DATA SHEET

TDA1576T
FM/IF amplifier/demodulator circuit

Product specification
Supersedes data of February 1991
File under Integrated Circuits, IC01

1998 Nov 18

Philips
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FM/IF amplifier/demodulator circuit TDA1576T

FEATURES

- Fully balanced 4-stage limiting IF amplifier
- Symmetrical quadrature demodulator
- Field strength indication output for 1 mA ammeter
- Detune detector for side response and noise attenuation
- Detune voltage output
- Internal muting circuit
- 0° and 180° AF output signals
- Reference voltage output
- Electronic smoothing of the supply voltage.

GENERAL DESCRIPTION

The TDA1576T is a monolithic integrated FM/IF amplifier circuit for use in mono and stereo FM-receivers of car radios or home sets.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	supply voltage (pin 1)		7.5	8.5	15	V
I_P	supply current		10	16	23	mA
$V_{iIF(rms)}$	input sensitivity (RMS value)	–3 dB before limiting	14	22	35	μV
		S/N = 26 dB	–	10	–	μV
		S/N = 46 dB	–	55	–	μV
$V_{oAF(rms)}$	AF output voltage (RMS value)		60	67	75	mV
THD	total harmonic distortion with double resonant circuits		–	0.02	–	%
S/N	signal-to-noise ratio	V_i > 1 mV	–	72	–	dB
α_{AM}	AM suppression		–	50	–	dB
RR	ripple rejection	f = 100 Hz	43	48	–	dB
I_{15}	maximum indicator output current		–	–	2	mA
T_{amb}	operating ambient temperature		–30	–	+80	°C

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA1576T	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1

BLOCK DIAGRAM

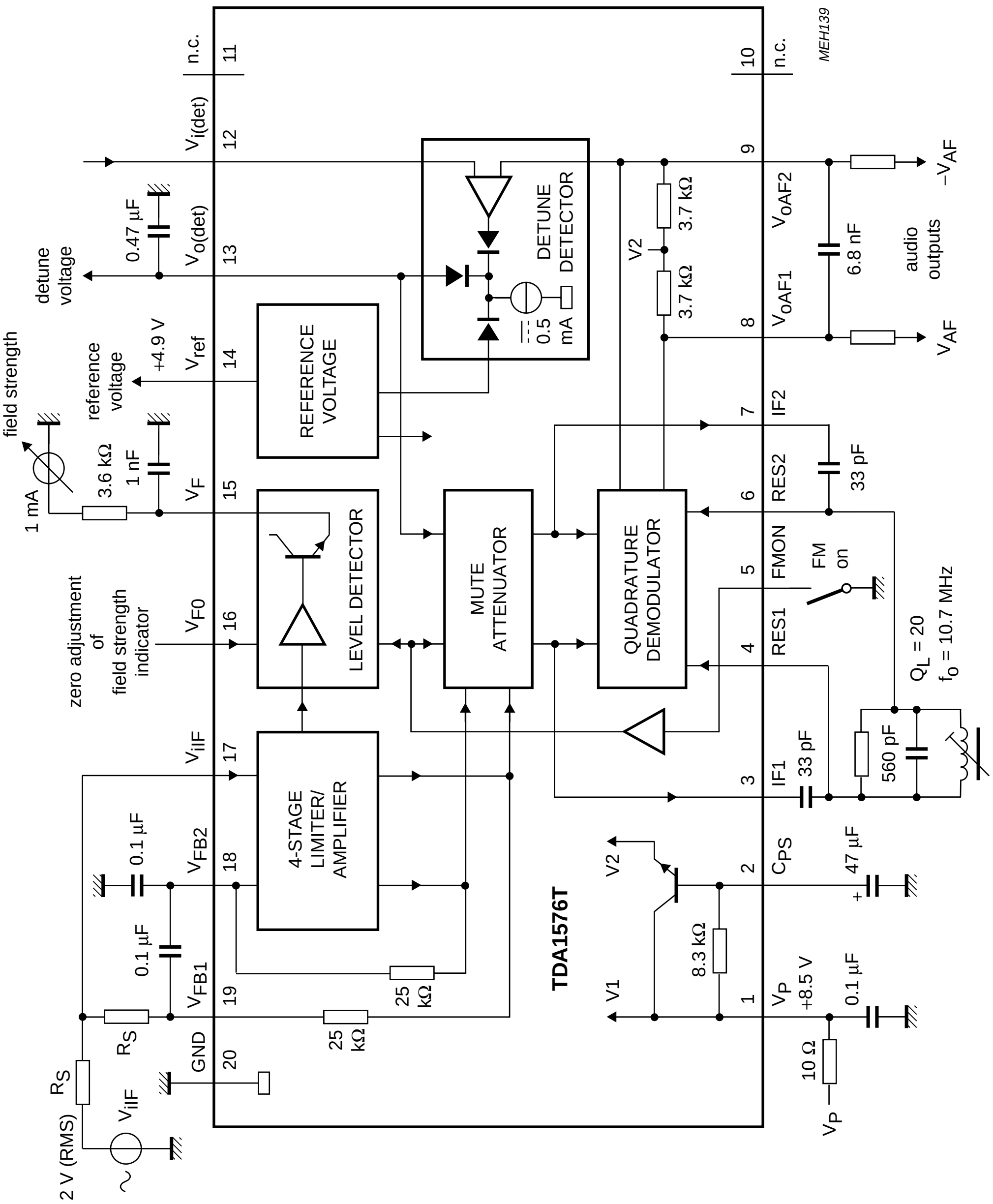


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
V_P	1	positive supply voltage
C_{PS}	2	smoothing capacitor of power supply
IF1	3	IF signal to resonant circuit
RES1	4	resonant circuit input 1
FMON	5	FM-ON, standby switch
RES2	6	resonant circuit input 2
IF2	7	IF signal to resonant circuit
V_{oAF1}	8	AF output voltage 1 (0° phase)
V_{oAF2}	9	AF output voltage 2 (180° phase)
n.c.	10	not connected
n.c.	11	not connected
$V_{i(det)}$	12	detune detector input voltage for external audio reference
$V_{o(det)}$	13	detune detector output voltage
V_{ref}	14	reference voltage output
V_F	15	level output for field strength
V_{F0}	16	zero adjust voltage for field strength
V_{iIF}	17	FM/IF input signal voltage
V_{FB2}	18	DC feedback 2
V_{FB1}	19	DC feedback 1
GND	20	ground (0 V)

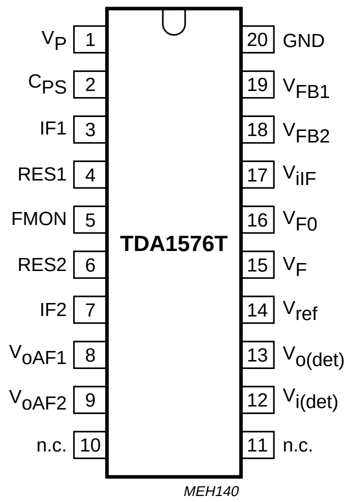


Fig.2 Pin configuration.

LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_P	supply voltage (pin 1)	0	15	V
$V_{2, 5, 16}$	voltage on pins 2, 5 and 16	0	V_P	V
P_{tot}	total power dissipation	0	450	mW
T_{stg}	storage temperature	–55	+150	°C
T_{amb}	operating ambient temperature	–30	+80	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient in free air	85	K/W

CHARACTERISTICS

V_P = 8.5 V; f_{IF} = 10.7 MHz; R_S = 60 Ω; f_m = 400 Hz with Δf = ±22.5 kHz; 50 μs de-emphasis ($C_{8\text{-}9}$ = 6.8 nF); T_{amb} = 25 °C and measurements taken in Fig.1; unless otherwise specified. The demodulator circuit is adjusted at minimum second harmonic distortion for V_{iIF} = 1 mV and a deviation Δf = ±75 kHz.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	supply voltage (pin 1)		7.5	8.5	15	V
I_P	supply current	$V_5 = V_9 = V_{13} = 0$	10	16	23	mA
Reference voltage						
V_{ref}	reference voltage (pin 14)	I_{14} = –1 mA	–	4.9	–	V
ΔV_{ref}	reference voltage dependence on temperature	$\frac{\Delta V_{14}}{V_{14} \times \Delta T}$	–	0.3	–	%/K
I_{14}	maximum output current	short-circuit current	4	6	7.5	mA
R_{14}	output resistor $\frac{\Delta V_{14}}{\Delta I_{14}}$	I_{14} < 1.2 mA	–	60	150	Ω
IF amplifier						
$V_{iIF(rms)}$	input sensitivity (RMS value; pin 17)	–3 dB before limiting	14	22	35	μV
$R_{17\text{-}18}$	input resistance	V_{iIF} = 200 mV (RMS)	10	–	–	kΩ
$C_{17\text{-}18}$	input capacitance	V_{iIF} = 200 mV (RMS)	–	5	–	pF
$V_{oIF(p\text{-}p)}$	output voltage at pins 3 and 7 (peak-to-peak value)	$Z_{3,\,7}$ = 10 pF parallel to 1 MΩ	610	680	750	mV
$R_{3\text{-}7}$	output resistance		200	250	300	Ω
Demodulator						
$R_{4\text{-}6}$	input resistance		20	30	40	kΩ
$C_{4\text{-}6}$	input capacitance		–	1	2.5	pF
$R_{8,\,9}$	output resistance		2.9	3.7	4.5	kΩ
$V_{8,\,9}$	DC offset voltage on output pins at $V_{4\text{-}6}$ = 0	V_5 > 3 V or $V_{3\text{-}7}$ = 0 or V_{13} < 0.3 V	–	0	±100	mV
$\frac{\Delta V}{\Delta \varphi}$	demodulator efficiency	$\frac{\Delta V_{8\text{-}9}}{\Delta \varphi}$	–	40	–	mV/°
	demodulator efficiency dependent on supply voltage	$\frac{V_{8\text{-}9}}{\Delta \varphi (V_P - 3V_{BE})}$	–	6.2	–	mV/°
V/V	DC voltage ratio	$\frac{V_8 + V_9}{2V_2}$	0.653	0.667	0.680	V/V
$\frac{\Delta V}{\Delta T}$	dependence on temperature	$\frac{\Delta \frac{V_8 + V_9}{2V_2}}{\Delta T}$	–	10^{-5}	–	1/K

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Field strength output; see Fig.4						
V_{15}	output voltage	V_{iIF} = 0	0	0.1	0.25	V
		V_{iIF} = 1 mV (RMS)	1.1	1.5	1.9	V
		V_{iIF} = 250 mV (RMS)	3.2	3.6	4.1	V
S	control steepness		–	0.85	–	V/dec
R_{15}	output resistance		–	150	200	Ω
$\frac{\Delta V}{\Delta T}$	dependence on temperature	$V_{iIF} = \frac{\Delta V_{15}}{\Delta T \times V_{15}}$	–	0.3	–	%/K
I_{15}	standby operational cut-off current	$V_5 \geq 3$ V; V_{15} = 0 to 5 V	–	–	10	µA
Zero level adjustment						
V_{16}	internal bias voltage		–	260	–	mV
R_{16}	input resistance		–	19	–	kΩ
S	control steepness	V_{iIF} = 100 mV; $A = \frac{\Delta V_{15}}{\Delta V_{16}}$	0.87	1.0	1.2	V/V
Detuning detector						
I_{12}	input bias current		–	20	100	nA
Z_{12}	input impedance	$Z_{12} = \frac{5\ V}{\Delta I_{12}}$; see Fig.5	6	30	–	MΩ
$\frac{V_{13}}{V_{14}}$	output voltage ratio for $\Delta\varphi = \varphi(V_{3-7}) - \varphi(V_{4-6}) - 90°$	$V_1 = V_2$ = 7.5 V; R_{13-14} = 10 kΩ; pins 9 and 12 short-circuit; see Fig.6				
	Δφ = 9.2° (43 kHz); Q = 20	$V_{9,\ 12}$ = 334 mV	0.45	0.5	0.55	V/V
	Δφ = 3.5° (16 kHz); Q = 20	$V_{9,\ 12}$ = 138 mV	0.75	0.8	0.85	V/V
	Δφ = 14° (65 kHz); Q = 20	$V_{9,\ 12}$ = 501 mV	0.335	0.345	0.355	V/V
I_{13}	maximum output current	V_{13} = 6 V; see Fig.7	0.4	0.5	0.6	mA
	cut-off current	V_{13} = 2.5 V; $V_{9,\ 12}$ = 0	–	–	–100	nA
Internal audio attenuation; see Fig.8						
$\frac{V_{13}}{V_{14}}$	output voltage ratio	α = attenuation factor				
		α = 1 dB	0.11	0.12	0.13	V/V
		α = 7.2 dB	0.095	0.1	0.105	V/V
		α ≥ 40 dB	–	0.06	–	V/V
I_{13}	input current	$V_{13} \leq 0.1$ V	–	–	–225	nA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Standby switch; see Fig.9						
V_5	input voltage for FM on	$\frac{V_{3,7}}{V_{3,7(max)}} = 0.9$; $V_{19} = 0.3$ V	2.4	2.5	–	V
	input voltage for FM off		–	2.9	3	V
	linear range		–	350	–	mV
I_5	input current	V_5 = 0 to 2 V	–	–	–100	μA
		V_5 = 3.5 to 15 V	–	–	1	μA
$\frac{V_5}{\Delta T}$	temperature dependence	FM on ($3.5V_{BE}$)	–	7	–	mV/K
		FM off ($5V_{BE}$)	–	10	–	mV/K
Supply voltage smoothing						
V_{1-2}	internal voltage drop	proportional to $V_1 - 3V_{BE}$	80	210	400	mV
R_{1-2}	internal resistor		5.8	8.3	10.8	kΩ

OPERATING CHARACTERISTICS

V_P = 8.5 V; f_{IF} = 10.7 MHz; R_S = 60 Ω; f_m = 400 Hz with Δf = ±22.5 kHz; 50 μs de-emphasis (C_{8-9} = 6.8 nF); T_{amb} = 25 °C and measurements taken in Fig.1; unless otherwise specified. The demodulator circuit is adjusted at minimum second harmonic distortion with V_{iIF} = 1 mV.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
IF amplifier and demodulator						
$V_{iIF(rms)}$	input sensitivity (RMS value)	–3 dB before limiting	14	22	35	μV
		S/N = 26 dB	–	10	–	μV
		S/N = 46 dB	–	55	–	μV
$V_{oAF(rms)}$	AF output voltage (RMS value)		60	67	75	mV
V_{oN}	noise voltage for V_{iIF} = 0 (RMS value; pins 8 and 9)	R_S = 300 Ω; f = 250 to 15000 Hz	–	900	–	μV
	weighted noise voltage	in accordance with *“DIN 45405”*	–	2	–	mV
S/N	signal-to-noise ratio (pins 8 and 9)	V_{iIF} = 1 mV (RMS); see Fig.3	–	72	–	dB
α_{AM}	AM suppression	V_{iIF} = 0.5 to 200 mV; FM: 70 Hz; ±15 kHz; AM: 1 kHz; m = 30%	–	50	–	dB
α_{FM}	FM suppression for FM off	V_{iIF} = 500 mV; V_5 = 3 V	80	–	–	dB
$\Delta V_{8,9}$	AFC shift in relation to minimum second harmonic distortion α_{2H}	V_{iIF} = 0.03 to 500 mV	–	25	–	mV
	DC offset at second harmonic distortion	operating	–	0	±100	mV
		mute or FM off	–	0	±50	mV
α_{3H}	distortion for third harmonic		–	0.65	–	%
RR	ripple rejection V_{ripple} = 200 mV on V_P	f = 100 Hz	43	48	–	dB

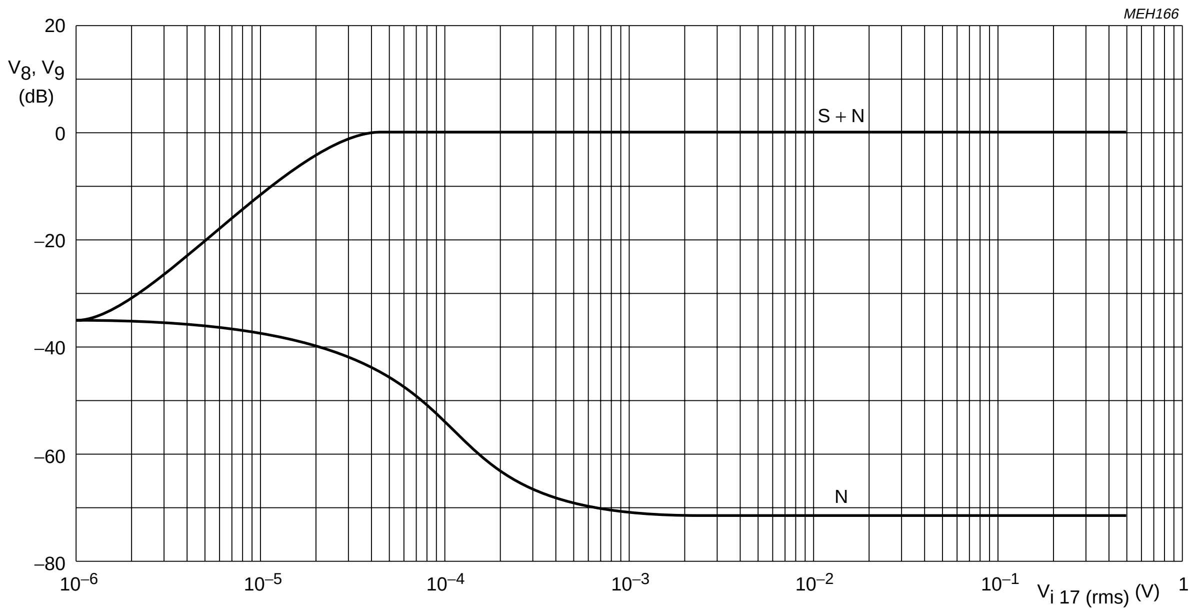


Fig.3 AF output voltage level on pins 8 and 9 as a function of V_{iIF} at V_P = 8.5 V; f_m = 1 kHz; Q_L = 20 with de-emphasis.

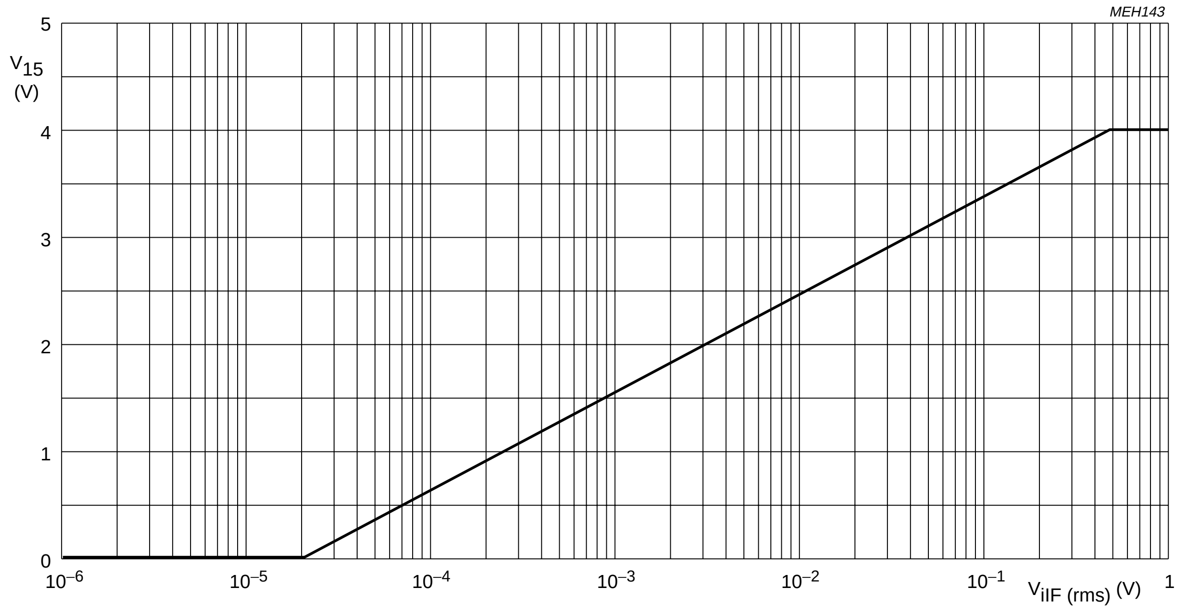


Fig.4 Field strength output (I_{16} = 0).

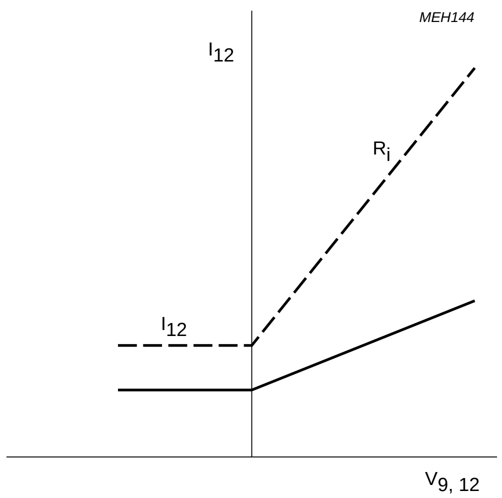


Fig.5 Detuning input impedance.

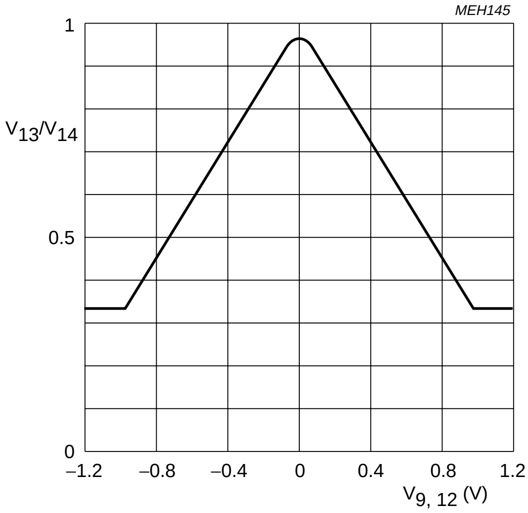


Fig.6 Detuning curve.

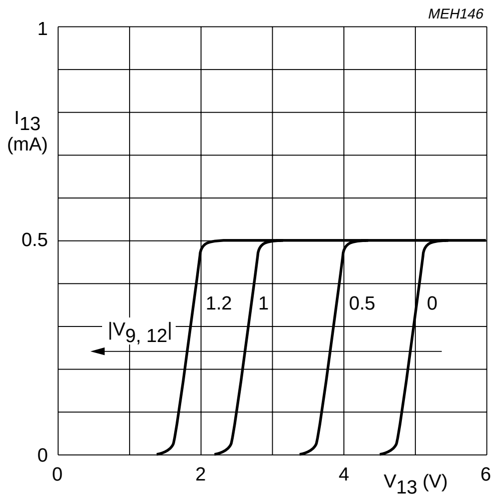


Fig.7 Detuning output.

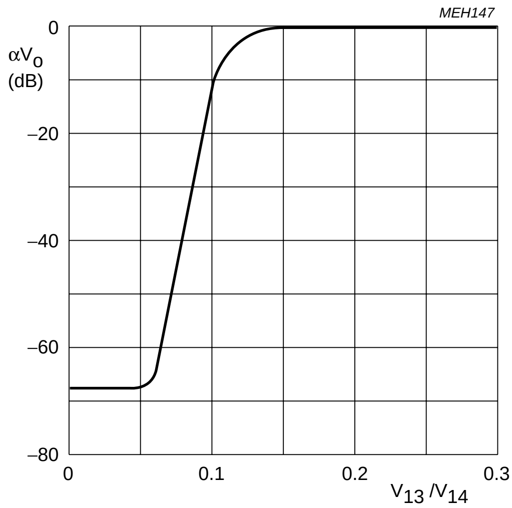


Fig.8 Internal audio attenuation.

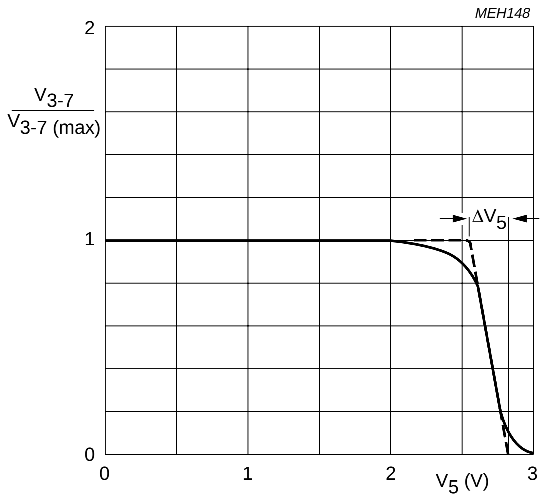
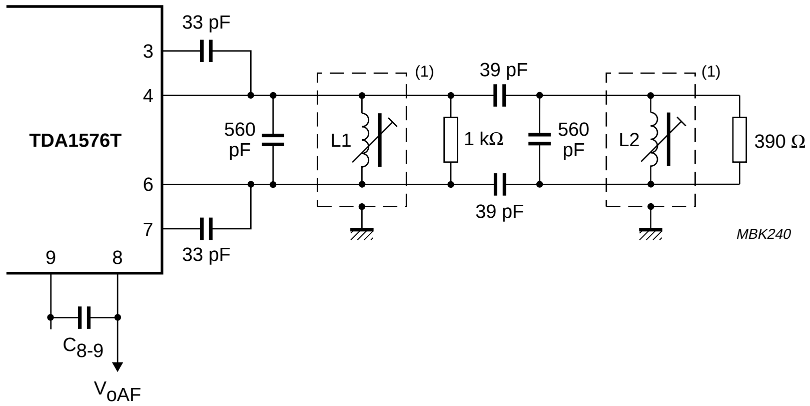


Fig.9 Standby switch.



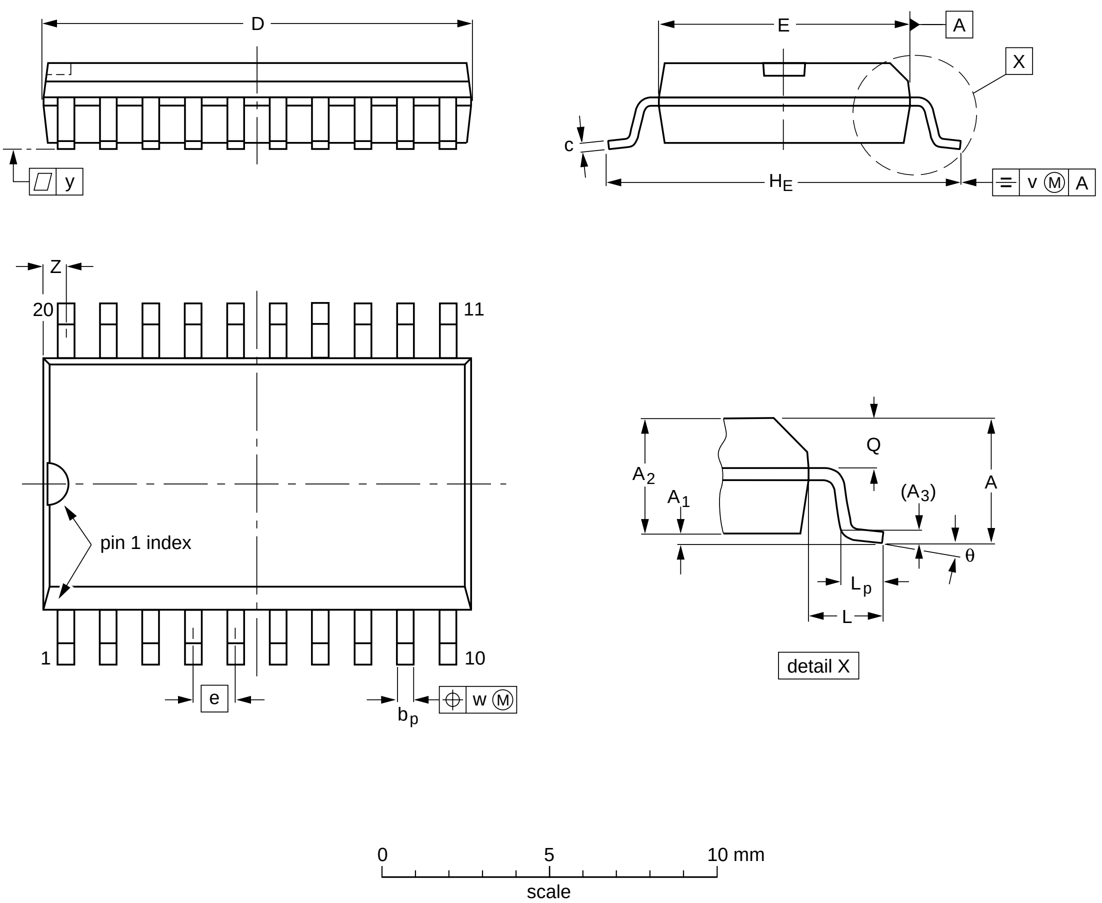
Adjustment of the demodulator circuit is obtained with an IF signal which is higher than the 3 dB limiting level; L2 should be short-circuited or detuned; L1 should be adjusted to minimum d_2 distortion, and then L2 to minimum d_2 distortion.

(1) Coil data: L1 = L2 = 0.38 μH; Q_o = 70; coil former KAN (C).

Fig.10 An example of the TDA1576T when using a demodulator with two tuned circuits.

PACKAGE OUTLINE

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 to soldering surface mount packages

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

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

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

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

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

Wave soldering

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

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

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

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

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

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

Typical dwell time is 4 seconds at 250 °C.
A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW(1)
BGA, SQFP	not suitable	suitable
HLQFP, HSQFP, HSOP, SMS	not suitable(2)	suitable
PLCC(3), SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended(3)(4)	suitable
SSOP, TSSOP, VSO	not recommended(5)	suitable

Notes

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

DEFINITIONS

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

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.

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