DATA SHEET

TDA1300T
Photodetector amplifiers and laser supply

Product specification
Supersedes data of 1995 Sep 27
File under Integrated Circuits, IC01

1995 Nov 16

Philips Semiconductors

PHILIPS

FEATURES

- Six input buffer amplifiers with low-pass filtering with virtually no offset
- HF data amplifier with a high or low gain mode
- Two built-in equalizers for single or double speed mode ensuring high playability in both modes
- Full automatic laser control including stabilization and an on/off switch and containing a separate supply V_{DDL} for power reduction
- Applicable with N-sub laser with N-sub or P-sub monitor diode
- Adjustable laser bandwidth and laser switch-on current slope
- Protection circuit preventing laser damage due to supply voltage dip
- Optimized interconnect between pick-up detector and TDA1301
- Wide supply voltage range
- Wide temperature range
- Low-power consumption.

GENERAL DESCRIPTION

The TDA1300 is an integrated data amplifier and laser supply for three beam pick-up detectors applied in a wide range of mechanisms for Compact Disc and Read Only optical systems. It offers 6 amplifiers which amplify and filter the focus and radial diode signals adequately and provides an equalized RF signal for single or double speed mode which can be switched by means of the speed control pin.

The device can handle astigmatic, single foucault and double foucault detectors and is applicable with all N-sub laser, N-sub or P-sub monitor diode units.

After a single initial adjustment the circuit keeps control over the laser diode current resulting in a constant light output power independent of ageing. The chip is mounted in a small SO24 package enabling mounting close to the laser pick-up unit on the sledge.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{DD}	supply voltage		3	–	5.5	V
Diode current amplifiers 6 times						
G_{dn}	amplification		1.43	1.55	1.67	
$I_{os(d)}$	offset current		–	–	100	nA
B	3 dB bandwidth	$I_{i(d)}$ = 1.67 µA	50	–	–	kHz
RFE amplifier (built-in equalizer)						
$t_{d(eq)}$	equalization delay time	f_i = 0.3 MHz	–	320	–	ns
$t_{d(f)}$	flatness delay time	double-speed	–	5	–	ns
Laser supply						
$I_{o(l)}$	output current	V_{DDL} = 3 V	–	–	–100	mA

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA1300T	SO24	plastic small outline package; 24 leads; body width 7.5 mm	SOT137-1

SCHEMATIC DIAGRAM

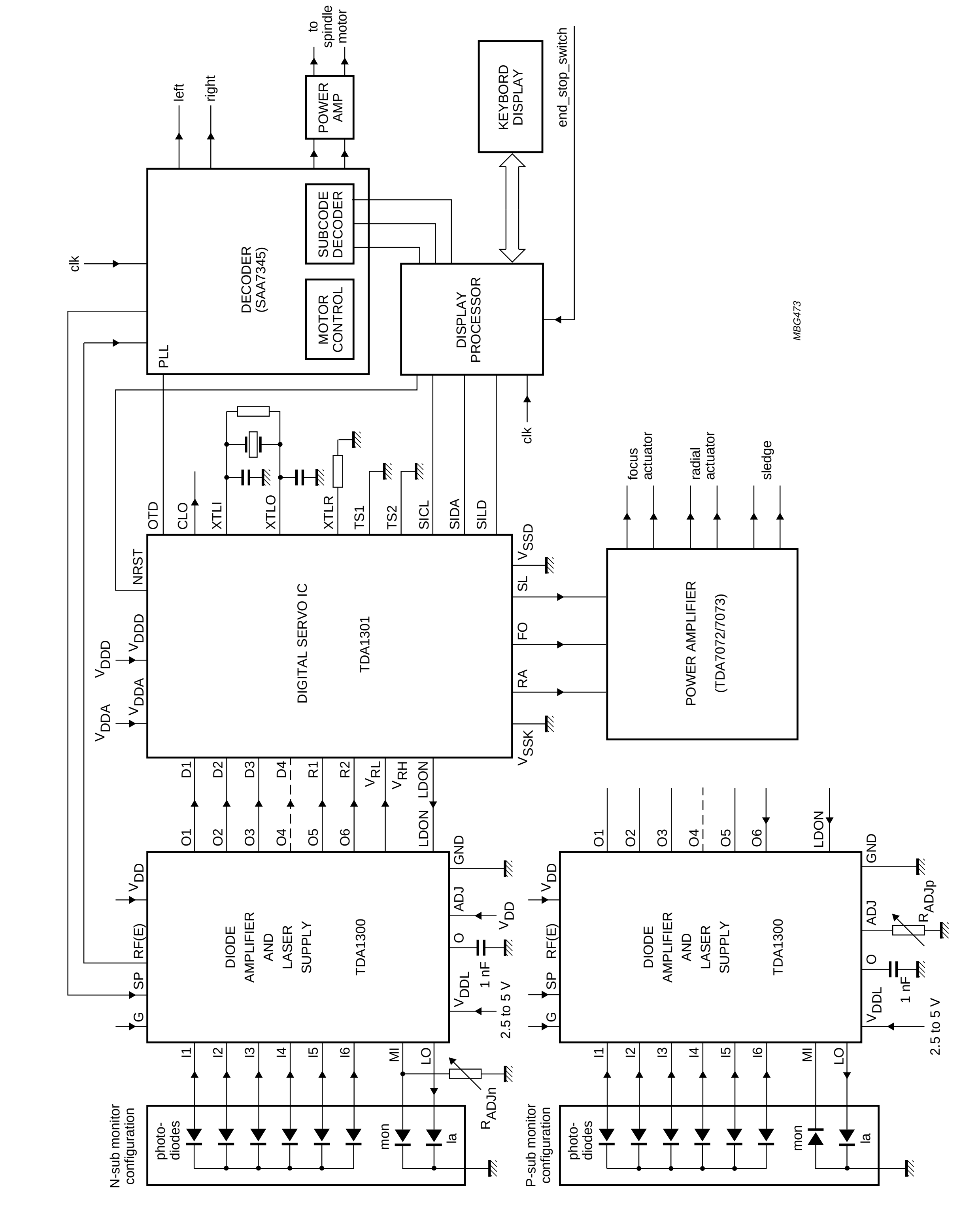


Fig.1 Schematic diagram for CD player.

BLOCK DIAGRAM

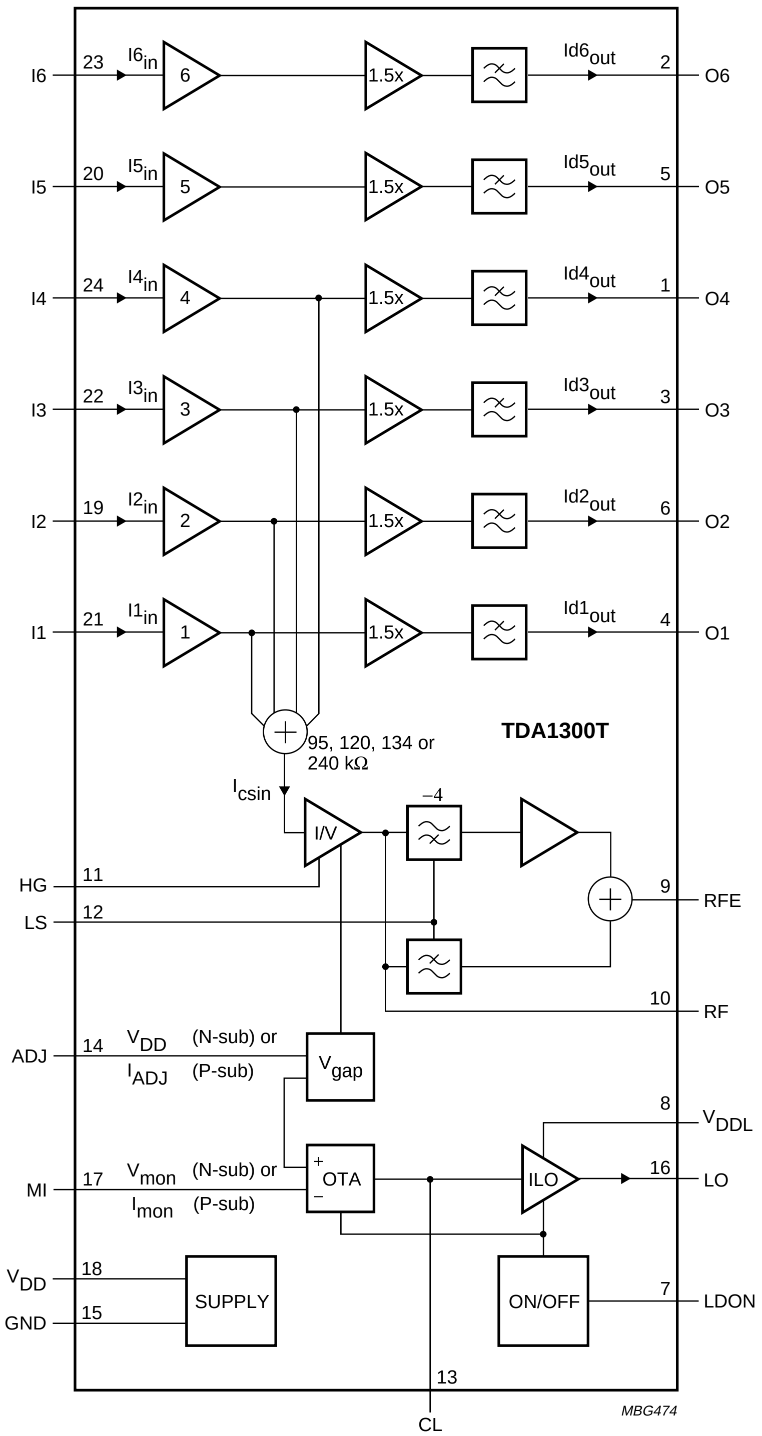


Fig.2 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
O4	1	output of current amplifier 4
O6	2	output of current amplifier 6
O3	3	output of current amplifier 3
O1	4	output of current amplifier 1
O5	5	output of current amplifier 5
O2	6	output of current amplifier 2
LDON	7	control pin for switching the laser on and off
V_{DDL}	8	laser supply voltage
RFE	9	equalized output voltage of sum signal of amplifiers 1 to 4
RF	10	unequalized output
HG	11	control pin for gain switch
LS	12	control pin for speed switch
CL	13	external capacitor
ADJ	14	if connected via resistor to GND P-sub monitor. If connected to V_{DD} N-sub monitor
GND	15	zero supply connection, substrate connection
LO	16	output for the laser, current output
MI	17	input for the monitor diode of the laser
V_{DD}	18	positive supply connection
I2	19	photo detector input 2 (central)
I5	20	photo detector input 5 (satellite)
I1	21	photo detector input 1 (central)
I3	22	photo detector input 3 (central)
I6	23	photo detector input 6 (satellite)
I4	24	photo detector input 4 (central)

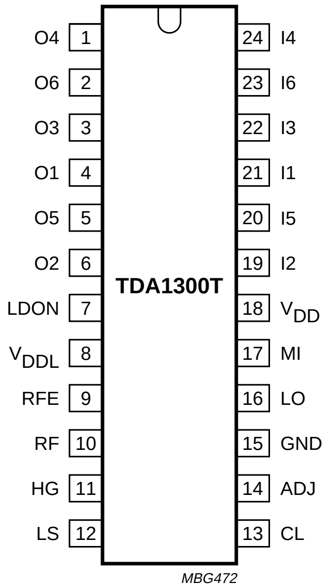


Fig.3 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA1302T can be divided into two main sections:

1. Laser control circuit
2. Photo diode signal filter and amplification section.

Laser control circuit

The main function of the laser control circuit is to control the laser diode current in order to achieve a constant light output power. This is done by monitoring the monitor diode. There is a fixed relation between light output power of the laser and the current of the monitor diode. The circuit can handle P-sub or N-sub monitor diodes.

N-sub MONITOR

In this event pin 14 (ADJ) must be connected to the positive supply voltage V_{DD} to select the N-sub mode. With an adjustable resistor (R_{ADJn}) across the diode the monitor current can be adjusted (and so the laser light output power) if one knows that the control circuit keeps the monitor voltage V_{mon} at a constant level of approximately 150 mV.

P-sub MONITOR

In this event pin 14 (ADJ) is connected via resistor R_{ADJp} to ground. The P-sub mode is selected and pin 14 (ADJ) acts as reference bandgap voltage, providing together with R_{ADJp} an adjustable current I_{ADJ}. Now the control circuit keeps the monitor current at a level which is $10 \times I_{ADJ}$.

The circuit is built-up in three parts:

The first part is the input stage which is able to switch between both modes (N-sub or P-sub).

The second part is the integrator part which makes use of an external capacitor C_L. This capacitor has two different functions:

1. During switch-on of the laser current, it provides a current slope of typically:

   $$\frac{\Delta I_{LO}}{\Delta t} \cong \frac{10^{-6}}{C_L} \quad \text{(A/s)}$$

2. After switch-on it ensures that the bandwidth is in accordance with the typical formula:

   $$f_{BP} \cong \frac{K \times A_{ext} \times 90 \times 10^{-9}}{C_L \times I_{mon}} \quad \text{(Hz) in case of}$$

   P-sub monitor.

   $$f_{BN} \cong \frac{R_{ADJn}}{C_L} K \times A_{ext} \times 870 \times 10^{-9} \quad \text{(Hz) in case of}$$

   N-sub monitor

   where A_{ext} represents the AC gain of an extra loop amplifier, if applied, and $K = \Delta I_{mon}/\Delta I_{laser}$ which is determined by the laser/monitor unit. I_{mon} is the average current (pin 17) at typical light emission power of the laser diode.

The third part is the power output stage, its input being the integrator output signal. This stage has a separate supply voltage (V_{DDL}) thereby offering the possibility of reduced power consumption by supplying this pin with the minimum voltage necessary.

It also has a laser diode protection circuit which comes into action just before the driving output transistor will get saturated due to a large voltage dip on V_{DDL}. Saturation will result in a lower current of the laser diode, which normally is followed immediately by an increment of the voltage of the external capacitor C_L. This could cause damage to the laser diode at the end of the dip. The protection circuit prevents an increment of the capacitor voltage and thus offers full protection to the laser diode under these circumstances.

Photo diode signal filter and amplification section

This section has 6 identical current amplifiers. Amplifiers 1 to 4 are designed to amplify the focus photo diode signals. Each amplifier has two outputs, an LF output and an internal RF output. Amplifiers 5 and 6 are used for the radial photo diode currents and only have a LF output. All 6 output signals are low-pass filtered with a corner frequency at 69 kHz. The internal RF output signals are summed together and converted to a voltage afterwards by means of a selectable transresistance.

This transresistance R_{RF} can be changed between 140 kΩ (3.3 V application) or 240 kΩ (5 V application) in combination with the P-sub monitor. In the event of the N-sub monitor selection, R_{RF} can be changed between 70 kΩ (3.3 V application) and 120 kΩ (5 V application). The RF signal is available directly at pin 10 but there is also an unfiltered signal available at pin 9.

The used equalization filter has 2 different filter curves:

1. One for single-speed mode
2. One for double-speed mode.

Table 1 Gain and monitor modes

PIN		MODE		INTENDED APPLICATION AREA
HG	ADJ	R_{RF}	MONITOR	
0	R_{ADJp} to ground	140 kΩ	P-sub	3.3 V
0	1	70 kΩ	N-sub	
1(1)	R_{ADJp} to ground	240 kΩ	P-sub	5 V
1(1)	1	120 kΩ	N-sub	

Note

1. Logic 1 or not connected.

Table 2 Speed and laser modes; note 1

PIN	DEFAULT(2)	MODE			
		SPEED		LASER	
		SINGLE	DOUBLE	on	off
LS	1	1	0	X(3)	X(3)
LDON	1	X(3)	X(3)	1	0

Notes

1. 1 = HIGH voltage V_{DD}; 0 = LOW voltage GND; X = don't care.
2. If not connected.
3. X = don't care.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DD}	supply voltage		–	8	V
P_{max}	maximum power dissipation		–	300	mW
T_{stg}	storage temperature		–65	+150	°C
T_{amb}	operating ambient temperature		–40	+85	°C
V_{es}(1)	electrostatic handling pin 16	note 2	–2	+2	kV
	electrostatic handling (all other pins)		–3	+3	kV

Notes

1. Classification A: human body model; C = 100 pF; R = 1500 Ω; V = ± 2000 V.
   Charge device model: C = 200 pF; L = 2.5 μH; R = 0 Ω; V = 250 V.
2. Equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient in free air	60	K/W

QUALITY SPECIFICATION

In accordance with *"SNW-FQ-611 part E"*. The numbers of the quality specification can be found in the *"Quality Reference Handbook"*. The handbook can be ordered using the code 9397 750 00192.

CHARACTERISTICS

V_{DD} = 3.3 V; V_{DDL} = 2.5 V; T_{amb} = 25 °C; R_{ADJ} = 48 kΩ; HG = logic 1; LS = logic 1; with an external low pass filter (R_{ext} = 750 Ω, C_{ext} = 47 pF) at the RFE output pin.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
I_{DD}	supply current	laser off	–	7	–	mA
V_{DD}	amplifier supply voltage		3	–	5.5	V
V_{DDL}	laser control supply voltage		2.5	–	5.5	V
P_{diss}	power dissipation	laser off; V_{DD} = 3 V	–	20	–	mW
Diode current amplifiers (n = 1 to 6; m = 1 to 6)						
$I_{i(d)}$	diode input current	note 1	–	–	10	µA
N_{eq}	equivalent noise input		–	1	–	pA/√Hz
$V_{i(d)}$	diode input voltage	$I_{i(d)}$ = 1.67 µA	–	0.9	–	V
$V_{o(d)}$	diode output voltage		–0.2	–	V_{DD} – 1	V
G_{dn}	amplification	$I_{i(d)}$ = 1.67 µA; $V_{o(dn)}$ = 0 V; note 2	1.43	1.55	1.67	times
$I_{os(d)}$	diode output offset current	I_{csin} = I_{tsin} = 0; note 3	–	–	100	nA
$Z_{o(d)}$	output impedance	I_{di} = 1.67 µA; $V_{o(dn)}$ = 0 V	500	–	–	kΩ
B	3 dB bandwidth	$I_{i(d)}$ = 1.67 µA	50	68	–	kHz
G_{mm}	mismatch in amplification	I_{di} = 1.67 µA; $V_{o(dn)}$ = $V_{o(dm)}$	–	–	3	%
Data amplifier; equalized single and double speed						
V_{RFO}	DC output voltage	I_{csin} = 0	–	0.3	–	V
$R_{RF\ nl}$	transresistance (gain) nl	note 3	56	70	84	kΩ
$R_{RF\ nh}$	transresistance (gain) nh	note 3	96	120	144	kΩ
$R_{RF\ pl}$	transresistance (gain) pl	note 4	112	140	168	kΩ
$R_{RF\ ph}$	transresistance (gain) ph	note 4	200	240	285	kΩ
V_{RFMO}	output voltage	note 5	–	–	V_{DD} – 1.2	V
SR_{RF}	slew rate	V_{SR} = 1 V (peak-to-peak)	–	6	–	V/µs
Z_{oRF}	output impedance	f_i = 1 MHz	–	100	–	Ω
$t_{d(eq)}$	equalization delay		–	320	–	ns
$t_{d(f)}$	flatness delay (Φ/ω)	LS = 1; note 6	–	10	–	ns
		LS = 0; note 6	–	5	–	ns
G_R	gain ratio	note 6	4.5	6	–	dB
B_{RF}	unequalized output bandwidth	$I_{i(d)}$ = 1.67 µA	3	5	–	MHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Control pins LDON, LS and HG (with 47 kΩ internal pull-up resistor)						
V_{IL}	LOW level input voltage		–0.2	–	+0.5	V
V_{IH}	HIGH level input voltage		V_{DD} – 1	–	V_{DD} + 0.2	V
I_{IL}	LOW level input current		–	–	100	µA
Laser output						
$V_{o(l)}$	output voltage	$I_{o(l)}$ = 100 mA	–0.2	–	V_{DDL} – 0.7	V
$I_{o(l)}$	output current		–	–	–100	mA
$\lvert \Delta_{Io(l)}/\Delta t \rvert$	slew rate output current	C_{Lint} = 1 nF	–	3.4	–	mA/µs
Monitor diode input						
V_{ref}	virtual reference voltage	N-sub mode	130	150	170	mV
I_L	leakage current	N-sub mode	–	1	–	nA
$V_{i(mon)}$	monitor input voltage	P-sub mode	–	V_{DD} – 0.7	–	V
$I_{i(mon)}$	monitor input current	P-sub mode	–	–	2	mA
ΔT	reference temperature drift	N-sub mode	–	40	–	ppm
SR_{ref}	reference supply rejection	N-sub mode	–	–	1	%
Reference source V_{ADJ} and laser adjustment current I_{ADJ}						
V_{ref}	reference voltage	R_{ADJ} = 48 kΩ	1.15	1.24	1.31	mV
ΔT	reference temperature drift		–	40	–	ppm
SR_{ref}	reference supply rejection		–	–	1	%
I_{ADJ}	adjustment current	R_{ADJ} = 5.6 kΩ	–	–	200	µA
Z_i	input impedance	R_{ADJ} = 4.8 kΩ	–	1	–	kΩ
M	multiplying factor (I_{mon}/I_{ADJ})		–	10	–	–

Notes to the characteristics

1. The maximum input current is defined as the current in which the amplification A_{dn} reaches its minimum. Increasing the supply voltage to V_{DD} = 5 V increases the maximum input current (see also Figs 4 and 5).
2. The amplification increases if a larger supply voltage is used (see Fig.6).
3. Transresistance 70 kΩ and 120 kΩ is only available in N-sub monitor mode. (see Table 1).
4. Transresistance 140 kΩ and 240 kΩ is only available in P-sub monitor mode. (see Table 1).
5. Output voltage swing will be: $V_{RFS} = V_{RFM} - V_{RFO(p-p)}$.
6. For single speed the gain ratio is defined as gain difference between 1 MHz and 100 kHz, while the flatness delay is defined up to 1 MHz (see Fig.7). For double speed the gain ratio is defined as gain difference between 2 MHz and 200 kHz, while the flatness delay is defined up to 2 MHz.

Transfer function

The equalized amplifier including C_{ext} and R_{ext} has the following transfer functions, where 'RFE' refers to equalized output only and 'RF' refers to equalized and not equalized outputs.

FOR SINGLE SPEED (SP = LOGIC 1)

$$\frac{V_{RFE}}{I_{csin}} = R_{RF} \times \frac{\left(1 - ks^2\right) / \omega^2{}_{os}}{1 + 1/Q \times s/\omega_{os} + s^2/\omega^2{}_{os}} \times \frac{1}{1 + s/\omega_1} \times \frac{1}{1 + sR_{ext} \times C_{ext}} \qquad (1)$$

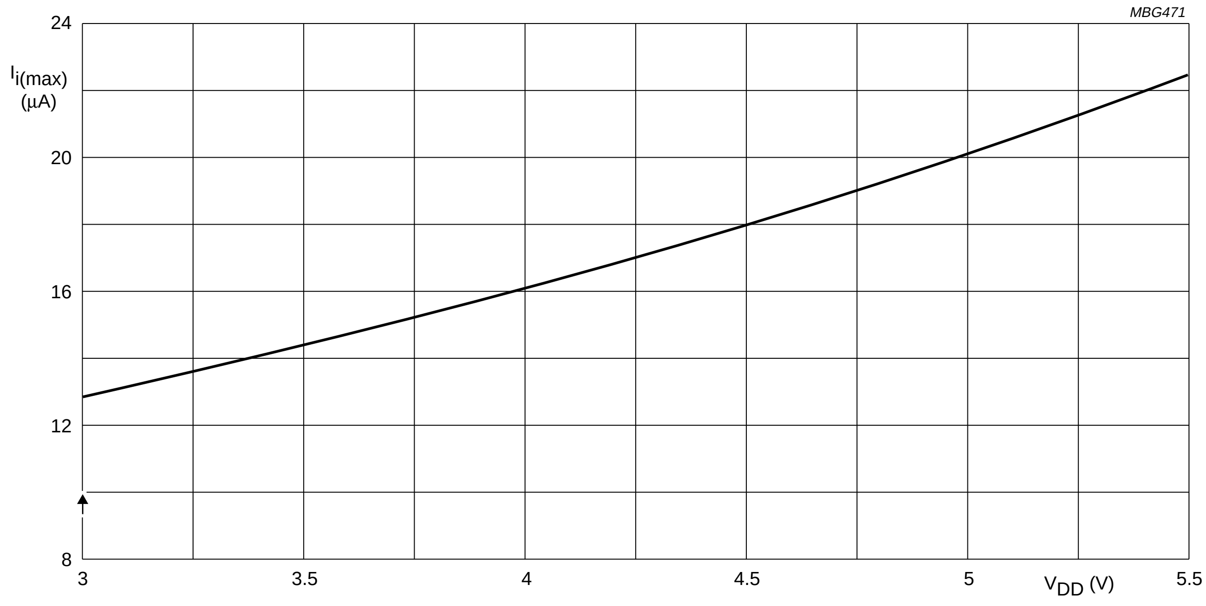
FOR DOUBLE SPEED (SP = LOGIC 0)

$$\frac{V_{RFE}}{I_{csin}} = R_{RF} \times \frac{\left(1 - ks^2\right) / \omega^2{}_{os}}{1 + 1/Q \times s/\omega_{od} + s^2/\omega^2{}_{od}} \times \frac{1}{1 + sR_{ext} \times C_{ext}} \qquad (2)$$

The denominator forms the denominator of a Bessel low-pass filter.

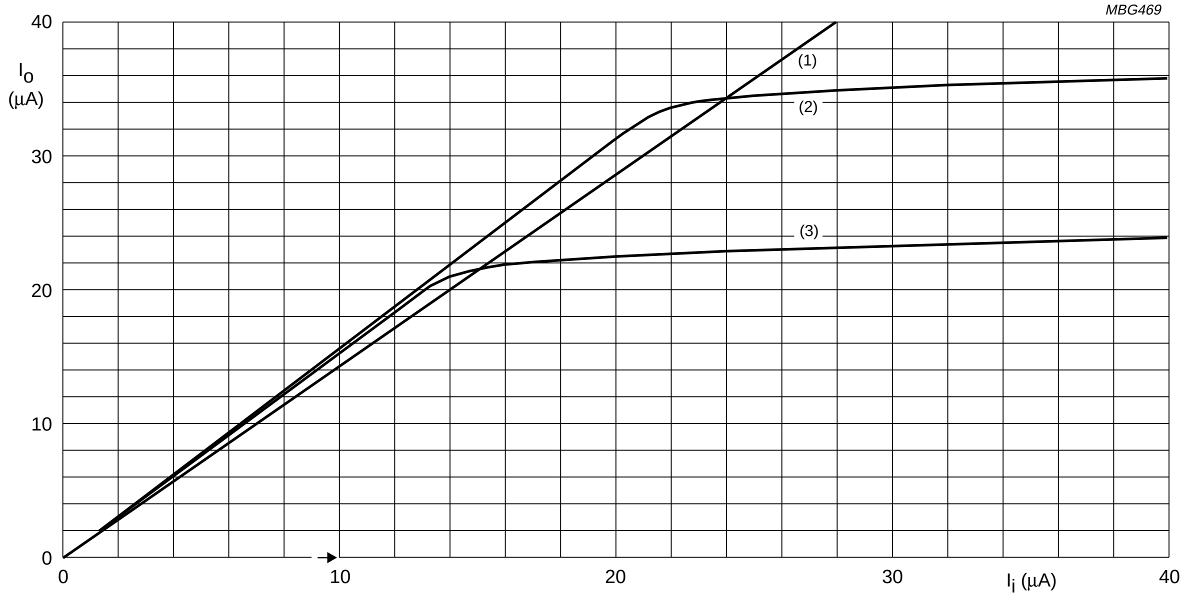
Table 3 Transresistance

SYMBOL	DESCRIPTION	TYP.	UNIT
k	internally defined	4	
$\omega_{os}/\omega_1 = \omega_{od}/\omega_2$	internally defined	1.094	
Q	internally defined	0.691	
$\omega_{od} = 2 \times \omega_{os}$	internally defined	17.6×10^{-6}	rad/s
R_{RF}	see Chapter "Characteristics"	–	
R_{ext}	external resistor	750	Ω
C_{ext}	external capacitor	47	pF



↑ = test limit.

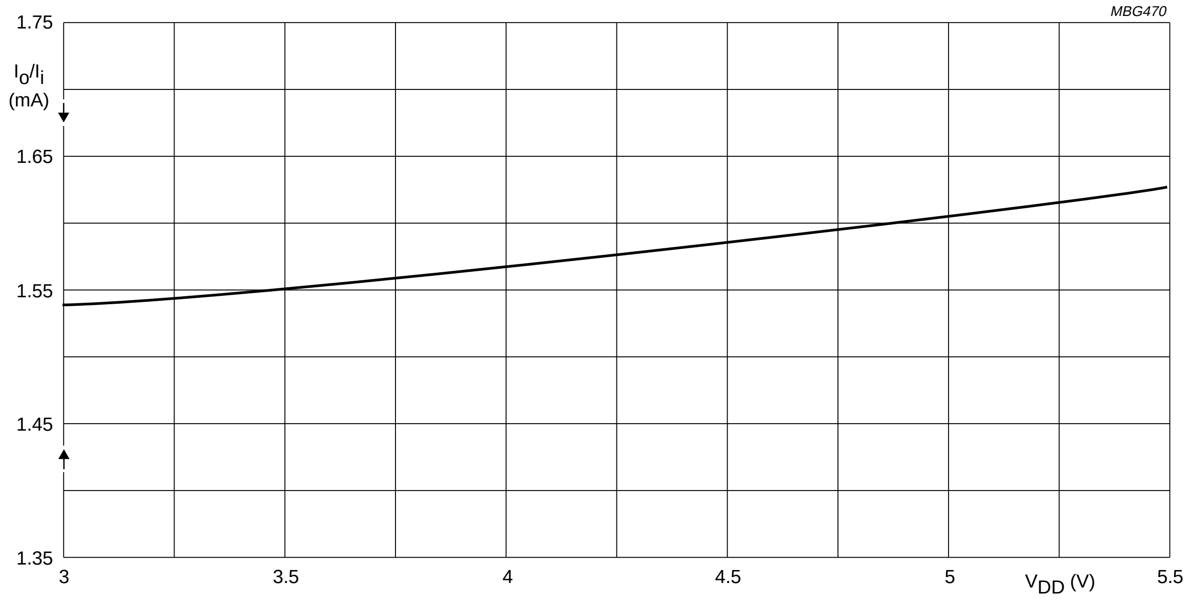
Fig.4 Maximum input current as a function of V_{DD}.



→ = test limit.

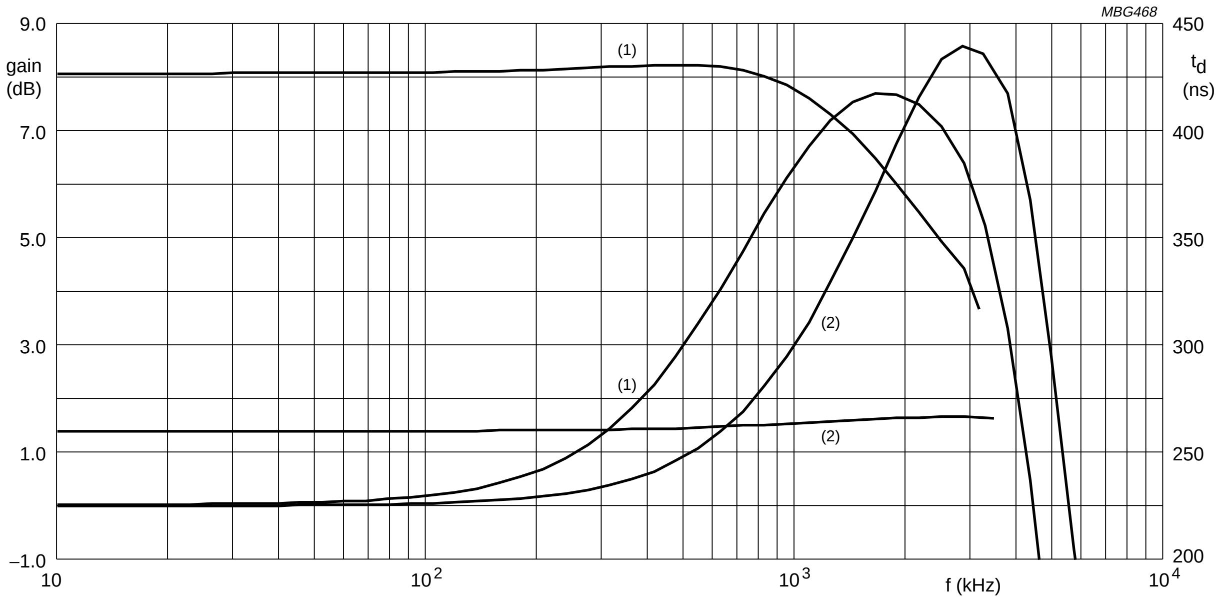
(1) G_{dn} = 1.43.
(2) V_{DD} = 5.5 V.
(3) V_{DD} = 3.4 V.

Fig.5 Output current as a function of input current.



↓ = test limit.

Fig.6 Gain as a function of V_{DD}.



(1) Single speed.
(2) Double speed.

Fig.7 Transfer of equalizer.

INTERNAL PIN CONFIGURATION

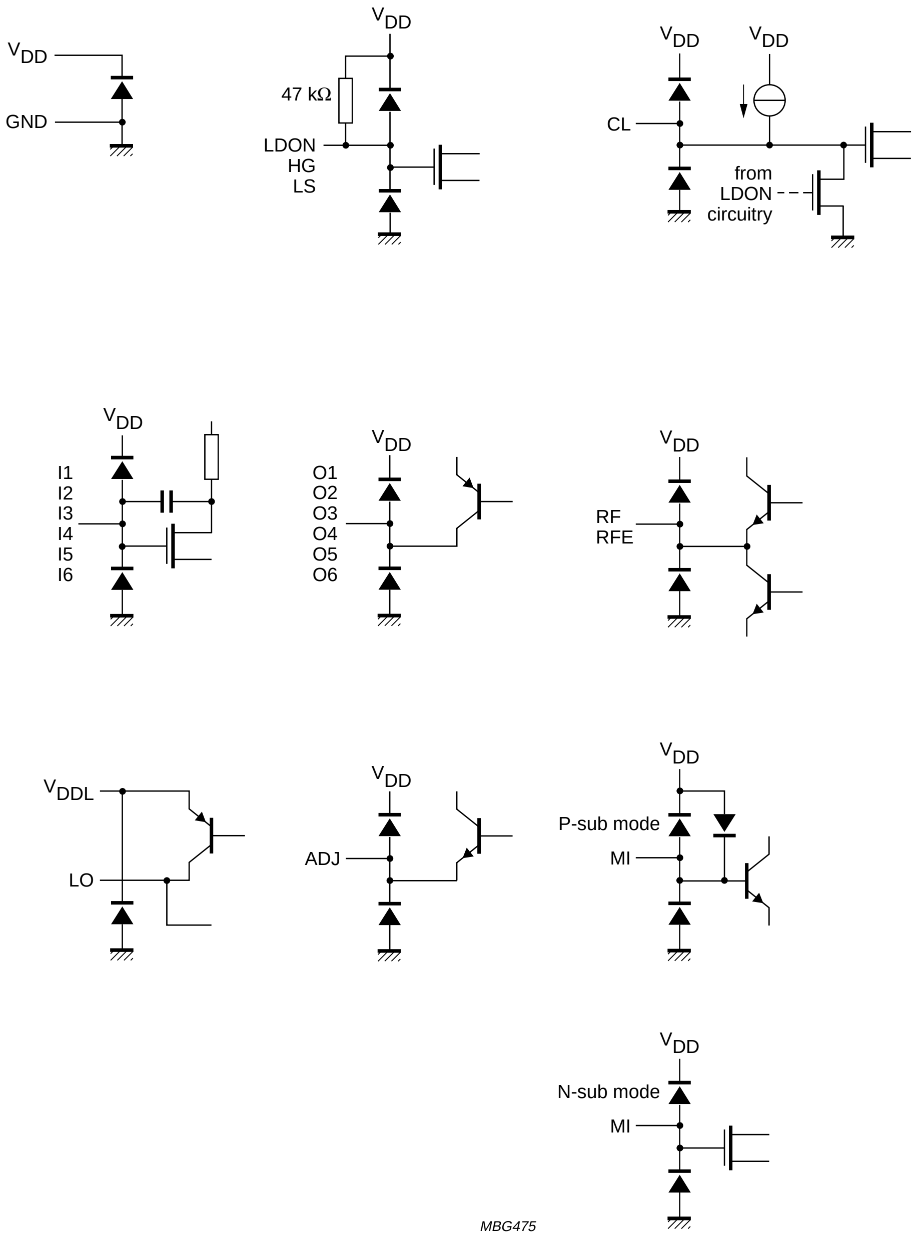
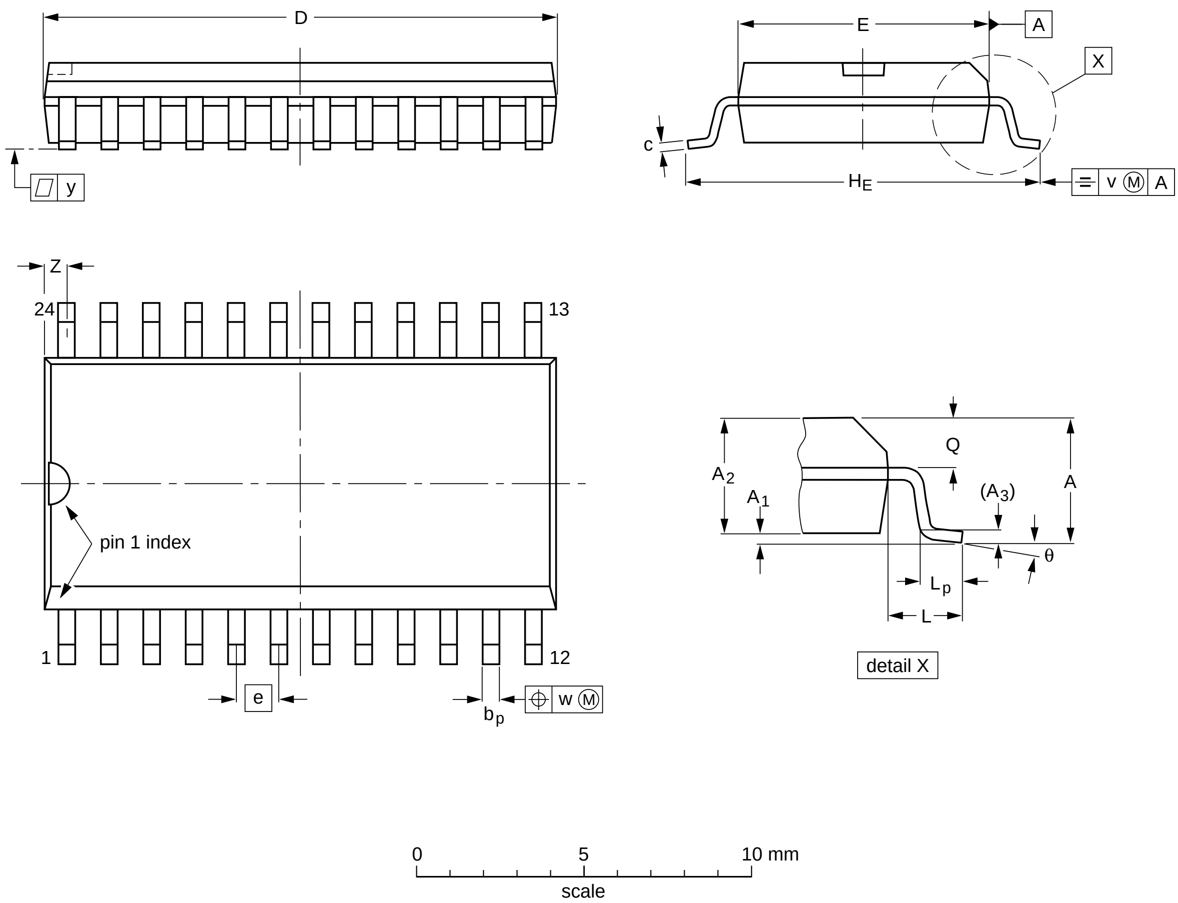


Fig.8 Equivalent internal pin diagrams.

PACKAGE OUTLINE

SO24: plastic small outline package; 24 leads; body width 7.5 mm **SOT137-1**



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	15.6 15.2	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	0.61 0.60	0.30 0.29	0.050	0.42 0.39	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			
SOT137-1	075E05	MS-013AD				~~92-11-17~~ 95-01-24

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 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.