Ordering number : EN*A1244A

Preliminary

SANYO Semiconductors
DATA SHEET

Thick-Film Hybrid IC

STK404-230-E — 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	

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 Vcc 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	Idc max	Pin 8 (DC)	+5	mA
ERROR pin input voltage	Verror	Pin 2 (ERROR)	+V_{CC}	V
ERROR pin input current	Ierror	Pin 2 (ERROR)	20	mA
Thermal resistance	θj-c	Per power transistor	1.6	°C/W
Junction temperature	Tj max	Must meet both Tj max and Tc max conditions	150	°C
Operating IC substrate temperature	Tc max		125	°C
Storage ambient temperature	Tstg		-30 to +125	°C
Allowable load shorted time *3	ts	V_{CC}=±44V, R_L=6Ω, f=50Hz, P_O=50W	0.3	s

Electrical Characteristics at Tc=25°C, R_L=6Ω, Rg=600Ω, VG=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	ri	±44	1k	1.0				55		kΩ
Output noise voltage *3	V_{NO}	±53				Rg=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	VST ON	±44				Standby mode		0	0.6	V
Pin 1 threshold voltage for standby OFF	VST 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.

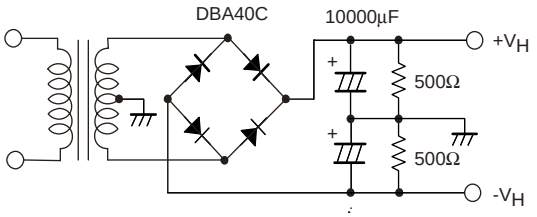
*4: Use the standby pin (pin 1) so that the applied voltage never exceeds the maximum rating. The power amplifier is turned on by applying +2.5V to +5.5V to the standby pin (pin 1).

*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.

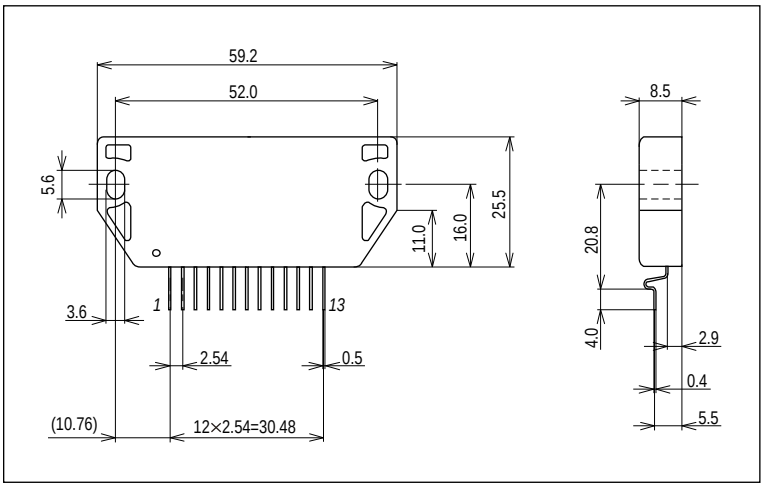
* The weight of hybrid IC alone: 15g
Package dimensions (length×width×height): 502mm×247mm×282mm

Designated transformer power supply
(MG-250 equivalent)

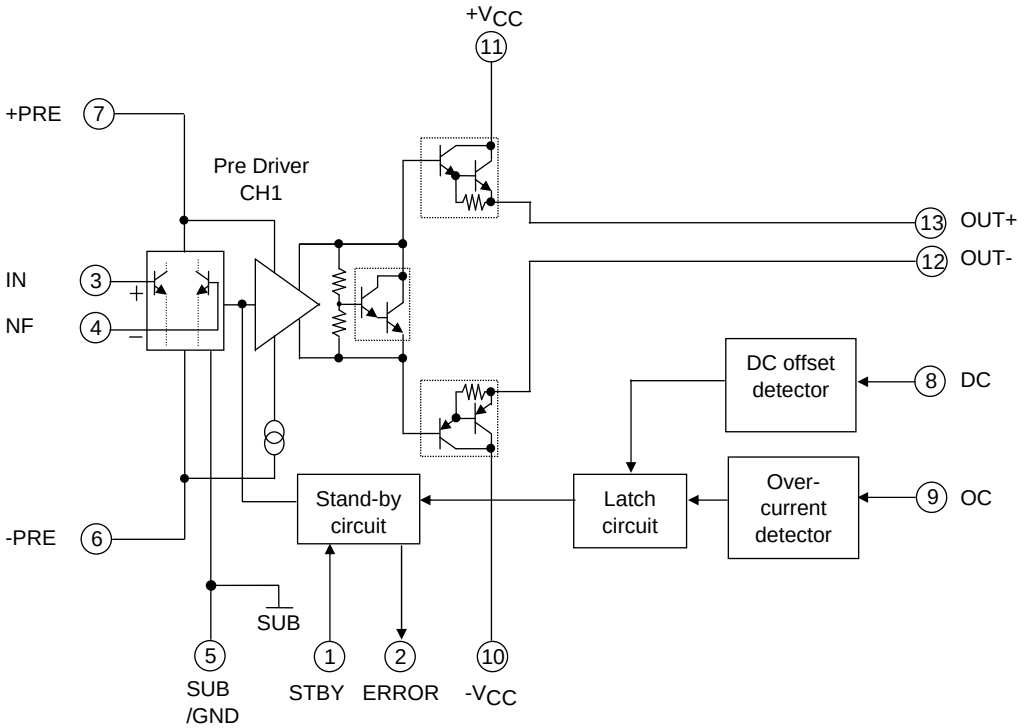


Package Dimensions

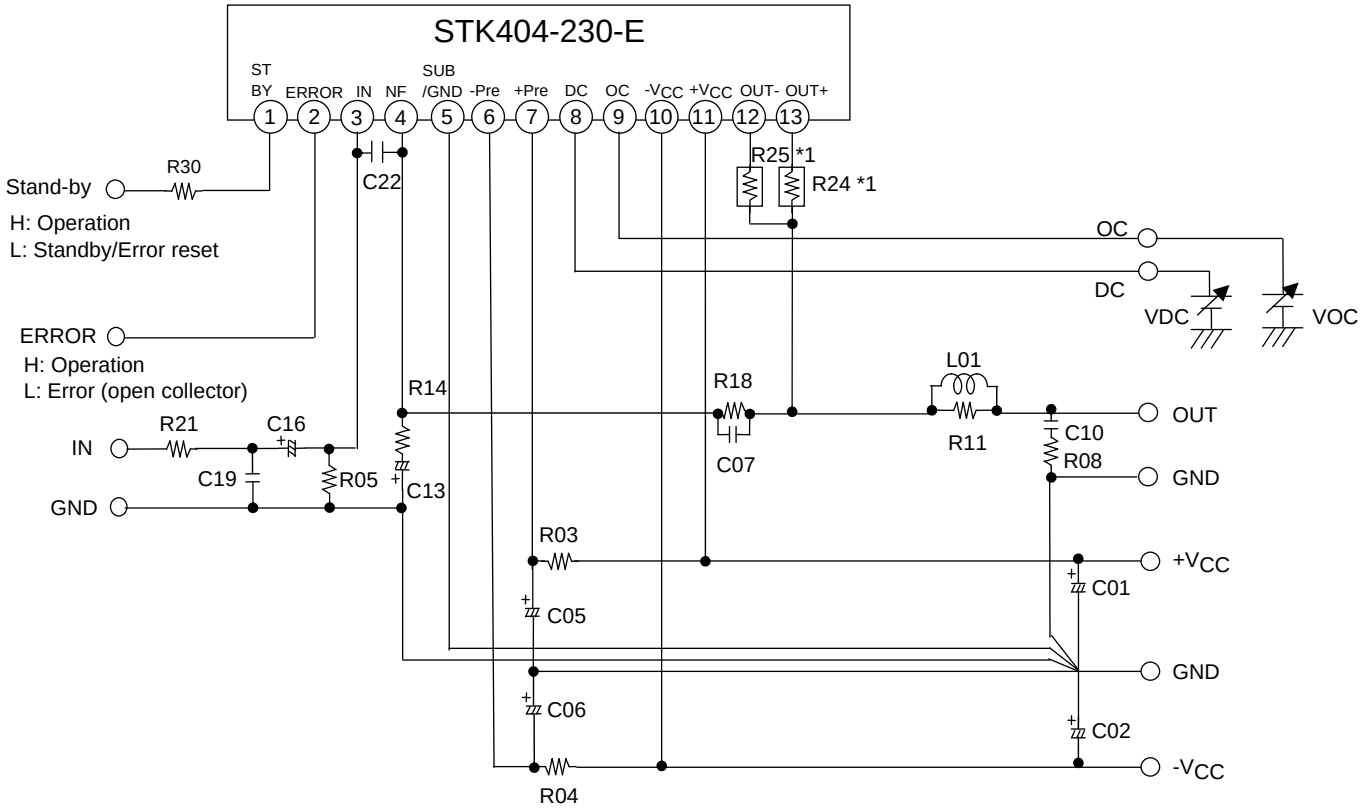
unit:mm (typ)



Internal Block Circuit



Test Circuit



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

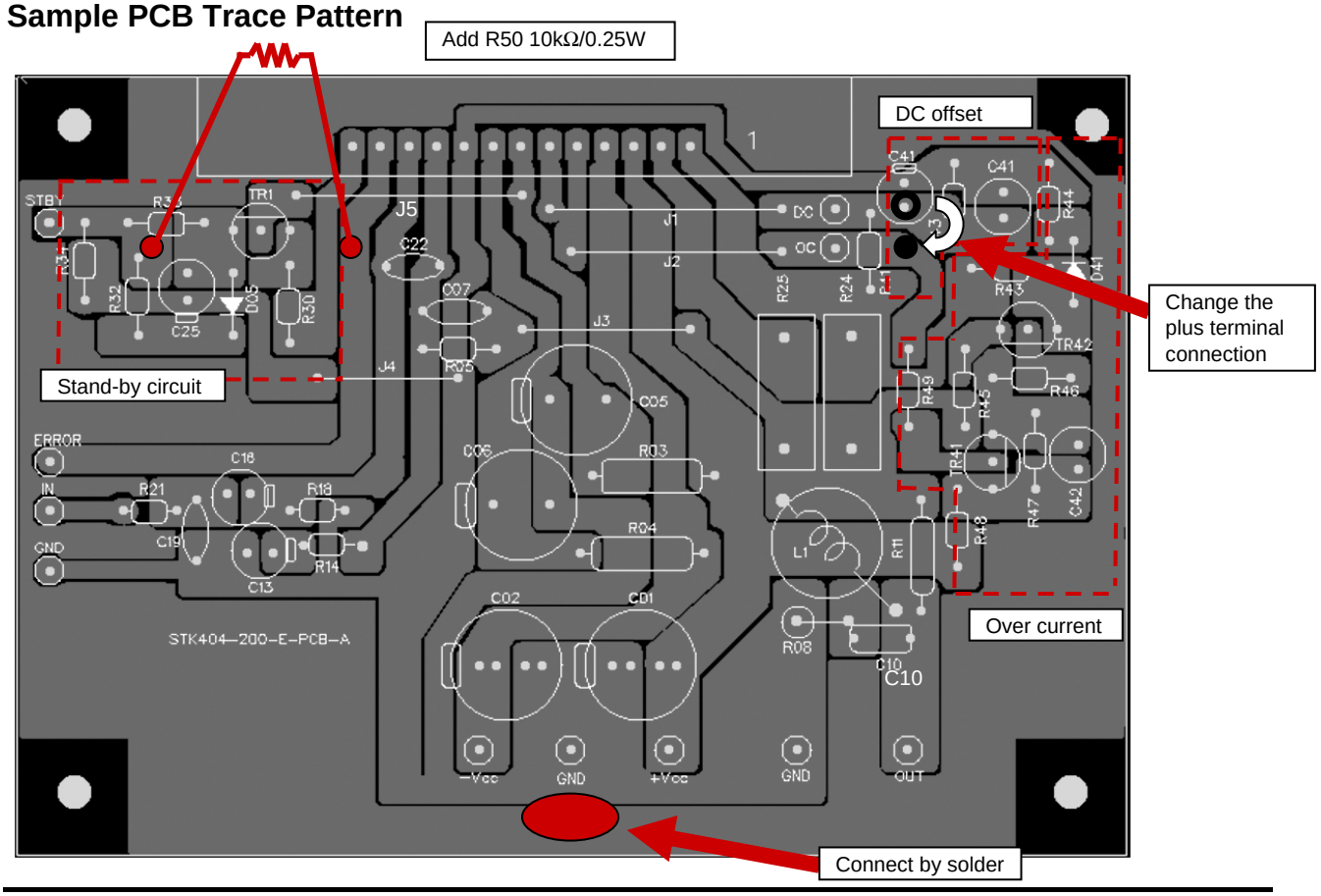
Pin Description

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	$-V_{CC}$	P	Negative power supply for power
11	$+V_{CC}$	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/fL=1/2π•C13•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.

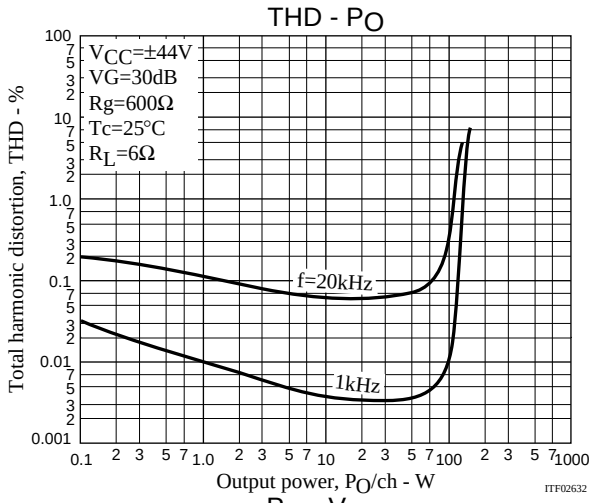
Sample PCB Trace Pattern

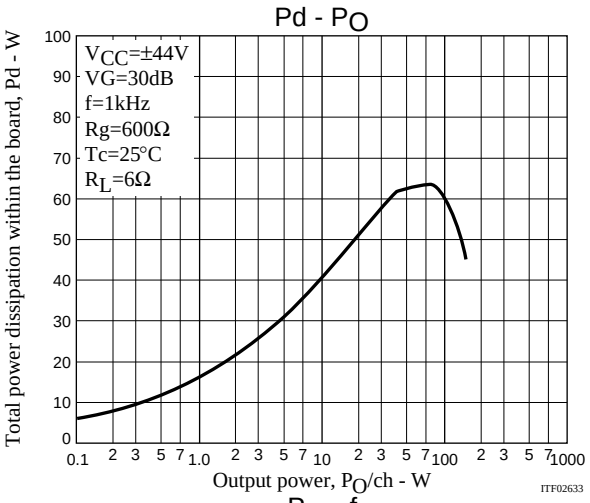


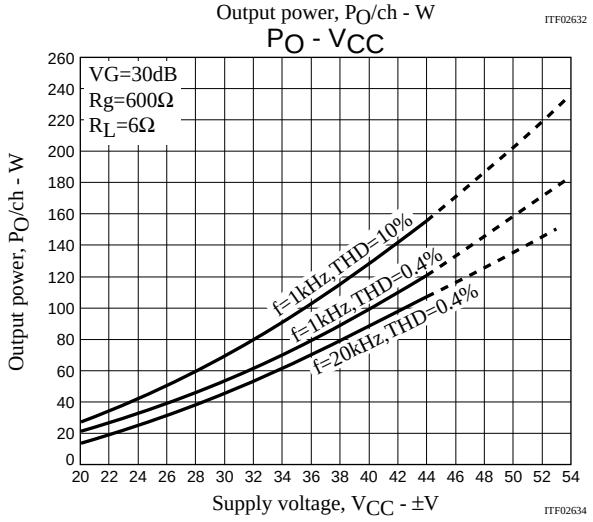
Parts List

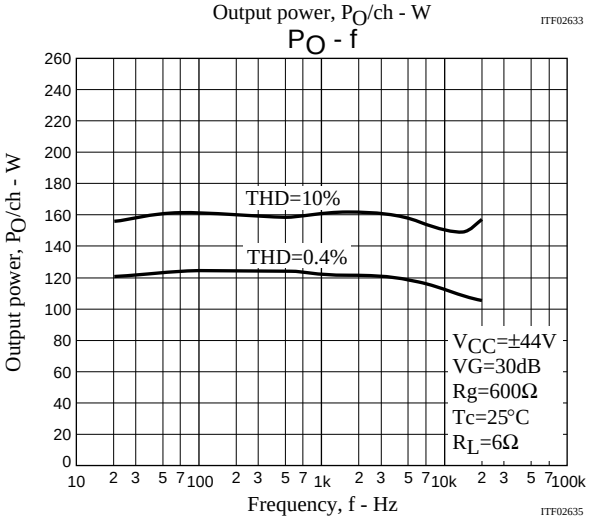
PCB No.		Parts	Rating
R03, R04		100Ω, 1W	ERG1SJ101
R05		56kΩ, 1/6W	RN16S563FK
R18		56kΩ, 1/6W	RN16S563FK
R08		4.7Ω, 1W	ERX1SJ4R7
R11		4.7Ω, 1/4W	RN14S4R7FK
R14		1.8kΩ, 1/6W	RN16S182FK
R21		1kΩ, 1/6W	RN16S102FK
R24, R25		0.22Ω±10%, 5W	BPR56CFR22J
C01, C02, C05, C06		100μF, 100V	100MV100HC
C07		3pF	DD104-63B3R0K50
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









[Thermal Design Example for STK404-230-E (R_L=6Ω)]

The thermal resistance, θc-a, of the heat sink for total power dissipation, Pd, within the hybrid IC is determined as follows.

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

$Pd \times \theta c\text{-}a + Ta < 125°C$ ..... (1)

Ta: Guaranteed ambient temperature for the end product

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

$Pd \times \theta c\text{-}a + Pd/N \times \theta j\text{-}c + Ta < 150°C$ ..... (2)

N: Number of power transistors

θj-c: Thermal resistance per power transistor

However, the power dissipation, Pd, 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 θc-a.

$\theta c\text{-}a < (125 - Ta)/Pd$ ..... (1)'

$\theta c\text{-}a < (150 - Ta)/Pd - \theta j\text{-}c/N$ ..... (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 Ta

[Example]

When the IC supply voltage, V_{CC}=±44V and R_L is 6Ω, the total power dissipation, Pd, within the hybrid IC, will be a maximum of 64W at 1kHz for a continuous sine wave signal according to the Pd-Po characteristics.

For the music signals normally handled by audio amplifiers, a value of $1/8P_O$ max (P_O=12.5W) is generally used for Pd 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:

$Pd \approx 45W$ (when $1/8P_O$ max. = 12.5W, P_O max. = 100W).

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

From formula (1)' $\theta c\text{-}a < (125 - 50)/45.0$

< 1.66

From formula (2)' $\theta c\text{-}a < (150 - 50)/45.0 - 1.6/4$

< 1.42

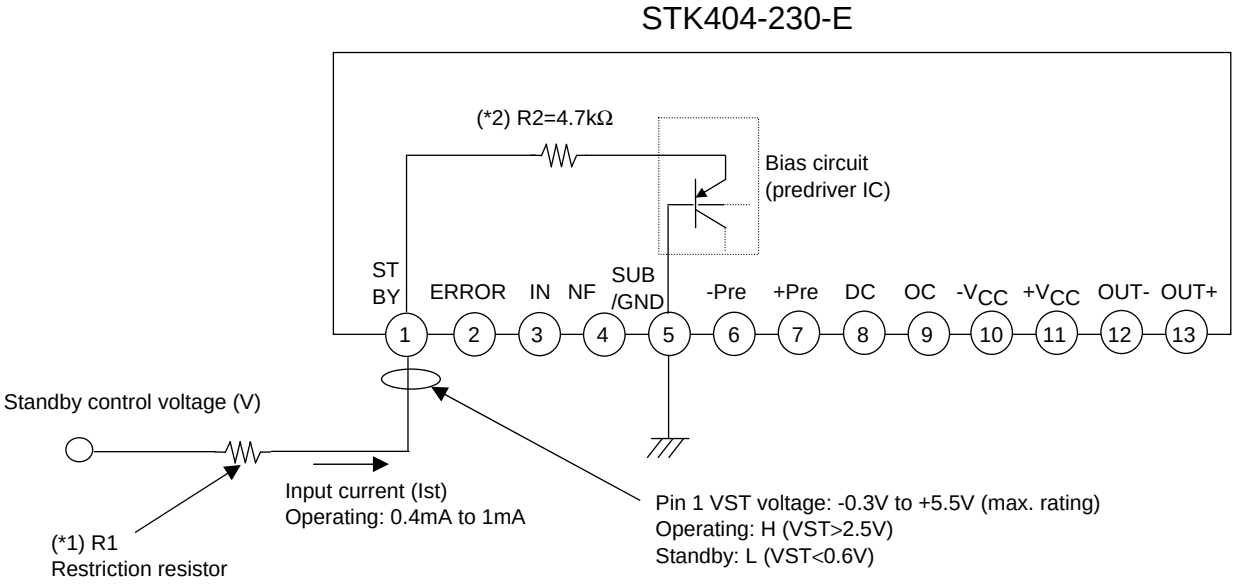
Therefore, the value of 1.42°C/W, which satisfies both of these formulae, is the required thermal resistance of the heat sink.

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.

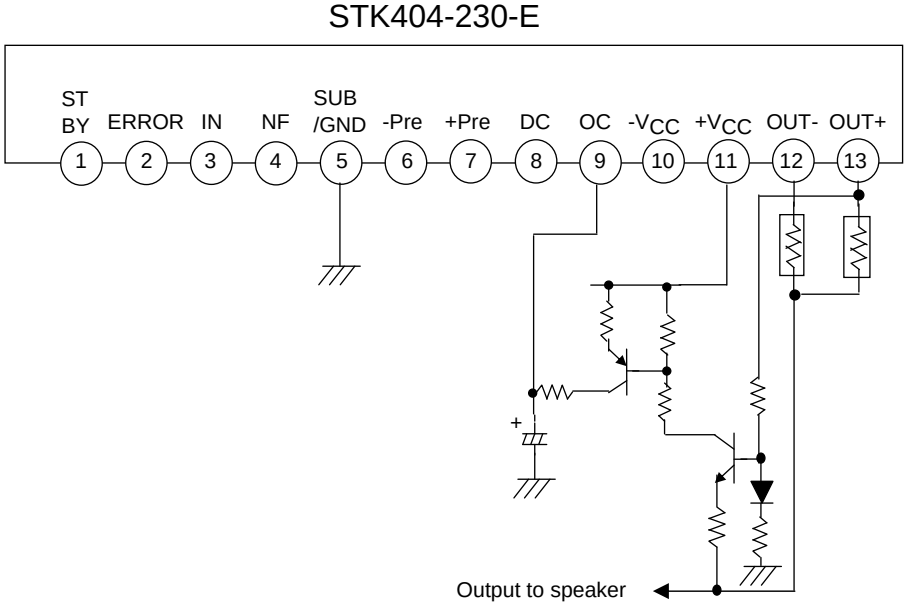


This pin has a function to release the latch when it is set to the ground level.

Overcurrent Protection Circuit

Overcurrent protection is activated if VOC ≈ 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



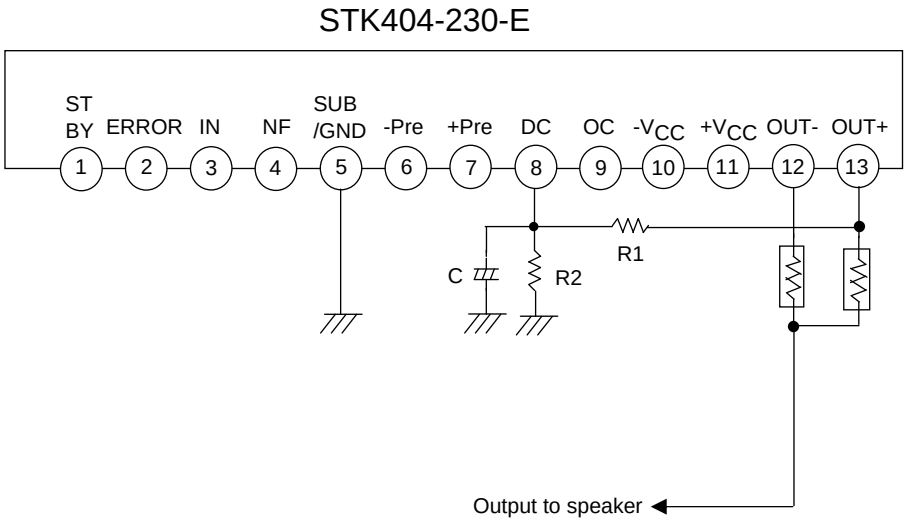
* See "Application Circuit" for recommended values.

DC Offset Detector Circuit

DC offset protection is activated if VDC(+) or VDC(-) 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.

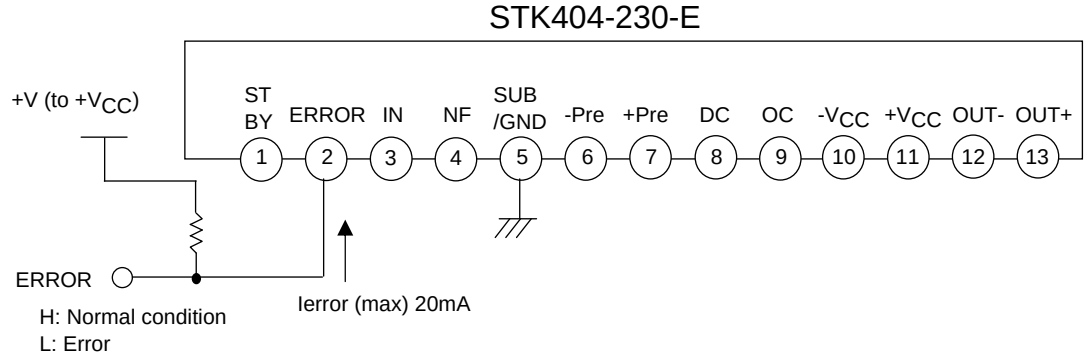
Sample Application Circuit



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

Error Indicator (Open Collector)

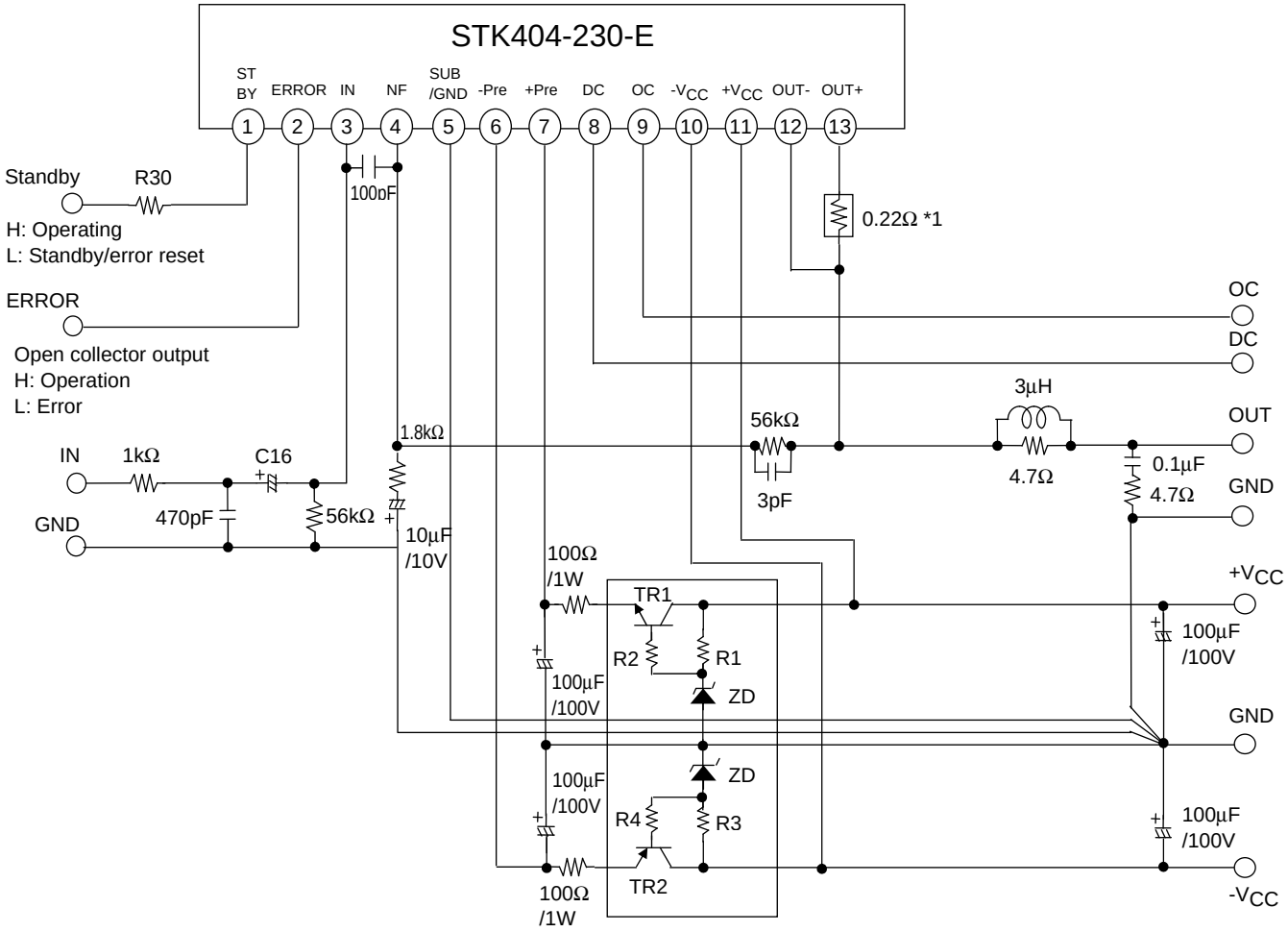
The state of the ERROR pin (#2) switches from high to low (open collector output) when a protection circuit is activated.



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 0.22Ω±10%(5W)

External Component Examples (at Ta=50°C)
[Conditions]
Limiting voltage = ±56V
V_{CC} max = ±80V
Ambient temperature = 50°C

TR1 : 2SD863, SANYO
TR2 : 2SB764, SANYO
ZD : MAZ7560 (Vz=56V), Panasonic
R1, R3 : 5.6kΩ
R2, R4 : 22Ω

* ±pre current = 25mA (max.)
* The external components should be selected according to the conditions of the product incorporating the HIC.