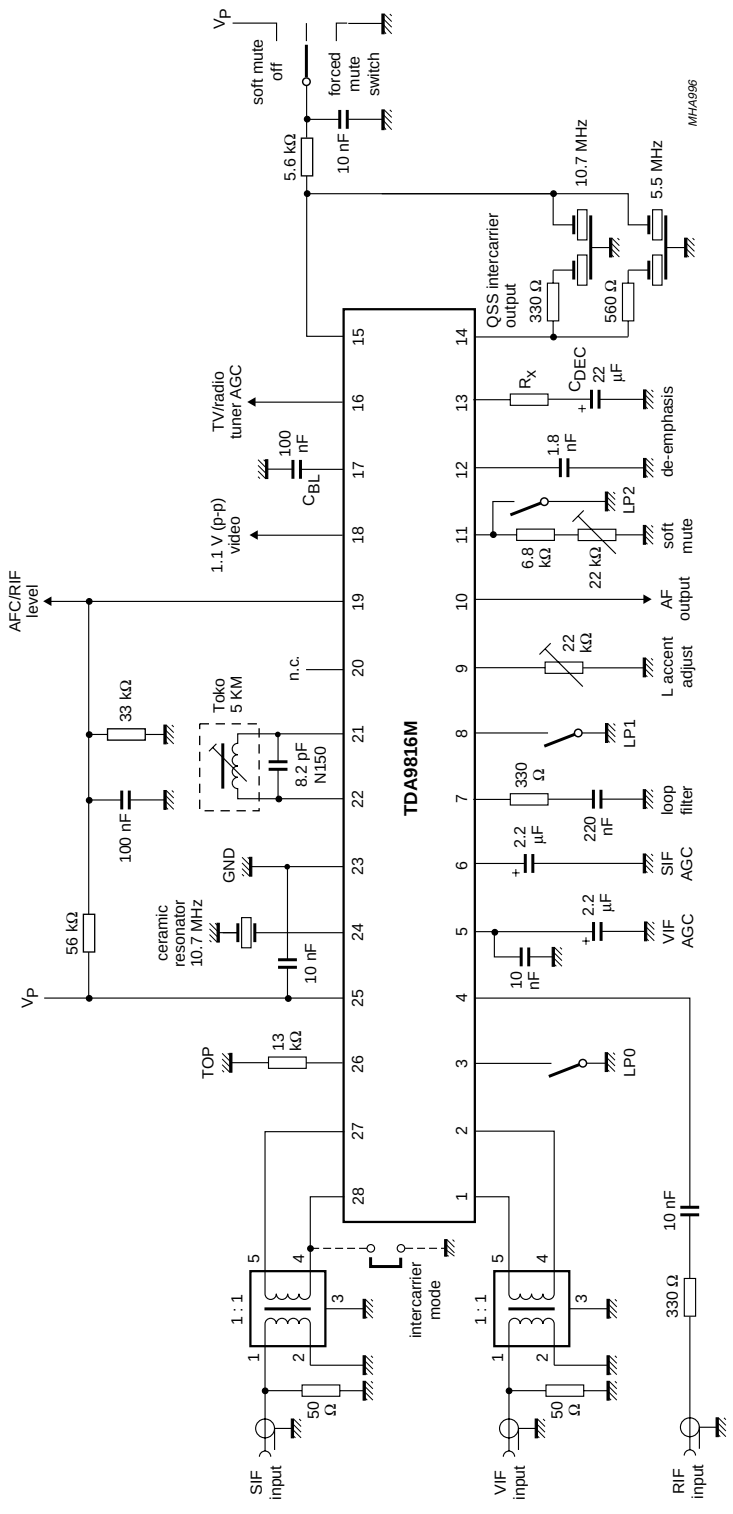


Fig.17 Test circuit.

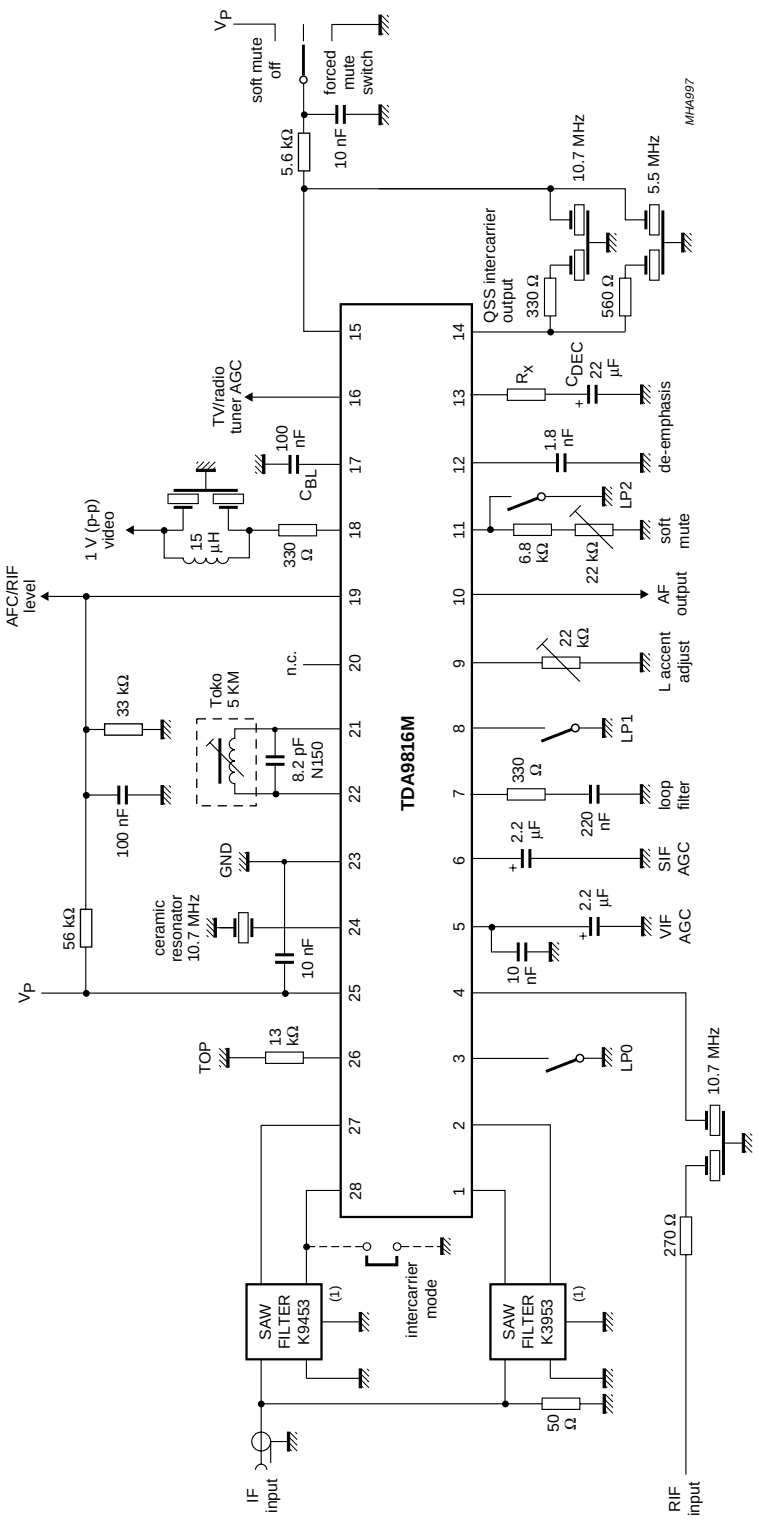
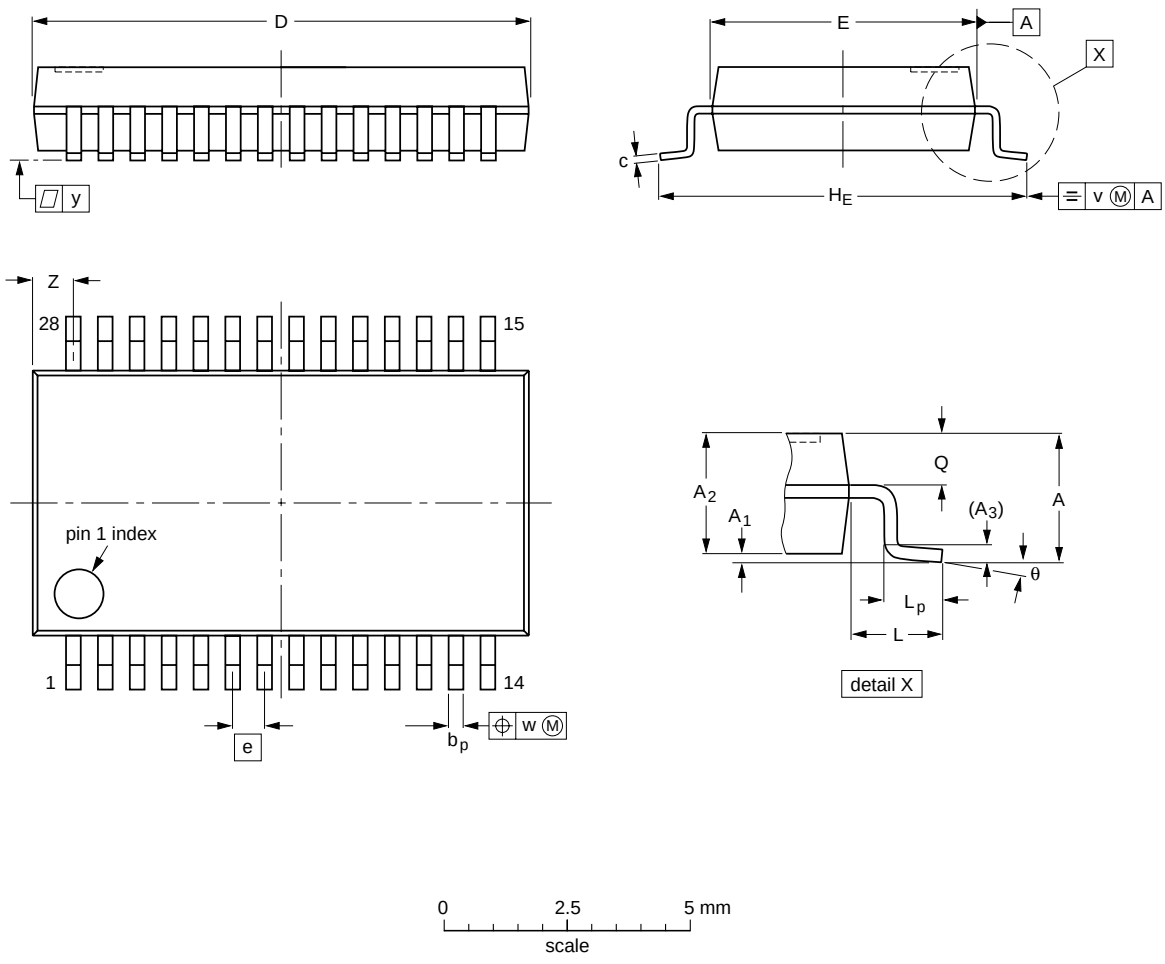


Fig.18 Application circuit.

(1) Depends on standard.

PACKAGE OUTLINE

SSOP28: plastic shrink small outline package; 28 leads; body width 5.3 mm **SOT341-1**



DIMENSIONS (mm are the original 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	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	10.4 10.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.1 0.7	8^o 0^o

Note

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT341-1		MO-150AH				~~93-09-08~~ 95-02-04

SOLDERING

Introduction

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

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

Reflow soldering

Reflow soldering techniques are suitable for all SSOP 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 is **not** recommended for SSOP packages. This is because of the likelihood of solder bridging due to closely-spaced leads and the possibility of incomplete solder penetration in multi-lead devices.

If wave soldering cannot be avoided, the following conditions must be 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 and must incorporate solder thieves at the downstream end.**

Even with these conditions, only consider wave soldering SSOP packages that have a body width of 4.4 mm, that is SSOP16 (SOT369-1) or SSOP20 (SOT266-1).

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.

Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTH RYDE, NSW 2113,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213, Tel. +43 160 1010,
Fax. +43 160 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 689 211, Fax. +359 2 689 102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,
Tel. +45 32 88 2636, Fax. +45 31 57 0044

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615800, Fax. +358 9 61580920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +30 1 4894 339/239, Fax. +30 1 4814 240

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: see Singapore

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,
Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZAWA,
Tel. +48 22 612 2831, Fax. +48 22 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 1231,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

South America: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 3 301 6312, Fax. +34 3 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 632 2000, Fax. +46 8 632 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2686, Fax. +41 1 481 7730

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2865, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 625 344, Fax.+381 11 635 777

For all other countries apply to: Philips Semiconductors,
International Marketing & Sales Communications, Building BE-p,
P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

Internet: http://www.semiconductors.philips.com

© Philips Electronics N.V. 1997 SCA56

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands 547047/1200/01/pp44 Date of release: 1997 Nov 19 Document order number: 9397 750 02596

Let's make things better.

Philips Semiconductors

PHILIPS