



SANYO Semiconductors

# DATA SHEET

## STK412-150C-E — Thick-Film Hybrid IC Two-Channel Power Switching System Audio Power IC, 150W+150W

### Overview

The STK412-150C-E is a class H audio power amplifier hybrid IC that features a built-in power supply switching circuit. This IC provides high efficiency audio power amplification by controlling (switching) the supply voltage supplied to the power devices according to the detected level of the input audio signal.

### Applications

- Audio power amplifiers.

### Features

- High output power by using power MOSFETs.
- Output load impedance:  $R_L = 8\Omega$  to  $6\Omega$  supported
- Using insulated metal substrate that features superlative heat dissipation characteristics that are among the highest in the industry.

### Series Models

	STK412-150C-E	STK412-170C-E
Output (0.7%/20Hz to 20kHz)	150W×2 channels ( $R_L=6\Omega$ )	180W×2 channels ( $R_L=4\Omega$ )
Max. rated $V_H$ (quiescent)	±95V	±95V
Max. rated $V_L$ (quiescent)	±61V	±60V
Recommended operating $V_H$	±57V	±54V
Recommended operating $V_L$	±38V	±37V
Dimensions (excluding pin height)	78.0mm×44.0mm×9.0mm	

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## Specifications

**Absolute maximum ratings** at  $T_a = 25^\circ\text{C}$  (excluding rated temperature items),  $T_c = 25^\circ\text{C}$  unless otherwise specified

Parameter	Symbol	Conditions	Ratings	Unit
$V_H$ maximum quiescent supply voltage 1	$V_H \text{ max (1)}$	When no signal	$\pm 95$	V
$V_H$ maximum supply voltage 2	$V_H \text{ max (2)}$	$R_L \geq 6\Omega$ , 150W, 50ms	$\pm 85$	V
$V_L$ maximum quiescent supply voltage 1	$V_L \text{ max (1)}$	When no signal	$\pm 61$	V
$V_L$ maximum supply voltage 2	$V_L \text{ max (2)}$	$R_L \geq 6\Omega$ , 150W, 50ms	$\pm 55$	V
Maximum voltage between $V_H$ and $V_L$ *4	$V_H - V_L \text{ max}$	No load	60	V
Thermal resistance	$\theta_{j-c}$	Per power transistor	1.3	$^\circ\text{C/W}$
Junction temperature	$T_j \text{ max}$	Both the $T_j \text{ max}$ and $T_c \text{ max}$ conditions must be met.	150	$^\circ\text{C}$
IC substrate operating temperature	$T_c \text{ max}$		125	$^\circ\text{C}$
Storage temperature	$T_{\text{stg}}$		-30 to +125	$^\circ\text{C}$
Allowable load shorted time *3	$t_s$	$V_H = \pm 57\text{V}$ , $V_L = \pm 38\text{V}$ , $R_L = 6\Omega$ , $f = 50\text{Hz}$ , $P_O = 150\text{W}$ , 1-channel active	0.3	s

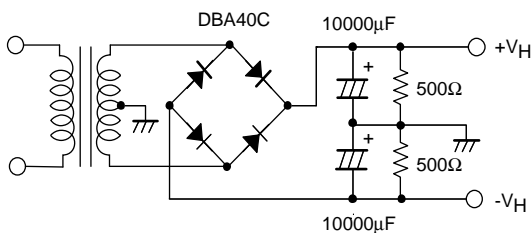
**Electrical Characteristics** at  $T_c = 25^\circ\text{C}$ ,  $R_L = 6\Omega$ ,  $R_g = 600\Omega$ ,  $V_G = 30\text{dB}$ ,  $V_Z = 18\text{V}$ , non-inductive load  $R_L$

Parameter	Symbol	Conditions *1					Ratings			unit	
		$V_{CC}$ (V)		f (Hz)	$P_O$ (W)	THD (%)	min	typ	max		
Output power	$P_O$ (1)	$V_H$ $V_L$	$\pm 57$ $\pm 38$	20 to 20k		0.7	150			W	
Total harmonic distortion	THD (1)	$V_H$ $V_L$	$\pm 57$ $\pm 38$	20 to 20k	150			0.4		%	
Frequency characteristics	$f_L, f_H$	$V_H$ $V_L$	$\pm 57$ $\pm 38$		1.0		+0 -3dB	20 to 50k		Hz	
Input impedance	$r_i$	$V_H$ $V_L$	$\pm 57$ $\pm 38$	1k	1.0			55		k $\Omega$	
Output noise voltage *2	$V_{NO}$	$V_H$ $V_L$	$\pm 68$ $\pm 46$				$R_g = 2.2\text{k}\Omega$		1.0	mVrms	
Quiescent current	$I_{CCO}$	$V_H$	$\pm 68$				$R_L = \infty$		70	mA	
		$V_L$	$\pm 46$					100			
Output neutral voltage	$V_N$	$V_H$ $V_L$	$\pm 68$ $\pm 46$					-70	0	+70	mV

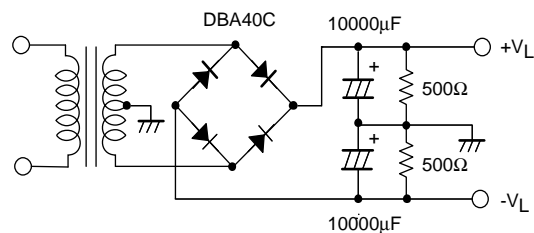
[Remarks]

- \*1: Unless otherwise specified, use a constant-voltage power supply to supply power when inspections are carried out.
- \*2: The output noise voltage values shown are peak values read with a VTVM. However, an AC stabilized (50Hz) power supply should be used to minimize the influence of AC primary side flicker noise on the reading.
- \*3: Use the designated transformer power supply circuit shown in the figure below for the measurements of allowable load shorted time and output noise voltage.
- \*4: Design circuits so that ( $|V_H| - |V_L|$ ) is always less than 40V when switching the power supply with the load connected.
- \*5: Set up the  $V_L$  power supply with an offset voltage at power supply switching ( $V_L - V_O$ ) of about 8V as an initial target.
- \*6: Weight of independent IC: 38.6g

Package dimensions (length×width×height): 429mm×245mm×275mm



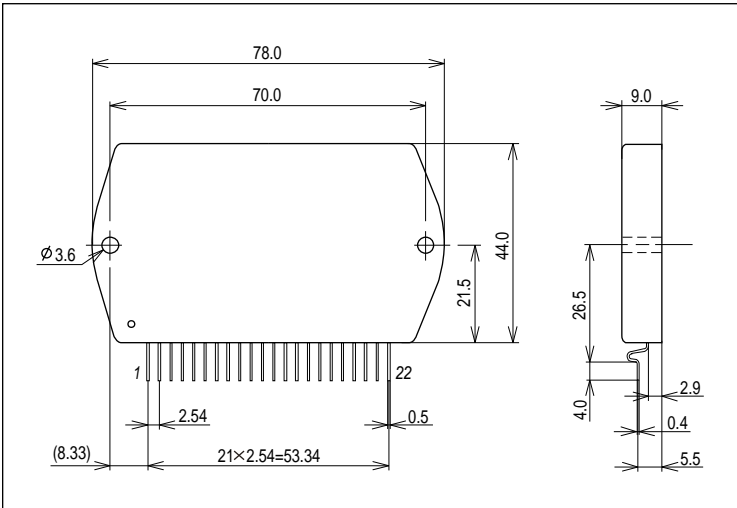
Designated transformer power supply (MG-250 equivalent)



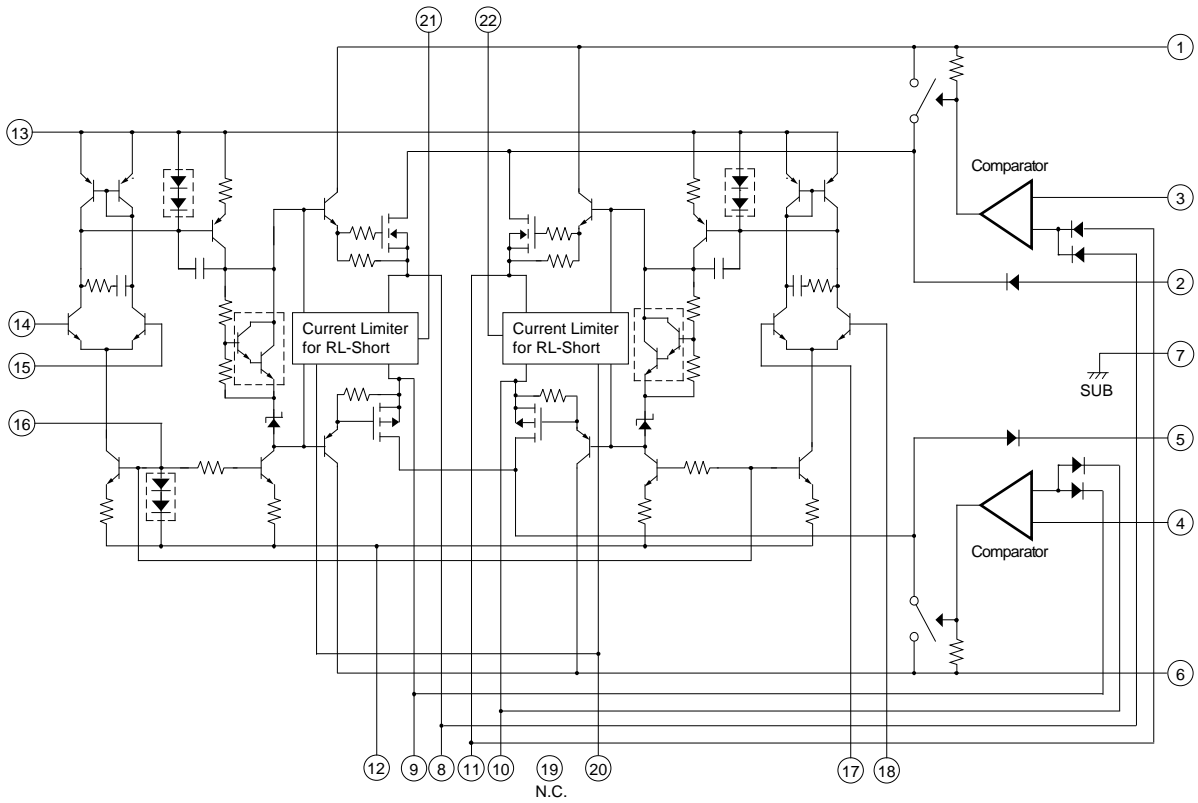
Designated transformer power supply (MG-200 equivalent)

**Package Dimensions**

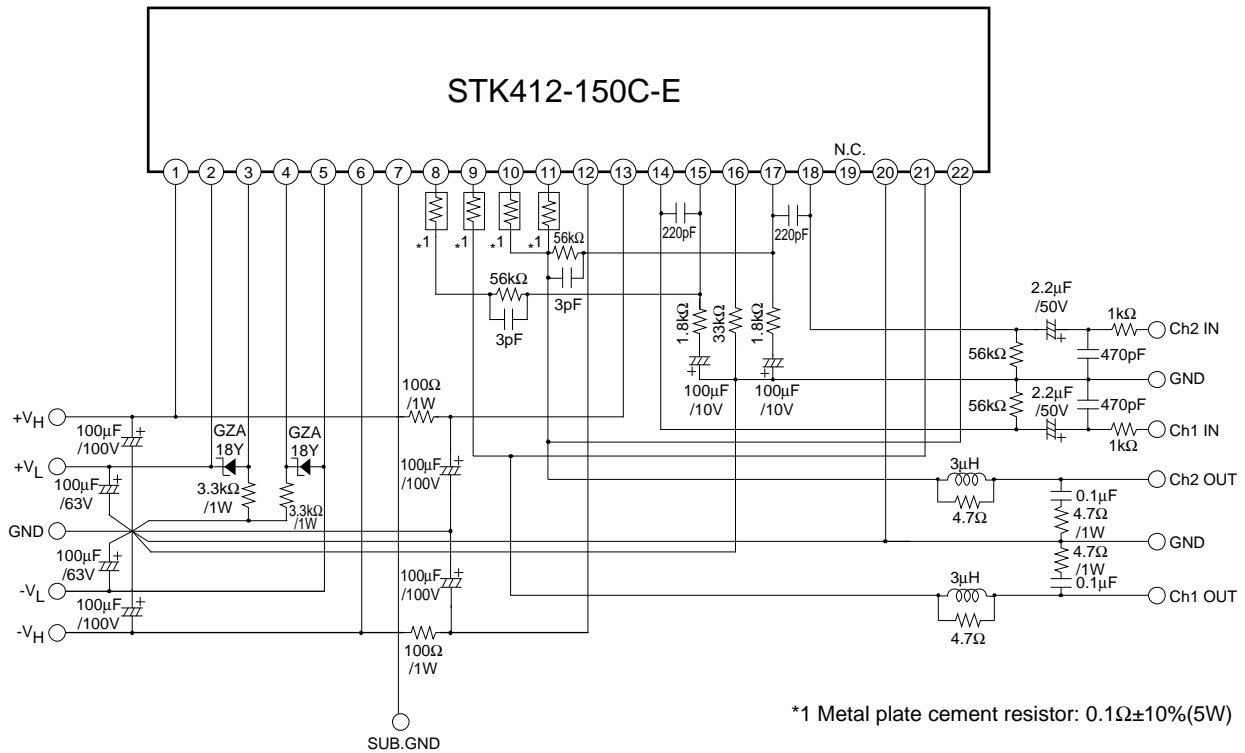
unit:mm (typ)



**Internal Equivalent Circuit**



**Application Circuit Example**

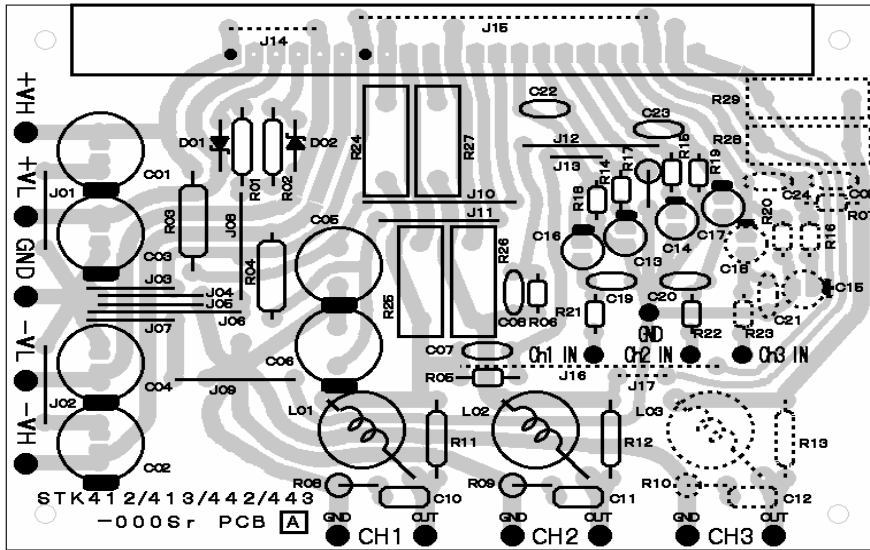


**Pin Assignments**

STK412-150C-E PIN Assignment

PIN No.	PIN Symbol	PIN Assignment
1	+V <sub>H</sub>	+V <sub>H</sub> Power Supply Voltage
2	+V <sub>L</sub>	+V <sub>L</sub> Power Supply Voltage
3	+V <sub>ref</sub>	+Side Shift Voltage Reference
4	-V <sub>ref</sub>	-Side Shift Voltage Reference
5	-V <sub>L</sub>	-V <sub>L</sub> Power Supply Voltage
6	-V <sub>H</sub>	-V <sub>H</sub> Power Supply Voltage
7	SUB GND	H-IC Sub GND
8	Ch1 +RE	Ch1 +Side Emitter Output
9	Ch1 -RE	Ch1 -Side Emitter Output
10	Ch2 -RE	Ch2 -Side Emitter Output
11	Ch1 +RE	Ch1 +Side Emitter Output
12	-Pre V <sub>H</sub>	-Side Pre. Supply Voltage
13	+Pre V <sub>H</sub>	+Side Pre. Supply Voltage
14	Ch1 IN	Ch1 Input
15	Ch1 NF	Ch1 Negative Feedback
16	Bias	Bias
17	Ch2 NF	Ch2 Negative Feedback
18	Ch2 IN	Ch1 Input
19	N.C.	No. Component
20	GND	GND
21	Ch2 FB	Ch2 Feedback for Protection
22	Ch1 FB	Ch1 Feedback for Protection

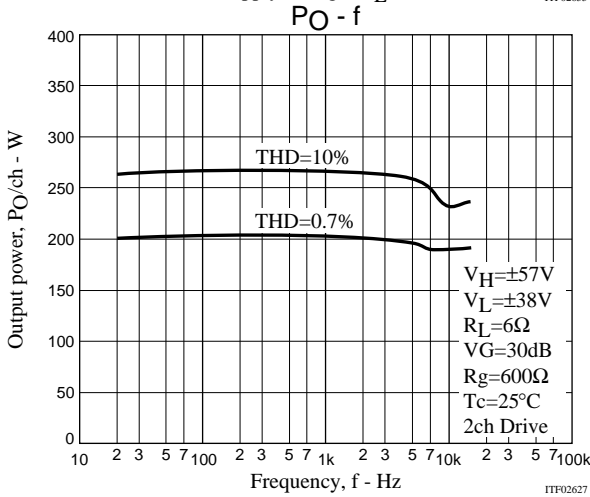
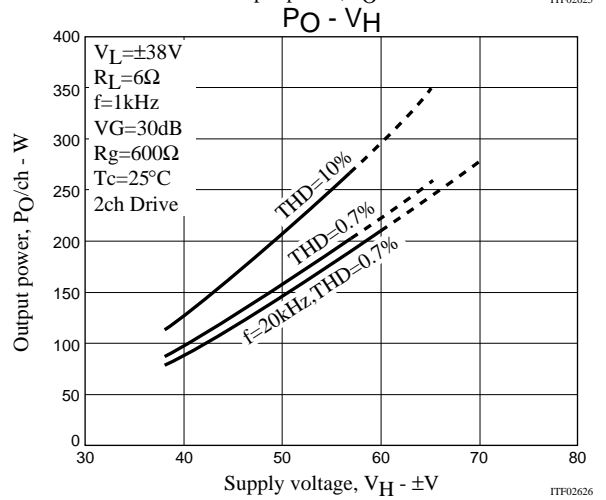
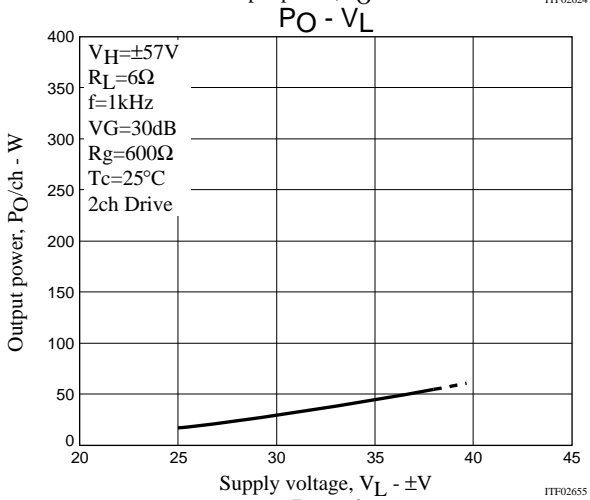
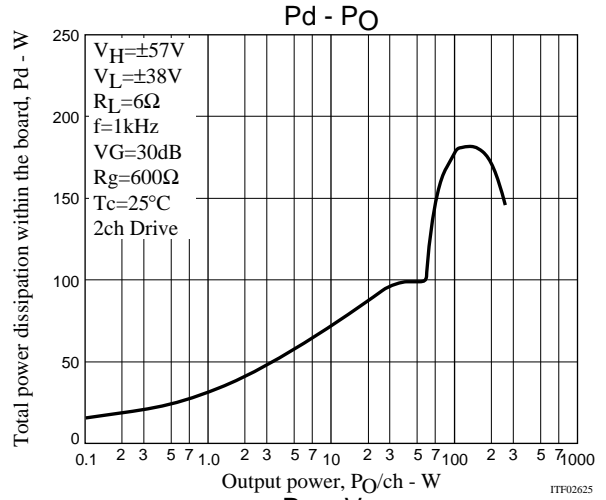
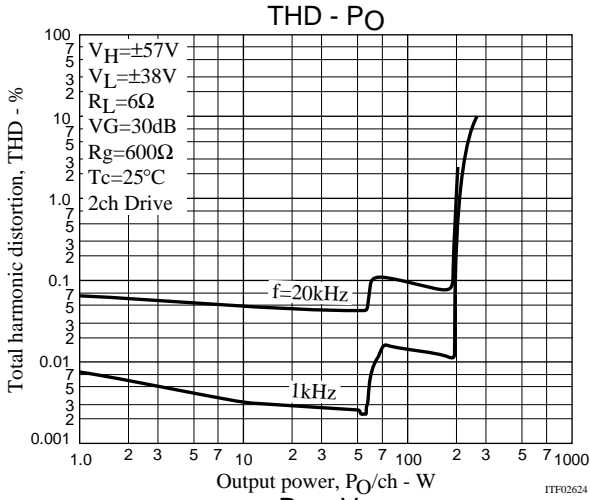
Sample PCB Trace Pattern



Parts List

P.C.B. No.	STK412-150C-E/STK412-170C-E
R 01, 02	3.3kΩ 1W
R 03, 04	100Ω 1W
R 05, 06, 18, 19, (07, 20)	56kΩ 1/6W
R 08, 09, (10)	4.7Ω 1W
R 11, 12, (13)	4.7Ω 1/4W
R 14, 15, (16)	1.8kΩ 1/6W
R 17	33kΩ 1/4W
R 21, 22, (23)	1kΩ 1/6W
R 24, 25, 26, 27, (28, 29)	0.1Ω ± 10% 5W
C 01, 02, 05, 06	100μF/100V
C 03, 04	100μF/63V
C 07, 08, (09)	3pF
C 10, 11, (12)	0.1μF/100V
C 13, 14, (15)	100μF/10V
C 16, 17, (18)	2.2μF/50V
C 19, 20, (21)	470pF
C 22, 23, (24)	220pF
L 01, 02, (03)	3μH
D 01, 02	GZA18Y (SANYO)
J 01, 02, 03, 07	10mm
J 04, 05	12mm
J 06, 10	17mm
J 08, 09, 11, 12	14mm
J 13	5mm
J 14	N.C
J 15	33mm
J 16	30mm
J 17	5mm

**Evaluation Board Characteristics**



[Thermal Design Example for STK412-150C-E]

The thermal resistance,  $\theta_{c-a}$ , of the heat sink for total power dissipation,  $P_d$ , within the hybrid IC is determined as follows.

Condition 1: The hybrid IC substrate temperature,  $T_c$ , must not exceed 125°C.

$$P_d \times \theta_{c-a} + T_a < 125^\circ\text{C} \dots\dots\dots (1)$$

$T_a$ : Guaranteed ambient temperature for the end product

Condition 2: The junction temperature,  $T_j$ , of each power transistor must not exceed 150°C.

$$P_d \times \theta_{c-a} + P_d/N \times \theta_{j-c} + T_a < 150^\circ\text{C} \dots\dots\dots (2)$$

$N$ : Number of power transistors

$\theta_{j-c}$ : Thermal resistance per power transistor

However, the power dissipation,  $P_d$ , for the power transistors shall be allocated equally among the number of power transistors.

The following inequalities result from solving equations (1) and (2) for  $\theta_{c-a}$ .

$$\theta_{c-a} < (125 - T_a)/P_d \dots\dots\dots (1)'$$

$$\theta_{c-a} < (150 - T_a)/P_d - \theta_{j-c}/N \dots\dots\dots (2)'$$

Values that satisfy these two inequalities at the same time represent the required heat sink thermal resistance.

When the following specifications have been stipulated, the required heat sink thermal resistance can be determined from formulas (1)' and (2)'.  
 • Supply voltage  $V_H, V_L$   
 • Load resistance  $R_L$   
 • Guaranteed ambient temperature  $T_a$

[Example]

When the IC supply voltage,  $V_H=\pm 57\text{V}$ ,  $V_L=\pm 38\text{V}$  and  $R_L$  is  $6\Omega$ , the total power dissipation,  $P_d$ , within the hybrid IC, will be a maximum of 180W at 1kHz for a continuous sine wave signal according to the  $P_d$ - $P_o$  characteristics. For the music signals normally handled by audio amplifiers, a value of  $1/8P_O \text{ max}$  is generally used for  $P_d$  as an estimate of the power dissipation based on the type of continuous signal. (Note that the factor used may differ depending on the safety standard used.)

This is:

$$P_d \approx 85\text{W} \quad (\text{when } 1/8P_O \text{ max.} = 19\text{W}).$$

The number of power transistors in audio amplifier block of these hybrid ICs,  $N$ , is 4, and the thermal resistance per transistor,  $\theta_{j-c}$ , is  $2.1^\circ\text{C/W}$ . Therefore, the required heat sink thermal resistance for a guaranteed ambient temperature,  $T_a$ , of  $50^\circ\text{C}$  will be as follows.

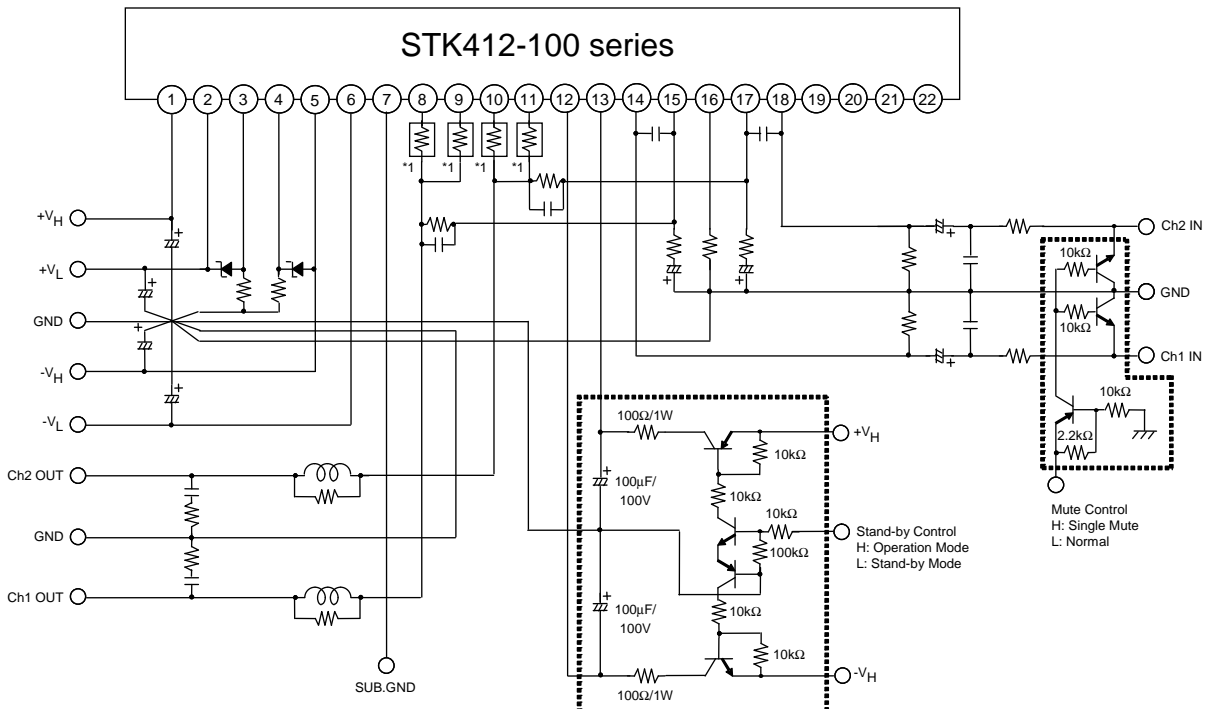
$$\begin{aligned} \text{From formula (1)'} \quad \theta_{c-a} &< (125 - 50)/85 \\ &< 0.88 \end{aligned}$$

$$\begin{aligned} \text{From formula (2)'} \quad \theta_{c-a} &< (150 - 50)/85 - 1.4/4 \\ &< 0.82 \end{aligned}$$

Therefore, the value of  $0.82^\circ\text{C/W}$ , which satisfies both of these formulae, is the required thermal resistance of the heat sink.

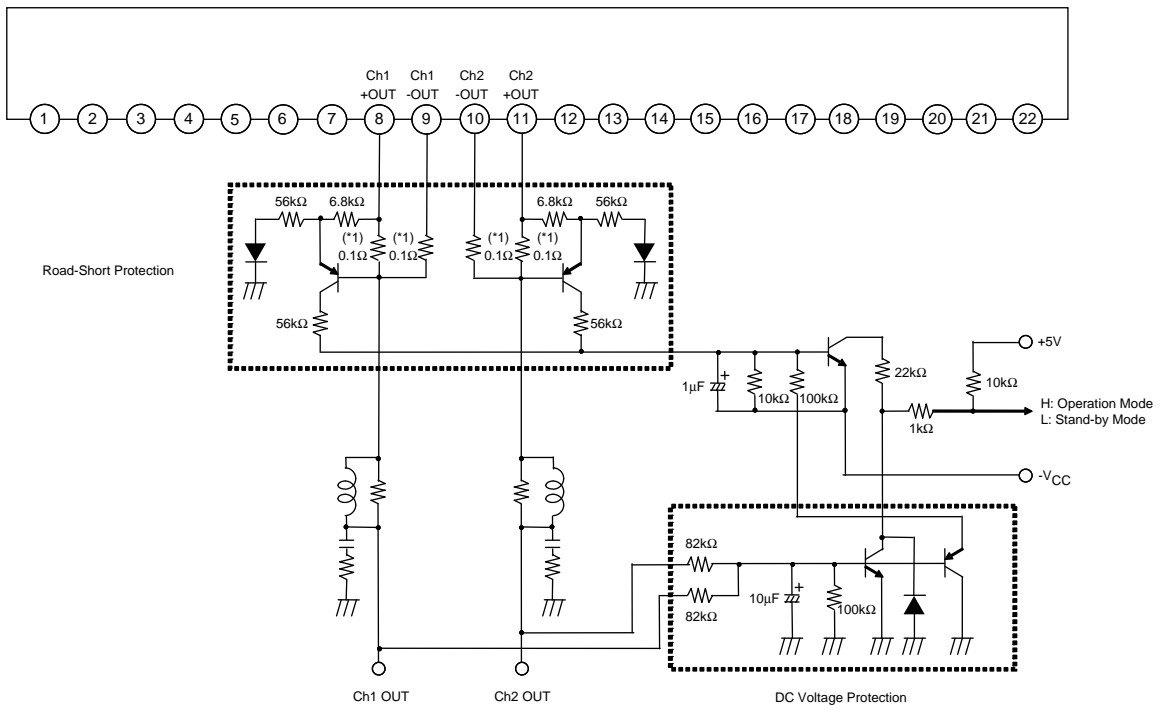
Note that this thermal design example assumes the use of a constant-voltage power supply, and is therefore not a verified design for any particular user's end product.

**STK412-100 Series Stand-by Control & Mute Control Application**



\*1 Metal Plate Cement Resistor 0.1Ω ±10% (5W)

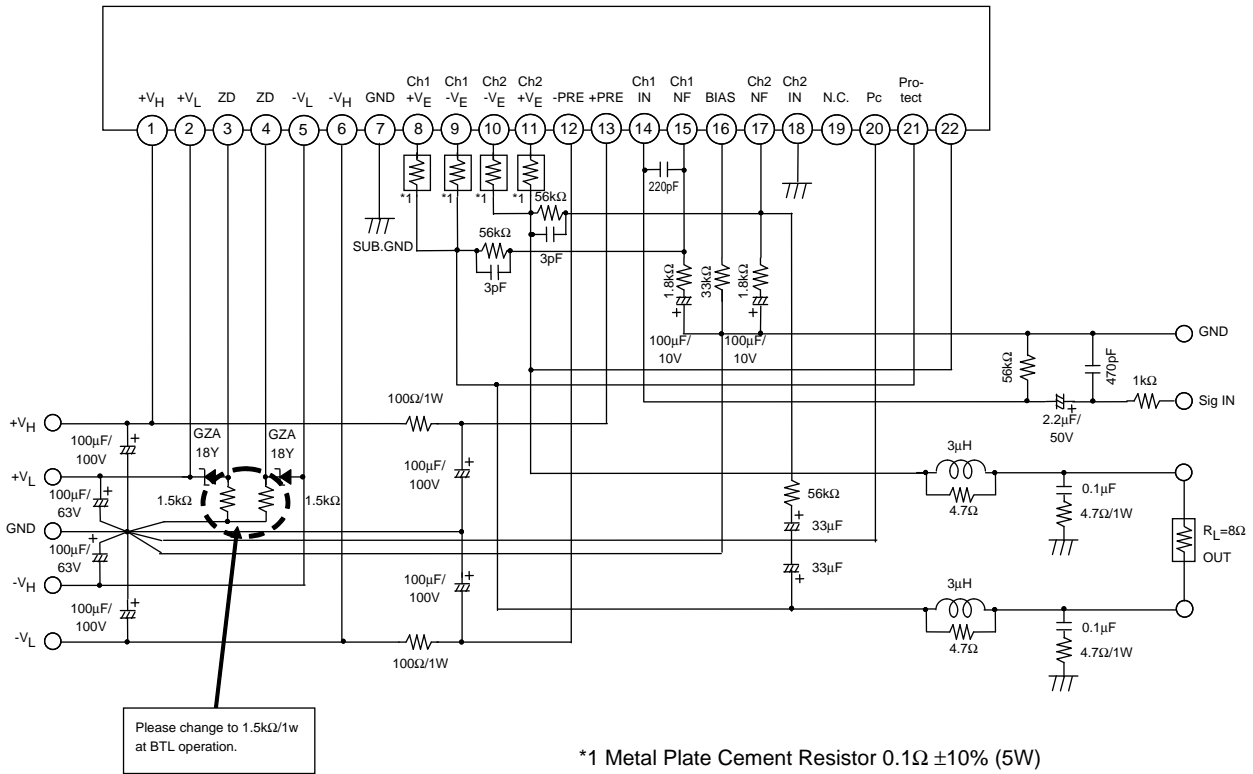
**STK412-100 Series Load-Short & DC Voltage Protect Application**



\*1 Metal Plate Cement Resistor 0.1Ω ±10% (5W)



**STK412-150C-E/STK412-170C-E BTL Application**



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