MAY 8 1993

INTEGRATED CIRCUITS

DATA SHEET

TDA8480T
RGB gamma-correction processor

Objective specification
File under Integrated Circuits, IC02

March 1993

Philips Semiconductors

PHILIPS

This Material Copyrighted By Its Respective Manufacturer

FEATURES

- Alignment free
- Low power
- High performance brightness control.

GENERAL DESCRIPTION

The TDA8480T is an I²C-bus controlled, RGB gamma-correction processor. The device can be used as a brightness control for LCDs, with crossed polarity filters, and for CRT applications. The variable gamma function offers an adjustable non-linear amplification of the RGB input signals which results in more expansion near black and more compression near white. The equivalent gamma value can be varied between 1 (the path from input to output is transparent) and 0.25. Separate inputs are available for video and data (TXT) which can be selected via a fast acting switch.

The RGB video and data inputs are AC-coupled externally. Black restoration is achieved during the clamping interval which is defined at pin 18. For the video channel the black level during scan can be adjusted to within 10%. This is activated by setting the Msys bit in the status/control register via the I²C-bus. Adjustment is realized by external hardwiring, thus defining a voltage at pin 9 . This option is required for some NTSC M-system transmitters.

The TDA8480T also contains a bandgap voltage generator and a power-down detector. If a power-down is detected, the POR-bit in the status/control register will be set which can be read by the I²C-bus.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	positive supply voltage	4.75	5.0	5.25	V
I_{CC}	supply current	–	10	–	mA
$V_{IRGB(p-p)}$	RGB amplifier input voltage, positive swing (peak-to-peak value)	–	0.7	1.0	V
$V_{IDAT(p-p)}$	DATA amplifier input voltage, positive swing (peak-to-peak value)	–	0.7	1.0	V
$V_{ORGB(p-p)}$	RGB amplifier output voltage, positive swing (peak-to-peak value)	–	0.7	1.0	V
$V_{ODAT(p-p)}$	DATA amplifier output voltage, positive swing (peak-to-peak value)	–	0.7	1.0	V

ORDERING INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
TDA8480T	20	SO	plastic	SOT163A

This Material Copyrighted By Its Respective Manufacturer

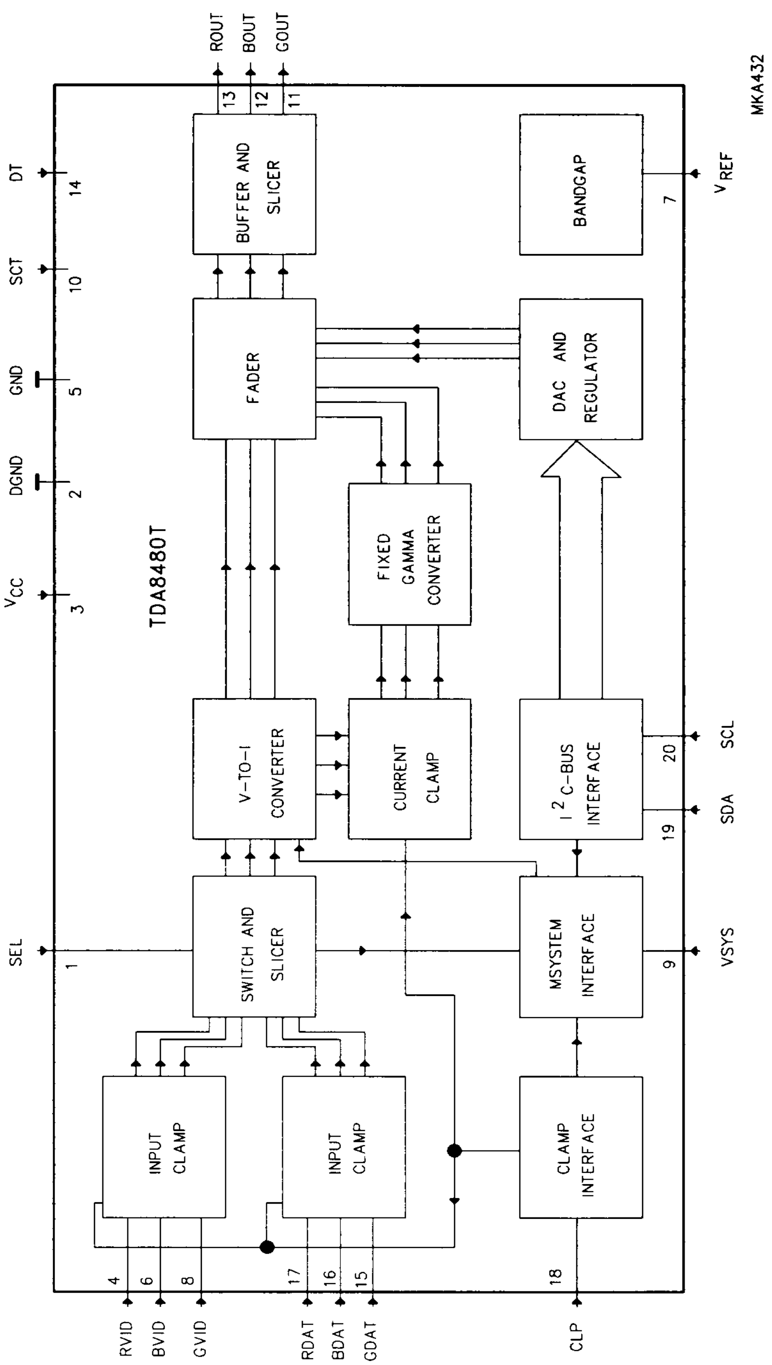


Fig.1 Block diagram.

This Material Copyrighted By Its Respective Manufacturer

PINNING

SYMBOL	PIN	DESCRIPTION
SEL	1	select input
DGND	2	digital ground
V_{CC}	3	positive supply voltage
RVID	4	red video input
GND	5	ground
BVID	6	blue video input
V_{REF}	7	voltage reference output
GVID	8	green video input
VSYS	9	video system interface input
SCT	10	test purposes only
GOUT	11	green output
BOUT	12	blue output
ROUT	13	red output
DT	14	test purposes only
GDAT	15	green data output
BDAT	16	blue data output
RDAT	17	red data output
CLP	18	clamp input
SDA	19	serial data input/output
SCL	20	serial clock input

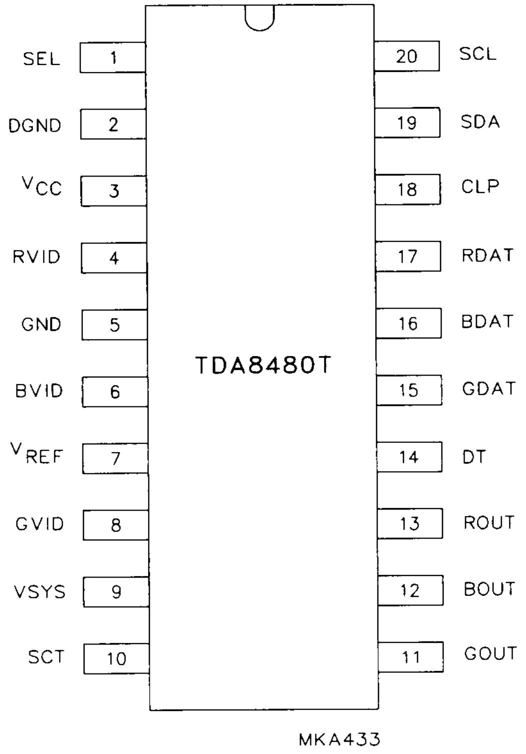


Fig.2 Pin configuration.

This Material Copyrighted By Its Respective Manufacturer

FUNCTIONAL DESCRIPTION

The basic function of the TDA8480T is to provide variable gamma correction. Each channel (R,G and B) is separated into a linear and a gamma converted path each with a fixed gamma value. A fader combines the outputs of the two paths with different weights (depending on the binary word) which are stored in the DAC that controls the fader.
The gamma function is defined as $y = x$ ^^ γ, with 'x' the input excitation normalized with respect to 0.7 V. As the theoretical infinite gain for $x = 0$ has a large impact on the system parameters, the inverse sinusoidal hyperbolic function (see also Figure 5) which is close to the ideal gamma function, as given in equation 1, is adopted:

$$\sinh^{-1}(g,x) = \ln\{gx + [(gx)^2+1]^{0.5}\} \quad (1)$$

The major advantage of the $\sinh^{-1}$ function is the limited gain for $x = 0$ (see also Figure 4). The value g can be fitted to an equivalent γ, within close approximation. When $\gamma = 0.25$ the parameter $g = 27.32$ can be found.

Both the adoption of the $\sinh^{-1}$ function and the fader action ensures that the converted output signals do not obey the ideal gamma conversion. However, it can be shown that the resulting error is negligible with respect to the colour reproduction if saturation correction is applied.

Three 6-bit DACs, controlled by the I²C-bus, set the output gamma values of the RGB channels. User control of the DACs for controlling the brightness (and in the event of LC panels the viewing angle) and the manufacturing control, (required when the gamma values of the display are not equal) must be supported by software programming. The DACs control the fader setting a_i where $0 <= a_i <= 1$ and i = R, G or B. Depending on the fader setting a_i the output y_i can be written as per equation 2:

$$y_i = a_i \times X + (1-a_i) \times \sinh^{-1}(g,x)/\sinh^{-1}(g,1) \quad (2)$$

The relationship between a_i and the effective gamma (when $g = 27.32$) is shown in Figure 5.

I²C-bus conventions

Table 1 I²C-bus conventions.

A6	A5	A4	A3	A2	A1	A0	R/W
1	0	0	0	0	1	0	X

Valid sub-address = 00 to 03

Table 2 Auto-increment mode available for sub-address.

REGISTER	ADDRESS	MSB							LSB
Status	--	X	X	X	X	X	X	X	POR
Control	00	X	X	X	X	X	X	X	MSYS
Gamma control RED	01	X	X	R5	R4	R3	R2	R1	R0
Gamma control BLUE	02	X	X	B5	B4	B3	B2	B1	B0
Gamma control GREEN	03	X	X	G5	G4	G3	G2	G1	G0

Where X = don't care

This Material Copyrighted By Its Respective Manufacturer

Table 3 Gamma control word.

CONTROL WORD	ADDRESS								REMARKS
Maximum DAC setting	X	X	1	1	1	1	1	1	or linear mode (a_i = 1)
Minimum DAC setting	X	X	0	0	0	0	0	0	or maximum non-linearity (a_i = 0)

Where X = don't care

Table 4 NTSC Msystem black-level control.

MSYS	REMARKS
0	not activated
1	activated

Table 5 Power status convention.

POR	REMARKS
1	power-down or power dip detected
0	normal power mode

FAST SWITCHING CONVENTION

Table 6 Input selection.

SEL	REMARKS
0	VIDEO selected
1	DATA selected

LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{CC}	positive supply voltage	–	5.5	V
T_{stg}	storage temperature	–55	+150	°C
T_{amb}	operating ambient temperature	–25	+80	°C

HANDLING

Inputs and outputs are protected against electrostatic discharge in normal handling. However, to be totally safe, it is desirable to take normal precautions appropriate to handling MOS devices.

THERMAL RESISTANCE

SYMBOL	PARAMETER	THERMAL RESISTANCE
$R_{th\ j-a}$	from junction to ambient in free air	75 K/W

This Material Copyrighted By Its Respective Manufacturer

CHARACTERISTICS

V_{CC} = 5 V; T_{amb} = 25 °C; C_L = 15 pF (pins 11 to 13); all ratios (%, dB) referenced to 700 mV; unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{CC}	positive supply voltage		4.75	5.0	5.25	V
I_{CC}	supply current		–	10	15	mA
V_{REF}	reference voltage (pin 7)		1.22	1.25	1.28	V
Z_O	output impedance (pin 7)		–	–	250	Ω
Video and data inputs						
V_{clamp}	voltage level during clamping		–	2.5	–	V
$V_{I(p-p)}$	input voltage swing positive to black (peak-to-peak value)		–	0.7	1.0	V
V_{blk}	negative voltage swing with respect to black		–	–	−0.3	V
Z_{scan}	input impedance during scan		100	–	–	kΩ
Z_{clamp}	input impedance during clamping		–	600	–	Ω
I_I	input current		–	–	150	nA
RGB outputs						
$V_{O(p-p)}$	output voltage swing (peak-to-peak value)	a_i = 1	–	0.72	–	V
V_{Oblk}	black output voltage level		–	0.8	–	V
V_{blk}	negative voltage swing with respect to black	note 1; a_i = 0	–	–	−100	mV
Z_O	output impedance		–	–	250	Ω
B	bandwidth	note 2; a_i = 0	6	9	–	MHz
S/N	signal-to-noise ratio at full bandwidth	note 3; a_i = 0	52	–	–	dB
t_d	delay from input to output	note 4; a_i = 0	–	25	100	ns
$MSYS_{mis}$	mismatch Msystems offsets	a_i = 1	–	–	7.0	mV
α	crosstalk between RGB outputs	note 5; a_i = 1	–	−40	–	dB
Clamping (pin 18)						
V_{18}	detection level of clamping voltage		1.5	–	3.2	V
t_{clamp}	clamping period		2	–	–	μs
Z_I	input impedance		100	–	–	kΩ
SR	clamping input slew rate		24	–	–	V/μs

This Material Copyrighted By Its Respective Manufacturer

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Select (pin 1)						
V_1	video voltage detection level		1.8	–	3.0	V
α	crosstalk from unselected input to equivalent output	note 5; $a_i = 0$	–	–	−46	dB
α	crosstalk from SEL edges to output	note 6; $a_i = 0$	–	–	70	mV
Δt	difference between transit time of signal and video switching	note 7; $a_i = 1$	–	25	–	ns
Z_I	input impedance		100	–	–	kΩ
MM_{blk}	mixed mode black-level offset	$a_i = 0$	–	0	–	%
Msystem input (pin 9)						
φ	black-level offset sensitivity	note 8	7	9	11	%/V
V_I	input voltage range		–	–	1.5	V
Z_I	input impedance	Msys = 1; SEL = 0	100	–	–	kΩ
I_{bias}	input bias current	Msys = 1; SEL = 0	–	–	300	nA
DAC accuracy						
IL	integral linearity		–	–	2	LSB
	matching accuracy between DAC control factors		–	–	0.5	LSB
Colour reproduction (note 9)						
	intersection accuracy at black or 0% FS	note 10	–	–	4	%
	intersection accuracy at white or FS	note 10	–	–	4	%
	amplitude tolerance at white or FS	note 11; $a_i = 1$	–	–	4	%
	absolute fader setting error		–	–	4	%
	transfer tolerance for each channel	note 12; $a_i = 0.6$	–	–	7	%
	matching tolerance between any channel for equal a_i	$0 < a_i < 1$; $V_I < 5\%$ FS	–	–	1+20 V_I/FS	%
		$0 < a_i < 1$; 5% FS $< V_I <$ FS	–	–	2	%

This Material Copyrighted By Its Respective Manufacturer

Notes to the characteristics

1. Input drive −0.3 V.
2. Measured at 10%, 50% and 90% of the nominal RGB input drive.
3. Measured at black.
4. Measured at 50% of a squarewave input signal of 0.7 V with rise and fall times of 20 ns and at 80% of the output signal.
5. Measured with a sinewave of 0.7 V (p-p) at a frequency of 5 MHz.
6. Rise time 20 ns.
7. Measured with rise time of 20 ns at 50% of input and output excursions. Video inputs at black, data inputs at nominal white.
8. Measuring black-level offset value with respect to nominal white.
9. All percentages given are relative to full scale (FS) and are derived from measuring the output voltages relative to the voltage level during clamping. FS differs for input related voltages (0.7 V) and output related voltages (0.72 V)
10. Fader position a_i running from minimum to maximum.
11. Absolute accuracy.
12. The transfer from input to output should match the theoretical faded inverse sinusoidal hyperbolic as formulated in relation (2) with the g-factor set to 29.3.

This Material Copyrighted By Its Respective Manufacturer

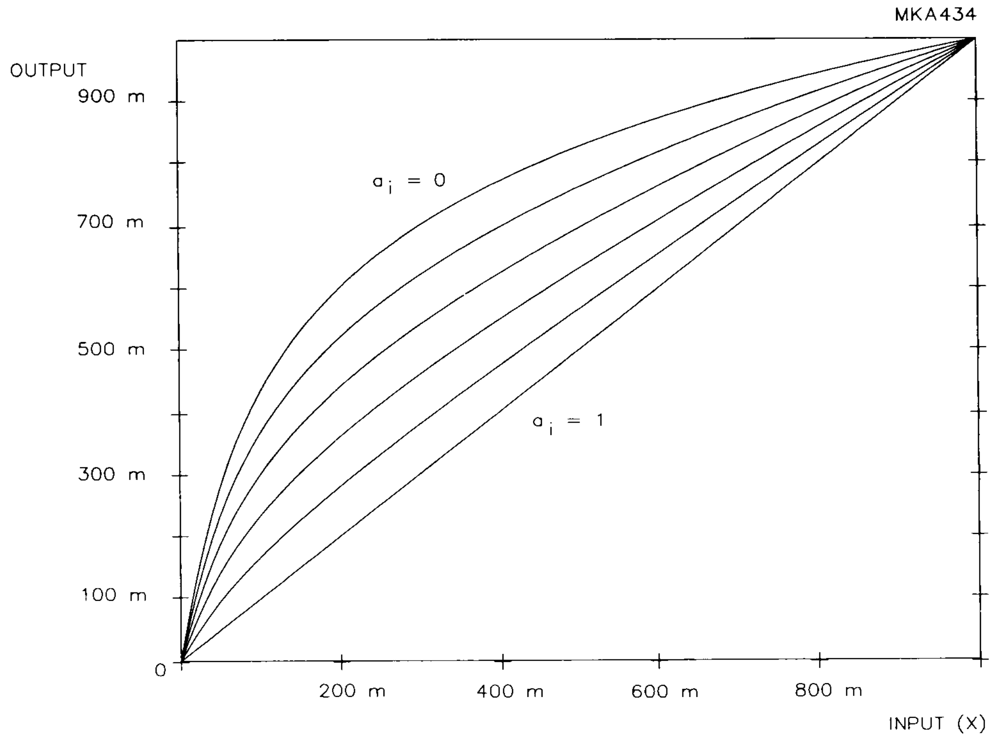


Fig.3 Output curves for the inverse sinusoidal hyperbolic converter (g = 29.3 and the fader position a_i runs from 0 to 1 in 0.2 step sizes).

This Material Copyrighted By Its Respective Manufacturer

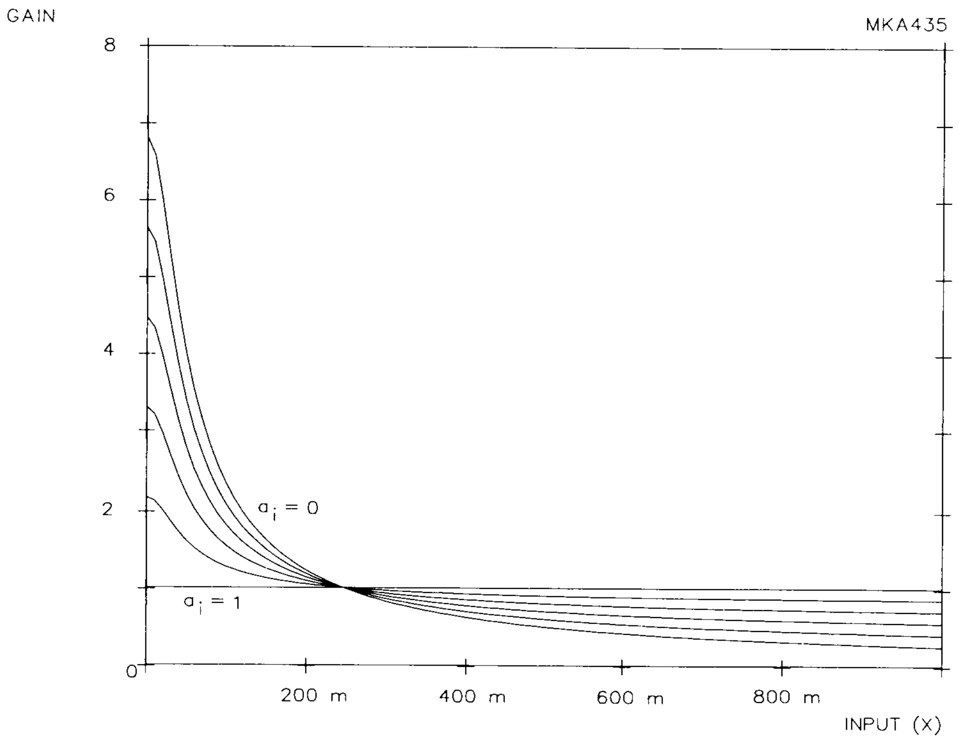


Fig.4 Local gain for the inverse sinusoidal hyperbolic converter (g = 29.3; the fader position a_i runs from 0 to 1 in 0.2 step sizes).

This Material Copyrighted By Its Respective Manufacturer

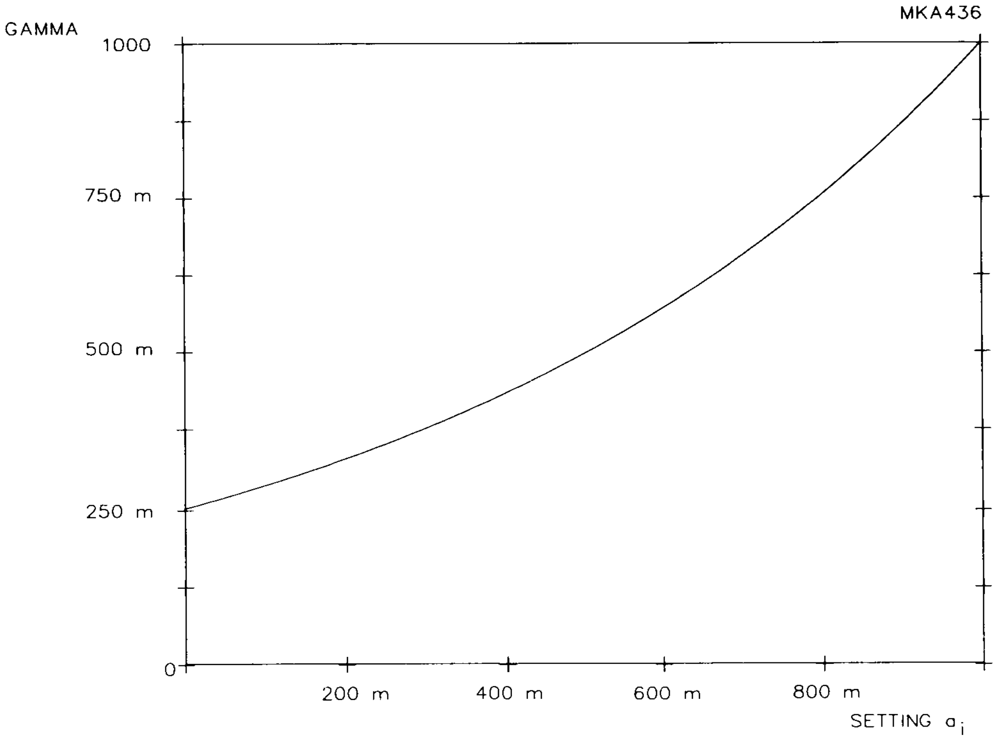


Fig.5 Relationship between the equivalent gamma value and the setting of the fader (g = 29.3).

This Material Copyrighted By Its Respective Manufacturer

APPLICATION INFORMATION

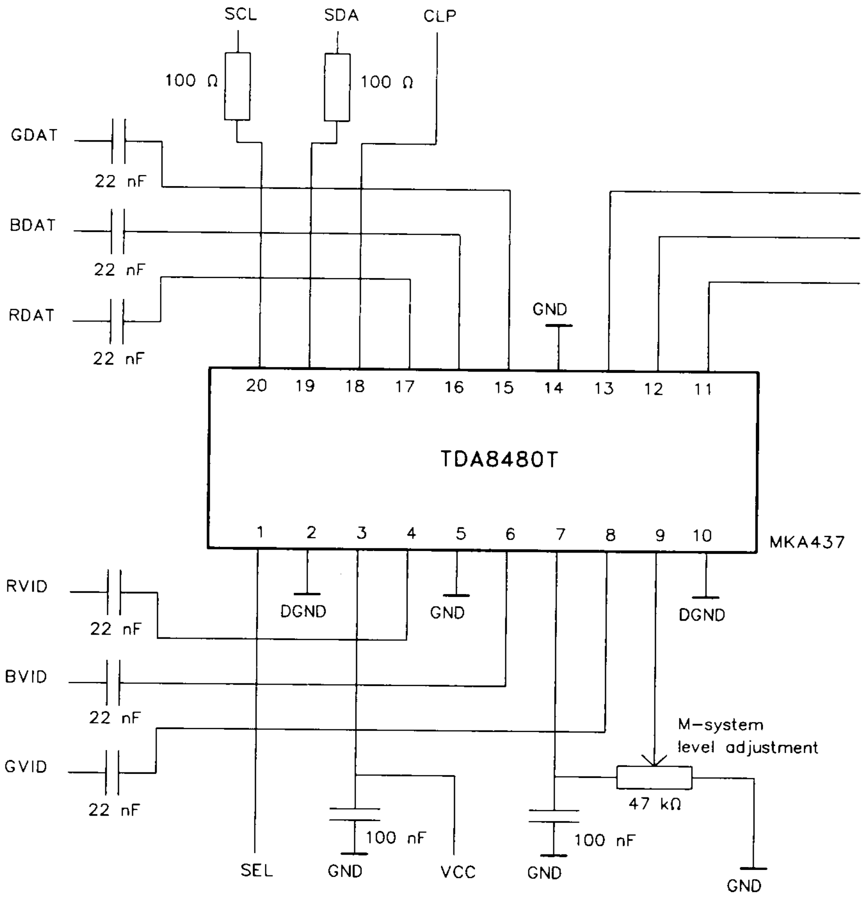


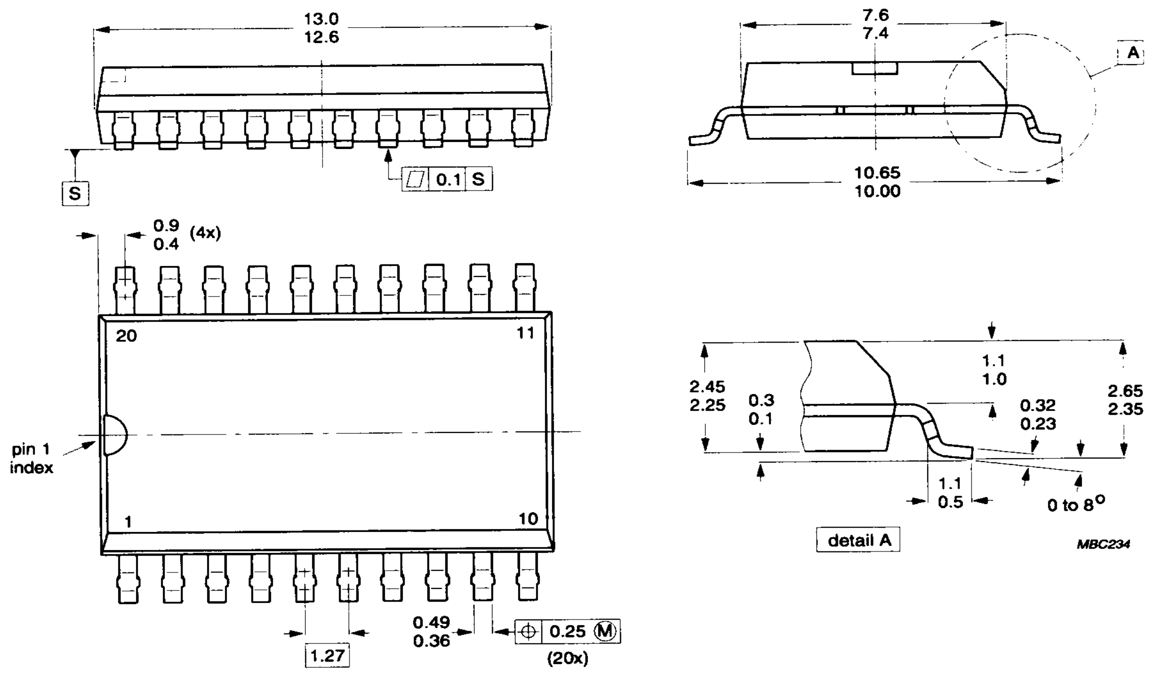
Fig.6 Application diagram.

PURCHASE OF PHILIPS I²C COMPONENTS

Purchase of Philips I²C components conveys a license under the Philips' I²C patent to use the components in the I²C system provided the system conforms to the I²C specification defined by Philips. This specification can be ordered using the code 9398 393 40011.

This Material Copyrighted By Its Respective Manufacturer

PACKAGE OUTLINE



Dimensions in mm

Fig.7 20-lead mini-pack; plastic (SO20; SOT163A).

This Material Copyrighted By Its Respective Manufacturer

SOLDERING

Plastic mini-packs

BY WAVE

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

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder bath is 10 s, if allowed to cool to less than 150 °C within 6 s. Typical dwell time is 4 s at 250 °C.

A modified wave soldering technique is recommended using two solder waves (dual-wave), in which a turbulent wave with high upward pressure is followed by a smooth laminar wave. Using a mildly-activated flux eliminates the need for removal of corrosive residues in most applications.

BY SOLDER PASTE REFLOW

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

Several techniques exist for reflowing; for example, thermal conduction by heated belt, infrared, and vapour-phase reflow. Dwell times vary between 50 and 300 s according to 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 min at 45 °C.

REPAIRING SOLDERED JOINTS (BY HAND-HELD SOLDERING IRON OR PULSE-HEATED SOLDER TOOL)

Fix the component by first soldering two, diagonally opposite, end pins. Apply the heating tool to the flat part of the pin only. Contact time must be limited to 10 s at up to 300 °C. When using proper tools, all other pins can be soldered in one operation within 2 to 5 s at between 270 and 320 °C. (Pulse-heated soldering is not recommended for SO packages.)

For pulse-heated solder tool (resistance) soldering of VSO packages, solder is applied to the substrate by dipping or by an extra thick tin/lead plating before package placement.

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.

This Material Copyrighted By Its Respective Manufacturer

Philips Semiconductors – a worldwide company

Argentina IEROD, Av. Juramento 1991 - 14.B, (1428) BUENOS AIRES, Tel. (541)541 4261/541 4106, Fax. (541)786 7635
Australia 34 Waterloo Road, NORTH RYDE, NSW 2113, Tel. (02)805 4455, Fax. (02)805 4466
Austria Triester Str. 64, 1101 WIEN, Tel. (01)60 101-1236, Fax. (01)60 101-1211
Belgium 80 Rue Des Deux Gares, B-1070 BRUXELLES, Tel. (02)525 6111, Fax. (02)525 7246
Brazil Rua do Rocio 220 - 5th floor, CEP:04552-000-SÃO PAULO-SP, Brazil. P.O. Box 7383-CEP:01051 Tel. (011)829-1166, Fax. (011)829-1849
Canada INTEGRATED CIRCUITS: Tel. (800)234-7381, Fax. (708)296-8556 DISCRETE SEMICONDUCTORS: 601 Milner Ave, SCARBOROUGH, ONTARIO, M1B 1M8, Tel. (0416)292 5161 ext. 2336, Fax. (0416)292 4477
Chile Av. Santa Maria 0760, SANTIAGO, Tel. (02)773 816, Fax. (02)777 6730
Colombia Carrera 21 No. 56-17, BOGOTA, D.E., P.O. Box 77621, Tel. (01)249 7624, Fax. (01)217 4549
Denmark Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S, Tel. (032)88 2636, Fax. (031)57 1949
Finland Sinikalliontie 3, SF-02630 ESPOO, Tel. (9)0-50261, Fax. (9)0-520971
France 117 Quai du Président Roosevelt, 92134 ISSY-LES-MOULINEAUX Cedex, Tel. (01)4093 8000, Fax. (01)4093 8127
Germany Burchardstrasse 19, D-2 HAMBURG 1, Tel. (040)3296-0, Fax. (040)3296 213
Greece No. 15, 25th March Street, GR 17778 TAVROS, Tel. (01)4894 339/4894 911, Fax. (01)4814 240
Hong Kong 15/F Philips Ind. Bldg., 24-28 Kung Yip St., KWAI CHUNG, Tel. (0)4245 121, Fax. (0)4806 960
India PEICO ELECTRONICS & ELECTRICALS Ltd., Components Dept., Shivsagar Estate, Block 'A', Dr. Annie Besant Rd., Worli, BOMBAY-400 018, Tel. (022)4938 541, Fax. (022)4941 595
Indonesia Philips House, Jalan H.R. Rasuna Said Kav. 3-4, P.O. Box 4252, JAKARTA 12950, Tel. (021)5201 122, Fax. (021)5205 189
Ireland Newstead, Clonskeagh, DUBLIN 14, Tel. (01)640 000, Fax. (01)640 200
Italy V. Le F. Testi, 327, 20162-MILANO, Tel. (02)6752.1, Fax. (02)6752.3350
Japan Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKIO 108, Tel. (03)3740 5101, Fax. (03)3740 0570
Korea (Republic of) Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL, Tel. (02)794-5011, Fax. (02)798-8022
Malaysia No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR, Tel. (03)7755 1088, Fax. (03)757 4880
Mexico Philips Components, 6D Founder Blvd., EL PASO, TX 79906, Tel. 9-5(800)234-7381, Fax. (708)296-8556
Netherlands Postbus 90050, 5600 PB EINDHOVEN, Tel. (040)78 37 49, Fax. (040)78 83 99
New Zealand 2 Wagener Place, C.P.O. Box 1041, AUCKLAND, Tel. (09)849-4160, Fax. (09)849-7811
Norway Box 1, Manglerud 0612, OSLO, Tel. (02)74 8000, Fax. (02)74 8341
Pakistan Philips Markaz, M.A. Jinnah Rd., KARACHI-3, Tel. (021)577 039, Fax. (021)569 1832
Peru Carretera Central 6.500, LIMA 3, Apartado 5612, Tel. (014)350 059, Fax. (014)468 999/468 949
Philippines PHILIPS SEMICONDUCTORS PHILIPPINES Inc, 106 Valero St. Salcedo Village, P.O. Box 911, MAKATI, Metro MANILA, Tel. (02)810 0161, Fax. (02)817 3474
Portugal Av. Eng. Duarte Pacheco 6, 1009 LISBOA Codex, Tel. (01)683 121, Fax. (01)658 013
Singapore Lorong 1, Toa Payoh, SINGAPORE 1231, Tel. (65)350 2000, Fax. (65)251 6500
South Africa 195-215 Main Road, Martindale, P.O. Box 7430,JOHANNESBURG 2000, Tel. (011)470-5433, Fax. (011)470-5494
Spain Balmes 22, 08007 BARCELONA, Tel. (03)301 6312, Fax. (03)301 4243
Sweden Tegeluddsvagen 1, S-11584 STOCKHOLM, Tel. (0)8-782 1000, Fax. (0)8-782 9002
Switzerland Allmendstrasse 140-142, CH-8027 ZÜRICH, Tel. (01)488 2211, Fax. (01)482 8595
Taiwan 69, Min Sheng East Road, Sec 3, P.O. Box 22978, TAIPEI, Tel. (2)509 7666, Fax. (2)500 5899
Thailand PHILIPS ELECTRONICS (THAILAND) Ltd., 60/14 MOO 11, Bangna - Trad Road Km. 3 Prakanong, BANGKOK 10260, Tel. (2)399-3280 to 9, (2)398-2083, Fax. (2)398-2080
Turkey Talatpasa Cad. No. 5, 80640 LEVENT/ISTANBUL, Tel. (01)279 2770, Fax. (01)269 3094
United Kingdom Philips Semiconductors Limited, P.O. Box 65, Philips House, Torrington Place, LONDON, WC1E 7HD, Tel. (071)436 41 44, Fax. (071)323 03 42
United States INTEGRATED CIRCUITS: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409, Tel. (800)234-7381, Fax. (708)296-8556 DISCRETE SEMICONDUCTORS: 2001 West Blue Heron Blvd., P.O. Box 10330, RIVIERA BEACH, FLORIDA 33404, Tel. (800)447-3762 and (407)881-3200, Fax. (407)881 3300
Uruguay Coronel Mora 433, MONTEVIDEO, Tel. (02)70-4044, Fax. (02)92 0601
Venezuela Calle 6, Ed. Las Tres Jotas, CARACAS, 1074A, App. Post. 78117, Tel. (02)241 7509, Fax. (02)241 4518

For all other countries apply to: Philips Semiconductors, International Marketing and Sales, Building BAF-1, P.O. Box 218, 5600 MD, EINDHOVEN, The Netherlands, Telex 35000 phtcnl, Fax. +31-40-724825

SCD16 © Philips Electronics N.V. 1993

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 9397 710 60011

Philips Semiconductors

PHILIPS

PHILIPS

036910 ✓

This Material Copyrighted By Its Respective Manufacturer