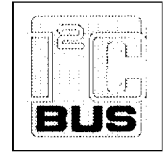


## RGB gamma-correction processor

TDA8480T

## FEATURES

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



## GENERAL DESCRIPTION

The TDA8480T is an I<sup>2</sup>C-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 I<sup>2</sup>C-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 I<sup>2</sup>C-bus.

## QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V <sub>CC</sub>	positive supply voltage	4.75	5.0	5.25	V
I <sub>CC</sub>	supply current	-	10	-	mA
V <sub>IRGB(p-p)</sub>	RGB amplifier input voltage, positive swing (peak-to-peak value)	-	0.7	1.0	V
V <sub>IDAT(p-p)</sub>	DATA amplifier input voltage, positive swing (peak-to-peak value)	-	0.7	1.0	V
V <sub>ORGB(p-p)</sub>	RGB amplifier output voltage, positive swing (peak-to-peak value)	-	0.7	1.0	V
V <sub>ODAT(p-p)</sub>	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

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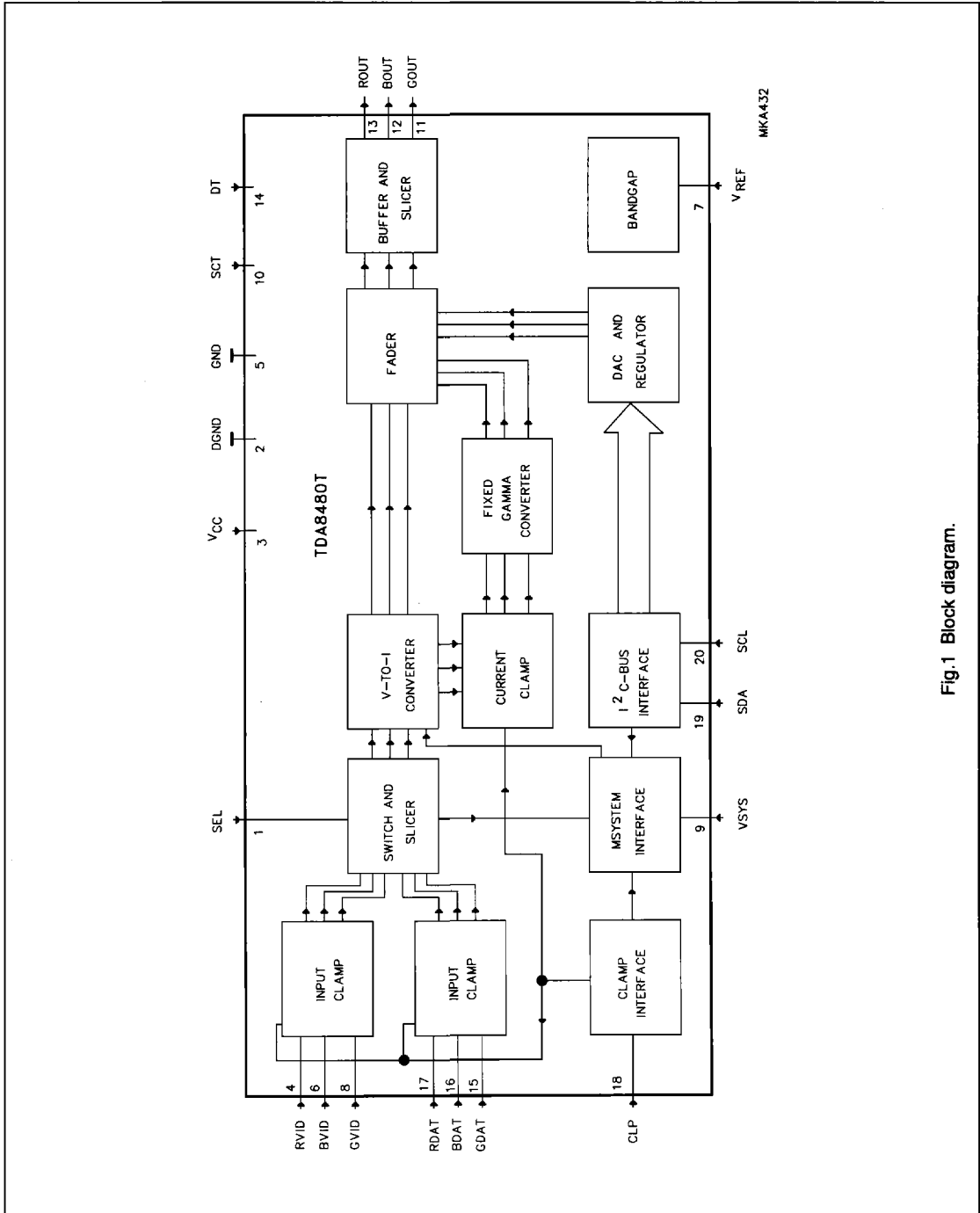


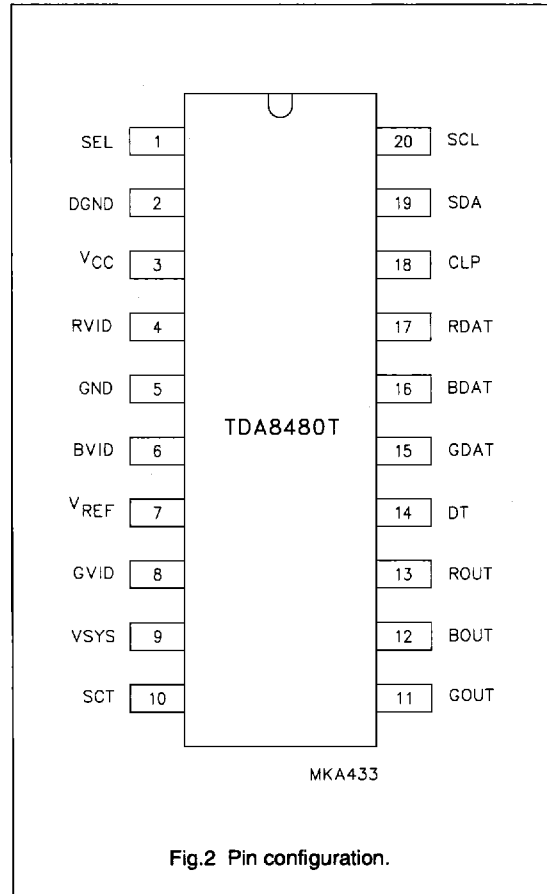
Fig.1 Block diagram.

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## PINNING

SYMBOL	PIN	DESCRIPTION
SEL	1	select input
DGND	2	digital ground
V <sub>CC</sub>	3	positive supply voltage
RVID	4	red video input
GND	5	ground
BVID	6	blue video input
V <sub>REF</sub>	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



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**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  $y = x^{\gamma}$ , 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  $\gamma$ , 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 I<sup>2</sup>C-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:

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

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

**I<sup>2</sup>C-bus conventions**

**Table 1** I<sup>2</sup>C-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

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**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

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supply</b>						
$V_{CC}$	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	$\Omega$
<b>Video and data inputs</b>						
$V_{clamp}$	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	-	-	k $\Omega$
$Z_{clamp}$	input impedance during clamping		-	600	-	$\Omega$
$I_I$	input current		-	-	150	nA
<b>RGB outputs</b>						
$V_{O(p-p)}$	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	$\Omega$
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
$\alpha$	crosstalk between RGB outputs	note 5; $a_i = 1$	-	-40	-	dB
<b>Clamping (pin 18)</b>						
$V_{18}$	detection level of clamping voltage		1.5	-	3.2	V
$t_{clamp}$	clamping period		2	-	-	$\mu\text{s}$
$Z_I$	input impedance		100	-	-	k $\Omega$
SR	clamping input slew rate		24	-	-	V/ $\mu\text{s}$

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Select (pin 1)</b>						
$V_I$	video voltage detection level		1.8	–	3.0	V
$\alpha$	crosstalk from unselected input to equivalent output	note 5; $a_i = 0$	–	–	–46	dB
$\alpha$	crosstalk from SEL edges to output	note 6; $a_i = 0$	–	–	70	mV
$\Delta t$	difference between transit time of signal and video switching	note 7; $a_i = 1$	–	25	–	ns
$Z_I$	input impedance		100	–	–	k $\Omega$
$MM_{blk}$	mixed mode black-level offset	$a_i = 0$	–	0	–	%
<b>Msystem input (pin 9)</b>						
$\varphi$	black-level offset sensitivity	note 8	7	9	11	%/V
$V_I$	input voltage range		–	–	1.5	V
$Z_I$	input impedance	$Ms_{ys} = 1; SEL = 0$	100	–	–	k $\Omega$
$I_{DIBAS}$	input bias current	$Ms_{ys} = 1; SEL = 0$	–	–	300	nA
<b>DAC accuracy</b>						
IL	integral linearity		–	–	2	LSB
	matching accuracy between DAC control factors		–	–	0.5	LSB
<b>Colour reproduction (note 9)</b>						
	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/FS	%
		$0 < a_i < 1;$ $5\% FS < V_I < FS$	–	–	2	%

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**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  $a$ , 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.



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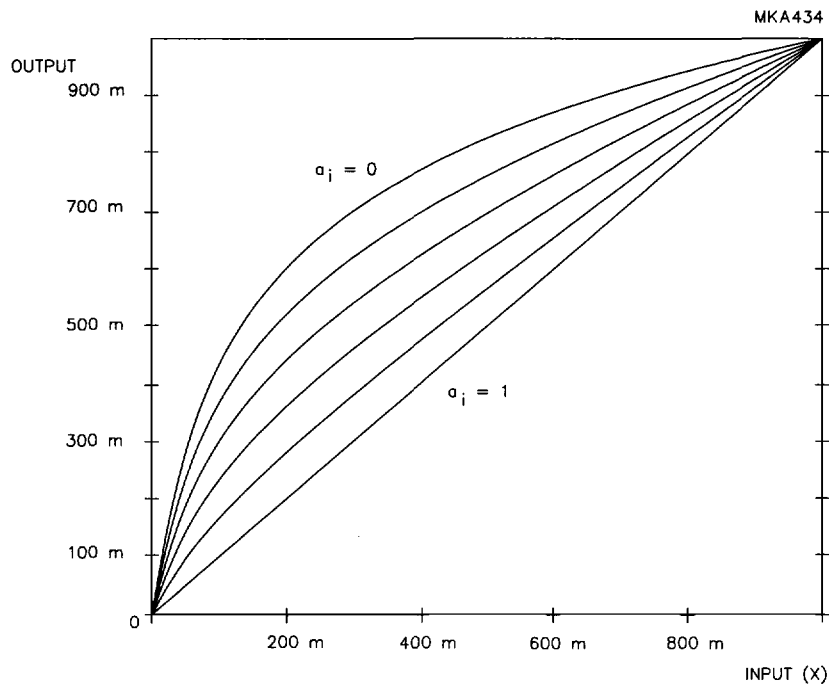
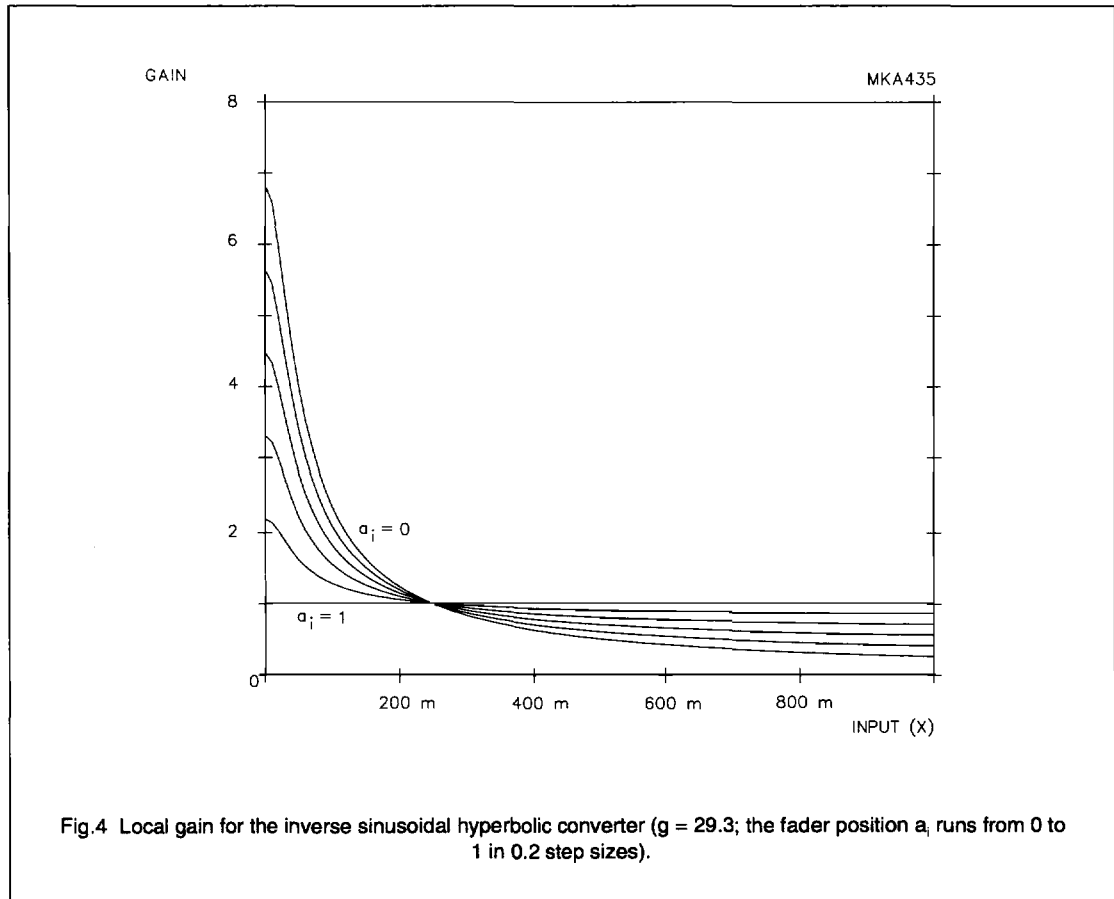


Fig.3 Output curves for the inverse sinusoidal hyperbolic converter ( $g = 29.3$  and the fader position  $a_i$  runs from 0 to 1 in 0.2 step sizes).

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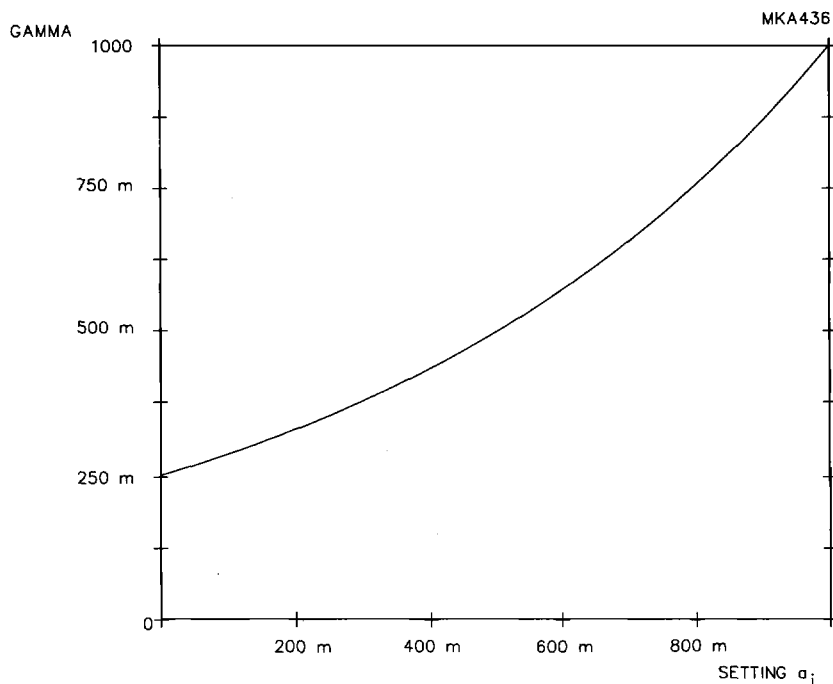


Fig.5 Relationship between the equivalent gamma value and the setting of the fader ( $g = 29.3$ ).

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APPLICATION INFORMATION

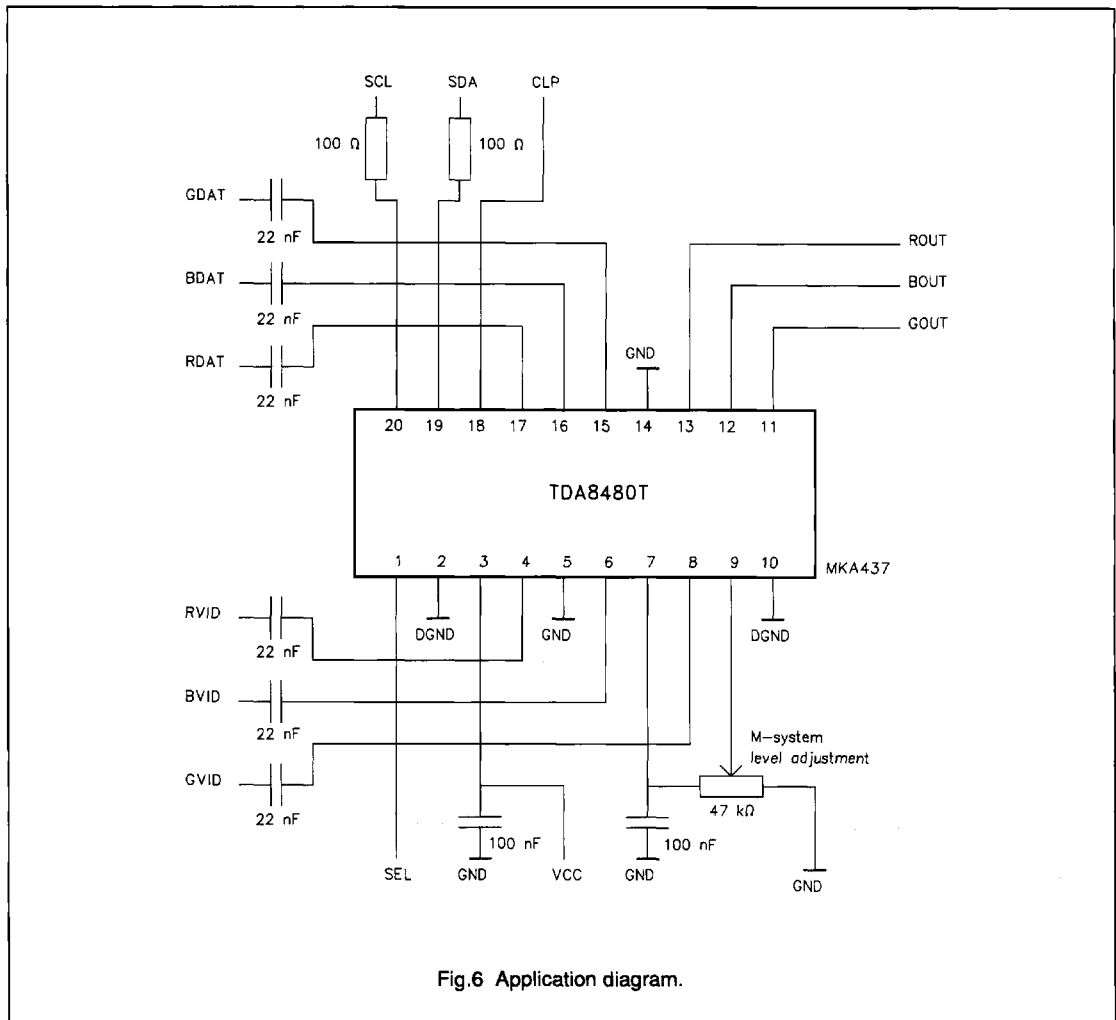
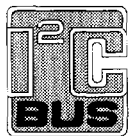


Fig.6 Application diagram.

PURCHASE OF PHILIPS I<sup>2</sup>C COMPONENTS



Purchase of Philips I<sup>2</sup>C components conveys a license under the Philips' I<sup>2</sup>C patent to use the components in the I<sup>2</sup>C system provided the system conforms to the I<sup>2</sup>C specification defined by Philips. This specification can be ordered using the code 9398 393 40011.