APPLICATION NOTE

Application and product Description of the TDA6107Q-N1 video output amplifier AN96072

Philips Semiconductors

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Abstract

This report gives the description of the TDA6107Q video output amplifier together with application aspects

Application and product Description of the TDA6107Q-N1 video output amplifier AN96072

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Keywords

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Summary

This note gives the device description of the TDA6107Q-N1 RGB video output amplifier and provides the user with basic hints to obtain an optimal performance in the application.
The TDA6107Q-N1 includes three video output amplifiers in a SIL 9 MP (Single In Line 9 pins Medium Power) package SOT111BE, using high-voltage DMOS technology, and is intended to drive the three cathodes of a colour picture tube.
Furthermore the device is provided with a black current measurement output for automatic black current stabilsation (ABS).
In contrast to previous types of DMOS video output amplifiers, the external resistors (Rf,Ri and Ra) are integrated, so the gain is fixed which saves 9 resistors.
To obtain maximum performance, the amplifier should be used with black-current control. In that case, there are no alignments any more on the CRT board, because of the automatic black current stabilisation and because the white point adjustment can be done in the TDA837X/TDA884X via I^2C.

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READ ME

The TDA6107Q-N1 does not meet the original specification target.
For a good flash immunity with the TDA6107Q-N1 it is necessary to apply an external protection circuit (resistor & flash diode) for each channel.
The N2 version will be improved regarding flash robustness, in that case it is allowed to eliminate these extra components.
For more detailed information concerning imperfections of N1 version, see appendix.
Never the less, by using the application hints given in this report a well performing and attractive low-cost video output stage can be realised with the TDA6107Q -N1.

1.0 **INTRODUCTION**

The aim of this application note is to describe the basic operation of the TDA6107Q-N1 RGB triple video output amplifier and provide the user with basic hints to realise an optimal performance in the application.
The TDA6107Q-N1 includes three video output amplifiers in a SIL 9 MP (Single In Line 9 pins Medium Power) package SOT111BE, using high-voltage DMOS technology, and is intended to drive the three cathodes of a colour picture tube.
In contrast to previous types of DMOS video amplifiers, the external resistors (Rf,Ri and Ra) are integrated, so the gain is fixed and it saves 9 resistors.
To obtain maximum performance, the amplifier should be used with black-current control and mounted on the CRT panel.
For sufficient flash protection of the TDA6107Q-N1 it is necessary to apply an external protection network (resistor & diode) for each channel.
The TDA6107Q-N1 is intended to be used for the low cost PAL & NTSC market, because of the limited bandwidth.

The main features are:

- Bandwidth : 4.0 MHz typ at 100Vpp, 1)
- Slewrate : 900 V / µs,
- Fixed gain of 52,
- No external components for gain and black-level set-up,
- Very simple application with a variety of colour decoders,
- Black-current measurement output for automatic black current stabilization,
- Only one supply voltage,
- Protection against ESD,
- Internal reference voltage,
- Low static dissipation,
- Thermal protection,
- Controllable switch-off behaviour,
- Very small PCB dimensions,
- Very high replacement value.

This report describes the application of the TDA6107Q-N1 in combination with the TDA837X/TDA884X one-chip video processor.
There are no alignments any more on the CRT panel, because of the automatic black current stabilisation and because the white point adjustment can be done in the TDA837X/TDA884X via I^2C bus.

1) Measured in application set-up, with Rfl =1K and Cl= Ctube+ Cpcb=10pF.

2.0 QUICK REFERENCE PRODUCT DATA

G	Fixed gain	52
Vdd	Operating voltage	180-210 V
Voc-max	max. output voltage	typ. Vdd - 10V
Voc-min.	min. output voltage	typ. 10V
BWs @ 60Vpp	Small signal bandwidth	typ. 5 MHz. 2)
BWl @ 100Vpp	Large signal bandwidth	typ. 4.5 MHz. 2)
t_r @ 100Vpp	Cathode output rise time	typ. 68 nSec. 2) 3)
t_f @ 100Vpp	Cathode output fall time	typ. 68 nSec. 2) 3)
Crosstalk, incl. PCB	at 4MHz	better then 20 dB

2) with Rfl=0Ω , Cl=10pF. 3) between 20 and 80%

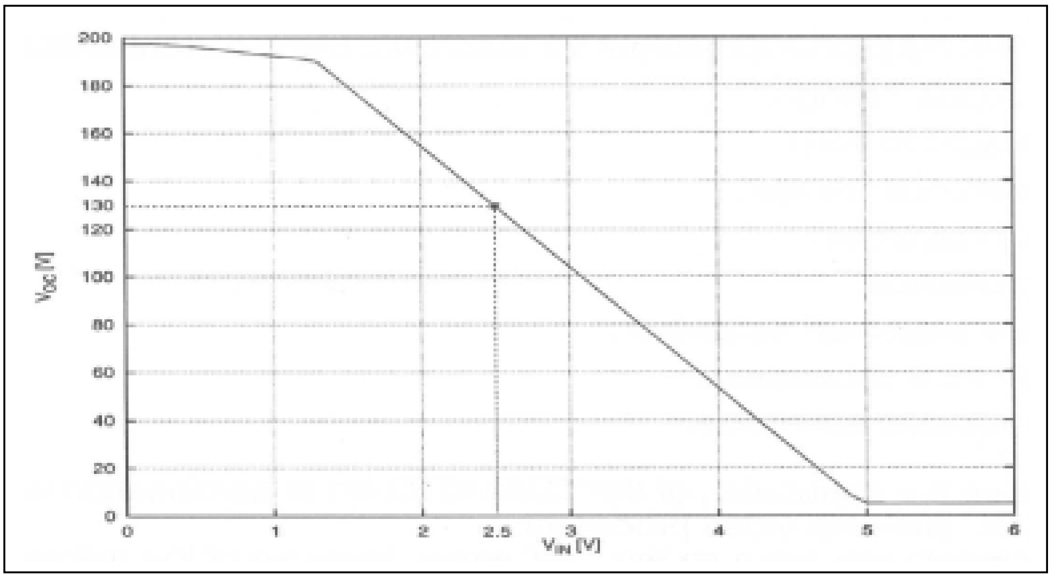


Fig.1 DC to DC transfer from input (Vin) to output (Voc).

PINNING

SYMBOL	PIN	DESCRIPTION
V_{i1}	1	inverting input 1
V_{i2}	2	inverting input 2
V_{i3}	3	inverting input 3
GND	4	ground, fin
Iom	5	BCS-output
V_{DD}	6	supply voltage
V_{oc3}	7	cathode output 3
V_{oc2}	8	cathode output 2
V_{oc1}	9	cathode output 1

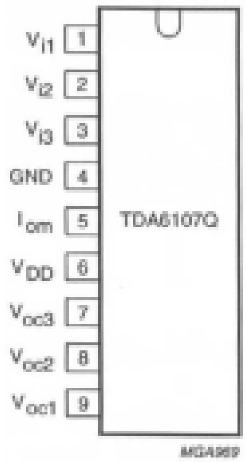


Fig.2 Pin configuration

THERMAL RESISTANCE

SYMBOL	PARAMETER	THERMAL RESISTANCE
$R_{th\ j\text{-}a}$	from junction to ambient	56 K/W
$R_{th\ j\text{-}fin}$	from junction to fin; note 1	11 K/W
$R_{th\ h\text{-}a}$	from heatsink to ambient	18 K/W

Note
1. An external heatsink is necessary.

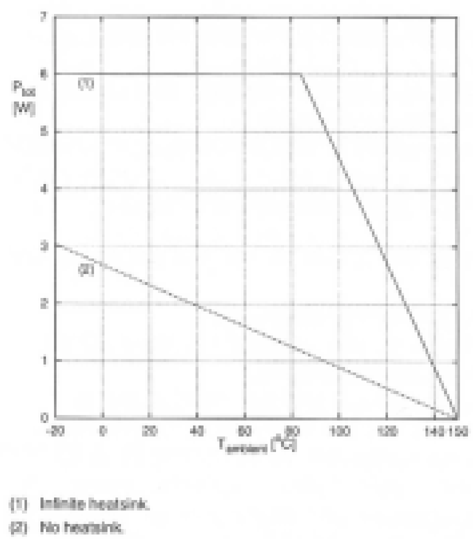


Fig.3 Power derating curves.

Thermal protecton

The internal thermal protection circuit gives a decrease of
the slew rate at high temperatures: 10% decrease at 130 °C and 30% decrease at 145 °C (typical values on the spot of the thermal protection circuit).

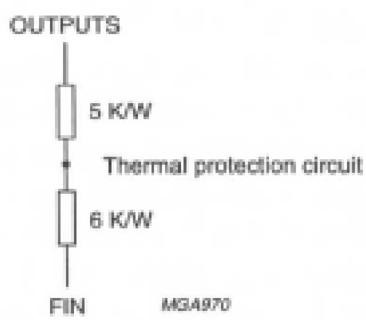
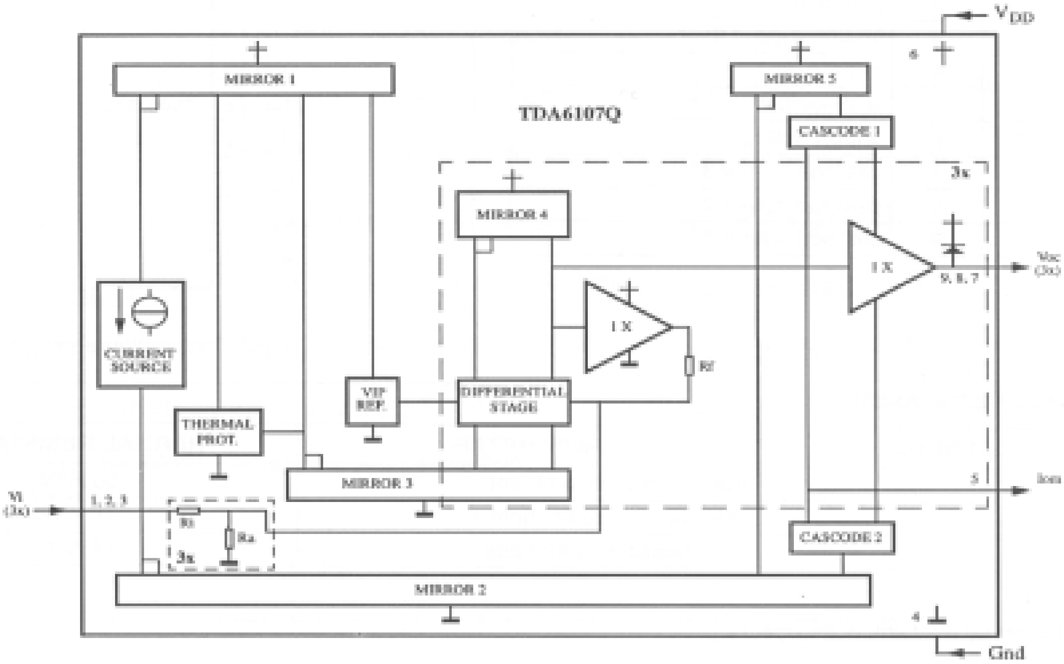


Fig.4 Equivalent thermal resistance network.

3.0 CIRCUIT DESCRIPTION.

3.1 BLOCK DIAGRAM DESCRIPTION.
The complete block diagram of the TDA6107Q-N1 is shown in Fig. 5.



The TDA6107Q-N1 consist of three monolithic video output amplifiers. The amplifier can be seen as an operational amplifier with negative feedback.
The advantage of negative feedback is that the amplifier characteristics do not play an important role up to certain frequencies.
External flash diodes combined with flash resistors and sparkgaps protect the amplifiers against flash over in the picture tube.
The TDA6107Q-N1 has an internal thermal protection circuit which gives a decrease of the slew rate at high temperatures.
Furthermore, the device needs only one power supply voltage(Vdd).
In contrast to previous types of DMOS video amplifiers, the external resistors (Rf,Ri and Ra) are integrated, so the gain is fixed and saves 9 resistors.
Furthermore the reference voltage is integrated, it saves a resistor divider and a decoupling capacitor. So, the replacement value of the TDA6107Q-N1 is very high.
The TDA6107Q-N1 is provided with a black current data pin. When using TDA 837X or TDA884X as drive device no adjustments are required for gain and black setting, as the TDA837X/TDA884X has I^2C white point adjustment and black current set-up.
The application diagram of theTDA6107Q-N1 is given in Fig.13 on page 28.

3.2 FUNCTIONAL PIN DESCRIPTION.

A functional pin description is given in this chapter.

Pin 1,2,3. This is the inverting input.The input configurarion consist of a resistor Ri connected to a virtual "ground". This virtual "ground" is the negative input of an operational amplifier and has a DC level of 2.5 V which is directly related to the internal reference voltage of 2.5 Volts.

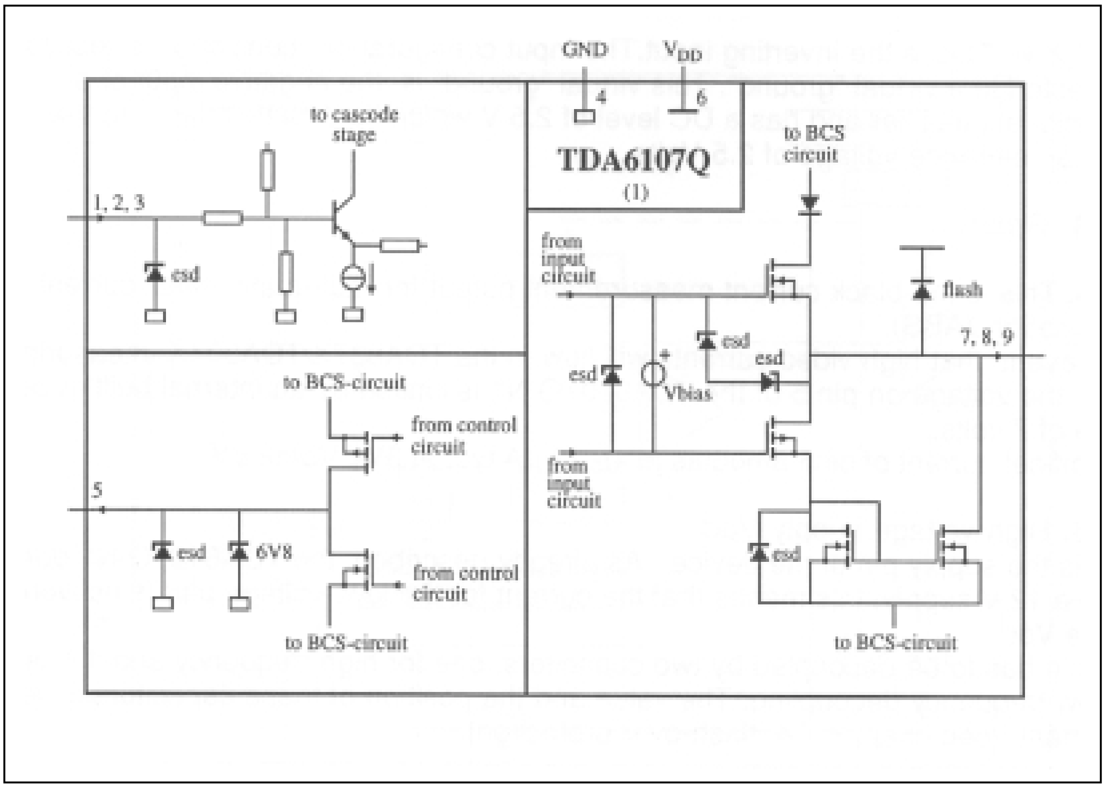
Pin 4. Ground.

Pin 5. This is the black current measurement output for automatic black current stabilisation (ABS).
To prevent that high video currents will flow in the TDA837X/TDA884X measuring input, the voltage on pin 5 of the TDA6107Q-N1 is limited by an internal built in zener diode of 7 volts.
The off-set current of pin5 amounts to +/- 12 μA typ. at 3V< Vom< 6V.

Pin 6. High-voltage supply Vdd.
This is the supply pin of the device. As already described, the TDA6107Q-N1 does not need a 12 V supply, this means that the current for the low voltage part is delivered by the Vdd.
The pin has to be decoupled by two capacitors, one for high frequency and the other for low frequency decoupling. The value and the position of these capacitors is very important (see chapter 7.4 flash-over protection).

Pin 7,8,9. Cathode output.
The video output current is delivered by a quasi complementary class-A/B push-pull stage, designed in DMOS technology and can source and sink a current of 20mA, for video output voltages of 100Vp-p with rise and fall times of 68 nSec (20%-80%).
A feature of this output stage is the low saturation voltage (typ. 10V) and the low voltage drop at high level (typ.Vdd-10V).
This output pin has to be connected to the cathode of the CRT via a standard resistor of 100Ω and a high-voltage flash-over protection resistor of1kΩ .
A high surge clamping diode has to be applied externally, so that the cathode output voltage clamps at Vdd+Vdiode.

3.3 INTERNAL PIN CONFIGURATION
The internal pin configuration of the TDA6107Q-N1 is given in Fig 6.



3.4 PROTECTION CIRCUITS.
The TDA6107Q-N1 has a lot of protection circuits built-in, in order to comply with requirements of reliability.

• Protection against electrostatic discharges.
All pins have an energy protection for positive and negative voltages.

• Thermal protection.
Thermal protection is implemented to protect the device against high temperatures for instance if the heatsink is incorrectly connected.

4.0 DESIGN CONSIDERATIONS.

4.1 AMPLIFIER PART.
The applied video output amplifier in the TDA6107Q-N1 is a negative voltage – feedback amplifier, the basic characteristics of this operational amplifier will be explained shortly.

The general inverting- feedback topology is depicted in Fig. 7

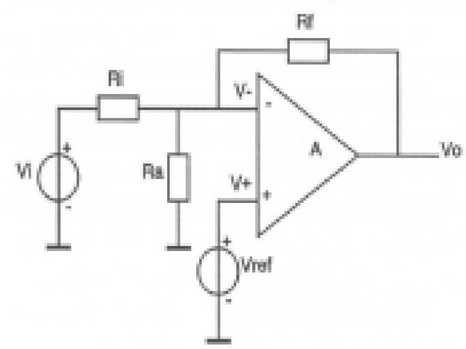


Fig.7 Basic configuration of the video amplifier.

It incorperates an operational amplifier with a differential input(V+ and V-) and a single ended voltage output. The input of the overall amplifier is Vi.
V+ is connected to an internal reference voltage (Vref), which is common for the three channels.
The reference voltage (Vref) is very stable regarding temperature drift.
In contrast to previous types of DMOS amplifiers, the resistors Ri,Ra and Rf are all integrated in the TDA6107Q-N1.
At low frequencies, the voltage is determined by the ratio Rf and Ri.
The amplifier characteristics do not play an important role. This is the advantage of negative voltage feedback.

4.2Voltage gain.

The voltage gain is defined by:

$$G = \frac{Rf}{Ri} \cdot \frac{1}{1 + 1/A\left(1 + \frac{Rf}{Ri//Ra}\right)}$$

Since the open loop gain A is high enough (>50 dB) ,we can approximate the equation:

$$G = Rf/Ri$$

For the one-chip processor TDA837X and TDA884X family a voltage gain of 50 is sufficient to get 100Vp-p video output signals.

Rf is188.7 kΩ and Ri = 3.77 kΩ.

4.3 DC toDC transfer related to cut-off level.

The black level voltage $Vo_{(black)}$ is determined by Ra, Rf ,Ri and the level of Vref and $Vi_{(black)}$.
$Vi_{(black)}$ is the typical value of the DC black level at the input and so the typical value of the brightness control voltage of the video processor.
Vref is fixed by an internal reference voltage of the TDA6107Q-N1.

When Rf and Ri are fixed, Ra can be calculated by applying the formula:

If Vi(black) = Vref $\quad Ra = \dfrac{Vref}{Vo(black) - Vref} \cdot Rf$

The typical black level Vi(black) of the TDA837X and TDA884X is 2.5V
In this case the resistor value of Ra is independent of Ri.
Ra has been chosen in such a way that the typical blacklevel output voltage $Vo_{(black)}$ is close to the cut-off voltage (Vco) of the picture tube.

For a cut-off level of 130V, Vref =2.5V,Ri=3.77 kΩ, Rf=188 kΩ the value of Ra=3.75kΩ.

From equation : $Vo= (1+ Rf/Ra) .Vref$ at $Vi =Vref$
the DC to DC transfer can be plotted. This shown in Fig.1

4.4 STABILITY.
The stability of the TDA6107Q-N1 is in principle quaranteed by the design.
.
In practice, the stability of the RGB board can be checked by :
- measuring the frequency response of the system, the amplitude must be as flat as possible (within a few dB),
- measuring the overshoot of a square wave signal.

For more detailed information about operational amplifier theory applied for video amplifiers, see Appendix 1 of the application note AN95007
-Application and product description of the TDA6103Q triple video output amplifier-.

4.5 Black current measurement output.

The TDA6107 is provided with a black current data pin.
The benefits to apply ABS are to compensate the differences in the gun characteristics during warming-up and ageing of the picture tube in order to have the correct colour balance in the10µA region.
The black current stabisation loop is an automatic control loop which stabilises the black current of each channel sequentially and independently.
To prevent that high video currents will flow in the black current input of the contol processor, the voltage on pin 5 of the TDA6107Q-N1 is limited by an internal built in zener diode of 7V.
More information about black current stabilisation with the one-chip TDA837X series is given in the application note AN94043 .(see references)

4.6 Flash-over protection.

The TDA6107Q-N1 needs external protection diodes (BAV21) combined with 100Ω resistors to protect the video amplifier against CRT flash-over discharges.
These diodes clamp the cathode output voltage to Vdd+Vdiode. To limit the diode current, an external 1k carbon high-voltage resistor (Rfl) in series with the cathode output and a 2kV spark gap is recommended. The value of this carbon resistor is a compromise between video bandwidth and flash immunity.
More details about flash protection are given in chapter 7 -"Circuit application & application hints"- and in the appendix of application note AN95064 (see Reference).

4.7 Thermal protection.

Thermal protection is built in to protect the X-tal against high temperatures for instance if the heatsink is incorrectly connected.
The thermal protection circuit controls the current sources and therefore also the power dissipation, resulting in 10% decrease of the slew rate at 130 ^{o}C and 30% decrease at 145 ^{o}C (typical values on the spot of the thermal protection circuit).
However, this does not mean that at high temperatures around 140 ^{o}C, the performance will be poor due to the decrease of the current Idd.
Of course the h.f parameters are less, but not visible on the sreen of the CRT.

5.0 EXTERNAL COMPONENTS CALCULATION.

The board described in this report is designed for the one-chip processor family TDA837X and TDA884X.
Because the gain and the DC to DC transfer are fixed by internal resistors, the implementation of the TDA6107Q-N1 in an application is very simple and requires only the determination of a few external component values. These components are supply decoupling components , which are directly related to flash protection.
In addition the dissipation of the IC must be calculated in order to define the thermal resistance of the heatsink.

5.1 Decoupling [C3 and C4]

To protect the video amplifiers against picture tube flash-over discharges the high supply voltage (Vdd) must be decoupled by a capacitor >20nF/250V (e.g. a film capacitor of 100nF/250V with short leads and with good HF characteristics), placed as close as possible to pins 4 and 6 of the TDA6107Q-N1 and definitely within 5mm).
This capacitor limits voltage excursions of Vdd during the first part (T_{rise}=10 nsec) of a low resistance flash.

$$\Delta U = I(flash).\frac{T.}{C} = \frac{Vspark\ (max.)}{Rfl} . \frac{T\ rise}{Ch.f.} = \frac{4\ kV}{1k5} . \frac{10\ nsec}{20\ nF} = 1.3\ V$$

at Ch.f. = 100nF , Δ U= 0.25V.

with: V(spark(max.) = maximum ignition voltage of the sparkgap,
Trise = rise time of the cathode voltage to exceed the Vspark(max.),
Rfl= flash resistor,
Ch.f.= high frequency decoupling capacitor.

The high supply voltage (Vdd) must also be decoupled with a capacitor ≥3.3uF/250V on the CRT board . This capacitor limits the voltage excursion during a high resistance flash. For the calculation of this voltage excursion it is supposed that there is no ignition of the spark gap and that the picture tube discharges completely through the video amplifier. In that case the maximal voltage excursion will be:

$$\Delta U = \frac{Ctube\ .\ Veht}{Cl.f.} = \frac{1nF\ .\ 28\ kV}{3.3\ \mu F} = 8.5\ V$$

with: Ctube = capacitance of the picture tube, the value of the capacitance is a function of the picture tube size, at a 15 inch tube Ctube is about 1nF.
Veht = voltage of extra high tension,
Cl.f. = low frequency decoupling capacitor.

This means for a large size CRT , the value of Cl.f. has to be increased for the same value of ΔU.

6.0 DISSIPATION & HEATSINK CALCULATION.

6.1 Static and dynamic dissipation.
The dissipation of the TDA6107Q-N1 consists of the static contribution of the quiescent current and the dynamic dissipation caused by high frequency drive (proportional to frequency)

The static dissipation, incl. dissipating of the internal resistors(Rf), equals:

Pstat = Vdd. Idd + 3. [Voc. Ioc] (6-1)

Ioc = DC value of the cathode current.
Voc = DC value of the cathode voltage.
With Vdd=200V, Voc=100V and Idd_{max}=8.2 mA the static dissipation equals : Pstat= 1.64W.

The dynamic dissipation equals:
Pdyn = 3. Vdd . (Cl + Cint) . f . Vo p-p . b. (6-2)

Cl = load capacitance
Cint = internal load capacitance (4 pF)
f = input frequency
Vo p-p = output voltage (peak to peak)
b = non blanking duty cycle.

With Vo p-p=100V(80Vpp at 4MHz), f=4MHz (sine wave), Cl=10 pF, Cint=4 pF and b=0.8, the dynamic dissipation Pdyn. equals 2.2 W.

The total dissipation Ptot=Pstat+Pdyn under given conditions is 3.84 W.

6.2 A more practical approach regarding dissipation

In the previous part , the dissipation has been calculated for the TDA6107Q-N1. However, this is a rather theoretical approach and in practice it differs from this, in particular the dynamic dissipation. This will be explained now.
In a TV set the worst case of dissipation occurs with :
- a noise signal (from the tuner) in TV mode,
- a multi-burst pattern (0.8-5.8MHz) in AV mode.

Measurements in a TV set show a lower dynamic dissipation in TV and AV mode compared with the calculated values given in the previous part.
The power dissipation respectively the junction temperature in both cases(TV and AV mode) are nearly equal under given conditions.
Furthermore, it is not realistic that there will be a continuous picture containing a full screen of 4MHz signals .
The dynamic dissipation has been measured in a TV set equipped with TDA6107Q-N1 shows a dynamic dissipation of 0.8 W at a multi- burst of 100Vpp in AV mode.
The total dissipation under given practical conditions is Pstat+ Pdyn = 2.64 Watts.

6.3 HEATSINK CALCULATION

Because the TDA6107Q-N1 is provided with a thermal protection it is allowed to calculate the heatsink with the practical total dissipation of 2.64 Watts.

Thermal resistances of the TDA6107Q-N1:

$R_{th,j\text{-}am}$ = 56K/W (typ).
$R_{th,j\text{-}mb}$ = 11 K/W (typ).

The $R_{th,mb\text{-}heatsink}$ = 0.5 K/W depends on mounting method of the heatsink.
The junction temperature can be calculated with equation (6-3).

$$T_{junction}=T_{amb,set} + P_{tot} \cdot R_{th,j\text{-}amb} \quad \text{[no heatsink]} \qquad (6\text{-}3)$$

If the max. operating temperature in a TV set is about 65 ^{o}C, with a power dissipation of 2.64W and a thermal resistance of 56K/W, the thermal protection will be active too early.
To realise that the thermal protection is starting at about 150^{o}C junction temperature (120^{o}C on the fin) , a heatsink has to be applied with a thermal resistance of:

$$R_{th,h\text{-}a}= [(T_j\text{-}T_{amb})/P_{tot}] - [R_{th,j\text{-}mb} + R_{th,(mb\text{-}heatsink)}] \geq 20K/W \qquad (6\text{-}4)$$

7.0 CIRCUIT APPLICATION & APPLICATION HINTS

In this chapter information is given concerning the application of the TDA6107Q-N1 as video output stage. The circuit diagram of a complete video output stage for use in a TV-set is given in Fig. 13 on page 28. The circuit application is optimised for handling the output signals from the One Chip colour processor TDA837X/TDA884X in order to drive a flat square black-line CRT, with an EHT of 28kV and a cut-off voltage of 130V. The signal gain is 34 dB and the output swing is 100Vp-p.

7.1 DESIGN-IN SEQUENCE of the TDA6107Q-N1 in conjuntion with the TDA837X.

The alignment procedure is summarized below:
1) Apply a signal with a black picture to the receiver.
2) Set brightness and contrast to mid position.
3) Set "gain" controls WPR,WPG and WPB to mid position (20_{hex})
4) Adjust Vg2 voltage to make the black level on the R,G and B cathodes equal to the specified cut-off voltage of the CRT. This is done by looking at the highest black current measuring pulse at one of the cathodes at the beginning of the scan (oscilloscope triggered on vertical). This pulse should be 10V below the desired cut-off voltage of the CRT.
5) Apply a signal with a white picture to the TV set. Set contrast control to mid position.
6) Use a colour analyzer to adjust WPR,WPG and WPB to the correct white point colour temperature.
7) Check grey scale.
8) Adjust the focus voltage for a sharp picture on the screen.

7.2 Printed Circuit Board.

The PCB shown in this report on page 30 is meant for evaluation purposes.
The CRT base socket is JEDEC B10-277. The connecters X1(R,G,B,Iom) and X2(Supply, aqua) are pin alligned with the connecters of the one chip TDA837X demonstration board of PS-SLE (Philips Semiconductors-Systems Laboratory Eindhoven, The Netherlands).

To get the optimal performance, special attention has to be payed on the following points of the PCB layout.
- keep h.f. current loops as short as possible,
- separate large and small signal current paths,
- minimize parasitic capacitors, keep hf-signal tracks as narrow as possible,
- use star point grounding, make ground and supply tracks as wide as possible.

- Concerning flash-over protection :
  the most important thing is that h.f. decoupling capacitor (C3=100nF) has to be placed as close as possible to pin 4 and 6 of the TDA6107Q-N1 and certainly within 5mm, the electrolytic capacitor (C4 = 3.3 µF) has to be mounted on the CRT panel.

7.3 Switch-off behaviour.

When a TV receiver is switched-off , several voltages become low. The cathode output voltage of the TDA6107Q-N1 is dependent on the input condition Vi and the high voltage supply Vdd.
The switch-off behaviour of the TDA6107Q-N1 is defined and controllable. This is due to the fact that the output pins of the TDA6107Q-N1 are still under control of the input pin for relative low supply voltages (approximately 30 V and higher).
There are two types of switch-off behaviour:

7.31 Voc follows Vdd ,after switch off.

Voc=f(t) is shown in fig.8
This kind of switch-off is most general used.
Conditions: Vi < Vref, after switch-off. (Vref=2.5V, internally).
The fall time of Voc is determined by the fall time of Vdd and can be adapted by the value of the decoupling capacitor on Vdd. The minimum value (3.3µF) is limited by flash over behaviour.

7.32 Voc is switched to zero, after switch off while Vdd = high.

Voc=f(t) is shown in fig.9
Conditions: Vi > Vref, after switch-off.
In this case the Ceht of the CRT will be discharged directly after switch off. This can be a safety requirement of the setmaker for service/repair.

When using TDA837X/TDA8444X, the kind of switch-off behaviour (7.3.1 or 7.3.2) can be choosen via the I^2C bus when switching from normal to standby mode.

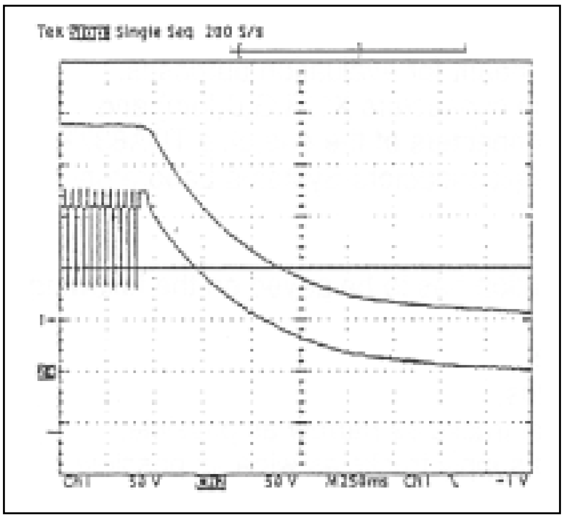


Fig.8
Upper: Vdd= f(t) ,50V/div, 250mS/div.
Lower: Voc= f(t) ,50V/div, 250mS/div.

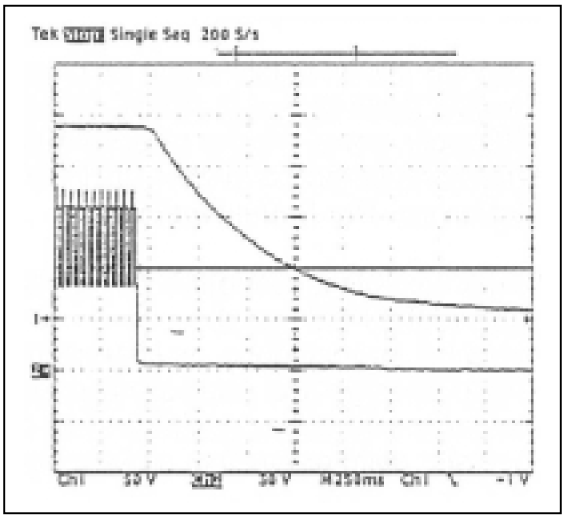


Fig.9
Upper: Vdd= f(t) ,50V/div, 250mS/div.
Lower: Voc= f(t) ,50V/div, 250mS/div.

The 1-> and 2-> markers show the ground level. C=10µF.
1-> for the upper trace and 2-> for the lower trace.

7.4 Flash-over protection.

A picture tube has generally several high voltage discharges in its life time.
During the discharge (flash), an overvoltage can occur on the cathodes. This overvoltage can damage the RGB video amplifier, since it is directly connected to the CRT.
Essential for flash-over protection is the connection between aquadag and main PCB(deflection/supply board). In our concept the aquadag is connected to the sparkgap on the CRT board and from here a connection to the main board. See fig.10.
Furthermore a separate earth wire must be connected from the ground of the CRT board to the line/supply main board.

The TDA6107Q-N1 needs external flash protection diodes to protect each video amplifier against CRT flash-over discharges. These diodes clamp the cathode output voltage to Vdd+Vdiode. To limit the diode current, an external 1k carbon high-voltage resistor (Rfl) in series with the cathode output and a 2kV spark gap is recommended.
The value of this carbon resistor is a compromise between video bandwidth and flash immunity.

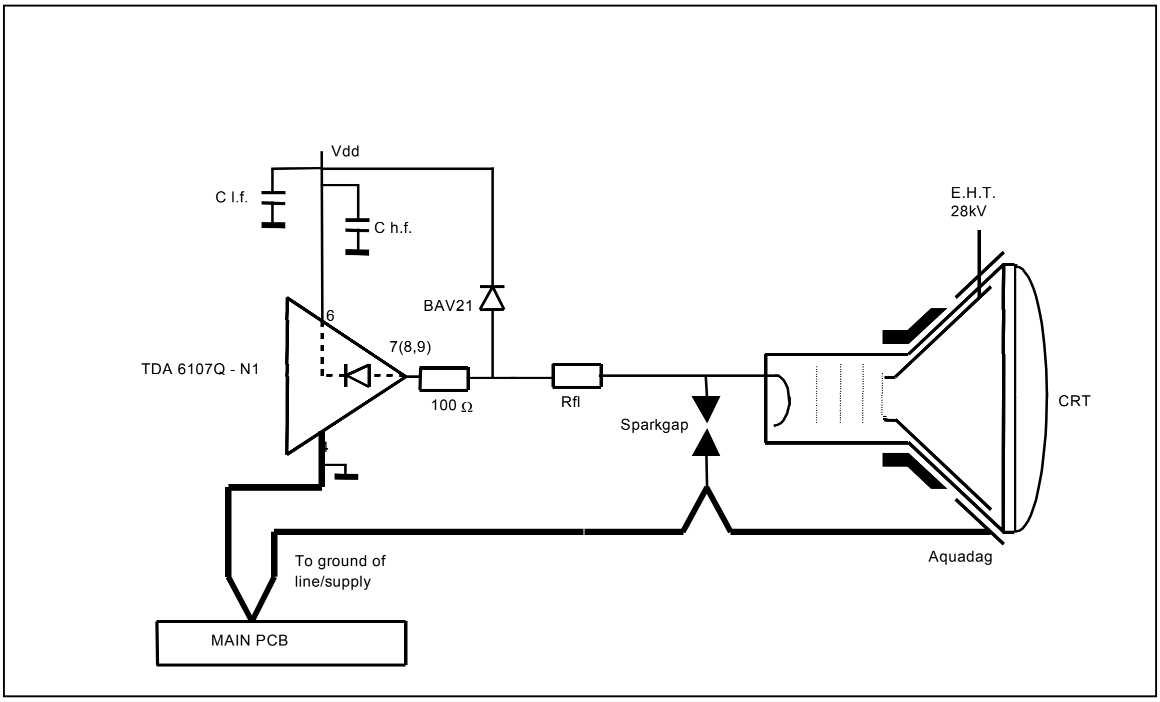


Fig.10 Grounding of aquadag & RGB board.

The following remarks are very important w.r.t. flash protection.

•To protect the TDA6107Q-N1 against fast voltage peaks during a low-ohmic flash pin 6 must be decoupled with a capacitor >20nF/250V with good h.f properties and placed as close as possible between pin 6 and pin 4, but definitely within 5mm.
This is necessary, otherwise a voltage peak can occur due to the inductance of the long wires between the TDA6107Q-N1 pins and the capacitor (V= L di/dt) and this voltage peak can damage the IC.

• For the discharge of the CRT during a high-resistance flash an electrolitic capacitor of >3.3µF/250V is necessary, mounted on the CRT board.

• For the TDA6107Q-N1, external flash diodes and series resistors of 100Ω have to be applied at each output (see application diagram, given in Fig.13)
The leads of the diodes must be kept as short as possible.

• Ignition level of the sparkgap must be typical 2kV and worst case <4kV.

• Flash resistors must be high voltage types (e.g. Allen Bradley)

• To have a short primary flash loop, earth connections of aquadag and sparkgaps are very important.
Connect the aquadag ground via a short wire (and low inductance) to the earth of the sparkgap, and from here with a wire to the ground of the line transformer on the main PCB. The inductance can be made small, e.q. by keeping it close to the surface of the picture tube.
The ground of the TDA6107Q-N1 must be connected via a separate wire to the ground of the line transformer on the main board. The wire diagram is shown in Fig. 10 .

• Grid G1 connection.
In a lot of applications, grid G1 can be directly connected to aquadag ground.
In that case you can omit the flash resistor in the G1 connection to create a permanent low impedance path for the flash current and thus better protect the cathodes , with the video output amplifiers.
The direct aquadag grounding of G1 can't be applied when measuring the EHT info, this will be discussed in the next part.

<u>Flash -protection for alternative aquadag grounding.</u>

The basic application described in this report is designed for an application in which the beam current of the EHT is measured by using a "beam current " capacitor C_{bc} in the line output stage.
In that case, the lower side of the EHT transformer is not connected to ground (for instance the TDA837X & supply demonstration kit of PS-SLE).
Therefore, special attention has to be given to flash-over behaviour.
The simplfied circuit diagram is given in Fig.11.

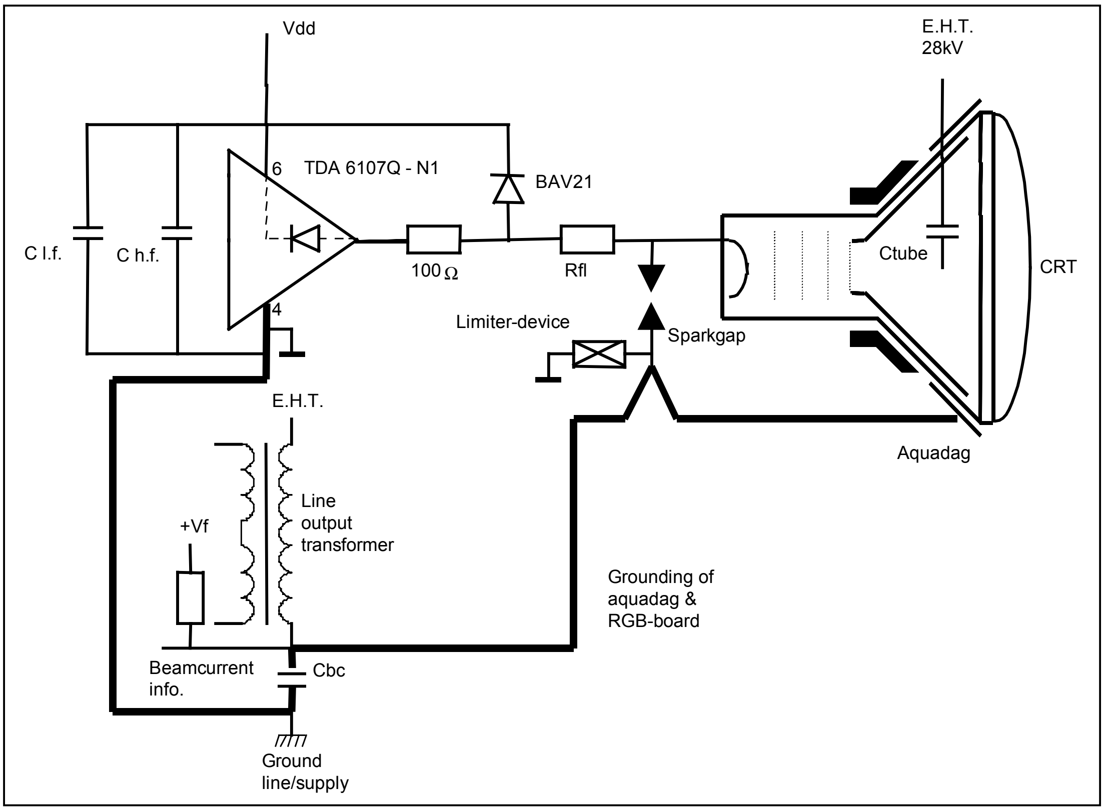


Fig.11 Alternative aqua grounding.

In case of a high resistance flash the current is low and the sparkgap does not ignite. During that flash the aquadag capacitor C_{tube} is discharged and the charge will transfer via Rfl and the internal flash diode to the capacitors Cl.f. // Ch.f. and Cbc. The available charge of Ctube will be distributed across these capacitors.
When C_{tube}=1-4 nF, Cbc=22nF and Cl.f.=3.3-10 µF the capacitor Cbc is charged at a level of several kilo Volts with a negative polarity w.r.t supply ground.
At a level of 2kV the sparkgap ignites and the voltage over Cbc will be present on the output of the TDA6107Q-N1, resulting in a damaged IC.
To prevent this, a suppression/limiter device (zenerdiode + a series diode) or VDR has to be placed from the aquadag wire (lower side of the sparkgap) on the CRT board to supply ground. This is shown in Fig.11 (limiter device).
The suppression device must be a medium power type to handle the flash currents.

More detailed information about flash protection is given in the Appendix of the application note AN95064(see reference) .

7.5 Black current stabilisation.

The most simple application of the TDA6107Q-N1 in an automatic black current set-up in conjunction with the one-chip TDA837X is shown in Fig. 12 .
The black current stabisation loop is an automatic control loop which stabilises the black current of each channel sequentially and independently every field.
The loop is active for a four line period , immediately after the end of the field blanking.
During field scan (outside the 4L black current measuring time) , the normal video current flows in the ABS feedback path.
To prevent that high video currents will flow in the TDA837X black current input, the voltage on pin 5 of the TDA6107Q-N1 is limited by an internal built in zener diode of 7V.
The TDA837X has I^2C bus adjustments for the white point, the gain and colour balance in the 10μA region, therefore no adjustments are required for gain and black setting at the TDA6107Q-N1 application.
The black current input of the TDA837X family is a low impedance current driven input with leak current compensation.

The beam current output of the TDA6107Q-N1 can be directly connected to the black current input of the TDA837X.

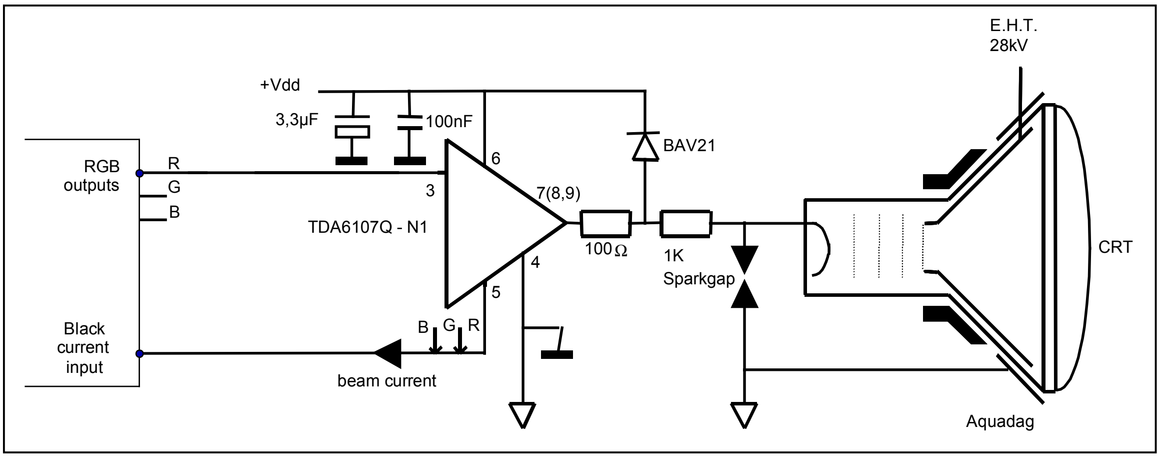


Fig. 12 Basic ABS application with the TDA6107Q-N1/TDA837X.

More detailed information about black current stabilisation in conjunction with the one chip coulour processors is described in the application note AN94043 (see reference).

8.0 PERFORMANCE EVALUATION.

The evaluation board has been designed to obtain the best results.
To evaluate the h.f performance , the best way is to measure outside the TV set by driving the amplifier by an h.f. generator or network analyzer.
The flash behaviour has to be examined in a TV set. In this situation the TDA6107Q-N1 as well as the application are tested.

Measurement conditions for h.f. :
The schematic diagram of the h.f measurement set-up is shown in Fig 15 on page 31.

- High voltage supply Vdd=200V
- Biasing: Voc(DC)=100V
- AC Gain: 34 dB
- Loading: see curves
- All measurement results include a flash resistor of 1k and Cl=7pF
  Cl is the cathode capacitance of the CRT.
  The total load capacitance, including the parasitic capacitances of the PCB , will be about 10pF.

Measurement Results:

8.1 Bandwidth.

The measurement set-up is given in Fig.15 on page 31.
The curves in Fig.18 and 19, on page 33, show the frequency response with 60Vp-p and 100Vp-p output voltages.
Rfl=1k and Cload is pF (total load capacitance about 10pF.
Bandwidth at 100Vp-p, amounts to 4 MHz. (-3dB)
Bandwidth at 60Vp-p, amounts to 4 MHz. (-3dB)

The value of the flash resistor is a compromise between flash-over behaviour and bandwidth.
A common used value for Rfl is 1k5. For the TDA6107Q-N1 the value of Rfl is reduced to 1k, in order to compensate partly the slope of bode plot characteristic of the device.
Reduction of the flash resistor is allowed due to the applied external flash protection.

8.2 Cross-talk.

The measurement set-up is given in Fig.16 on page 31.
A sine wave input signal is injected in one channel and the output signal of one of the other channels is measured.

$$\text{Cross-talk} = 20 \log \frac{\text{Voc (drive channel)}}{\text{Voc (one of the other channels)}} \quad [\text{dB}]$$

The curves given in Fig.20, 21 and 22 on page 34 and 35 show the cross-talk of this application board at which Voc= 50Vp-p .The worst value is -22 dB at 4 MHz.
The cross-talk is not the same for the six different combinations of the three channels.

8.2 Rise and fall time.

The curves Fig.23 and 24 on page 36 respectively show the rise and fall time at 100Vp-p output signal of the red channel, measured in a TV set (AV mode).
Typ. value Tf= 122 nSec. at 100Vp-p, with Rfl=1k.
Typ. value Tr= 122 nSec. at 100Vp-p, with Rfl=1k.

8.4 Flash test.

Fig. 17 on page 32 shows the test set-up applied for flash-over tests by Philips.
With this test, the TDA6107Q-N1 as well as the application are tested.

Test conditions:
TV set with 33 inch soft flash picture tube, Veht=28 kV.
So the total available charge will be Q= Ctube.Veht = 3.5nF. 28kV= 100 µC.
Number of flashes: 50

8.4.1 High-resistance flash.

During high resistance flashes , the sparkgap does not ignite and the total charge transfers via the flash resistor Rm, Rfl and the flash diode into the decoupling capacitor of Vdd.
Where Rm is the simulation of the arc resistance in the CRT between g4 and the cathode.
In practice , the minimum value of Rm at which the sparkgap does not ignite is :

$$Rm = \frac{Rfl(Veht - V(spark)}{V(spark)} = \frac{1k(28-4)}{4k} = 6k\Omega$$

The peak current amounts to Veht / (Rm+ Rfl)= 28kV / (9k+1k)= 4 A.
at which Vign of the sparkgap is worst case (4kV), Veht=28kV and Rfl=1kΩ.

At the high resistance flash-test, switch S1 is closed (Rfl=0 Ω), which means that the sparkgap can not ignite.
To test at various values of flash currents, the value of Rm has to be adapted.

8.4.2 Low -resistance flash.
During low-resistance flashes , S1 is open, the sparkgap ignites and only a little charge tranfers via the flash resistor Rfl and the flash diode into the decoupling capacitors of Vdd.
Very fast peak voltages can occur on the Vdd pin of the TDA6107Q-N1 , the h.f. capacitor has to prevent the device for these peak voltages.
At a low-resistance flash , the resistor Rm (equivalent of the arc of the CRT) is typical 400Ω and worst case 200Ω for a soft flash picture tube.

9.0. REFERENCES.

1) DATA SHEET TDA6107Q-N1.
2) DATA SHEET TDA837X
3) DATA SHEET TDA884X
4) Soft-flash colour tubes, PHILIPS COMPONENTS Technical publication 253
5) Flashover in picture tubes and methods of protection. - By A. Ciuciura.- The Radio and Electronic Engineer, Vol.37, No3, March 1969.
6) Black current stabilisation description and application for the TDA8362A, TDA8366 and TDA8376. -AN94043- By: T. Bruton.
7) Application and product description of the TDA6103Q triple video amplifier. -AN 95007- By: E.H Schutte.
8) Application and product description of the TDA6106Q video output amplifier. -AN 95064- By: E.H Schutte.

APPENDIX

- Imperfections of the TDA6107Q-N1, see page 37.

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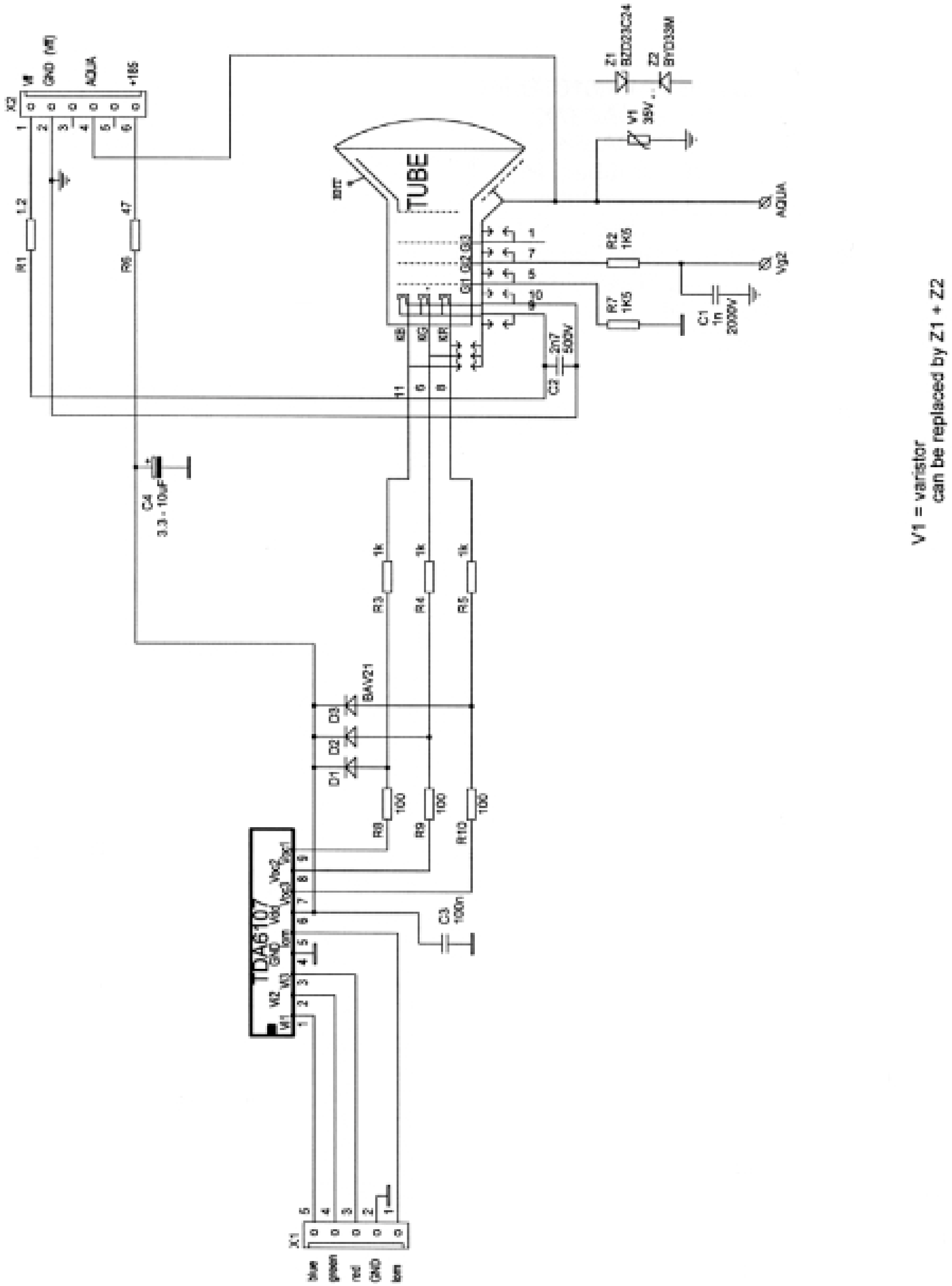
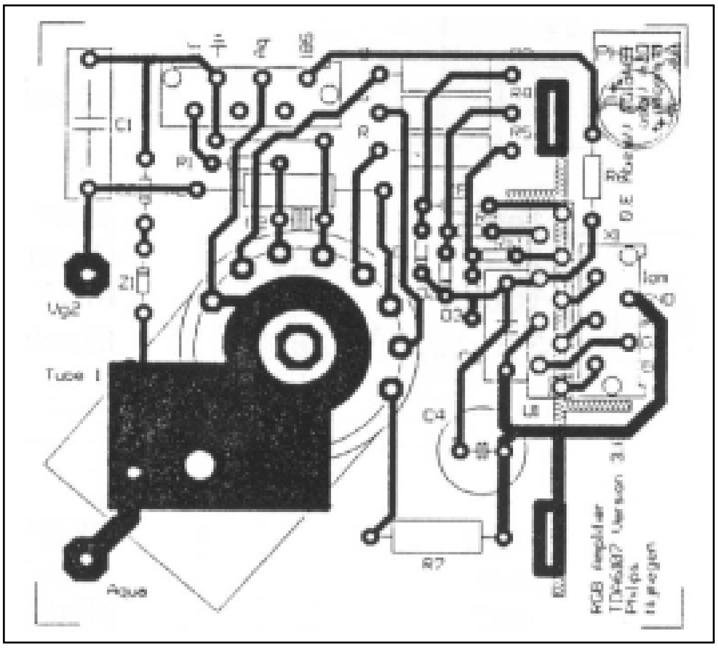


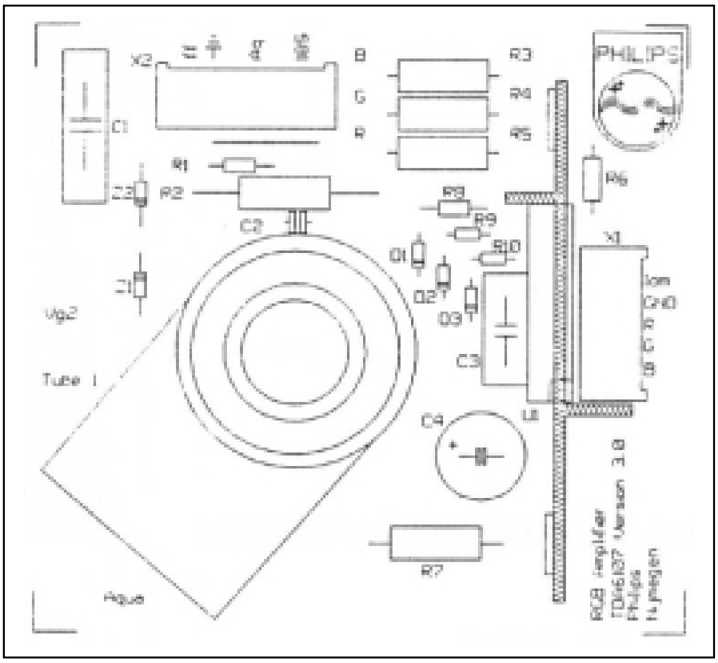
Fig. 13 Application diagram of the TDA6107Q-N1.

PART LIST.

Position no.	VALUE	RATING	TYPE
Integrated Circuit(s)			
			TDA6107Q-N1
Capacitors			
C1	1nF		2000V MKP
C2	2n7	500V	Ceramic plate
C3	100nF	250V	MKT
C4	3.3 -10µF 1)	250V	Electrolytic
Resistors.			
R1	1.2Ω		SFR16T
R2, R7	1k5		High V. Allen Bradley -1/2 W
R3,R4,R5	1kΩ		High V. Allen Bradley -1/2 W
R6	47Ω		NFR25
R8,R9,R10	100Ω		SFR16T
Diodes			
D1,D2,D3			BAV21
Z1	24V		BZD23C24
Z2			BYD33M
VDR			
V1(Varistor)	35V		
Special parts			
X1			5-pole connector
X2			6-pole connector
Picture tube socket, with integrated sparkgaps			EDEC B10-277

1) At a 15 inch CRT, C4=3.3µF.
21 inch CRT, C4= 6.8µF.
29 inch CRT, C4=10µF.





Scale: 1:1

Fig.14 TDA6107Q-N1 Evaluation board layout & components view.

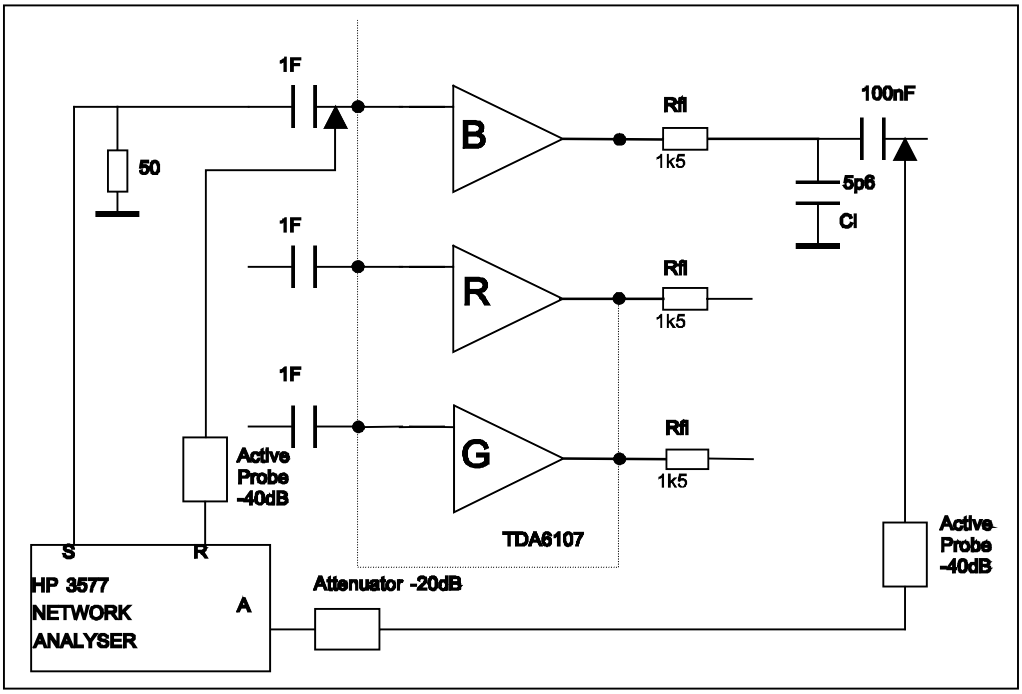


Fig.15 Bandwidth measurement set-up

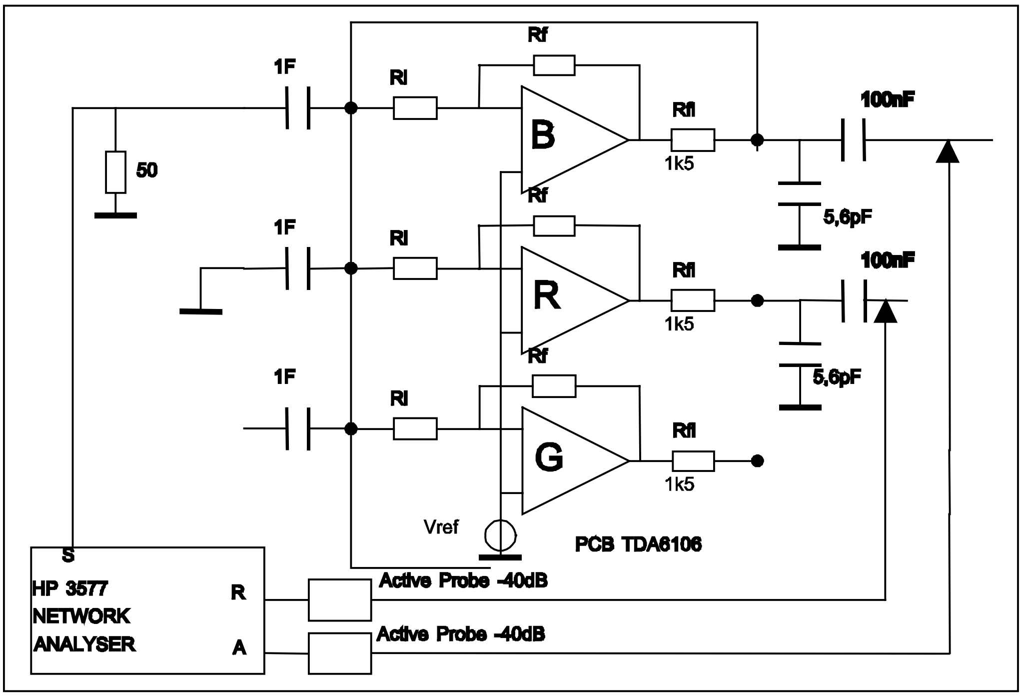


Fig. 16 Crosstalk measurement set-up

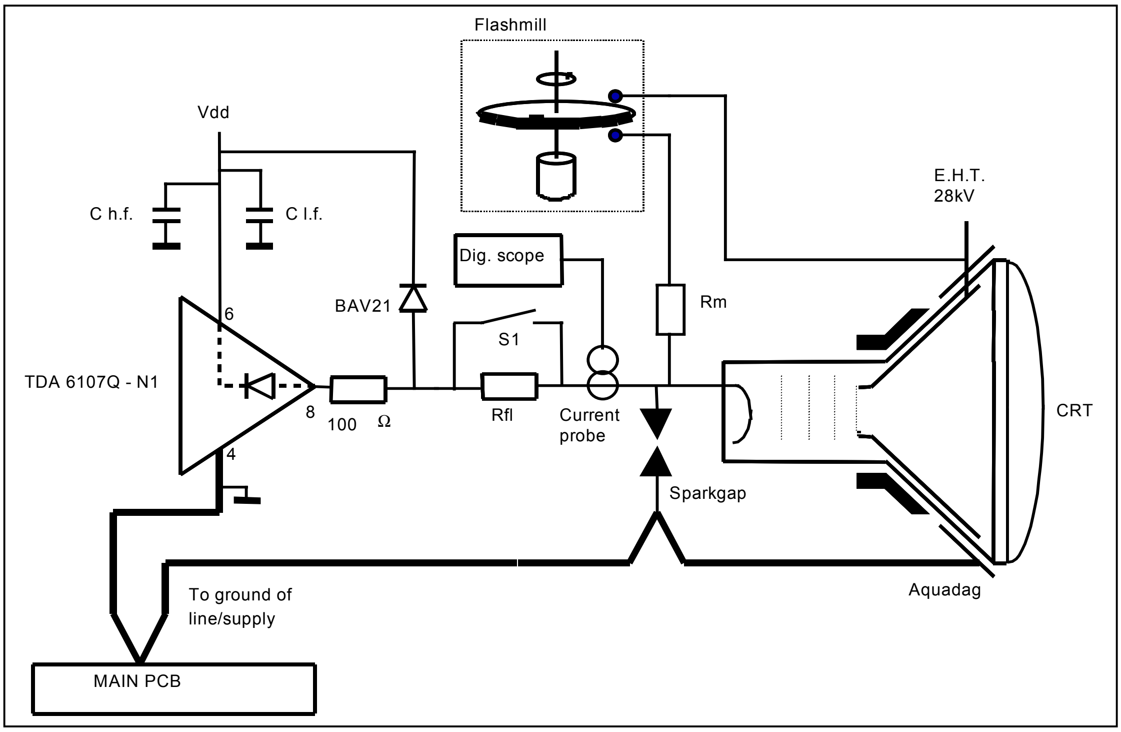
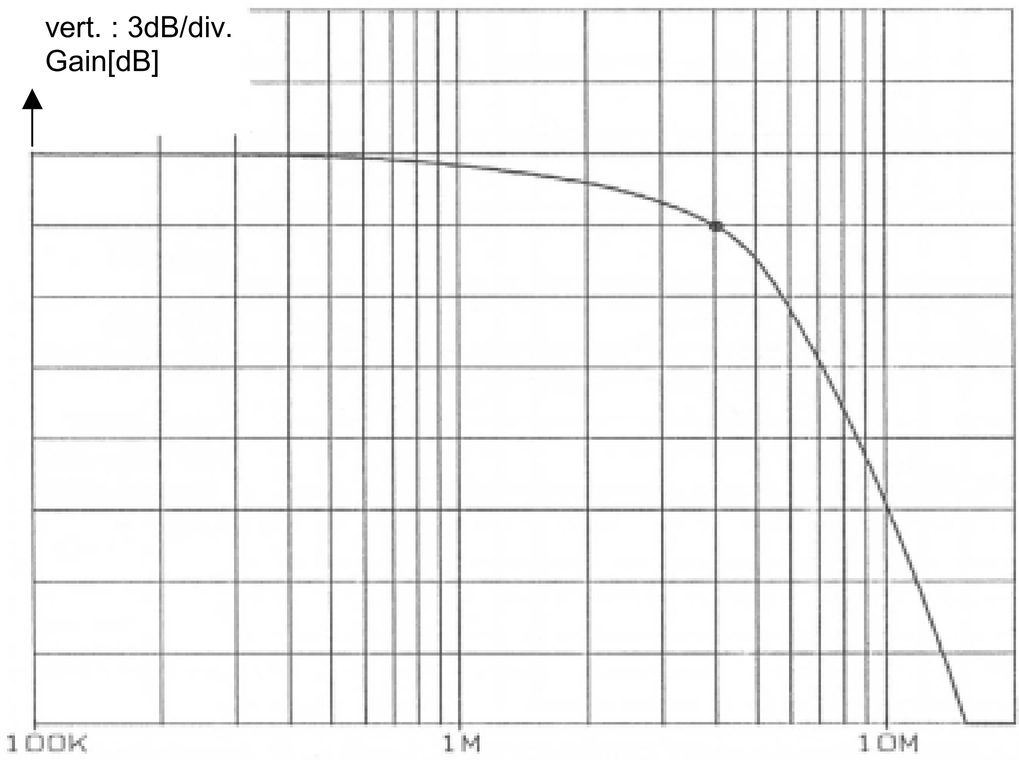


Fig.17 Flash-over test set-up.

Rfl = 1kΩ

The value of Rm depends on type of test (200Ω -10kΩ) and is built with resistors in series.
Type: Allen Bradley - high voltage.
Rm is the simulation of the arc resitance in the picture tube between the EHT and the cathode.



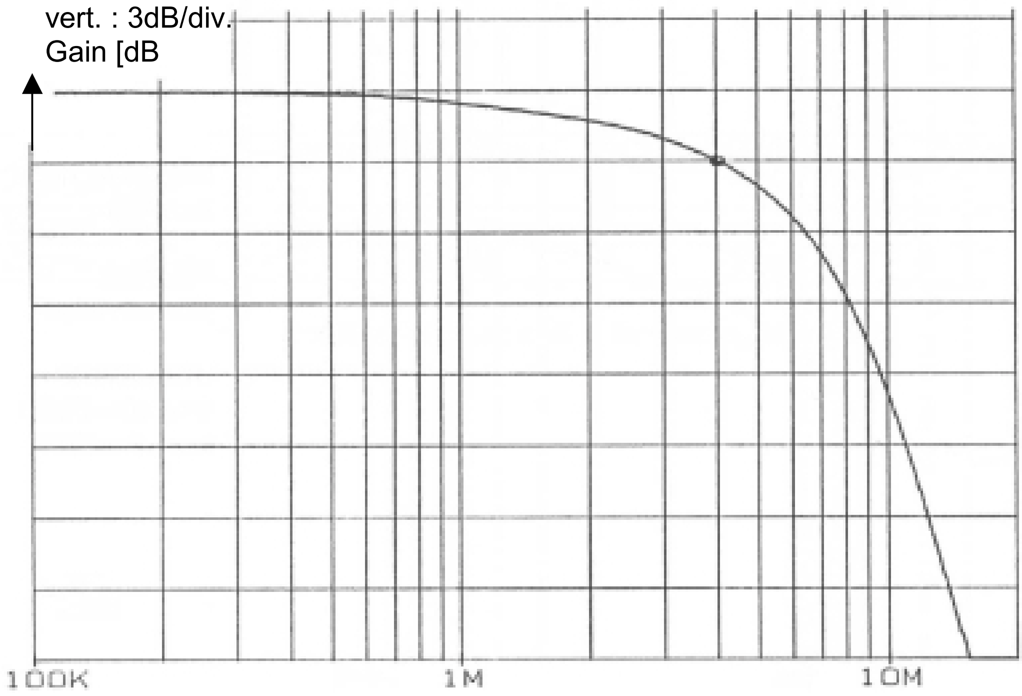
Measurement after Rfl

Rfl=1kΩ
Cload=10pF

Vdd=200V
Voc-dc=100V
Voc-ac=60V

-------> f [Hz]

Fig.18 Small signal bandwidth of the TDA6107Q-N1



Measurement after Rfl

Rfl=1kΩ
Cload=10pF

Vdd=200V
Voc-dc=100V
Voc-ac=100V

--------> f [Hz]

Fig.19 Large signal bandwidth of the TDA6107Q-N1.

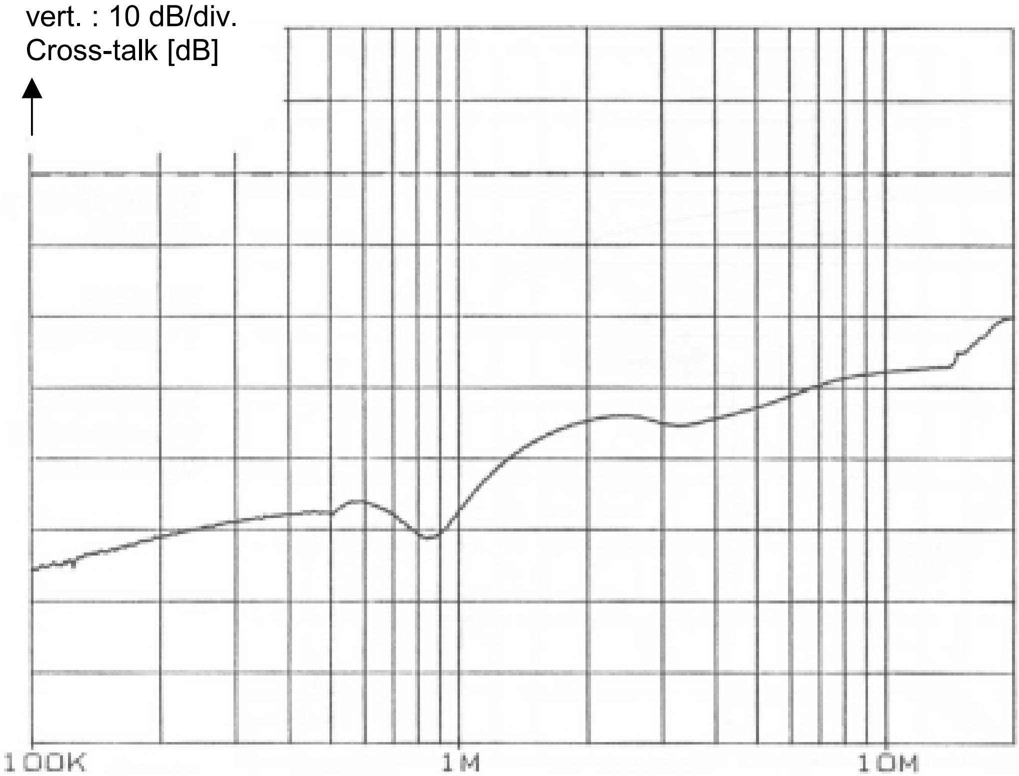


Fig.20 Crosstalk behaviour of the TDA6107Q-N1 - source= R, crosstalk=B

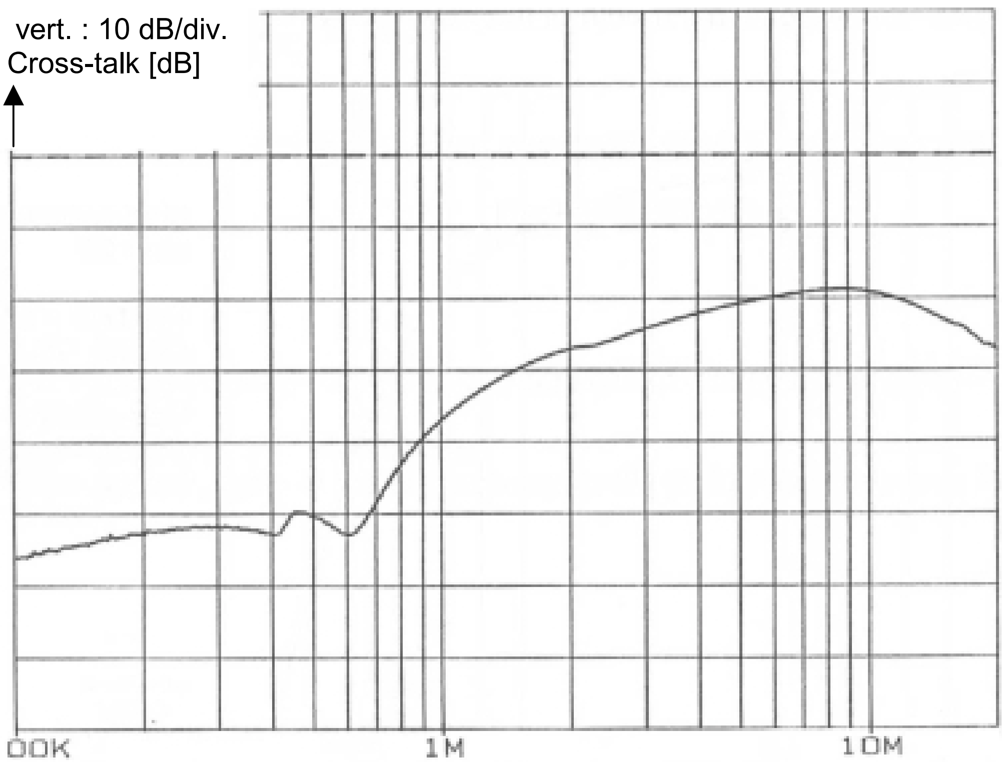


Fig.21 Crosstalk behaviour of the TDA6107Q-N1 - source= G, crosstalk=B

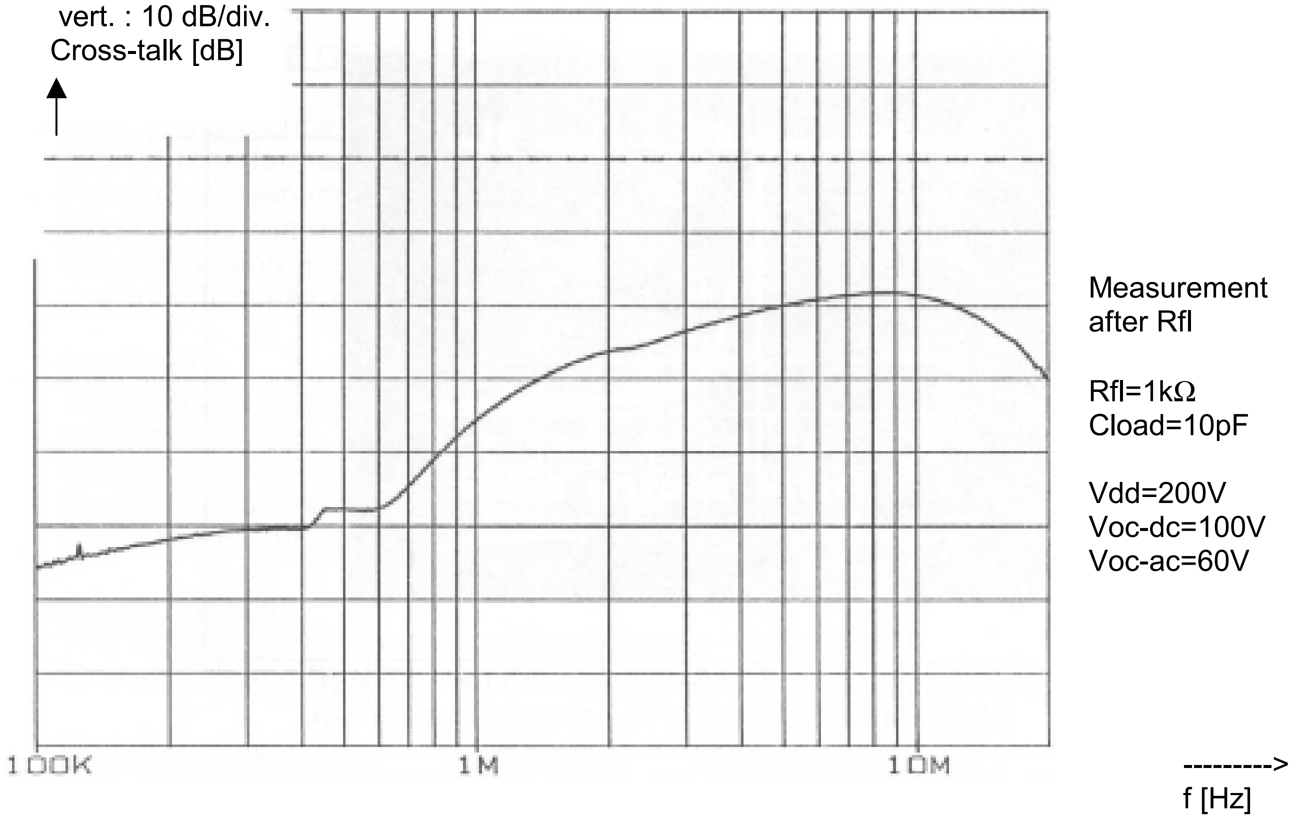


Fig.22 Crosstalk behaviour of the TDA6107Q-N1 - source= G, crosstalk=R

	Crosstalk Blue	Crosstalk Red	Crosstalk Green
Signal Blue	X	36dB	23dB
Signal Red	34dB	X	22dB
Signal Green	23dB	22dB	X

Table of crosstalk at a frequency of 4 Mhz.

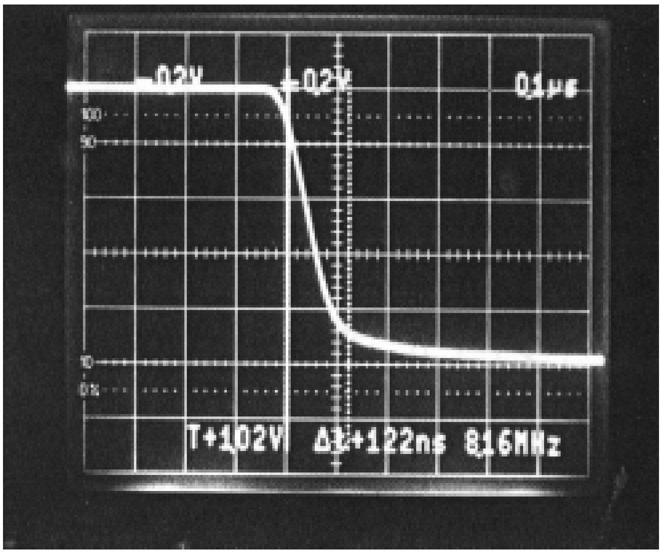


Fig.23 Fall time of the TDA6107Q-N1 at Vo= 100Vp-p
Measured with Rflash = 1k , measured in TV set.
Hor: 100nS/div Vert: 20V/div

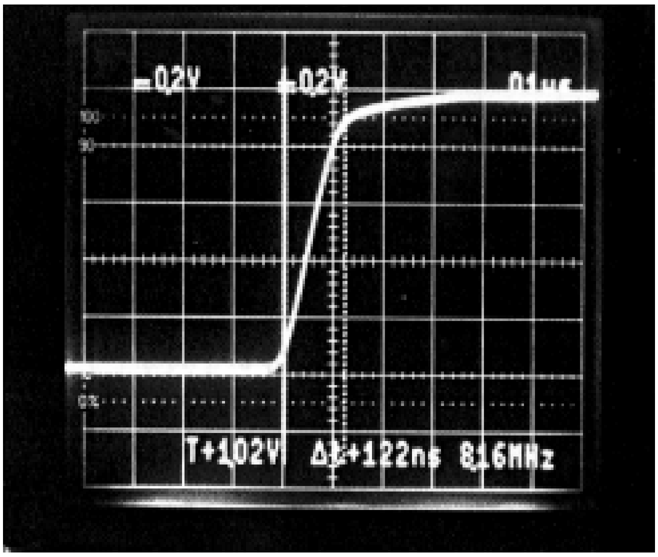


Fig.24 Rise time of the TDA6107Q-N1 at Vo= 100Vp-p
Measured with Rflash = 1k , measured in TV set.
Hor: 100nS/div Vert: 20V/div

APPENDIX.

IMPERFECTIONS OF TDA6107Q-N1.

- Flash performance.
  The flash performance of the TDA6107Q-N1 is not good.
  For a good flash immunity with the TDA6107Q-N1 it is necessary to apply an external protection circuit (resistor & flash diode) for each channel.
  The N2 version will be improved regarding flash robustness, in that case it is allowed to eliminate these extra components.

- Bandwidth.
  The frequency characteristic is not flat. The bode plot shows a decrease of1dB, starting at 1MHz.
  For the TDA6107Q-N1 the value of Rfl is reduced to 1k, in order to compensate partly the slope of bode plot characteristic of the device.
  Reduction of the flash resistor is allowed due to the applied external flash protection.

- Rise & Fall time.
  The rise and fall times are too long between 10 and 90%.
  Between 20 and 80% it is all right.

- Brightness flickering.
  This effect is application/set dependent, but can be solved by the application, no extra components are needed.
  The N1 version is sensitive for unwanted currents in the signal ground which disturb the ABS loop.
  Therefore no capacitive connections between the aquadag connections on the CRT board and the signal ground, in order to prevent injection of discharge currents into the signal ground.

- ESD
  The maximum allowable ESD voltage for the N1 is 1000V HBM and 300V MM.
  However, if Vdd is decoupled properly to ground (situation when IC is mounted on the PCB board) the HBM level has been increased to over 3500V for all pins.

NOTE.
All above mentioned imperfections of the N1 version will be solved at the N2 version.