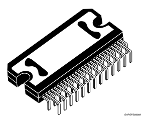
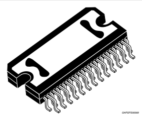
4 x 45 W power amplifier with full I^2C diagnostics, high efficiency and low voltage operation

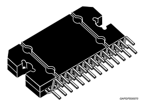
Datasheet - production data



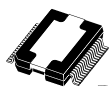
Flexiwatt27 (Horiz.)



Flexiwatt27 (SMD)



Flexiwatt27 (Vert.)



PowerSO36

Features

- Multipower BCD technology
- MOSFET output power stage
- DMOS power output
- High efficiency (class SB)
- High output power capability 4x25 W/4 Ω @ 14.4 V, 1 kHz, 10% THD, 4 x 45 W max power
- 2 Ω driving capability (64 W max power)
- Full I^2C bus driving:
  - Standby
  - Independent front/rear soft play/mute
  - Selectable gain 26 dB /16 dB (for low noise line output function)
  - High efficiency enable/disable
  - I^2C bus digital diagnostics (including DC and AC load detection)
- Flexible fault detection through integrated diagnostic
- DC offset detection
- Four independent short circuit protection
- Clipping detector pin with selectable threshold (2 %/10 %)
- Standby/mute pin
- Linear thermal shutdown with multiple thermal warning
- ESD protection
- Very robust against misconnections
- Improved SVR suppression during battery transients
- Capable to operate down to 6 V (e.g. “Start-stop”)

Description

The TDA75610LV is a new quad bridge car radio amplifier, designed in BCD technology, in order to include a wide range of innovative features in a very compact and flexible device.

The TDA75610LV is equipped with the most complete diagnostics array that communicates the status of each speaker through the I^2C bus.

The dissipated output power under average listening condition is significantly reduced when compared to the conventional class AB solutions, thanks to the patented 'class SB' efficiency concept. TDA75610LV has been designed to be very robust against several kinds of misconnections. It is moreover compliant to the most recent OEM specifications for low voltage operation (so called 'start-stop' battery profile during engine stop), helping car manufacturers to reduce the overall emissions and thus contributing to environment protection. The ST BCD in combination with 'class SB' efficiency and 'intelligent power' has been sold in million of units to most known car manufacturers, the TDA75610LV is the last and most compact member of this power amplifiers family.

Table 1. Device summary

Order code	Package	Packing
TDA75610LVSM	Flexiwatt27 (SMD)	Tube
TDA75610LVSMTR		Tape and reel
TDA75610LV	Flexiwatt27 (vert.)	Tube
TDA75610LVH	Flexiwatt27 (horiz.)	Tube
TDA75610LVPD	PowerSO36	Tube
TDA75610LVPDTR		Tape and reel

Contents

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List of figures

1 Block diagram and application circuits

Figure 1. Block diagram

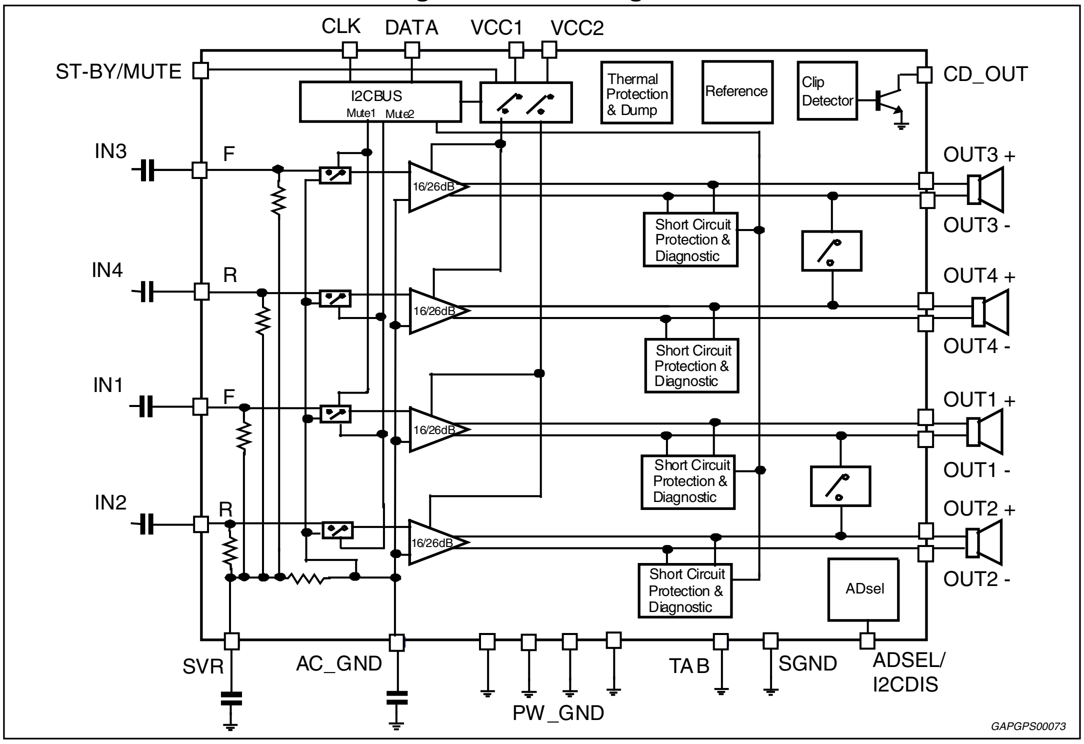


Figure 2. Application circuit

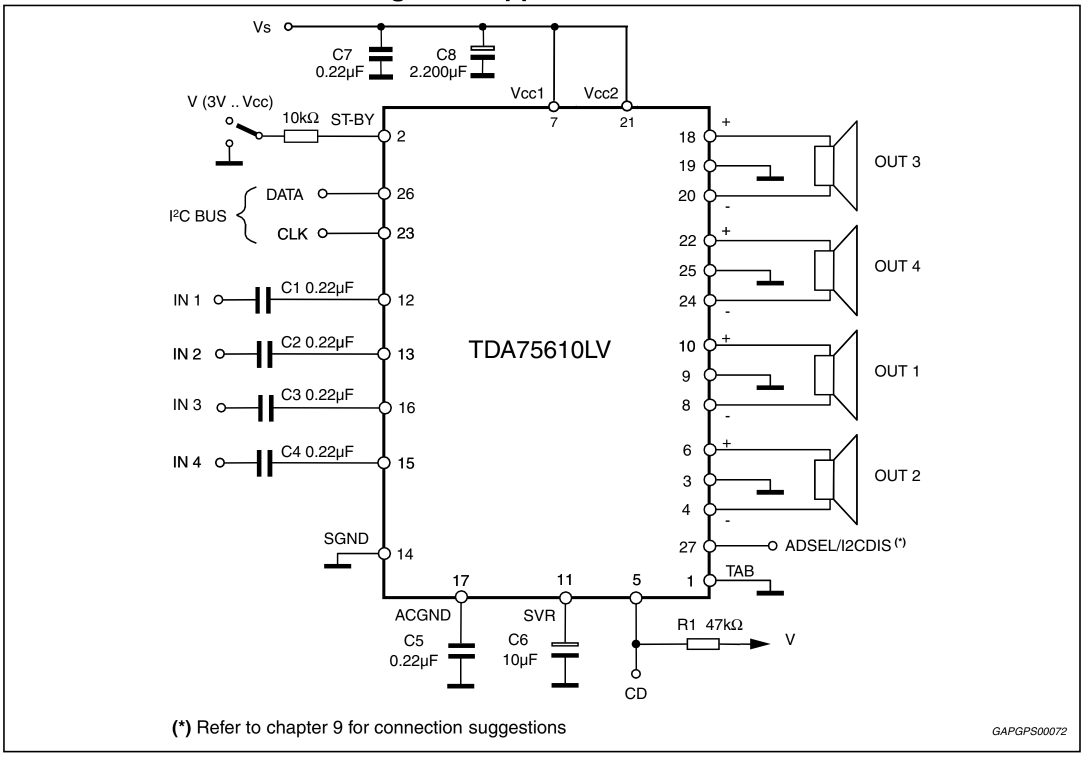
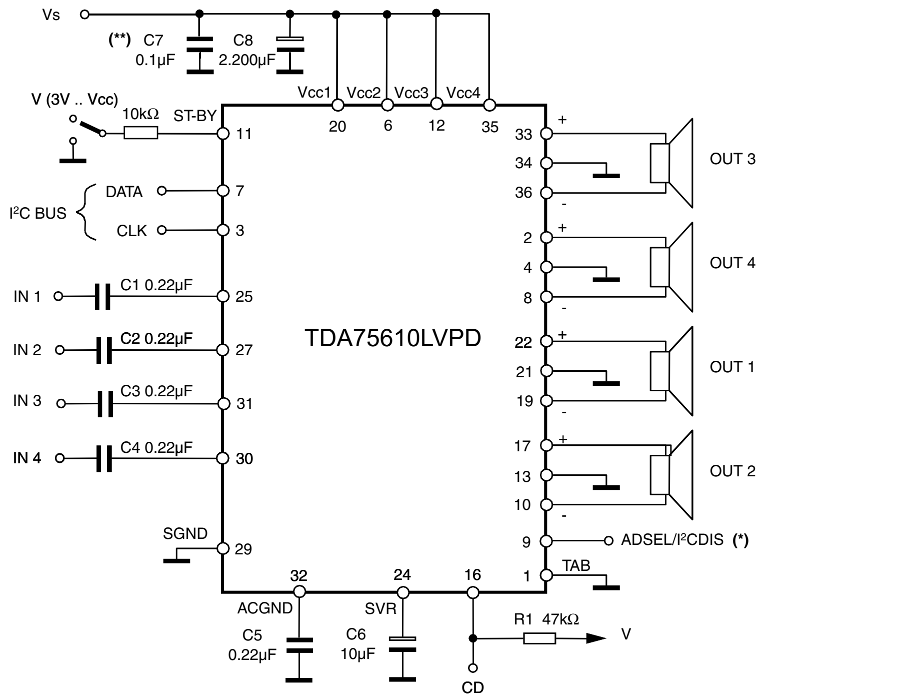


Figure 3. Application circuit (TDA75610LVPD)



(*) Refer to chapter 9 for connection suggestions.
(**) 0.1 μF is the minimum recomended value, 0.22 μF suggested as well.

2 Pin description

For channel name reference: CH1 = LF, CH2 = LR, CH3 = RF and CH4 = RR.

Figure 4. Pin connection diagram of the Flexiwatt27 (top of view)

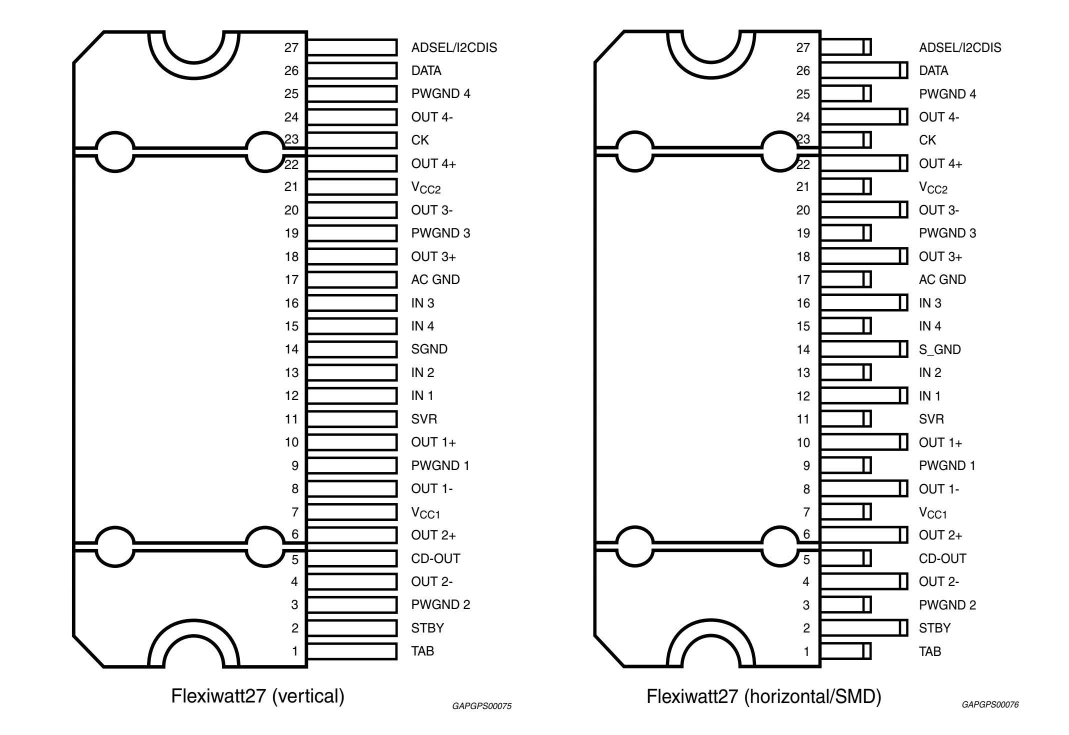


Figure 5. Pin connection diagram of the PowerSO36 slug up (top of view)

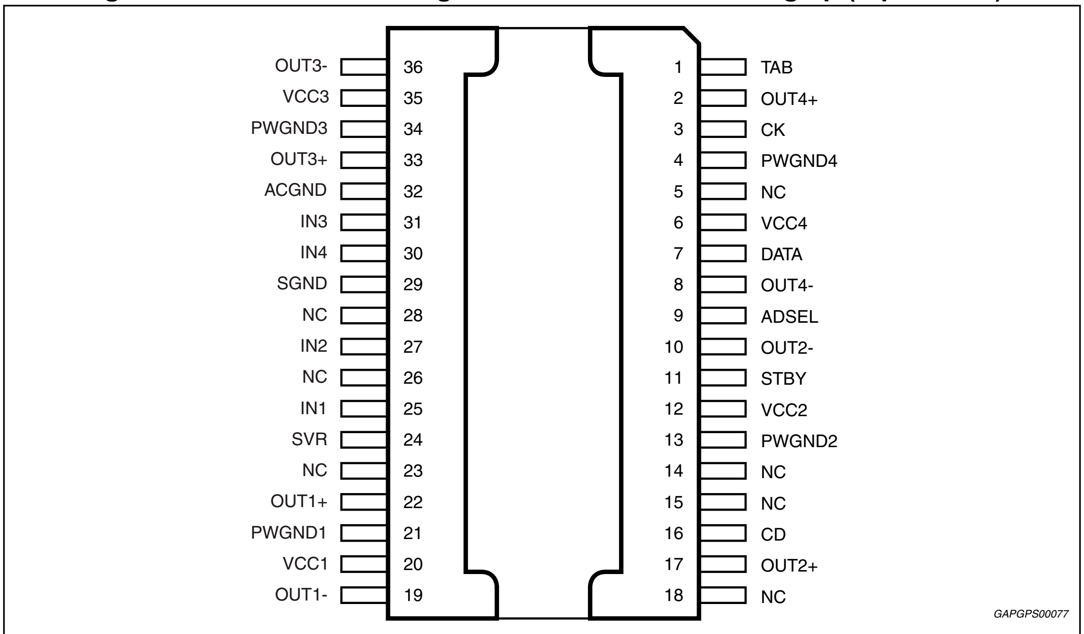


Table 2. Pin list description

Pin # (PowerSo36)	Pin # (Flexiwatt27)	Pin name	Function
1	1	TAB	-
2	22	OUT4+	Channel 4, + output
3	23	CK	I^2C bus clock/HE selector
4	25	PWGND4	Channel 4 output power ground
5	-	NC	Not connected
6	-	VCC4	Supply voltage pin4
7	26	DATA	I^2C bus data pin/gain selector
8	24	OUT4-	Channel 4, - output
9	27	ADSEL	Address selector pin/ I^2C bus disable (legacy select)
10	4	OUT2-	Channel 2, - output
11	2	STBY	Standby pin
12	21	VCC2	Supply voltage pin2
13	3	PWGND2	Channel 2 output power ground
14	-	NC	Not connected
15	-	NC	Not connected
16	5	CD	Clip detector output pin
17	6	OUT2+	Channel 2, + output
18	-	NC	Not connected
19	8	OUT1-	Channel 1, - output
20	7	VCC1	Supply voltage pin1
21	9	PWGND1	Channel 1 output power ground
22	10	OUT1+	Channel 1, + output
23	-	NC	Not connected
24	11	SVR	SVR pin
25	12	IN1	Input pin, channel 1
26	-	NC	Not connected
27	13	IN2	Input pin, channel 2
28	-	NC	Not connected
29	14	SGND	Signal ground pin
30	15	IN4	Input pin, channel 4
31	16	IN3	Input pin, channel 3
32	17	AC GND	AC ground
33	18	OUT3+	Channel 3, + output
34	19	PWGND3	Channel 3 output power ground
35	-	VCC3	Supply voltage pin3
36	20	OUT3-	Channel 3, - output

3 Electrical specifications

3.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{op}	Operating supply voltage(1)	18	V
V_S	DC supply voltage	28	V
V_{peak}	Peak supply voltage (for t_{max} = 50 ms)	50	V
GNDmax	Ground pins voltage	-0.3 to 0.3	V
V_{CK}, V_{DATA}	CK and DATA pin voltage	-0.3 to 6	V
V_{cd}	Clip detector voltage	-0.3 to 5.5	V
V_{stby}	STBY pin voltage	-0.3 to Vop	V
I_O	Output peak current (not repetitive t_{max} = 100ms)	8	A
	Output peak current (repetitive f > 10 kHz)	6	
P_{tot}	Power dissipation T_{case} = 70°C	85	W
T_{stg}, T_j	Storage and junction temperature(2)	-55 to 150	°C
T_{amb}	Operative temperature range	-40 to 105	°C

1. For R_L = 2 Ω the output current limit might be reached for V_{OP} > 16 V; thus triggering sel-protection.
2. A suitable dissipation system should be used to keep T_j inside the specified limits.

3.2 Thermal data

Table 4. Thermal data

Symbol	Parameter	PowerSO	Flexiwatt	Unit
$R_{th\ j\text{-}case}$	Thermal resistance junction-to-caseMax.	1	1	°C/W

3.3 Electrical characteristics

Refer to the test circuit, V_S = 14.4 V; R_L = 4 Ω; f = 1 kHz; G_V = 26 dB; T_{amb} = 25 °C; unless otherwise specified.
Tested at T_{amb} = 25 °C and T_{hot} = 105 °C; functionality guaranteed for T_j = -40 °C to 150 °C.

Table 5. Electrical characteristics

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
General characteristics						
V_S	Supply voltage range	R_L = 4 Ω	6	-	18	V
		R_L = 2 Ω	6	-	16 (1)	
I_d	Total quiescent drain current	-	-	165	250	mA
R_{IN}	Input impedance	-	45	60	70	kΩ
V_{AM}	Min. supply mute threshold	IB1(D7) = 1 Signal attenuation -6 dB	7	-	8	V
		IB1(D7) = 0 (default);(2) Signal attenuation -6 dB	5	-	5.8	
V_{OS}	Offset voltage	Mute & play	-80	0	80	mV
V_{dth}	Dump threshold	-	18.5	-	20.5	V
I_{SB}	Standby current	$V_{standby}$ = 0	-	1	5	µA
SVR	Supply voltage rejection	f = 100 Hz to 10 kHz; V_r = 1 Vpk; R_g = 600 Ω	60	70	-	dB
T_{ON}	Turn on timing (Mute play transition)	D2/D1 (IB1) 0 to 1	-	25	50	ms
T_{OFF}	Turn off timing (Play mute transition)	D2/D1 (IB1) 1 to 0	-	25	50	ms
TH_{WARN1}	Average junction temperature for TH warning 1	DB1 (D7) = 1	-	160	-	°C
TH_{WARN2}	Average junction temperature for TH warning 2	DB4 (D7) = 1	-	145	-	
TH_{WARN3}	Average junction temperature for TH warning 3	DB4 (D6) = 1	-	125	-	
Audio performances						
P_O	Output power	Max. power(3) V_s = 15.2 V, R_L = 4 Ω	-	45	-	W
		THD = 10 %, R_L = 4 Ω THD = 1 %, R_L = 4 Ω	23 -	25 22	-	W W
		R_L = 2 Ω; THD 10 % R_L = 2 Ω; THD 1 % R_L = 2 Ω; Max. power(3) V_s = 14.4 V	-	44 33 64	-	W W W
		Max power@ V_s = 6 V, R_L = 4 Ω	-	5	-	W

Table 5. Electrical characteristics (continued)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
THD	Total harmonic distortion	P_O = 1 W to 10 W; STD mode HE MODE; P_O = 1.5 W HE MODE; P_O = 8 W	-	0.015 0.05 0.1	0.1 0.1 0.5	% % %
		P_O = 1-10 W, f = 10 kHz	-	0.15	0.5	%
		G_V = 16 dB; STD Mode V_O = 0.1 to 5 VRMS	-	0.02	0.05	%
C_T	Cross talk	f = 1 kHz to 10 kHz, R_g = 600 Ω	50	65	-	dB
G_{V1}	Voltage gain 1	-	25	26	27	dB
ΔG_{V1}	Voltage gain match 1	-	-1	-	1	dB
G_{V2}	Voltage gain 2	-	15	16	17	dB
ΔG_{V2}	Voltage gain match 2	-	-1	-	1	dB
E_{IN1}	Output noise voltage 1	R_g = 600 Ω 20 Hz to 22 kHz	-	45	60	µV
E_{IN2}	Output noise voltage 2	R_g = 600 Ω; G_V = 16 dB 20 Hz to 22 kHz	-	20	30	µV
BW	Power bandwidth	-	100	-	-	kHz
CMRR	Input CMRR	V_{CM} = 1 Vpk-pk; Rg = 0 Ω	-	70	-	dB
ΔV_{OITU}	ITU Pop filter output voltage	**Standby to Mute and Mute to Standby transition** T_{amb} = 25 °C, ITU-R 2K, C_{svr} = 10 µF V_s = 14.4 V	-7.5	-	+7.5	mV
		Mute to Play transition T_{amb} = 25 °C, ITU-R 2K, V_s = 14.4 V (4)	-7.5	-	+7.5	mV
		Play to Mute transition T_{amb} = 25 °C, ITU-R 2K, V_s = 14.4 V (5)	-7.5	-	+7.5	mV
Clip detector						
CD_{LK}	Clip det. high leakage current	CD off / V_{CD} = 6 V	-	0	5	µA
CD_{SAT}	Clip det sat. voltage	CD on; I_{CD} = 1 mA	-	-	300	mV
CD_{THD}	Clip det THD level	D0 (IB1) = 1	5	10	15	%
		D0 (IB1) = 0	1	2	3	%
Control pin characteristics						
V_{SBY}	Standby/mute pin for standby	-	0	-	1.2	V
V_{MU}	Standby/mute pin for mute	-	2.9	-	3.5	V
V_{OP}	Standby/mute pin for operating	-	4.5	-	18	V
I_{MU}	Standby/mute pin current	$V_{st\text{-}by/mute}$ = 4.5 V	-	1	5	µA
		$V_{st\text{-}by/mute}$ < 1.2 V	-	0	5	µA

Table 5. Electrical characteristics (continued)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
A_{SB}	Standby attenuation	-	90	110	-	dB
A_M	Mute attenuation	-	80	100	-	dB
Turn on diagnostics 1 (Power amplifier mode)						
Pgnd	Short to GND det. (below this limit, the Output is considered in short circuit to GND)	Power amplifier in standby	-	-	1.2	V
Pvs	Short to Vs det. (above this limit, the output is considered in short circuit to Vs)		Vs -1.2	-	-	V
Pnop	Normal operation thresholds. (Within these limits, the output is considered without faults).		1.8	-	Vs -1.8	V
Lsc	Shorted load det.		-	-	0.5	Ω
Lop	Open load det.		85	-	-	Ω
Lnop	Normal load det.		1.5	-	45	Ω
Turn on diagnostics 2 (Line driver mode)						
Pgnd	Short to GND det. (below this limit, the output is considered in short circuit to GND)	Power amplifier in standby	-	-	1.2	V
Pvs	Short to Vs det. (above this limit, the output is considered in short circuit to Vs)	-	Vs -1.2	-	-	V
Pnop	Normal operation thresholds. (Within these limits, the output is considered without faults).	-	1.8	-	Vs -1.8	V
Lsc	Shorted load det.	-	-	-	1.5	Ω
Lop	Open load det.	-	330	-	-	Ω
Lnop	Normal load det.	-	7	-	180	Ω
Permanent diagnostics 2 (Power amplifier mode or line driver mode)						
Pgnd	Short to GND det. (below this limit, the Output is considered in short circuit to GND)	Power amplifier in mute or play, one or more short circuits protection activated	-	-	1.2	V
Pvs	Short to Vs det. (above this limit, the output is considered in short circuit to Vs)		Vs -1.2	-	-	V
Pnop	Normal operation thresholds. (Within these limits, the output is considered without faults).		1.8	-	Vs -1.8	V
L_{SC}	Shorted load det.	Power amplifier mode	-	-	0.5	Ω
		Line driver mode	-	-	1.5	Ω

Table 5. Electrical characteristics (continued)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_O	Offset detection	Power amplifier in play, AC input signals = 0	±1.5	±2	±2.5	V
I_{NLH}	Normal load current detection	V_O < (V_S-5)pk, IB2 (D7) = 0	500	-	-	mA
I_{OLH}	Open load current detection		-	-	250	mA
I_{NLL}	Normal load current detection	V_O < (V_S-5)pk, IB2 (D7) = 1	250	-	-	mA
I_{OLL}	Open load current detection		-	-	125	mA
I^2C bus interface						
S_{CL}	Clock frequency	-	-	-	400	kHz
V_{IL}	Input low voltage	-	-	-	1.5	V
V_{IH}	Input high voltage	-	2.3	-	-	V

1. When V_S > 16 V the output current limit is reached (triggering embedded internal protections).
2. In legacy mode only low threshold option is available.
3. Saturated square wave output.
4. Voltage ramp on STBY pin:
from 3.3 V to 4.2 V in t ≥ 40 ms.
In case of I^2C mode command IB1(D1) = 1 (Mute → Unmute rear channels) and/or IB1(D2) = 1 (Mute → Unmute front channels) must be transmitted before to start the voltage ramp on STBY pin.
5. Voltage ramp on STBY pin:
from 4.05 V to 3.55 V in t ≥ 40 ms.
In case of I^2C mode command IB1(D1) = 0 Unmute → Mute rear channels) and/or IB1(D2) = 0 (Unmute → Mute front channels) must be NOT transmitted before to start the voltage ramp on STBY pin.

3.4 Typical electrical characteristics curves

Figure 6. Quiescent current vs. supply voltage

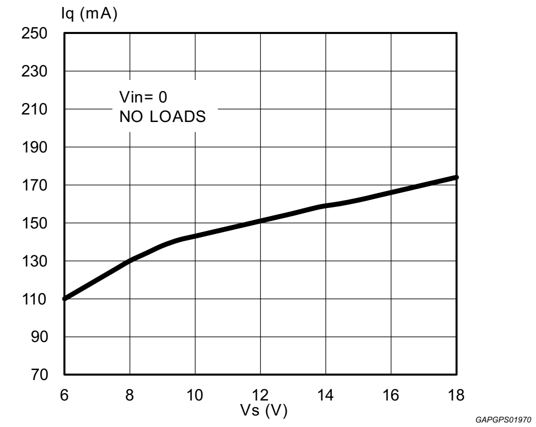


Figure 7. Output power vs. supply voltage (4 Ω)

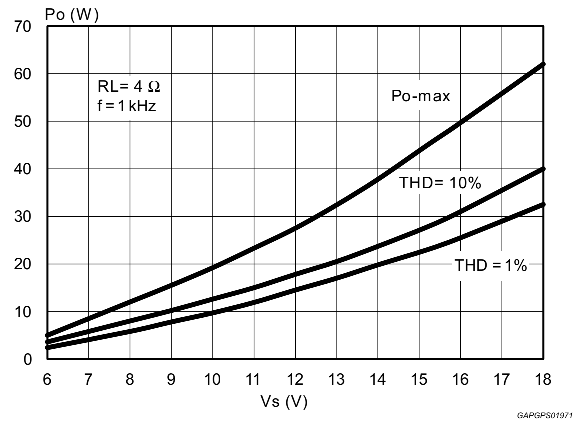


Figure 8. Output power vs. supply voltage (2 Ω)

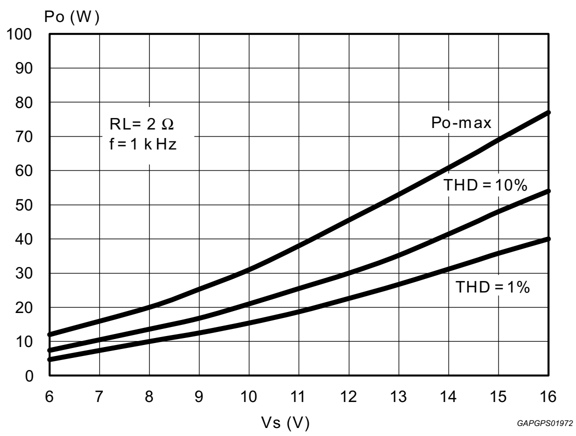


Figure 9. Distortion vs. output power (4 Ω, STD)

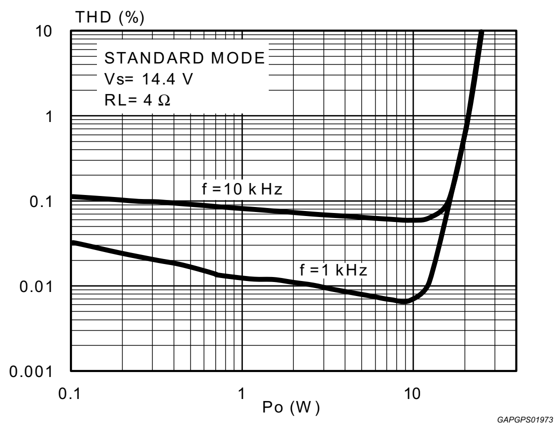


Figure 10. Distortion vs. output power (4 Ω, HI-EFF)

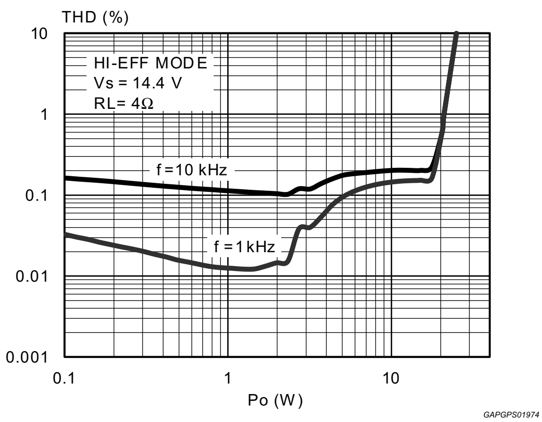


Figure 11. Distortion vs. output power (2 Ω, STD)

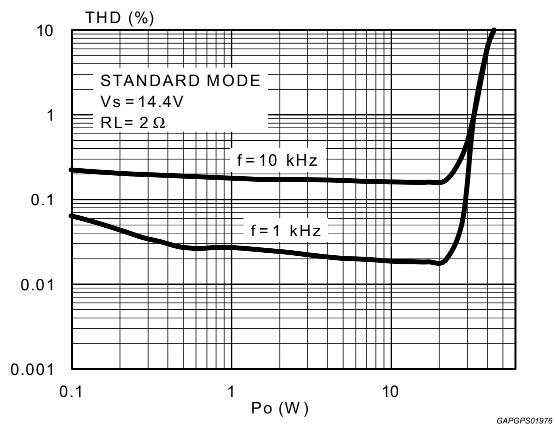


Figure 12. Distortion vs. output power (2 Ω, HI-EFF)

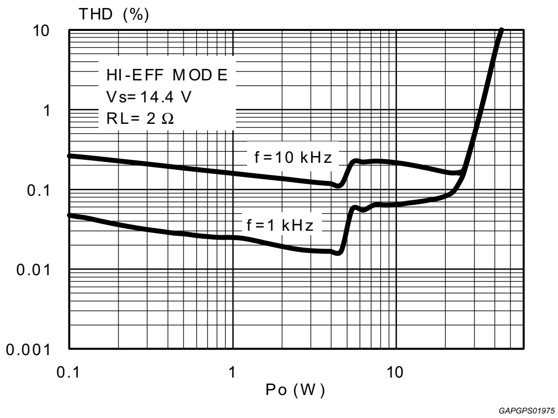


Figure 13. Distortion vs. output power V_s = 6 V (4 Ω, STD)

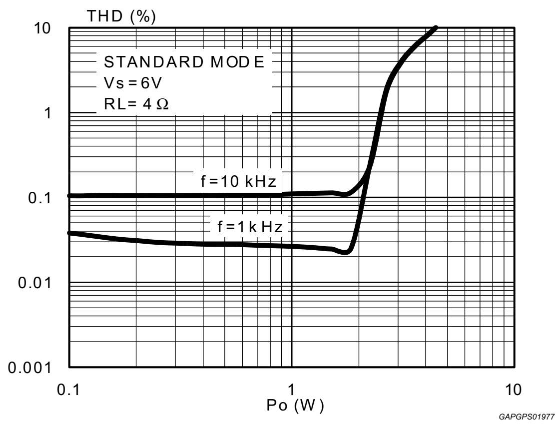


Figure 14. Distortion vs. frequency (4 Ω)

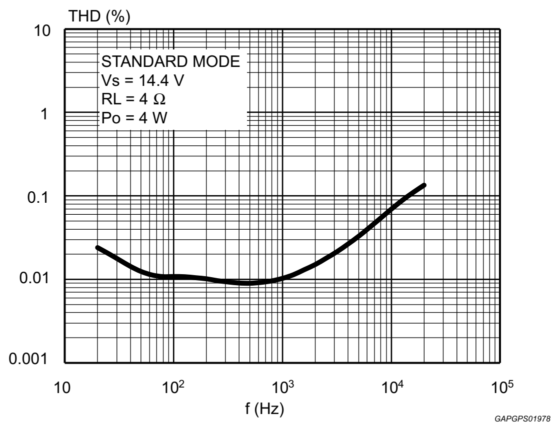


Figure 15. Distortion vs. frequency (2 Ω)

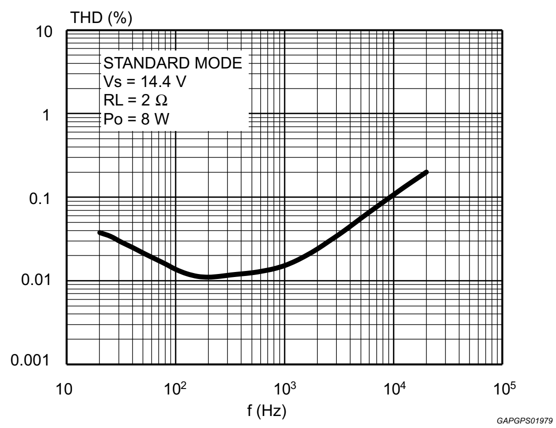


Figure 16. Crosstalk vs. frequency

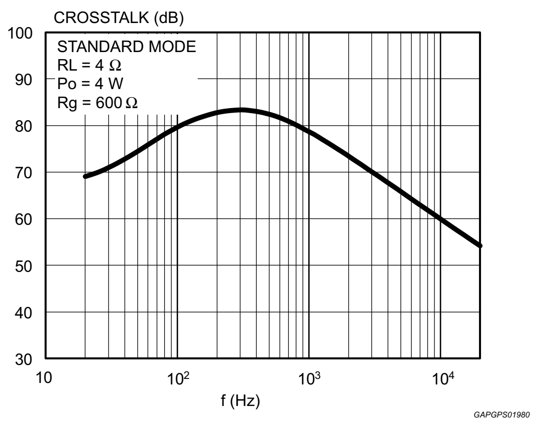


Figure 17. Supply voltage rejection vs. frequency

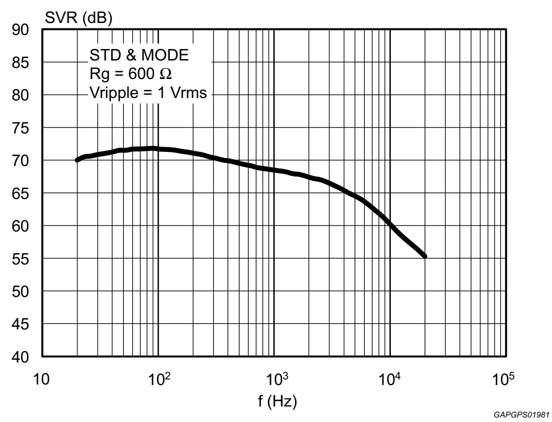


Figure 18. Power dissipation vs. average output power (audio program simulation, 4 Ω)

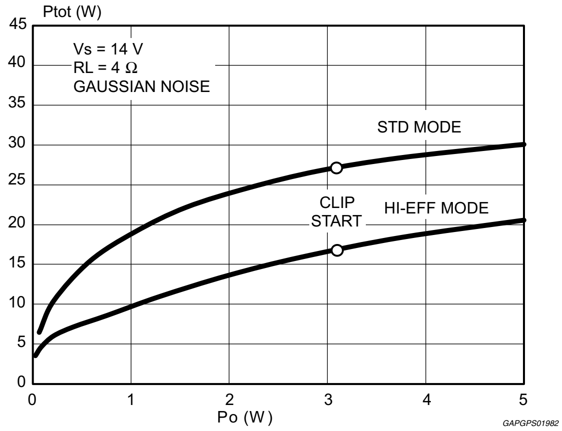


Figure 19. Power dissipation vs. average output power (audio program simulation, 2 Ω)

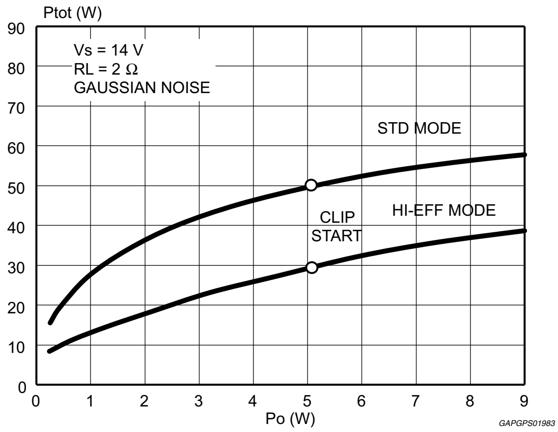


Figure 20. Total power dissipation and efficiency vs. output power (4 Ω, HI-EFF, Sine)

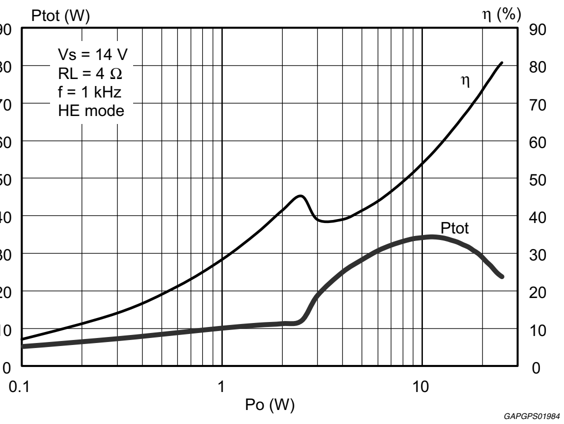


Figure 21. Total power dissipation and efficiency vs. output power (4 Ω, STD, Sine)

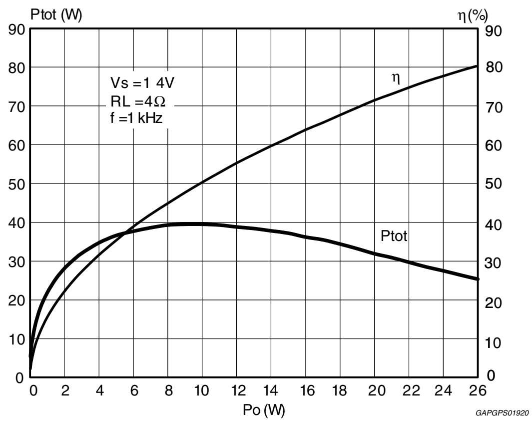
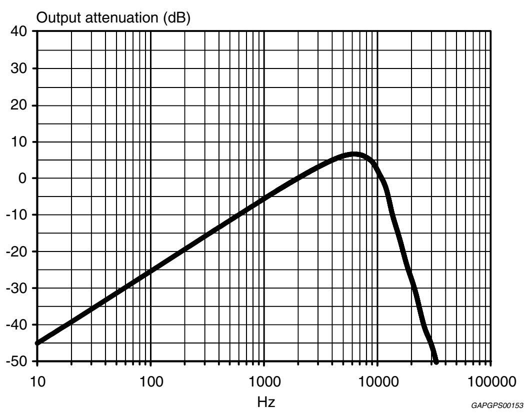


Figure 22. ITU R-ARM frequency response, weighting filter for transient pop



4 Diagnostics functional description

4.1 Turn-on diagnostic

It is recommended to activate this function at the turn-on (standby out) through an I^2C bus request. Detectable output faults are:

- SHORT TO GND
- SHORT TO VS
- SHORT ACROSS THE SPEAKER
- OPEN SPEAKER

To verify if any of the above misconnections are in place, a subsonic (inaudible) current pulse (*Figure 23*) is internally generated, sent through the speaker(s) and sunk back.The Turn On diagnostic status is internally stored until a successive diagnostic pulse is requested (after a I^2C reading).

If the "standby out" and "diag. enable" commands are both given through a single programming step, the pulse takes place first (during the pulse the power stage stays 'off', showing high impedance at the outputs).

Afterwards, when the amplifier is biased, the PERMANENT diagnostic takes place. The previous turn-on state is kept until a short appears at the outputs.

Figure 23. Turn-on diagnostic: working principle

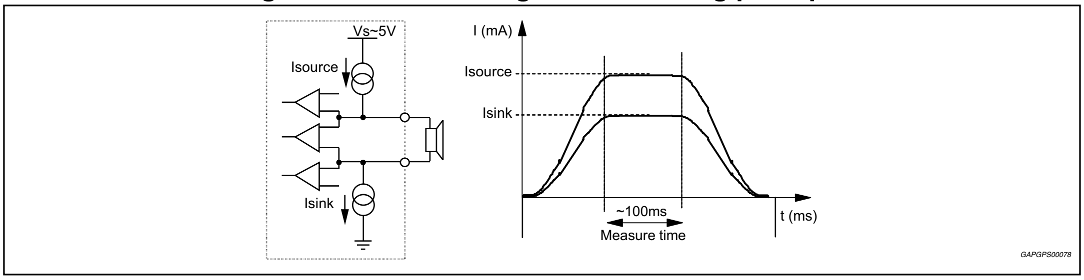


Figure 24 and *25* show SVR and OUTPUT waveforms at the turn-on (standby out) with and without turn-on diagnostic.

Figure 24. SVR and output behavior (Case 1: without turn-on diagnostic)

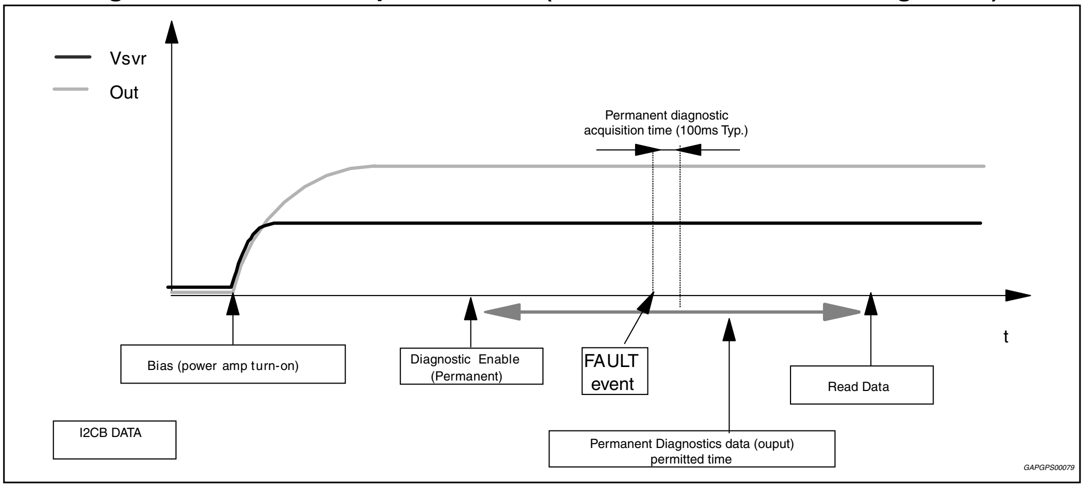
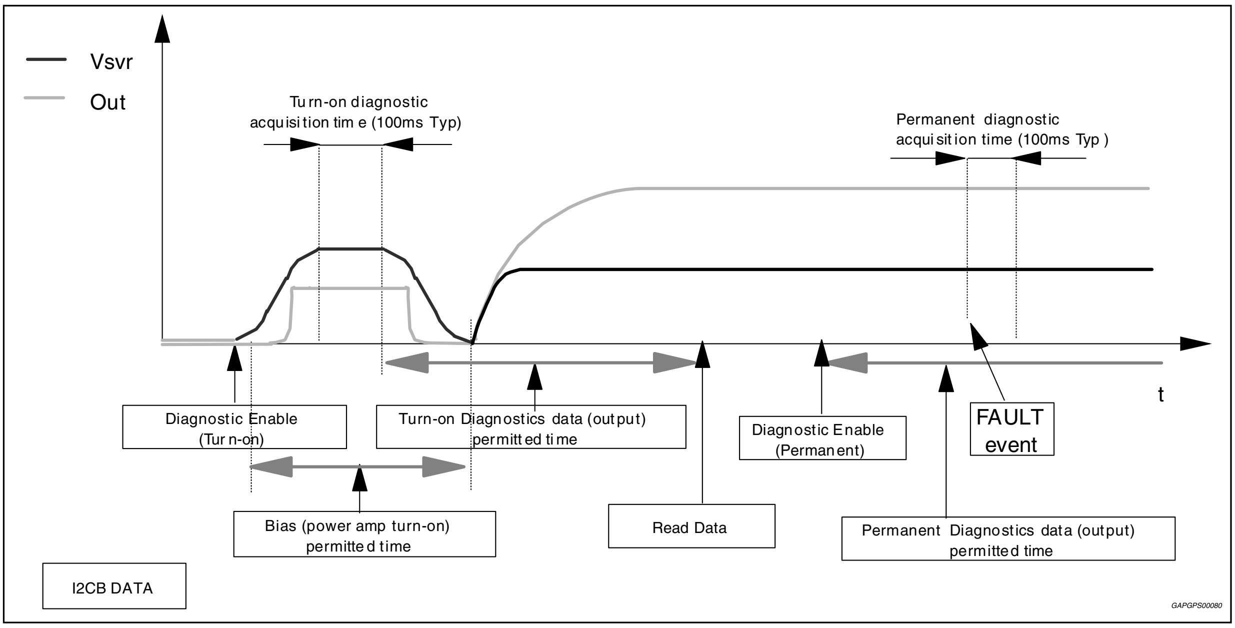
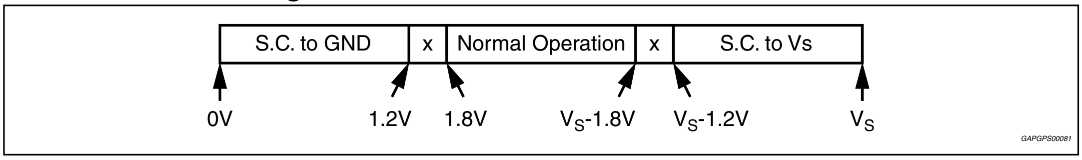


Figure 25. SVR and output pin behavior (Case 2: with turn-on diagnostic)



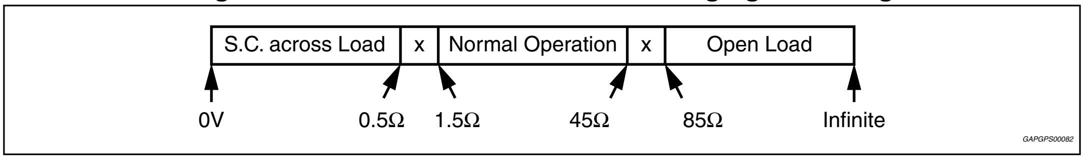
The information related to the outputs status is read and memorized at the end of the current pulse plateau. The acquisition time is 100 ms (typ.). No audible noise is generated in the process. As for SHORT TO GND / Vs the fault-detection thresholds remain unchanged from 26 dB to 16 dB gain setting. They are as follows:

Figure 26. Short circuit detection thresholds



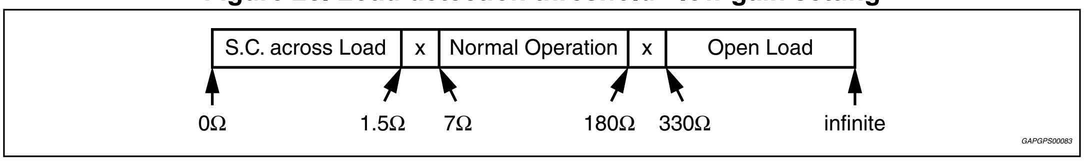
Concerning SHORT ACROSS THE SPEAKER / OPEN SPEAKER, the threshold varies from 26 dB to 16 dB gain setting, since different loads are expected (either normal speaker's impedance or high impedance). The values in case of 26 dB gain are as follows:

Figure 27. Load detection thresholds - high gain setting



If the Line-Driver mode (Gv= 16 dB and Line Driver Mode diagnostic = 1) is selected, the same thresholds will change as follows:

Figure 28. Load detection threshold - low gain setting



4.2 Permanent diagnostics

Detectable conventional faults are:
- Short to GND
- Short to Vs
- Short across the speaker

The following additional feature is provided:
- Output offset detection

The TDA75610LV has 2 operating status:

1. RESTART mode. The diagnostic is not enabled. Each audio channel operates independently of each other. If any of the a.m. faults occurs, only the channel(s) interested is shut down. A check of the output status is made every 1 ms (*Figure 29*). Restart takes place when the overload is removed.
2. DIAGNOSTIC mode. It is enabled via I^2C bus and it self activates if an output overload (such as to cause the intervention of the short-circuit protection) occurs to the speakers outputs. Once activated, the diagnostics procedure develops as follows (*Figure 30*):
   - To avoid momentary re-circulation spikes from giving erroneous diagnostics, a check of the output status is made after 1ms: if normal situation (no overloads) is detected, the diagnostic is not performed and the channel returns active.
   - Instead, if an overload is detected during the check after 1 ms, then a diagnostic cycle having a duration of about 100 ms is started.
   - After a diagnostic cycle, the audio channel interested by the fault is switched to RESTART mode. The relevant data are stored inside the device and can be read by the microprocessor. When one cycle has terminated, the next one is activated by an I^2C reading. This is to ensure continuous diagnostics throughout the car-radio operating time.
   - To check the status of the device a sampling system is needed. The timing is chosen at microprocessor level (over half a second is recommended).

Figure 29. Restart timing without diagnostic enable (permanent) - Each 1 mS time, a sampling of the fault is done

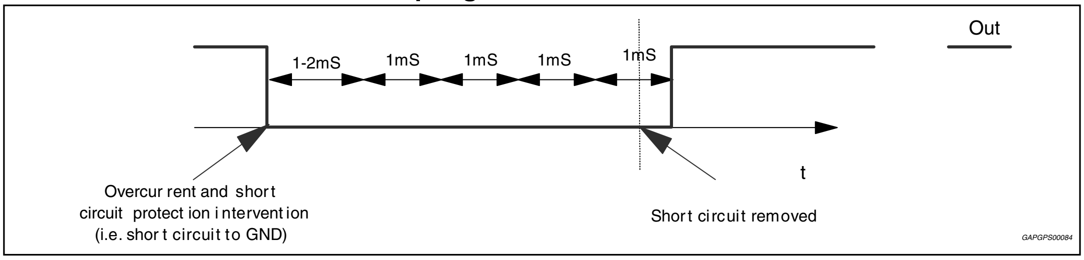
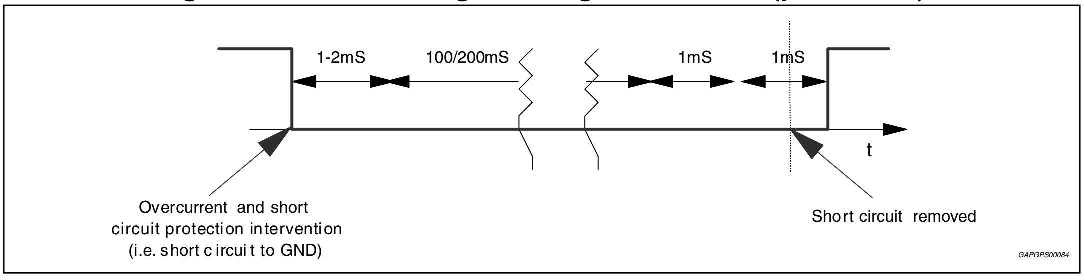


Figure 30. Restart timing with diagnostic enable (permanent)



4.3 Output DC offset detection

Any DC output offset exceeding ±2 V are signalled out. This inconvenient might occur as a consequence of initially defective or aged and worn-out input capacitors feeding a DC component to the inputs, so putting the speakers at risk of overheating.

This diagnostic has to be performed with low-level output AC signal (or Vin = 0).

The test is run with selectable time duration by microprocessor (from a "start" to a "stop" command):

- START = Last reading operation or setting IB1 - D5 - (OFFSET enable) to 1
- STOP = Actual reading operation

Excess offset is signalled out if it is persistent of all the assigned testing time. This feature is disabled if any overloads leading to activation of the short-circuit protection occurs in the process.

4.4 AC diagnostic

It is targeted at detecting accidental disconnection of tweeters in 2-way speaker and, more in general, presence of capacitive (AC) coupled loads.

This diagnostic is based on the notion that the overall speaker's impedance (woofer + parallel tweeter) will tend to increase towards high frequencies if the tweeter gets disconnected, because the remaining speaker (woofer) would be out of its operating range (high impedance). The diagnostic decision is made according to peak output current thresholds, and it is enabled by setting (IB2-D2) = 1. Two different detection levels are available:

- High current threshold IB2 (D7) = 0
  Iout > 500 mApk = normal status
  Iout < 250 mApk = open tweeter
- Low current threshold IB2 (D7) = 1
  Iout > 250 mApk = normal status
  Iout < 125 mApk = open tweeter

To correctly implement this feature, it is necessary to briefly provide a signal tone (with the amplifier in "play") whose frequency and magnitude are such as to determine an output current higher than 500 mApk with IB2(D7) = 0 (higher than 250 mApk with IB2(D7) = 1) in normal conditions and lower than 250 mApk with IB2(D7) = 0 (lower than 125 mApk with IB2(D7)=1) should the parallel tweeter be missing.

The test has to last for a minimum number of 3 sine cycles starting from the activation of the AC diagnostic function IB2<D2>) up to the I^2C reading of the results (measuring period). To confirm presence of tweeter, it is necessary to find at least 3 current pulses over the above threadless over all the measuring period, else an "open tweeter" message will be issued.

The frequency / magnitude setting of the test tone depends on the impedance characteristics of each specific speaker being used, with or without the tweeter connected (to be calculated case by case). High-frequency tones (> 10 kHz) or even ultrasonic signals are recommended for their negligible acoustic impact and also to maximize the impedance module's ratio between with tweeter-on and tweeter-off.

Figure 31 and *32* shows the load impedance as a function of the peak output voltage and the relevant diagnostic fields.

It is recommended to keep output voltage always below 8 V (high threshold case) or 4 V (low threshold case) to avoid the circuit to saturate (causing wrong detection cases).

This feature is disabled if any overloads leading to activation of the short-circuit protection occurs in the process.

Figure 31. Current detection high: load impedance |Z| vs. output peak voltage

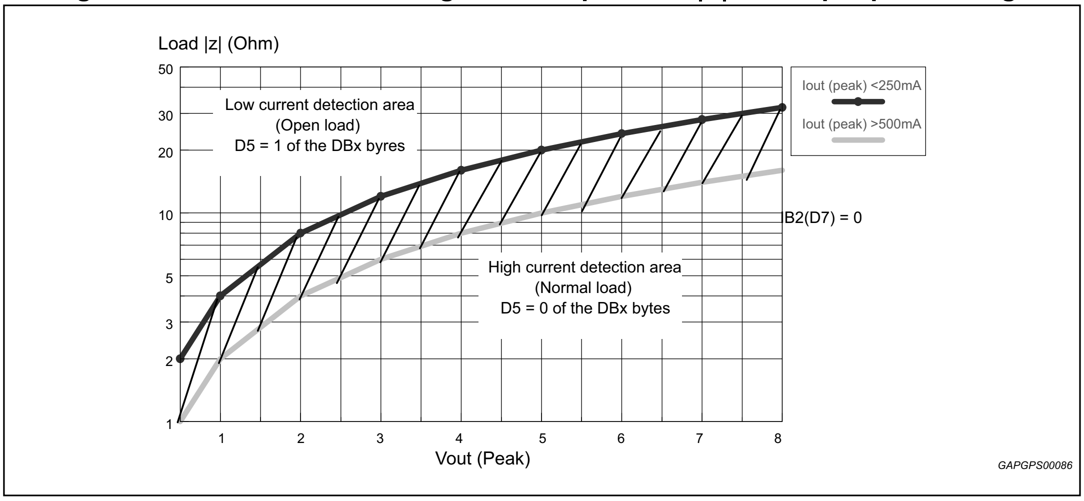
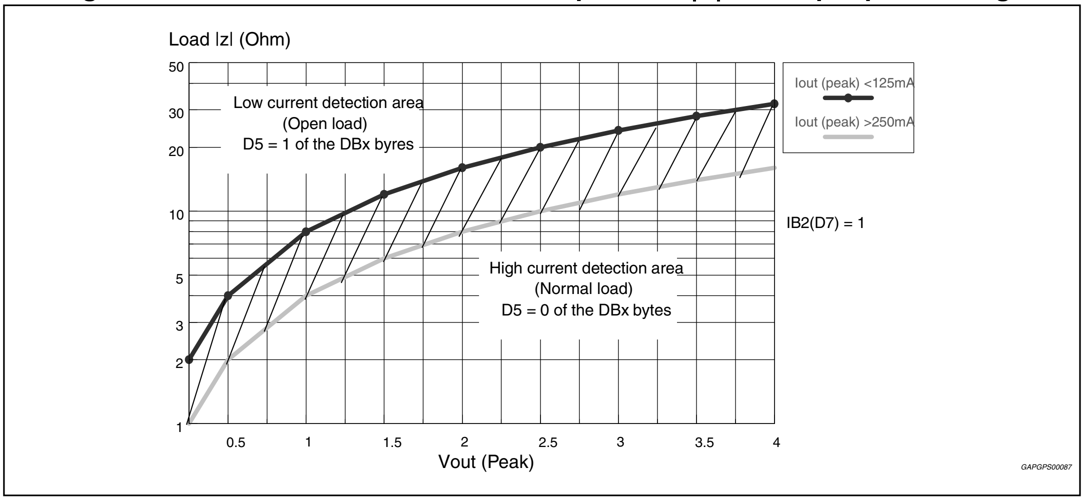


Figure 32. Current detection low: load impedance |Z| vs. output peak voltage



5 Multiple faults

When more misconnections are simultaneously in place at the audio outputs, it is guaranteed that at least one of them is initially read out. The others are notified after successive cycles of I^2C reading and faults removal, provided that the diagnostic is enabled. This is true for both kinds of diagnostic (Turn on and Permanent).

The table below shows all the couples of double-fault possible. It should be taken into account that a short circuit with the 4 ohm speaker unconnected is considered as double fault.

Table 6. Double fault table for turn on diagnostic

	S. GND	S. Vs	S. Across L.	Open L.
S. GND	S. GND	S. Vs + S. GND	S. GND	S. GND
S. Vs	/	S. Vs	S. Vs	S. Vs
S. Across L.	/	/	S. Across L.	N.A.
Open L.	/	/	/	Open L. (*)

In Permanent Diagnostic the table is the same, with only a difference concerning Open Load(*), which is not among the recognizable faults. Should an Open Load be present during the device's normal working, it would be detected at a subsequent Turn on Diagnostic cycle (i.e. at the successive Car Radio Turn on).

5.1 Faults availability

All the results coming from I^2C bus, by read operations, are the consequence of measurements inside a defined period of time. If the fault is stable throughout the whole period, it will be sent out.

To guarantee always resident functions, every kind of diagnostic cycles (Turn on, Permanent, Offset) will be reactivate after any I^2C reading operation. So, when the micro reads the I^2C, a new cycle will be able to start, but the read data will come from the previous diag. cycle (i.e. The device is in Turn On state, with a short to Gnd, then the short is removed and micro reads I^2C. The short to Gnd is still present in bytes, because it is the result of the previous cycle. If another I^2C reading operation occurs, the bytes do not show the short). In general to observe a change in Diagnostic bytes, two I^2C reading operations are necessary.

6 Thermal protection

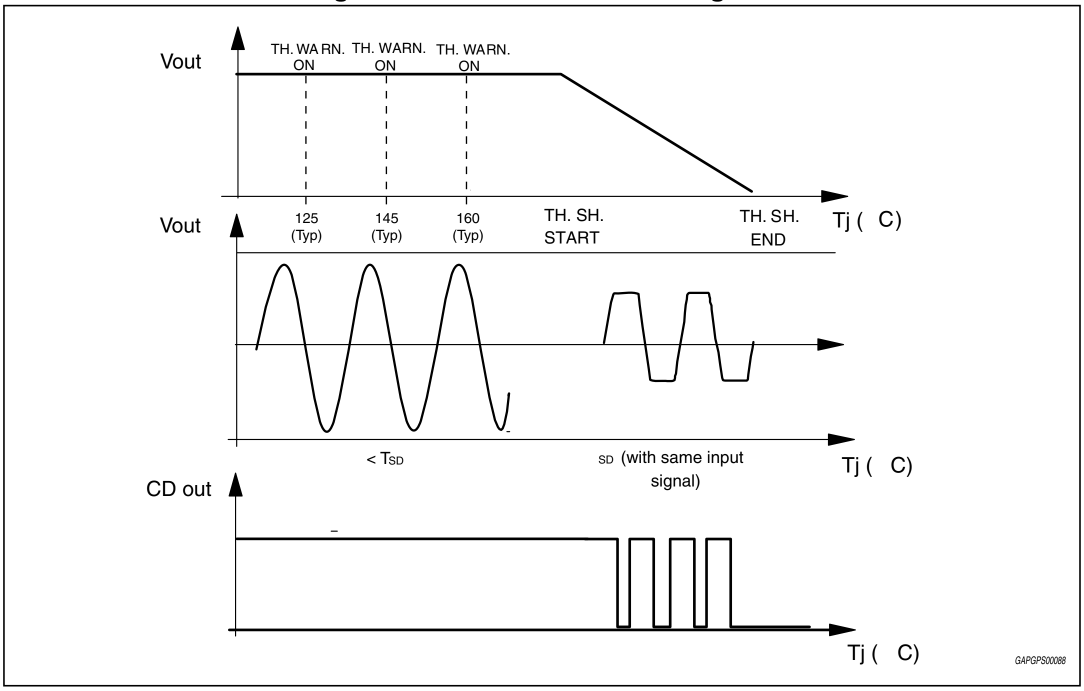
Thermal protection is implemented through thermal foldback (*Figure 33*).

Thermal foldback begins limiting the audio input to the amplifier stage as the junction temperatures rise above the normal operating range. This effectively limits the output power capability of the device thus reducing the temperature to acceptable levels without totally interrupting the operation of the device.

The output power will decrease to the point at which thermal equilibrium is reached. Thermal equilibrium will be reached when the reduction in output power reduces the dissipated power such that the die temperature falls below the thermal foldback threshold. Should the device cool, the audio level will increase until a new thermal equilibrium is reached or the amplifier reaches full power. Thermal foldback will reduce the audio output level in a linear manner.

Three thermal warning are available through the I^2C bus data. After thermal shut down threshold is reached, the CD could toggle (as shown in *Figure 33*) or stay low, depending on signal level.

Figure 33. Thermal foldback diagram



6.1 Fast muting

The muting time can be shortened to less than 1.5 ms by setting (IB2) D5 = 1. This option can be useful in transient battery situations (i.e. during car engine cranking) to quickly turnoff the amplifier to avoid any audible effects caused by noise/transients being injected by preamp stages. The bit must be set back to “0” shortly after the mute transition.

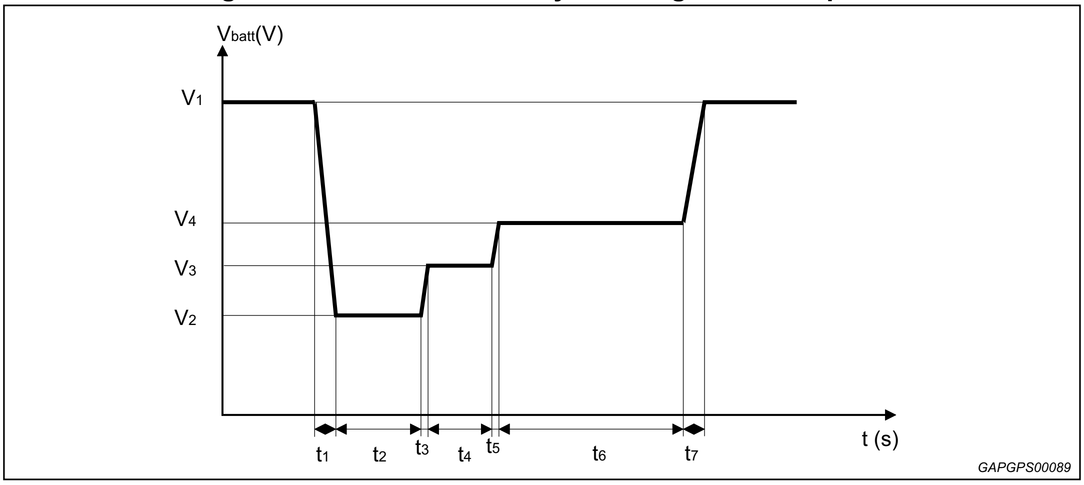
7 Battery transitions management

7.1 Low voltage operation (“start stop”)

The most recent OEM specifications are requiring automatic stop of car engine at traffic light, in order to reduce emissions of polluting substances. The TDA75610LV, thanks to its innovating design, allows to go on playing sound when battery falls down to 6/7V during such conditions, without producing pop noise. The maximum system power will be reduced accordingly.

Supported battery cranking curves are shown below, indicating the shape and durations of allowed battery transitions.

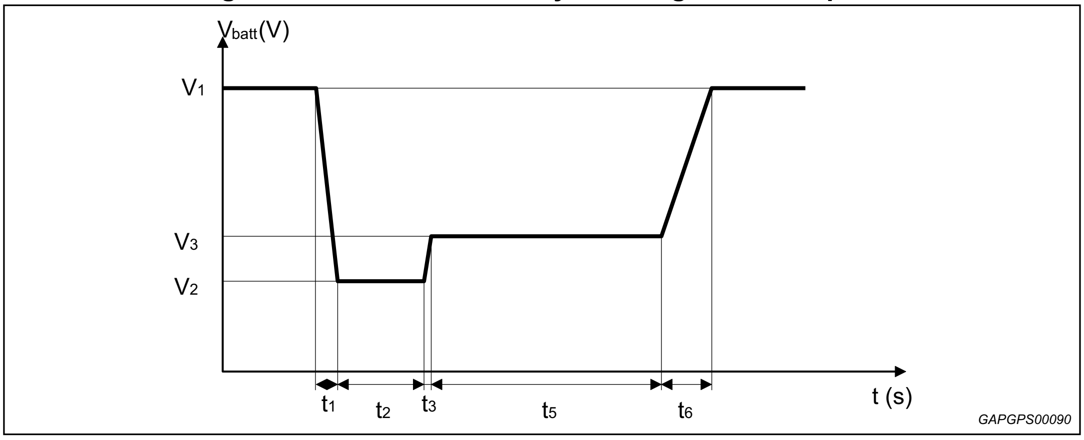
Figure 34. Worst case battery cranking curve sample 1



V1 = 12 V; V2 = 6 V; V3 = 7 V; V4 = 8 V

t1 = 2 ms; t2 = 50 ms; t3 = 5 ms; t4 = 300 ms; t5 =10 ms; t6 = 1 s; t7 = 2 ms

Figure 35. Worst case battery cranking curve sample 2



V1 = 12 V; V2 = 6 V; V3 = 7 V

t1 = 2 ms; t2 = 5 ms; t3 = 15 ms; t5 = 1 s; t6 = 50 ms