Ordering number : EN*A1694

Preliminary

SANYO Semiconductors

DATA SHEET

STK433-870-E — Thick-Film Hybrid IC 4-channel class AB audio power IC, 60W×4ch

Overview

The STK433-870-E is 60W×4 channels class-AB audio frequency power amplifier hybrid IC.

Applications

- Audio power amplifiers.

Features

- Pin-to-pin compatible outputs ranging from 60W to 80W
- Can be used to replace the STK433-000/-100 series (30W to 150W/2ch/class-AB), STK415-100Series (80W to 150W/2ch/class H) due to its pin compatibility of ch1/ch2.
  2ch class AB (30W to 60W, THD=10%) : STK433-000 series
  2ch class AB (80W to 150W, THD=10%) : STK433-100 series
  2ch class H (80W to 150W, THD=10%) : STK415-100 series
- Compact package (64.0mm×31.1mm×9.0mm, 78.0mm×44.1mm×9.0mm)
- Output load impedance R_L=6Ω, 8Ω supported.
- Allowable load shorted time: 0.3s
- Allows the use of predesigned applications for standby and mute circuits

Series Models

	STK433-870-E	STK433-890-E
Output 1 (10%/1kHz)	60W×4ch	80W×4ch
Output 2 (0.4%/20Hz to 20kHz)	40W×4ch	50W×4ch
Maximum Rating V_{CC} max (No signal)	±50V	±54V
Maximum Rating V_{CC} max (6Ω)	±44V	±47V
Recommended operating V_{CC} (6Ω)	±37V	±40V
Dimensions (excluding pin height)	64.0mm×31.1mm×9.0mm	78.0mm×44.1mm×9.0mm

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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	V_{CC} max (0)	No signal	±50	V
	V_{CC} max (1)	When signals are present, $R_L \geq 6\Omega$	±44	V
	V_{CC} max (2)	When signals are present, $R_L = 4\Omega$	±37	V
Minimum operating supply voltage	V_{CC} min		±10	V
Stand-by pin maximum voltage	VST OFF max		-0.3 to +5.5	V
Thermal resistance	θj-c	Per one power transistor	3.5	°C/W
Junction temperature	Tj max	Both the Tj max and Tc max conditions must be met.	150	°C
IC substrate operating temperature	Tc max		125	°C
Storage temperature	Tstg		-30 to +125	°C
Allowable load shorted time	ts	V_{CC}=±30V, R_L=6Ω, f=50Hz, P_O=40W, 1ch drive	0.3	s

Operating Characteristics at Tc=25°C, R_L=6Ω (Non-inductive Load), Rg=600Ω, VG=30dB, 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)	±30	20 to 20k		0.4		38	40		W
	P_O (2)	±30	1k		10			60		
Total harmonic distortion *1	THD (1)	±30	20 to 20k	5.0		VG=30dB			0.4	%
	THD (2)	±30	1k					0.02		
Frequency characteristics *1	f_L, f_H	±30		1.0		+0 -3dB		20 to 50k		Hz
Input impedance	ri	±30	1k	1.0				55		kΩ
Output noise voltage *3	V_{NO}	±36				Rg=2.2kΩ			1.0	mVrms
Quiescent current	I_{CCO}	±36				No loading	40	90	140	mA
Stand-By Current	ICST	±36				VST=0V		0.05		mA
Output neutral voltage	V_N	±36					-70	0	+70	mV
#13 voltage when standby ON *5	VST ON	±30				Standby		0	0.6	V
#13 voltage when standby OFF *5	VST OFF	±30				Operating	2.5	3.0	5.5	V

[Remarks]

*1. For 1-channel operation

*2. Unless otherwise specified, use a constant-voltage power supply to supply power when inspections are carried out.

*3. 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.

*4. Use the designated transformer power supply circuit shown in the figure below for the measurement of allowable load shorted time and output noise voltage.

*5. The impression voltage of '#13 (Stand-By) pin' must not exceed the maximum rating. Power amplifier operates by impressing voltage +2.5 to +5.5V to '#13 (Stand-By) pin'.

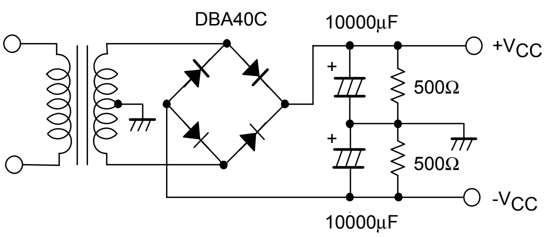
* Please connect -Pre V_{CC} pin (#1 pin) with the stable minimum voltage and connect so that current does not flow in by reverse bias.

* Thermal design must be implemented based on the conditions under which the customer's end products are expected to operate on the market.

* The case of this Hybrid-IC is using thermosetting silicon adhesive (TSE322SX).

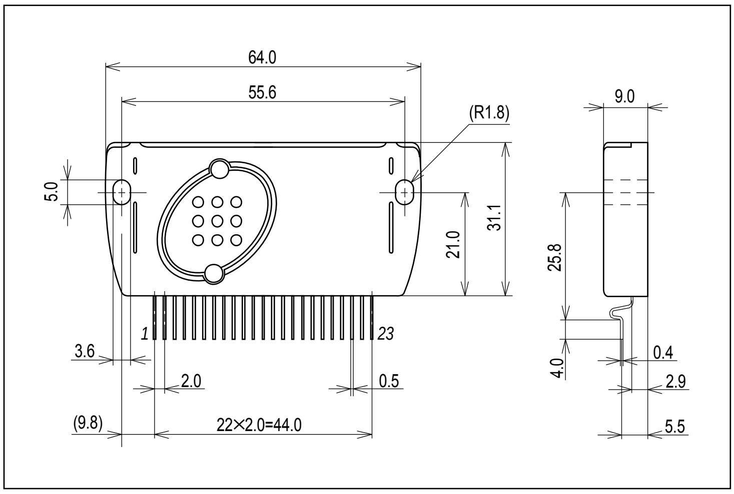
* Weight of HIC: 20.6g
Outer carton dimensions (W×L×H): 502mm×247mm×282mm

Designated transformer power supply
(MG-200 equivalent)



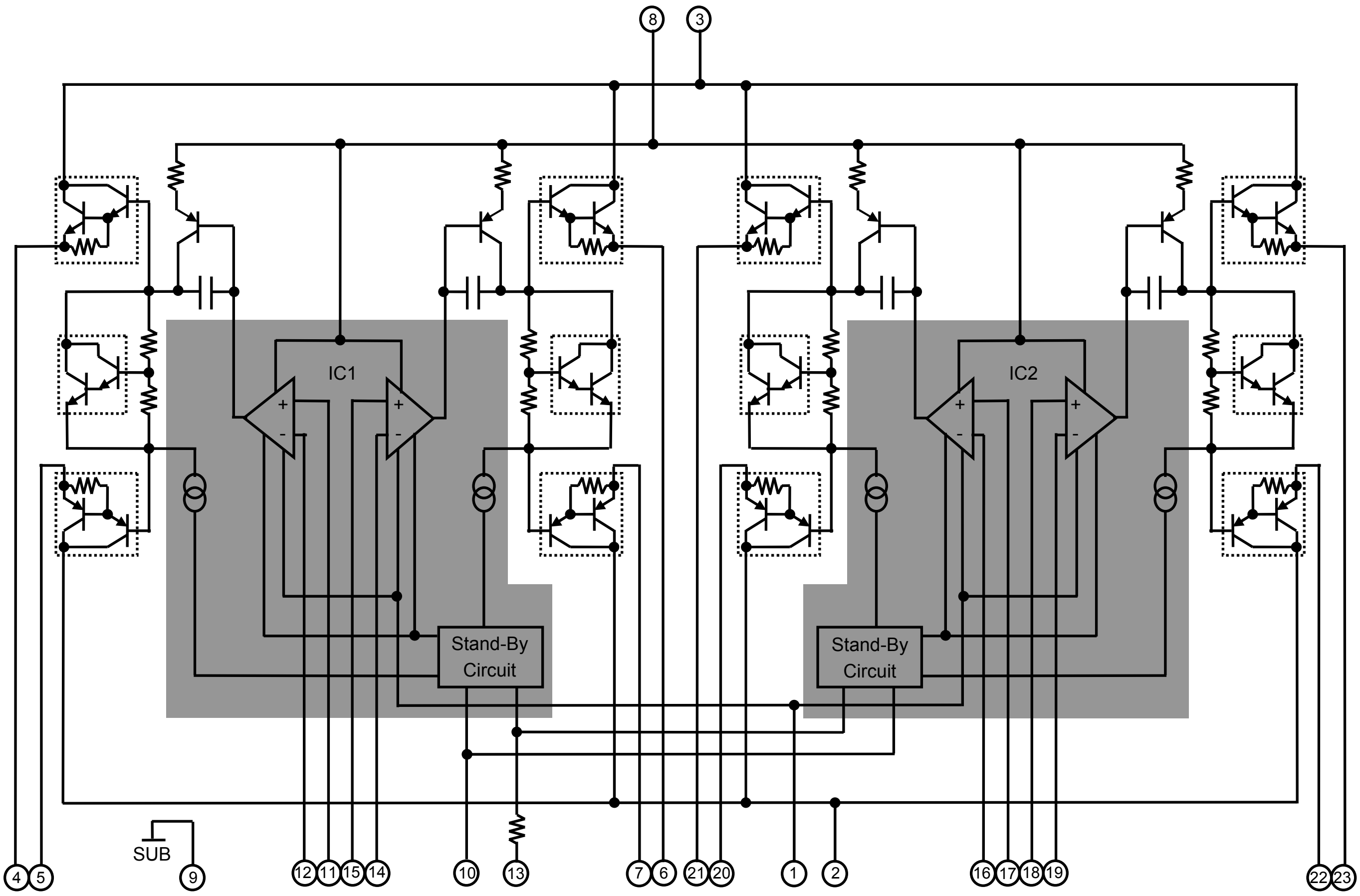
Package Dimensions

unit:mm (typ)

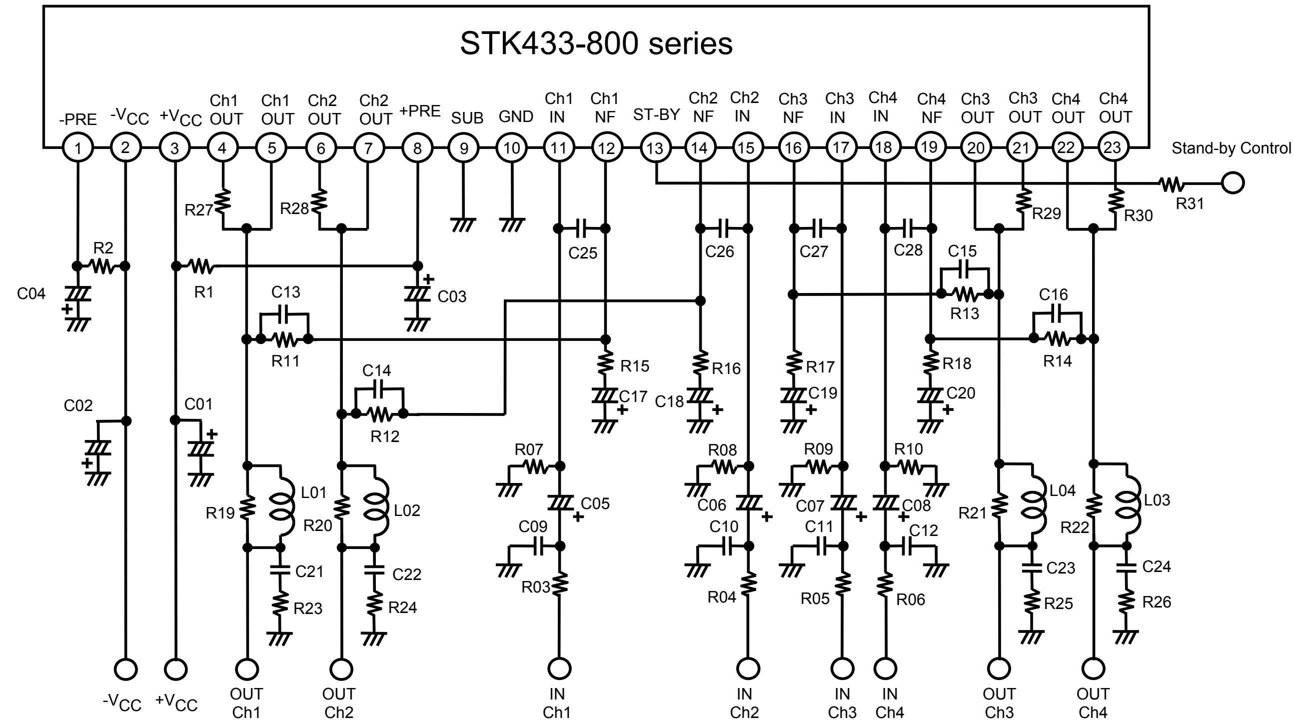


RoHS directive pass

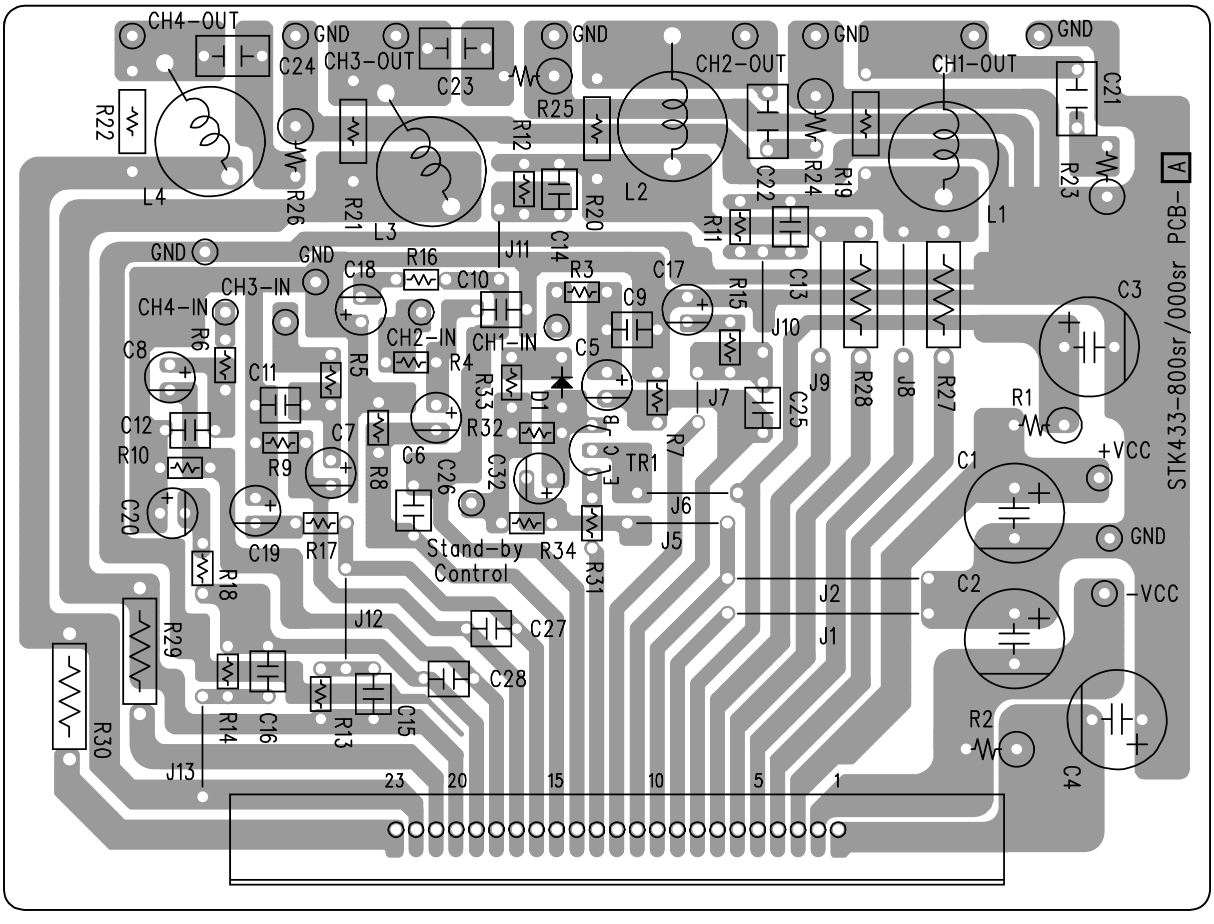
Equivalent Circuit



Application Circuit



PCB Layout Example



Recommended Values for Application Parts (for the test circuit)

Parts Location	Recommended value	Circuit purpose	Above Recommended value	Below Recommended value
R01, R02	100Ω/1W	Resistance for Ripple filter. (Fuse resistance is recommended. Ripple filter is constituted with C03, C04.)	Short-through current may decrease at high frequency.	Short-through current may increase at high frequency.
R03, R04, R05, R06	1kΩ	Resistance for input filters.	-	-
R07, R08, R09, R10	56kΩ	Input impedance is determined.	Output neutral voltage (VN) shift. (It is referred that R07=R11, R08=R12, R09=R13, R10=R14)	
R11, R12, R13, R14	56kΩ	Voltage Gain (VG) is determined with R15, R16, R17, R18.	-	-
R15, R16, R17, R18	1.8kΩ	Voltage Gain (VG) is determined with R11, R12, R13, R14. (As for VG, it is desirable to set up by R15, R16, R17, R18.)	It may oscillate. (VG<30dB)	With especially no problem
R19, R20, R21, R22	4.7Ω	Noise absorption resistance.	-	-
R23, R24, R25, R26	4.7Ω/1W	Resistance for oscillation prevention.	-	-
R27, R28, R29, R30	0.22Ω ±10%, 5W	Output emitter resistor (Metal-plate resistor is recommended.)	Decrease of maximum output power	It may cause thrmal runaway
R31	Note *5	Select restriction resistance, for the impression voltage of '#17(Stand-By) pin' must not exceed the maximum rating.		
C01, C02	100μF/ 100V	Capacitor for oscillation prevention. • Locate near the HIC as much as possible. • Power supply impedance is lowered and stable operation of the IC is carried out. (Electrolytic capacitor is recommended.)	-	-
C03, C04	100μF/ 100V	Decoupling capacitor • The ripple ingredient mixed in an input side Is removed from a power supply line. (Ripple filter is constituted with R01, R02.)	The change in the ripple ingredient mixed in an input side from a power supply line	
C05, C06, C07, C08	2.2μF/50V	Input coupling capacitor. (for DC current prevention.)	-	
C09, C10, C11, C12	470pF	Input filter capacitor • A high frequency noise is reduced with the filter constituted by R03, R04, R05, R06.	-	
C13, C14, C15, C16	3pF	Capacitor for oscillation prevention.	It may oscillate.	
C17, C18, C19, C20	10μF/10V	Negative feedback capacitor. • The cutoff frequency of a low cycle changes. ex / f_L=1/2π•C13•R11)	The voltage gain (VG) of low frequency is extended. However, the pop noise at the time of a power supply injection also becomes large.	The voltage gain (VG) of low frequency decreases.
C21, C22, C23, C24	0.1μF	Capacitor for oscillation prevention. (Mylar capacitors are recommended.)	It may oscillate.	
C25, C26, C27, C28	100pF	Capacitor for oscillation prevention.	It may oscillate.	
L01, L02, L03, L04	3μH	Coil for oscillation prevention.	With especially no problem	It may oscillate.

STK433-800 series PCB PARTS LIST

PCB Name: STK433-800 series PCB A

Location No.		PARTS	RATING	Component	
				STK433-870-E	STK433-890-E
R01, R02		ERG1SJ101	100Ω, 1W	○	○
R03, R04, R05, R06		RN16S102FK	1kΩ, 1/6W	○	○
R07, R08, R09, R10, R11, R12, R13, R14		RN16S563FK	56kΩ, 1/6W	○	○
R15, R16, R17, R18		RN16S182FK	1.8kΩ, 1/6W	○	○
R19, R20, R21, R22		RN14S4R7FK	4.7Ω, 1/4W	○	○
R23, R24, R25, R26		ERX1SJ4R7	4.7Ω, 1W	○	○
R27, R28, R29, R30		ERX2SJR22	0.22Ω, 5W	○	○
C01, C02, C03, C04		100MV100HC	100μF, 100V	○	○
C05, C06, C07, C08 (*1)		50MV2R2HC	2.2μF, 50V	○	○
C09, C10, C11, C12		DD104-63B471K50	470pF, 50V	○	○
C13, C14, C15, C16		DD104-63CJ0*0C50	***pF, 50V	3pF	5pF
C17, C18, C19, C20 (*1)		10MV10HC	10μF, 10V	○	○
C21, C22, C23, C24		ECQ-V1H104JZ	0.1μF, 50V	○	○
C25, C26, C27, C28		DD104-63B101K50	100pF, 50V	○	○
L01, L02, L03, L04		-	3μH	○	○
Stand-By Control Circuit	Tr1	2SC3332 (Reference)	V_{CE}≥54V, I_C≥10mA	○	○
	D1	GMB01 (Reference)	Di	○	○
	R31	RN16S132FK	1.3kΩ, 1/6W	○	○
	R32	RN16S333FK	33kΩ, 1/6W	○	○
	R33	RN16S102FK	1kΩ, 1/6W	○	○
	R34	RN16S202FK	2kΩ, 1/6W	○	○
	C32	10MV33HC	33μF, 10V	○	○
J1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13		-	-	○	○

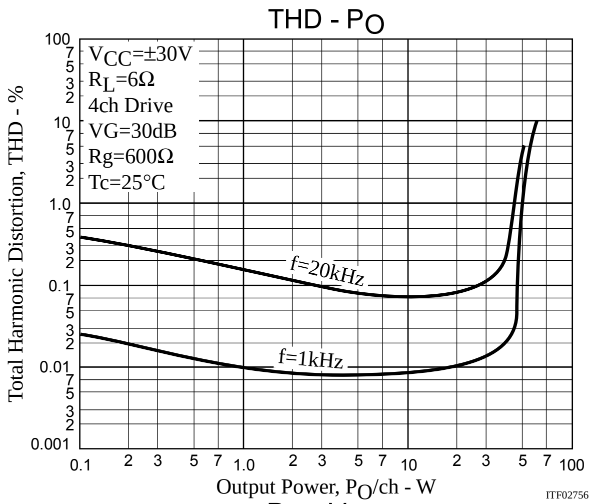
(*1) Capacitor mark “A” side is “-” (negative).

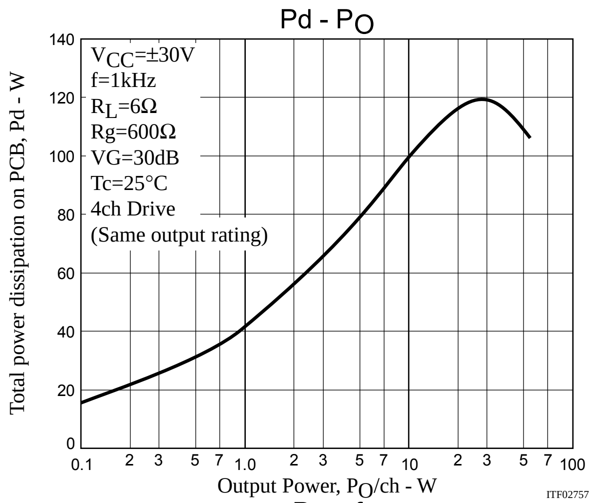
Pin Assignments

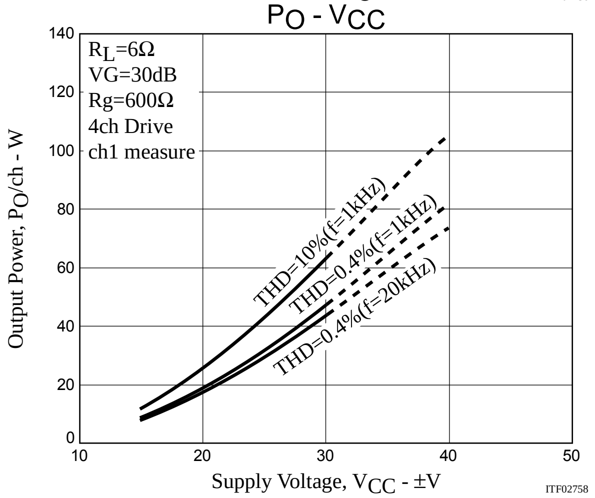
[STK433-800 series Pin Layout]

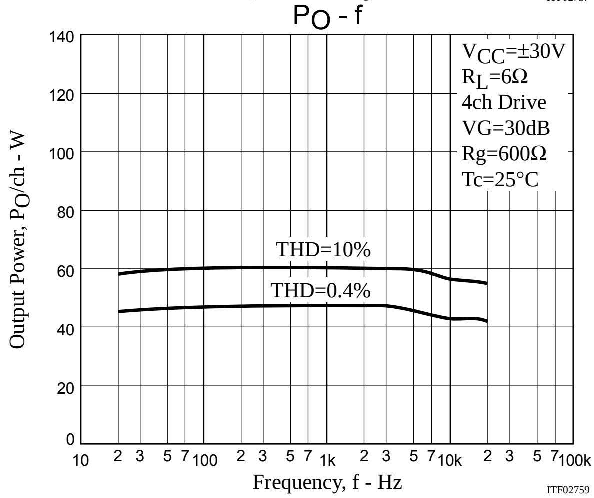
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	2ch classAB/2.00mm																						
STK433-000-E sr 30W to 60W (JEITA)×2ch Package Size/ 47.0mm×25.6mm×9.0mm STK433-100-E sr 80W to 150W (JEITA)×2ch Package Size/ 67.0mm×25.6mm×9.0mm	-PRE	-VCC	+VCC	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB	GND	IN/CH1	NF/CH1	STAND BY	NF/CH2	IN/CH2								
	4ch classAB/2.00mm																						
STK433-800-E sr 60W to 80W (JEITA)×4ch Package Size/ 64.0mm×31.1mm×9.0mm 78.0mm×44.1mm×9.0mm	-PRE	-VCC	+VCC	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB	GND	IN/CH1	NF/CH1	STAND BY	NF/CH2	IN/CH2	NF/CH3	IN/CH3	IN/CH4	NF/CH4	OUT/CH3-	OUT/CH3+	OUT/CH4-	OUT/CH4+

Evaluation Board Characteristics









[Thermal Design Example for STK433-870-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.

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

Ta: Guaranteed ambient temperature for the end product

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

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

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.

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

$$\theta c\text{-}a < (150 - Ta)/Pd - \theta j\text{-}c/N \quad \cdots\cdots (2)'$$

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 Ta

[Example]

When the IC supply voltage, V_{CC}, is ±30V and R_L is 6Ω, the total power dissipation, Pd, within the hybrid IC, will be a maximum of 120W at 1kHz for a continuous sine wave signal according to the Pd-P_O characteristics.

For the music signals normally handled by audio amplifiers, a value of 1/8P_O max 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 ≈ 78.0W (when 1/8P_O max. = 5.0W).

The number of power transistors in audio amplifier block of these hybrid ICs, N, is 8, and the thermal resistance per transistor, θj-c, is 3.5°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)' θc-a < (125 – 50)/78.0

< 0.96

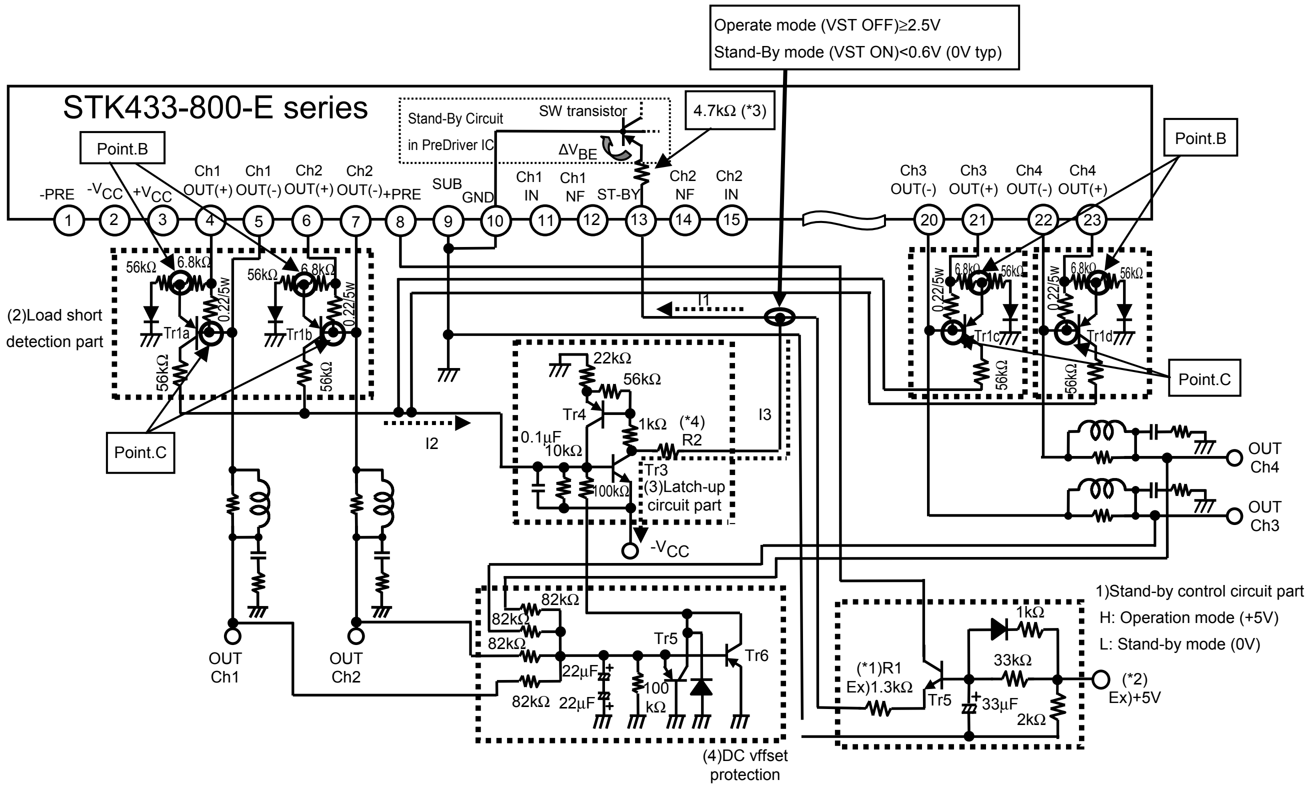
From formula (2)' θc-a < (150 – 50)78.0 – 3.5/8

< 0.84

Therefore, the value of 0.84°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.

STK433-800-E series Application Explanation



A protection application circuit of STK433-800-E series consists of each block of (1)-(4).
(1)Stand-by control circuit part
(2)Load short detection part
(3)Latch-up circuit part
(4)DC voltage protection part

1)Stand-by control circuit part
About #13 pin reference voltage VST.

<1>Operation Mode
The SW transistor of Pre-driver IC is turned on at VST≥2.5V, and the amplifier becomes operation mode.
ex)at VST (min)=2.5V
VST=(*2)×IST+0.6V→2.5V=4.7kΩ×IST+0.6V therefore, I1≈0.40mA

<2>Stand-by mode
The SW transistor of Pre-driver IC is turned off at VST≤0.6V (typ 0V), and the amplifier becomes Stand-by mode.
ex)at VST=0.6V
VST=(*2)×IST+0.6V→0.6V=4.7kΩ×IST+0.6V therefore, I1≈0mA

(*1)Resistance for restriction
Please set R1 for the voltage (VST) of the Stand-By terminal to become ratings (+2.5V to 5.5V (typ 3.0V)).
(*2)Please supply the Stand-by Control voltage by the microcomputer etc.
(*3)The limitation resistance is built into hybrid IC internal (#13pin) and 4.7kΩ is built into.

2)Load short detection part
TR1 (a, b, c, d) doesn't move by normal operation. Because, Point.B - Point.C < 0.6V.
Therefore load short detection part doesn't operate.
But, When a load short-circuited, TR1 (or TR2) operate(Point.B - Point.C > 0.6V), and an electric current ‘I2’ flows.

3)Latch-up circuit part

When I2 was supplied to latch-up circuit, TR3 operate.
VST becomes Stand-by mode (0V) when TR3 operates (I3 flows), the power amplifier is protected.
Stand-by mode is maintained when once TR3 operates because TR3 and TR4 compose the thyristor.
It is necessary to make the Stand-By Control voltage (*2) L (0V) once to release Stand-by mode and to make the power amplifier operate again.
After, when Stand-By Control (*2) is returned to H (ex, +5V), it operates again.

(*4)I3 is changed depending on the power-supply voltage ($-V_{CC}$).
Please set resistance (R2) to become I1<I3 by the following calculation types.

$$I1 \leq I3 = V_{CC}/R2$$

4)DC offset protection part

DC offset protection works at applying VDC (+), VDC (-)≈0.5V (typ) to ‘OUT (ch1 to ch4)’, then HIC will shutdown (Stand-by mode).
It is necessary to make the Stand-By Control voltage (*2) L (0V) once to release Stand-by mode.
The power amplifier operates again after Stand-By Control (*2) return to H(ex, +5V).

Please set the protection level by the resistance of ‘82kΩ’.
Moreover, please set the time constant by ‘22μ//22μ’ so as not to mis-detect it when the audio signal is output.

This catalog provides information as of May, 2010. Specifications and information herein are subject to change without notice.