



SANYO Semiconductors

DATA SHEET

STK404-230-E — Thick-Film Hybrid IC One-Channel Class AB Audio Power Amplifier IC 100W

Overview

The STK404-230-E is a hybrid IC designed to be used in 100W (1-channel) class AB audio power amplifiers.

Applications

- Audio power amplifiers.

Features

- 1-channel audio power amplifier
- Built-in standby circuit
- Overcurrent protection
- Output DC offset protection
- Shutdown circuit when latch-up occurs
- Error signal output (open collector)

Series Models

	STK404-200-E	STK404-230-E
Output 1 (10%/1kHz)	100W×1 channels	150W×1 channels
Output 2 (0.4%/20Hz to 20kHz)	60W×1 channels	100W×1 channels
Maximum rated V_{CC} (6Ω)	±50V	±63V
Recommended operating V_{CC} (6Ω)	±36V	±44V
Dimensions (excluding pin height)	59.2mm×25.5mm×8.5mm	

■ Any and all SANYO Semiconductor Co.,Ltd. products described or contained herein are, with regard to "standard application", intended for the use as general electronics equipment (home appliances, AV equipment, communication device, office equipment, industrial equipment etc.). The products mentioned herein shall not be intended for use for any "special application" (medical equipment whose purpose is to sustain life, aerospace instrument, nuclear control device, burning appliances, transportation machine, traffic signal system, safety equipment etc.) that shall require extremely high level of reliability and can directly threaten human lives in case of failure or malfunction of the product or may cause harm to human bodies, nor shall they grant any guarantee thereof. If you should intend to use our products for applications outside the standard applications of our customer who is considering such use and/or outside the scope of our intended standard applications, please consult with us prior to the intended use. If there is no consultation or inquiry before the intended use, our customer shall be solely responsible for the use.

■ Specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.

STK404-230-E

Specifications

Absolute Maximum Ratings at Ta = 25°C (excluding rated temperature items), Tc=25°C unless otherwise specified

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage 1	V _{CC} max (1)	Pin 11 (+V _{CC}), pin 10 (-V _{CC}), R _L =6Ω, f=1kHz, P _O =100W, t≤25ms	±80	V
Maximum supply voltage 2	V _{CC} max (2)	Pin 11 (+V _{CC}), pin 10 (-V _{CC}), R _L ≥6Ω	±63	V
Maximum Pre V _{CC} supply voltage	Pre V _{CC} max	Pin 7 (+PRE), pin6 (-PRE)	±63	V
Minimum operating supply voltage	V _{CC} min		±25	V
STBY pin applied voltage *4	Vst max	Pin 1 (STBY)	-0.3 to +5.5	V
STBY pin applied current	Ist max	Pin 1 (STBY)	1.0	mA
OC pin maximum input current	Ioc max	Pin 9 (OC)	±5	mA
DC pin maximum input current	I _{dc} max	Pin 8 (DC)	+5	mA
ERROR pin input voltage	V _{error}	Pin 2 (ERROR)	+V _{CC}	V
ERROR pin input current	I _{error}	Pin 2 (ERROR)	20	mA
Thermal resistance	θ _{j-c}	Per power transistor	1.6	°C/W
Junction temperature	T _j max	Must meet both T _j max and T _c max conditions	150	°C
Operating IC substrate temperature	T _c max		125	°C
Storage ambient temperature	T _{stg}		-30 to +125	°C
Allowable load shorted time *3	t _s	V _{CC} =±44V, R _L =6Ω, f=50Hz, P _O =50W	0.3	s

Electrical Characteristics at Tc=25°C, R_L=6Ω, R_g=600Ω, V_G=30dB, non-inductive load R_L, unless otherwise specified

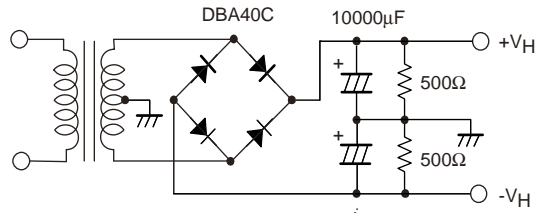
Parameter	Symbol	Conditions *2				Ratings			unit	
		V _{CC} (V)	f (Hz)	P _O (W)	THD (%)	min	typ	max		
Output power *1	P _O (1)	±44	20 to 20k		0.4	100			W	
	P _O (2)	±44	1k		10		150			
Total harmonic distortion *1	THD	±44	20 to 20k	100			0.4		%	
Frequency characteristics *1	f _L , f _H	±44		1.0		+0 -3dB	20 to 50k		Hz	
Input impedance	r _i	±44	1k	1.0			55		kΩ	
Output noise voltage *3	V _{NO}	±53				R _g =2.2kΩ		1.0	mVrms	
Quiescent current	I _{CCO}	±53				R _L =∞		50	mA	
Output neutral voltage	V _N	±53					-70	0	+70	mV
Pin 8 output DC (+) offset detection voltage	V _{DC} (-)	±44						0.5	0.7	V
Pin 8 output DC (-) offset detection voltage	V _{DC} (-)	±44					-0.7	-0.5		V
Pin 9 overcurrent detection voltage	V _{OC}	±44						0.5	0.7	V
Pin 1 threshold voltage for standby ON	V _{ST ON}	±44				Standby mode		0	0.6	V
Pin 1 threshold voltage for standby OFF	V _{ST OFF}	±44				Operating mode	2.5	3.0		V

[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 allowable load shorted time and output noise voltage measurement.
- *4: Use the standby pin (pin 1) so that the applied voltage never exceeds the maximum rating.
The power amplifier is turned on by applying +2.5V to +5.5V to the standby pin (pin 1).
- *5: The -Pre V_{CC} (pin 6) must be at the lowest level under any circumstances so that the reverse-bias current does not flow.
- * Thermal design must be implemented based on the conditions under which the customer's end products are expected to operate on the market.
- * The weight of hybrid IC alone: 15g
Package dimensions (length×width×height): 502mm×247mm×282mm

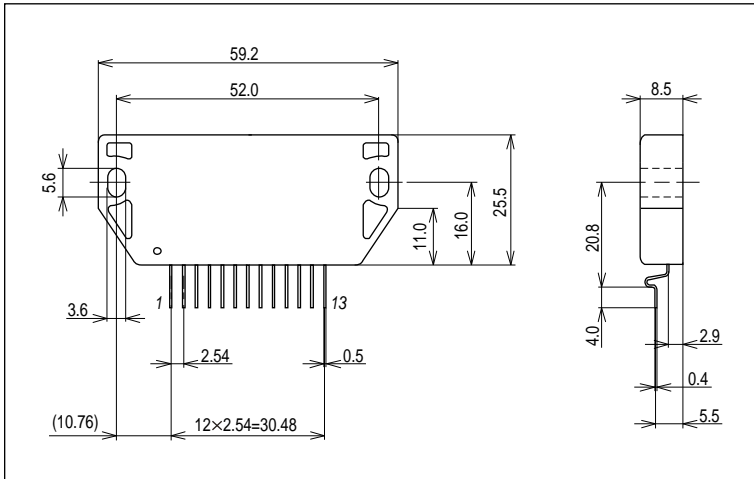
STK404-230-E

Designated transformer power supply
(MG-250 equivalent)

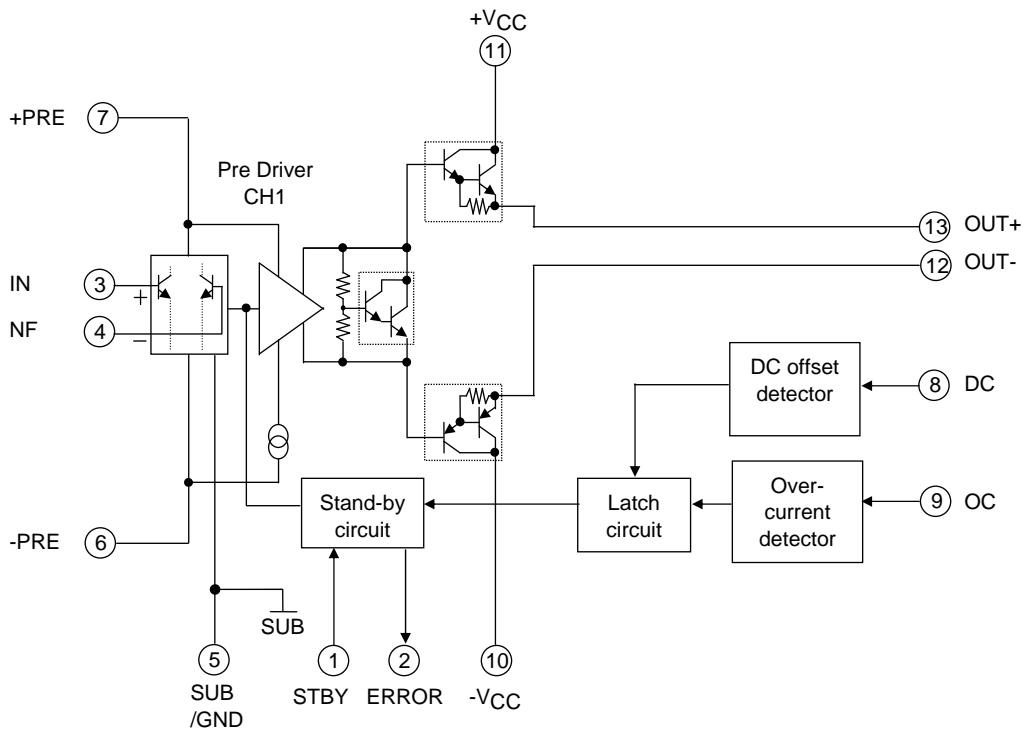


Package Dimensions

unit:mm (typ)

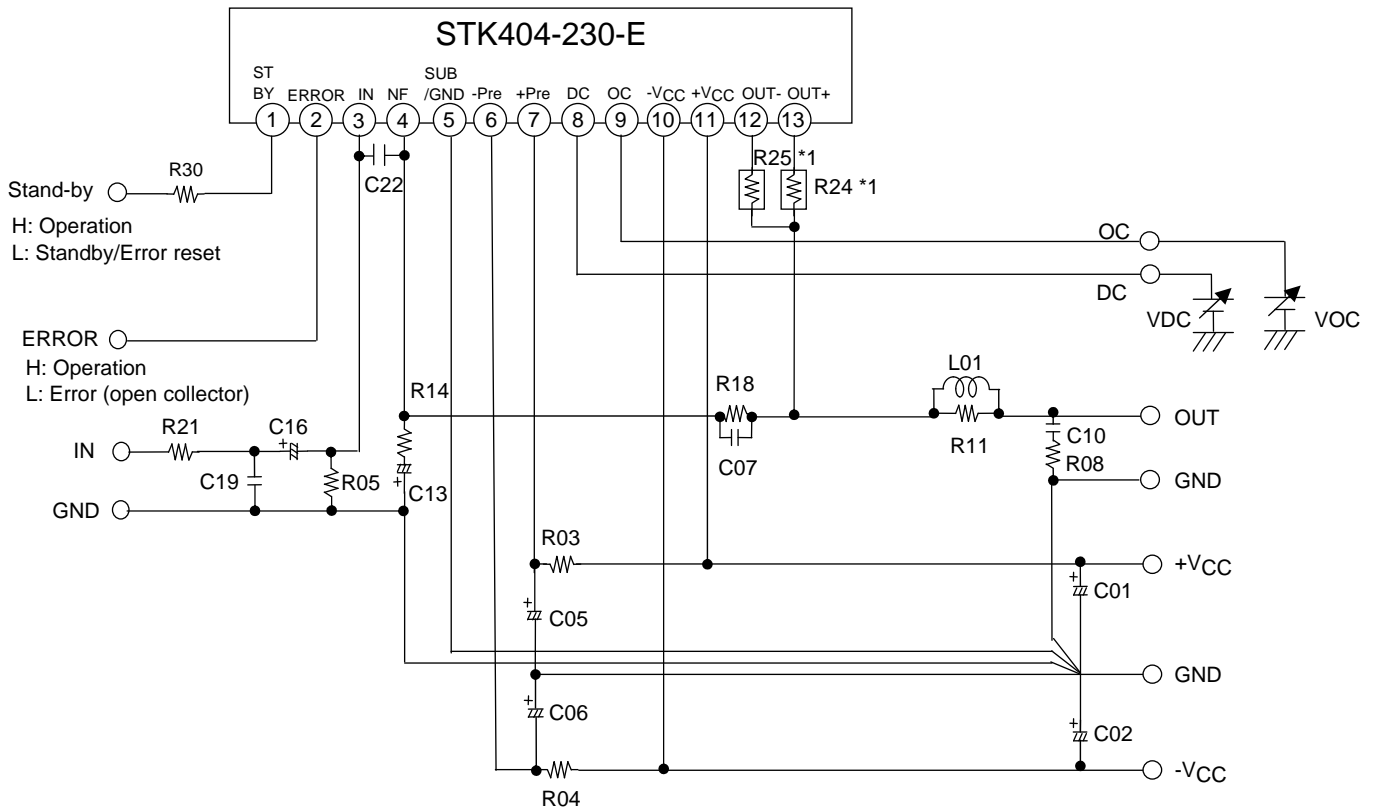


Internal Block Circuit



STK404-230-E

Test Circuit



*1 Metal plate cement resistor: 0.22Ω±10% (5W)

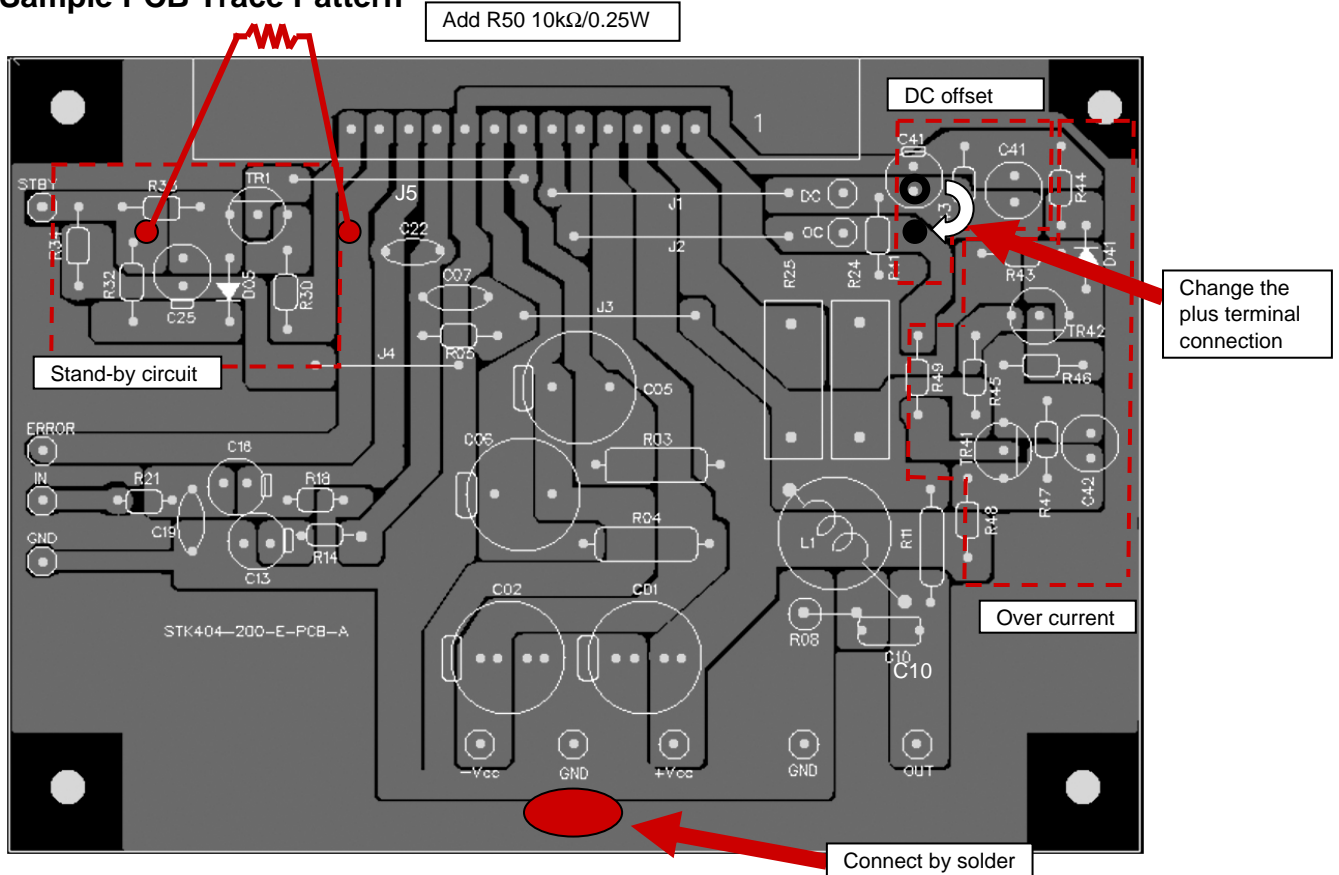
Pin Description

Pin No.	Pin name		Function
1	STBY	I	Standby terminal H: Operation mode, L: Standby mode
2	ERROR	O	Error signal output in protection mode (open collector) H: Operation mode, L: Protection mode (shutdown)
3	IN	I	Input signal terminal
4	NF	I	NF signal input terminal
5	SUB/GND	G	Ground terminal, circuit ground and sub-ground
6	-PRE	V	Negative power supply for predriver
7	+PRE	V	Positive power supply for predriver
8	DC	I	DC offset detection signal input L: Protection disabled, H: Protection enabled (system shutdown)
9	OC	I	Overcurrent detection signal input L: Protection disabled, H: Protection enabled (system shutdown)
10	-VCC	P	Negative power supply for power
11	+VCC	P	Positive power supply for power
12	OUT-	O	Negative output terminal (emitter of PNP power transistor)
13	OUT+	O	Positive output terminal (emitter of NPN power transistor)

Recommended External Parts

Symbol	Recommended Value	Description	Larger than Recommended Value	Smaller than Recommended Value
R03, R04	100Ω/1W	Ripple filtering resistors (Use of fusing resistors is desirable. Used with C05 and C06 to form a ripple filter.)	-	Increase in through current at high frequencies.
R05	56kΩ	Virtually determines the input impedance.	VN offset (Ensure R05=R18 when changing.)	
R08	4.7Ω/1W	Oscillation prevention resistor	-	-
R11	4.7Ω	Noise suppression resistor	-	-
R14	1.8kΩ	Used with R18 to determine the voltage gain VG. (VG should desirably be determined by the R14 value.)	It may oscillate (Vg<30dB)	None
R18	56kΩ	Used with R14 to determine the voltage gain VG.	-	-
R21	1kΩ	Input filtering resistor	-	-
R24, R25	0.22Ω±10%, 5W	Output emitter resistors (Use of cement resistor is desirable)	Decrease in maximum output power	It may cause thermal-runaway.
R30	Remarks *4	A resistor must be used such that the voltage at the Stand-by pin (pin 1) does not exceed the maximum rating.		
C01, C02	100μF/100V	Oscillation prevention capacitors. • Insert the capacitors as close to the IC as possible to decrease the power impedance for reliable IC operation (use of electrolytic capacitors are desirable).	-	-
C05, C06	100μF/100V	Decoupling capacitors. Eliminate ripple components that pass into the input side from the power line. (Used with R03 and R04 to form a ripple filter.)	Increase in ripple components that pass into the input side from the power line	
C07	3pF	Oscillation prevention capacitor	It may oscillate	
C10	0.1μF	Oscillation prevention capacitor	It may oscillate	
C13	22μF/10V	NF capacitor (Changes the low cutoff frequency; $ex/f_L=1/2\pi\cdot C13\cdot R14$)	Increase in low-frequency voltage gain, with higher pop noise at power-on.	Decrease in low-frequency voltage gain
C16	2.2μF/50V	Input coupling capacitor (block DC current)	-	-
C19	470pF	Input filter capacitor (Used with R21 to form a filter that suppresses high-frequency noises.)	-	-
C22	100pF	Oscillation prevention capacitor	It may oscillate.	
L01	3μH	Oscillation prevention inductance	None	It may oscillate.

Sample PCB Trace Pattern

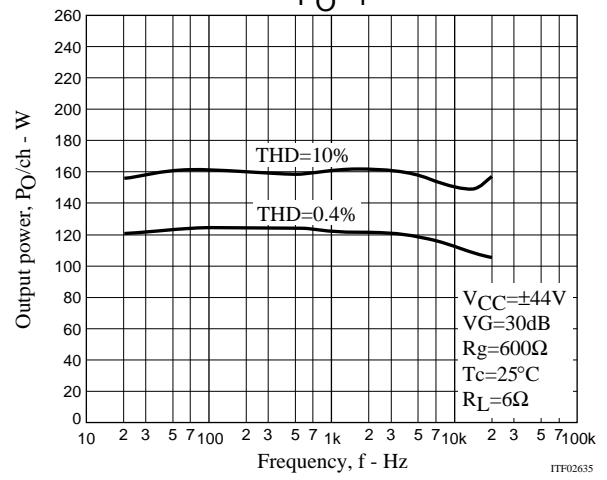
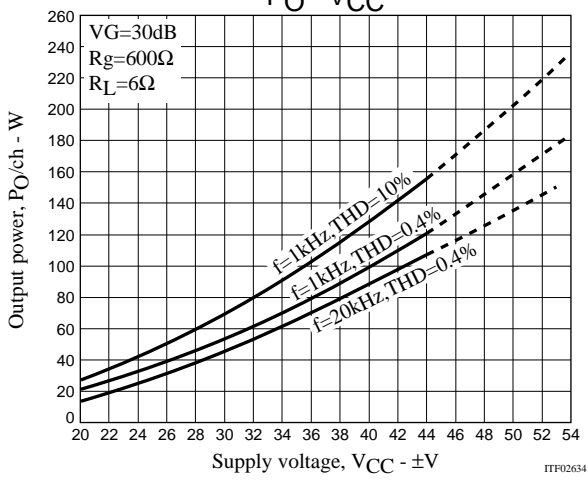
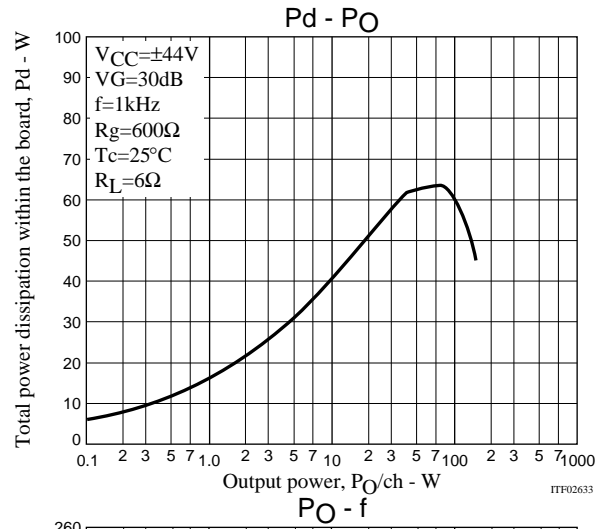
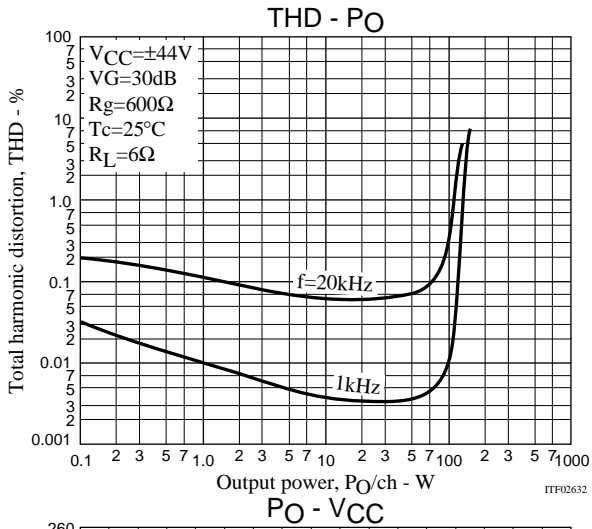


STK404-230-E

Parts List

PCB No.	Parts	Rating	
R03, R04	100Ω, 1W	ERG1SJ101	
R05	56kΩ, 1/6W	RN16S563FK	
R18	56kΩ, 1/6W	RN16S563FK	
R08	4.7Ω, 1W	ERX1SJ4R7	
R11	4.7Ω, 1/4W	RN14S4R7FK	
R14	1.8kΩ, 1/6W	RN16S182FK	
R21	1kΩ, 1/6W	RN16S102FK	
R24, R25	0.22Ω±10%, 5W	BPR56CFR22J	
C01, C02, C05, C06	100μF, 100V	100MV100HC	
C07	3pF	DD104-63B3R0K50	
C10	0.1μF, 100V	ECQ-V1H104JZ	
C13	10μF, 10V	10MV10HC	
C16	2.2μF, 50V	50MV2R2HC	
C19	470pF	DD104-63B471K50	
C22	100pF	DD104-63B101K50	
L01	3μH		
Stand-by	R30	5.6kΩ, 1/6W	RN16S152FK
	R32	1kΩ, 1/6W	RN16S102FK
	R33	3.3kΩ, 1/6W	RN16S332FK
	R34	2.2kΩ, 1/6W	RN16S222FK
	C25	33μF, 10V	10MV33HC
	D05	-	GMB01 (Ref.)
	TR1	-	2SC2362 (Ref.)
Over Current	TR41		2SA1016 (Ref.)
	TR42		2SC2362 (Ref.)
	C42	-	-
	C43	2.2μF, 10V	10MV2R2HC
	D41		GMB01 (Ref.)
	R43	220Ω, 1/6W	RN16S221FK
	R44	1.8kΩ, 1/6W	RN16S182FK
	R45	Jumper	-
	R46	15kΩ, 1/6W	RN16S153FK
	R47	5.1kΩ, 1/6W	RN16S512FK
	R48	15kΩ, 1/6W	RN16S153FK
R49	47kΩ, 1/6W	RN16S473FK	
DC offset	R41	33kΩ, 1/6W	RN16S333FK
	R42	10kΩ, 1/6W	RN16S103FK
	C41	33μF, 10V	10MV33HC
ERROR	R50	10kΩ, 1/4W	RN14S103FK
J01, 02, 03, 04, 05	Jumper		

Evaluation Board Characteristics



STK404-230-E

[Thermal Design Example for STK404-230-E ($R_L=6\Omega$)]

The thermal resistance, θ_{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

θ_{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 θ_{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_{CC}
 • Load resistance R_L
 • Guaranteed ambient temperature T_a

[Example]

When the IC supply voltage, $V_{CC}=\pm 44\text{V}$ and R_L is 6Ω , the total power dissipation, P_d , within the hybrid IC, will be a maximum of 64W 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 $1/8P_{O \text{ max}}$ ($P_{O \text{ max}}=12.5\text{W}$) 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:

$$P_d \approx 45\text{W} \quad (\text{when } 1/8P_{O \text{ max}} = 12.5\text{W}, P_{O \text{ max}} = 100\text{W}).$$

The number of power transistors in audio amplifier block of these hybrid ICs, N , is 2, and the thermal resistance per transistor, θ_{j-c} , is 1.6°C/W . Therefore, the required heat sink thermal resistance for a guaranteed ambient temperature, T_a , of 50°C will be as follows.

$$\begin{aligned} \text{From formula (1)'} \quad \theta_{c-a} &< (125 - 50)/45.0 \\ &< 1.66 \end{aligned}$$

$$\begin{aligned} \text{From formula (2)'} \quad \theta_{c-a} &< (150 - 50)/45.0 - 1.6/4 \\ &< 1.42 \end{aligned}$$

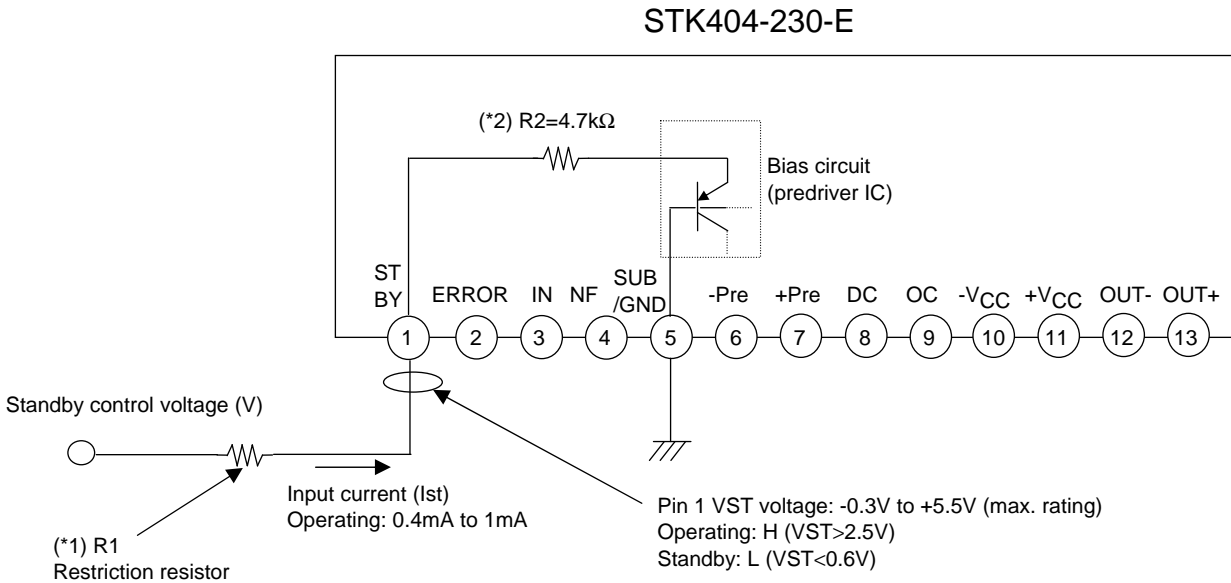
Therefore, the value of 1.42°C/W , which satisfies both of these formulae, is the required thermal resistance of the heat sink.

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.

Applications

Standby circuit

Use the current limiting resistor R1 (*1) so that the voltage applied to the Stand-by pin (pin #1) does not exceed the maximum rating voltage.

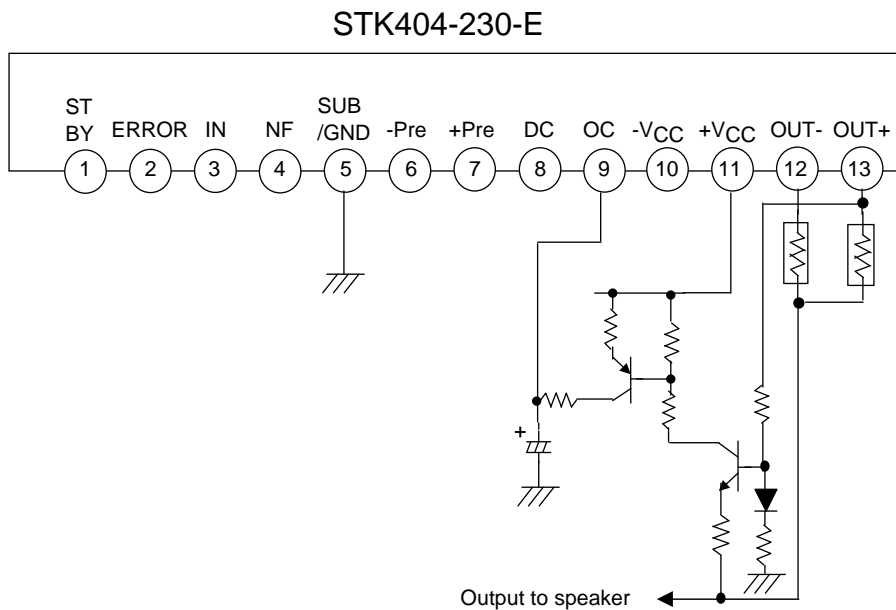


This pin has a function to release the latch when it is set to the ground level.

Overcurrent Protection Circuit

Overcurrent protection is activated if $V_{OC} \approx 0.5V$ (typ) is applied to OC (#9). The HIC shuts down (latch mode) and the state of the error pin switches from high to low. The (open collector output) latch mode is cleared by setting the pin to the ground level.

Sample Application Circuit



* See "Application Circuit" for recommended values.

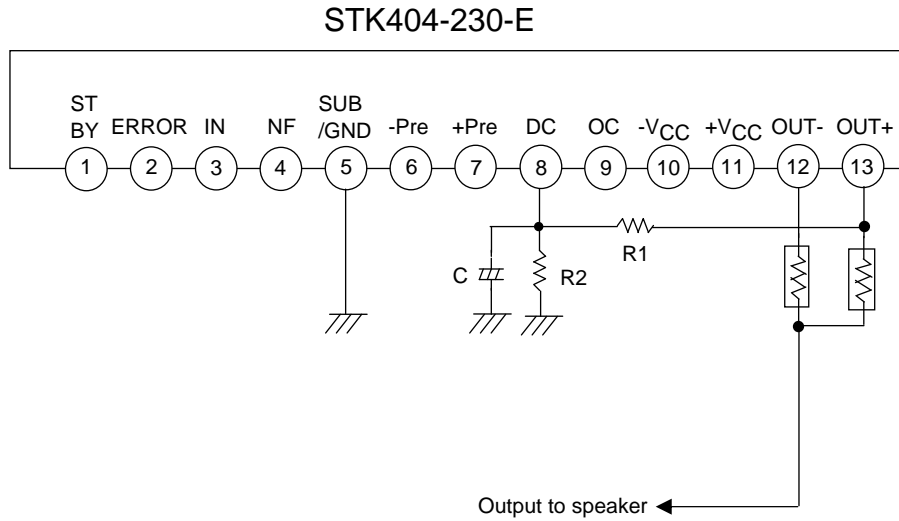
STK404-230-E

DC Offset Detector Circuit

DC offset protection is activated if $V_{DC}(+)$ or $V_{DC}(-) \geq 0.5V$ (typ) is applied to DC (#8). The HIC shuts down and the state of the error pin switches from high to low. The (open collector output) latch mode is cleared by setting the pin to the ground level.

Set the protection level with the voltage dividing resistors R1 and R2 and determine the time constant value of C so that the IC will not malfunction when generating the audio signals.

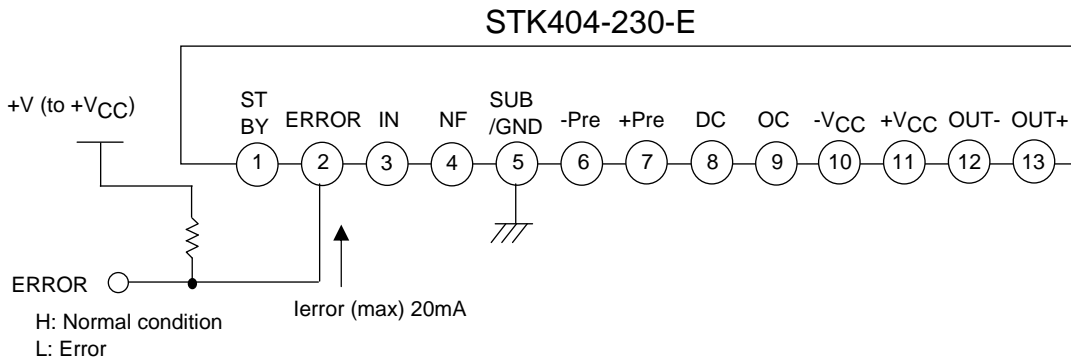
Sample Application Circuit



* Please refer to '13.Application circuit' about recommended Value.

Error Indicator (Open Collector)

The state of the ERROR pin (#2) switches from high to low (open collector output) when a protection circuit is activated.

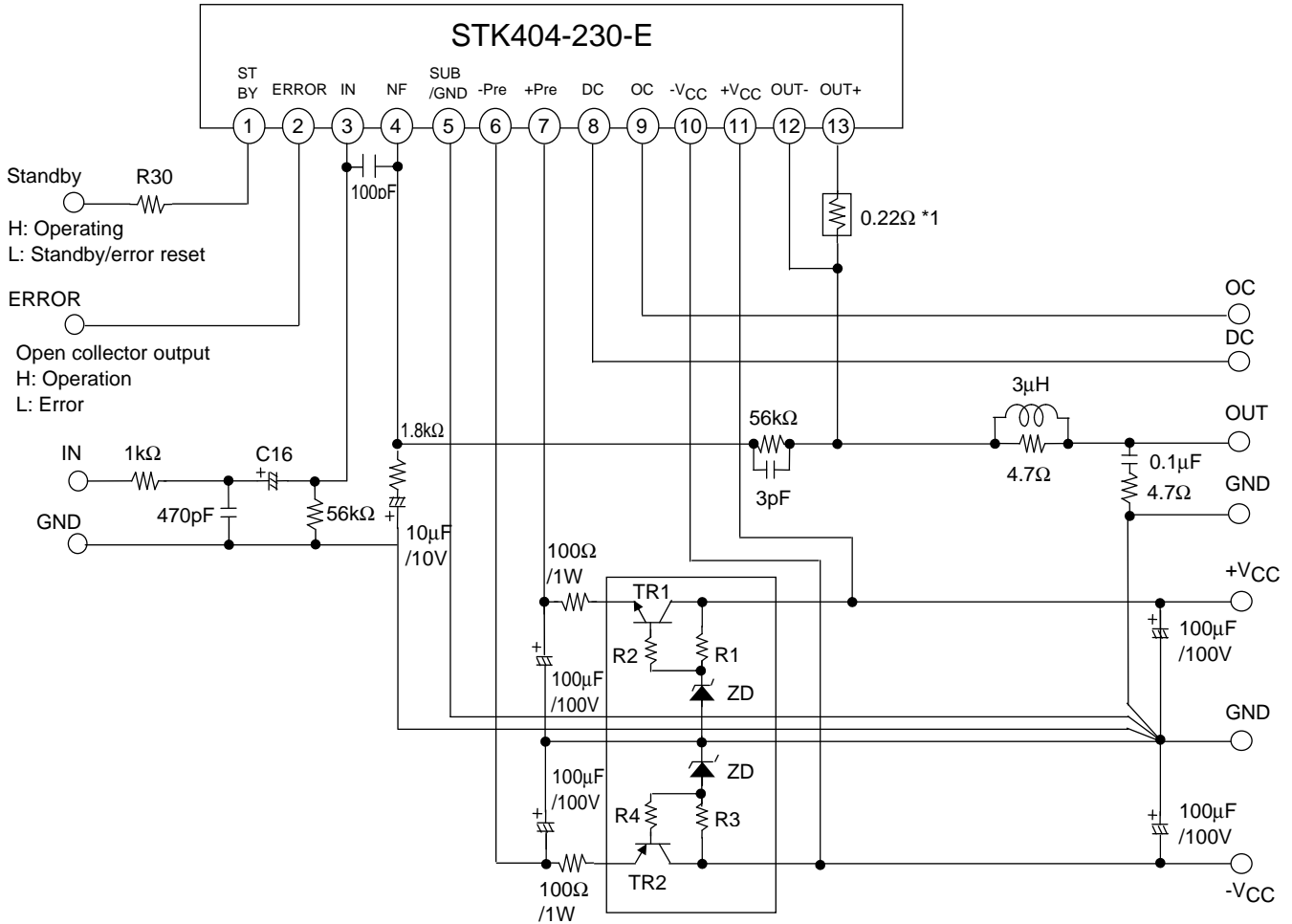


STK404-230-E

Pre-V_{CC} Limiting Circuit (STK404-230-E)

The ±Pre voltages can be limited under maximum rated conditions (±63V) as shown below.

Sample Circuit



*1 Metal Plate Cement Resistor $0.22\Omega \pm 10\%$ (5W)

External Component Examples (at $T_a = 50^\circ\text{C}$)

[Conditions]

Limiting voltage = $\pm 56\text{V}$

V_{CC} max = $\pm 80\text{V}$

Ambient temperature = 50°C

TR1	: 2SD863, SANYO
TR2	: 2SB764, SANYO
ZD	: MAZ7560 ($V_z = 56\text{V}$), Panasonic
R1, R3	: $5.6\text{k}\Omega$
R2, R4	: 22Ω

* \pm pre current = 25mA (max.)

* The external components should be selected according to the conditions of the product incorporating the HIC.

- SANYO Semiconductor Co.,Ltd. assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein.
- SANYO Semiconductor Co.,Ltd. strives to supply high-quality high-reliability products, however, any and all semiconductor products fail or malfunction with some probability. It is possible that these probabilistic failures or malfunction could give rise to accidents or events that could endanger human lives, trouble that could give rise to smoke or fire, or accidents that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO Semiconductor Co.,Ltd. products described or contained herein are controlled under any of applicable local export control laws and regulations, such products may require the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written consent of SANYO Semiconductor Co.,Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO Semiconductor Co.,Ltd. product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production.
- Upon using the technical information or products described herein, neither warranty nor license shall be granted with regard to intellectual property rights or any other rights of SANYO Semiconductor Co.,Ltd. or any third party. SANYO Semiconductor Co.,Ltd. shall not be liable for any claim or suits with regard to a third party's intellectual property rights which has resulted from the use of the technical information and products mentioned above.

This catalog provides information as of June, 2009. Specifications and information herein are subject to change without notice.