



SANYO Semiconductors

# DATA SHEET

An ON Semiconductor Company

## STK433-330N-E — Thick-Film Hybrid IC 3channel class-AB Audio Power IC 150W+150W+150W

### Overview

The STK433-330N-E is a hybrid IC designed to be used in 150W × 3ch class AB audio power amplifiers.

### Application

- Audio Power amplifiers

### Features

- Pin-to-pin compatible outputs ranging from 40W to 150W.
- Output load impedance:  $R_L = 6\Omega$  recommended.
- Allows the use of predesigned applications for standby and mute circuit.
- Miniature package.
- Allowable load shorted time: 0.3 second

### Series model

	STK433-040N-E	STK433-060N-E	STK433-130N-E	STK433-330N-E
Output1 (10%/1kHz)	40W × 2ch	50W × 2ch	150W × 2ch	150W × 3ch
Output2 (0.4%/20Hz to 20kHz)	25W × 2ch	35W × 2ch	100W × 2ch	100W × 3ch
Max. rating $V_{CC}$ (quiescent)	±38V	±46V	±71.5V	±71.5V
Max. rating $V_{CC}$ (6Ω)	±36V	±40V	±63V	±63V
Recommended operating $V_{CC}$ (6Ω)	±24V	±27V	±44V	±44V
Dimensions (excluding pin height)	47.0mm×25.6mm×9.0mm		67.0mm×25.6mm×9.0mm	64.0mm×36.6mm×9.0mm

	STK433-840N-E	STK433-870N-E	STK433-890N-E
Output1 (10%/1kHz)	40W × 4ch	60W × 4ch	80W × 4ch
Output2 (0.4%/20Hz to 20kHz)	25W × 4ch	40W × 4ch	50W × 4ch
Max. rating $V_{CC}$ (quiescent)	±38V	±50V	±54V
Max. rating $V_{CC}$ (6Ω)	±36V	±44V	±47V
Recommended operating $V_{CC}$ (6Ω)	±25V	±30V	±34V
Dimensions (excluding pin height)	64.0mm×31.1mm×9.0mm		78.0mm×44.1mm×9.0mm

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# STK433-330N-E

## Specifications

**Absolute Maximum Ratings** at  $T_a = 25^\circ\text{C}$ ,  $T_c = 25^\circ\text{C}$  unless otherwise specified

Parameter	Symbol	Conditions	Ratings	Unit
Maximum power supply voltage	$V_{CC}$ max (0)	Non- signal	$\pm 71.5$	V
	$V_{CC}$ max (1)	Signal, $R_L \geq 6\Omega$	$\pm 63$	V
Minimum operation supply voltage	$V_{CC}$ min		$\pm 10$	V
#13 Operating voltage *5	VST OFF max		-0.3 to +5.5	V
Thermal resistance	$\theta_{j-c}$	Per one power transistor	1.6	$^\circ\text{C}/\text{W}$
Junction temperature	$T_j$ max	Should satisfy $T_j$ max and $T_c$ max	150	$^\circ\text{C}$
Operating substrate temperature	$T_c$ max		125	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-30 to +125	$^\circ\text{C}$
Allowable time for load short-circuit *4	$t_s$	$V_{CC} = \pm 44\text{V}$ , $R_L = 6\Omega$ , $f = 50\text{Hz}$ $P_O = 100\text{W}$ , 1ch drive	0.3	s

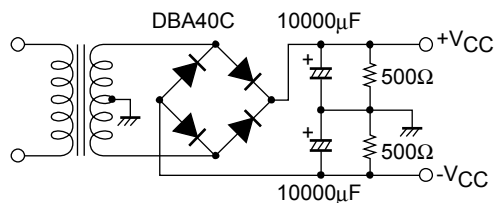
**Operating Characteristics** at  $T_c = 25^\circ\text{C}$ ,  $R_L = 6\Omega$  (Non-inductive Load),  $R_g = 600\Omega$ ,  $V_G = 30\text{dB}$

Parameter	Symbol	Conditions *2				Ratings			Unit
		$V_{CC}$ [V]	f [Hz]	$P_O$ [W]	THD [%]	min	typ	max	
Output power *1	$P_{O1}$	$\pm 44$	20 to 20k		0.4	96	100		W
	$P_{O2}$	$\pm 44$	1k		10		150		
Total harmonic distortion *1	THD 1	$\pm 44$	20 to 20k	5.0	VG=30dB			0.4	%
	THD 2	$\pm 44$	1k				0.01		
Frequency characteristics *1	$f_L, f_H$	$\pm 44$		1.0	+0 -3dB	20 to 50k			Hz
Input impedance	$r_i$	$\pm 44$	1k	1.0			55		$k\Omega$
Output noise voltage *3	$V_{NO}$	$\pm 53$			$R_g = 2.2k\Omega$			1.0	mVrms
Quiescent current	$I_{CCO}$	$\pm 53$			No load	60	120	160	mA
Output neutral voltage	$V_N$	$\pm 53$				-70	0	+70	mV
#13 Stand-by ON threshold *5	VST ON	$\pm 44$			Stand-by		0	0.6	V
#13 Stand-by OFF threshold *5	VST OFF	$\pm 44$			Operation	2.5	3.0	5.5	V

### Note

- \*1. 1channel operation.
- \*2. All tests are measured using a constant-voltage supply unless otherwise specified
- \*3. The output noise voltage is peak value of an average-reading meter with a rms value scale (VTVM).  
A regulated AC supply (50Hz) should be used to eliminate the effects of AC primary line flicker noise
- \*4. Allowable time for load short-circuit and output noise voltage are measured using the specified transformer power supply.
- \*5. The impression voltage of '#13 (Stand-By) pin' must not exceed the maximum rating.  
Power amplifier operate 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.
- \* In case of heat sink design, we request customer to design in the condition to have assumed market.
- \* The case of this Hybrid-IC is using thermosetting silicon adhesive (TSE322SX).
- \* Weight of HIC : (typ) 24.5g  
Outer carton dimensions (W×L×H) : 452mm×325mm×192mm

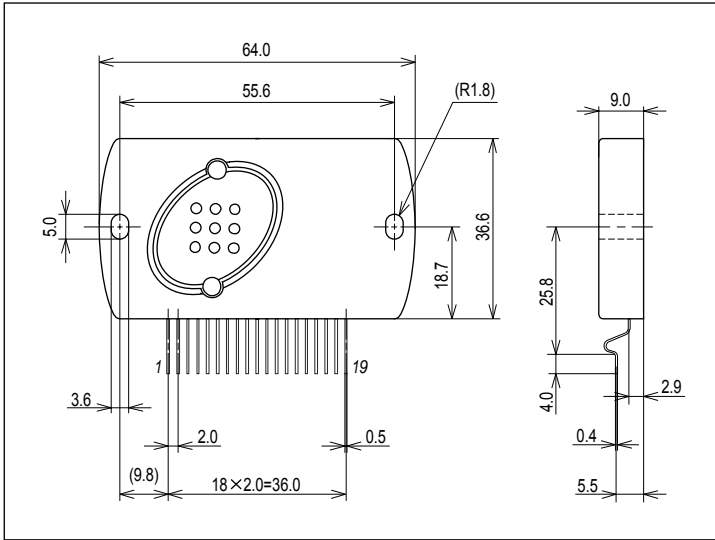
Specified transformer power supply  
(Equivalent to MG-250)



# STK433-330N-E

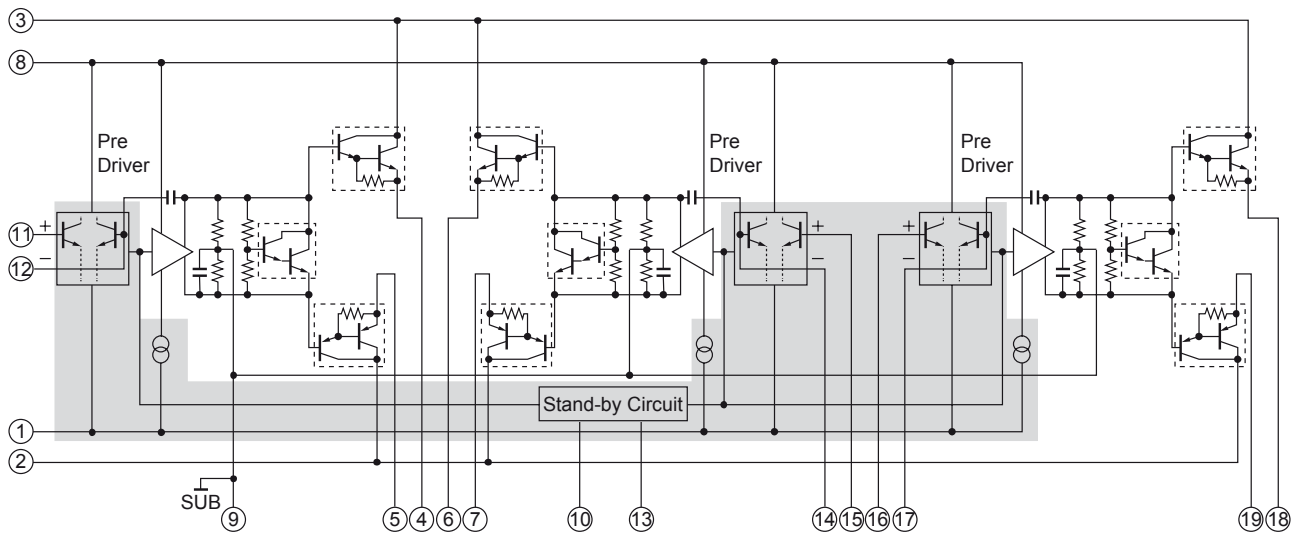
## Package Dimensions

unit : mm (typ)



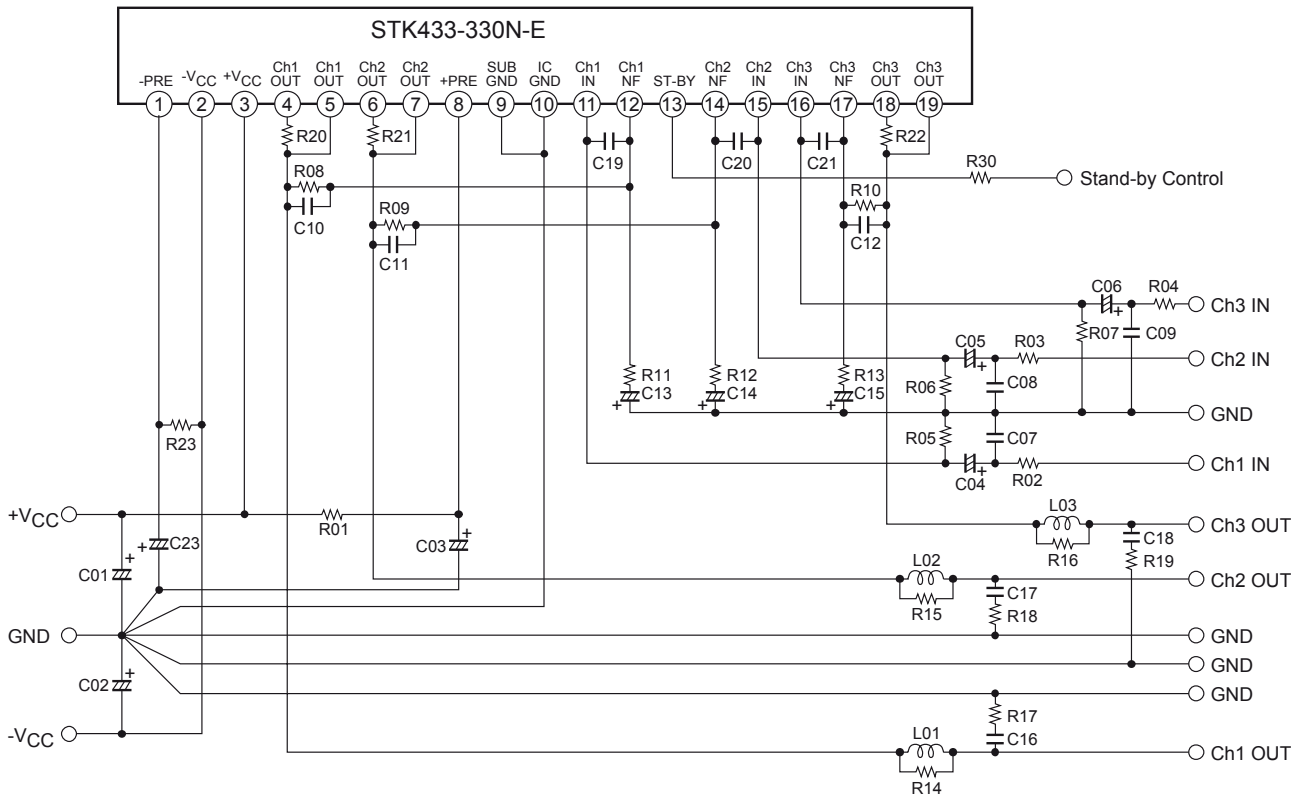
RoHS directive pass

## Equivalent Circuit



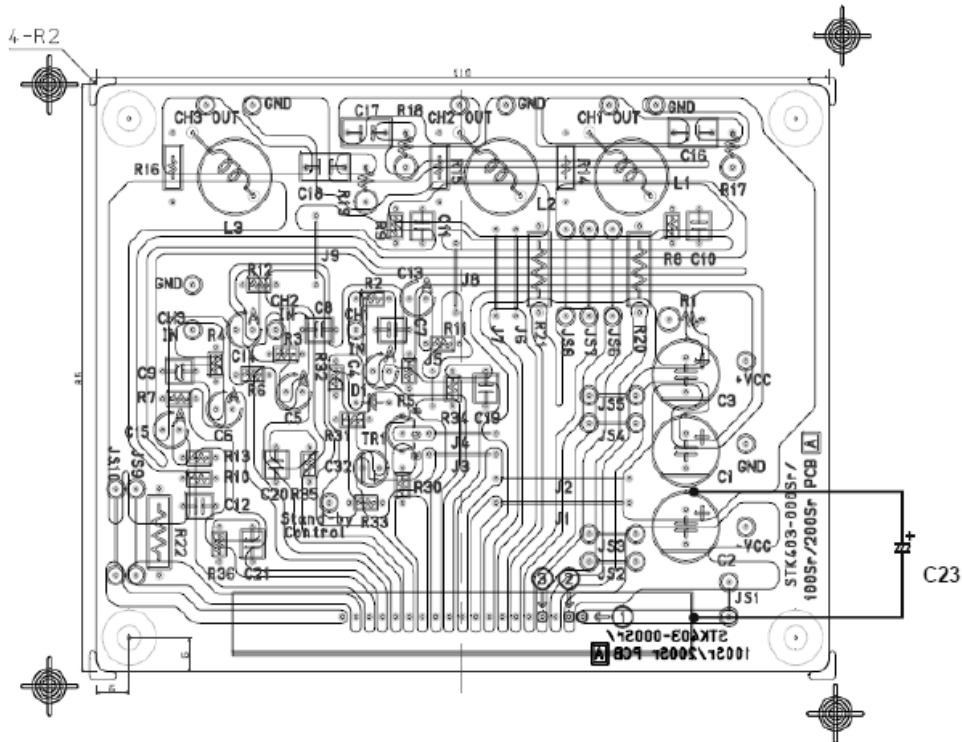
# STK433-330N-E

## Application Circuit



## PCB Layout Example

Top view



# STK433-330N-E

## STK433-040N-E/060N-E/130N-E/330N-E PCB PARTS LIST

PCB Name : STK403-000Sr/100Sr/200Sr PCB A

Location No.  (*2) 2ch Amp doesn't mount parts of ( ).	RATING	Component		
Hybrid IC#1 Pin Position	-	STK433-		
		040N-E	060N-E	130N-E/ 330N-E
R01	100Ω, 1W	○		
R02, R03, (R04)	1kΩ, 1/6W	○		
R05, R06, (R07), R08, R09, (R10)	56kΩ, 1/6W	○		
R11, R12, (R13)	1.8kΩ, 1/6W	○		
R14, R15, (R16)	4.7Ω, 1/4W	○		
R17, R18, (R19)	4.7Ω, 1W	○		
R20, R21, (R22)	0.22Ω, 5W	○		
C01, C02, C03, C23 (*3)	100μF, 100V	○		
C04, C05, (C06)	2.2μF, 50V	○ (*1)		
C07, C08, (C09)	470pF, 50V	○		
C10, C11, (C12)	3pF, 50V	○		
C13, C14, (C15)	10μF, 10V	○ (*1)		
C16, C17, (C18)	0.1μF, 50V	○		
C19, C20, (C21)	***pF, 50V	100pF	56pF	N.C.
R34, R35, (R36)	3kΩ, 1/6W	Short		
L01, L02, (L03)	3μH	○		
Stand-By Control Circuit	Tr1	VCE ≥ 75V, IC ≥ 1mA		○
	D1	Di		○
	R30 (*4)	***kΩ, 1/6W		○ (*4)
	R31	33kΩ, 1/6W		○
	R32	1kΩ, 1/6W		○
	R33	2kΩ, 1/6W		○
C32	33μF, 10V		○	
J1, J2, J3, J4, J5, J6, J8, J9	-	○		
J7, JS2, JS3, JS4, JS5, JS7 JS8, JS9	-	-		
JS6, JS10	-	○		
JS1 (R23)	100Ω, 1W	○		

(\*1) Capacitor mark "A" side is "-" (negative).

(\*2) STK433-040N-E/060N-E/130N-E (2ch Amp) doesn't mount parts of ( )

(\*3) Add parts C23 to the other side of PCB.

(\*4) Recommended standby circuit is used.

## STK433-330N-E

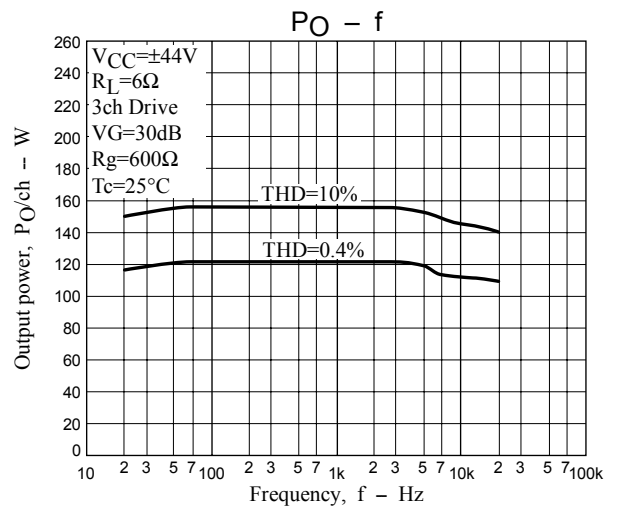
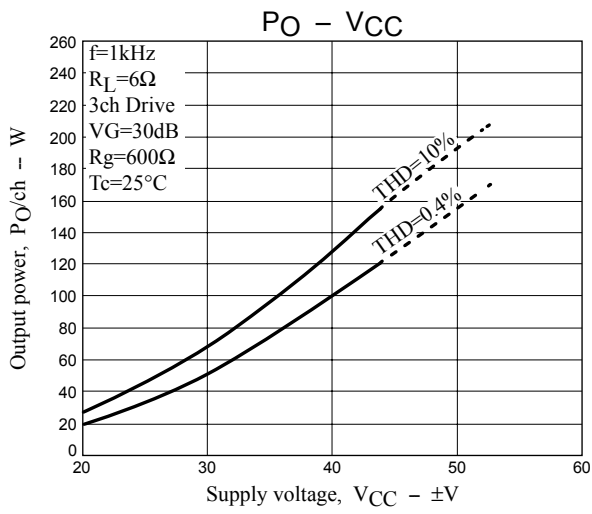
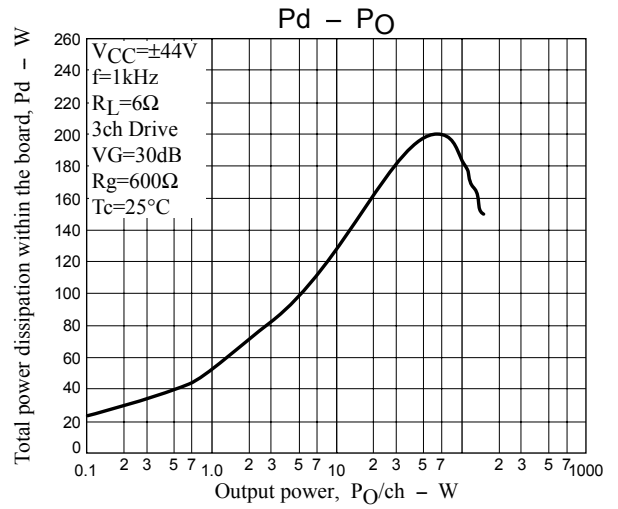
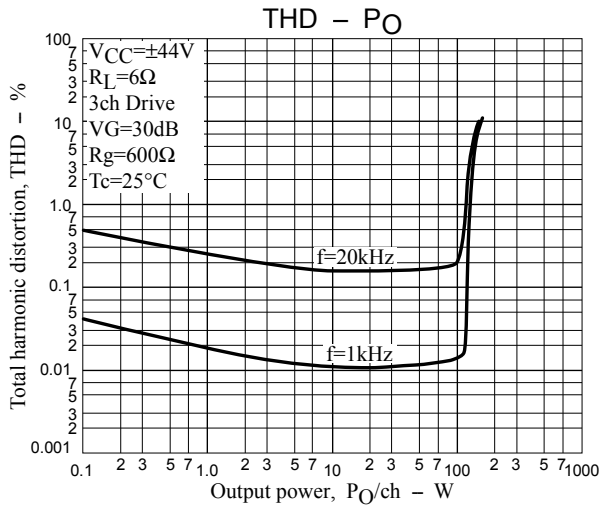
### Recommended external components

STK433-040N-E/060N-E/130N-E/330N-E

Parts Location	Recommended value	Circuit purpose	Above Recommended value	Below Recommended value
R01, R23	100Ω/1W	Resistance for Ripple filter. (Fuse resistance is recommended. Ripple filter is constituted with C03, C23.)	Short-through current may decrease at high frequency.	Short-through current may increase at high frequency.
R02, R03, R04	1kΩ	Resistance for input filters.	-	-
R05, R06, R07	56kΩ	Input impedance is determined.	Output neutral voltage(VN) shift. (It is referred that R05=R08, R06=R09)	
R08, R09, R10	56kΩ	Voltage Gain (VG) is determined with R11, R12, R13	-	-
R11, R12, R13	1.8kΩ	Voltage Gain (VG) is determined with R8, R9, R10 (As for VG, it is desirable to set up by R11, R12, R13)	It may oscillate. (Vg < 30dB)	With especially no problem
R14, R15, R16	4.7Ω	Resistance for oscillation prevention.	-	-
R17, R18, R19	4.7Ω/1W	Resistance for oscillation prevention.	-	-
R20, R21, R22	0.22Ω/2W	This resistance is used as detection resistance of the protection circuit application.	Decrease of Maximum output Power	It may cause thermal runaway
R30	Note *5	Select Restriction resistance, for the impression voltage of '#17 (Stand-By) pin' must not exceed the maximum rating.		
C01, C02	100μF/50V	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, C23	100μF/50V	Decoupling capacitor • The Ripple ingredient mixed in an input side is removed from a power supply line. (Ripple filter is constituted with R01, R23.)	The change in the Ripple ingredient mixed in an input side from a power supply line	
C04, C05, C06	2.2μF/50V	Input coupling capacitor.(for DC current prevention.)	-	
C07, C08, C09	470pF	Input filter capacitor • A high frequency noise is reduced with the filter constituted by R02, R03, R04	-	
C10, C11, C12	3pF	Capacitor for oscillation prevention.	It may oscillate.	
C13, C14, C15	10μF/10V	Negative feedback capacitor. The cutoff frequency of a low cycle changes. ( $f_L = 1/(2\pi \cdot C13 \cdot R11)$ )	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.
C16, C17, C18	0.1μF	Capacitor for oscillation prevention.	It may oscillate.	
C19, C20, C21	100pF (040N-E) 56pF (060N-E) N.C. (130N-E, 330N-E)	Capacitor for oscillation prevention.	It may oscillate.	
L01, L02, L03	3μH	Coil for oscillation prevention.	With especially no problem	It may oscillate.



Characteristic of Evaluation Board





A Thermal Design Tip For STK433-330N-E Amplifier

[Thermal Design Conditions]

The thermal resistance ( $\theta_{c-a}$ ) of the heat-sink which manages the heat dissipation inside the Hybrid IC will be determined as follow:

(Condition 1) The case temperature ( $T_c$ ) of the Hybrid IC should not exceed 125°C

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

Where  $T_a$  : the ambient temperature for the system

(Condition 2) The junction temperature of each power transistor should not exceed 150°C

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

Where  $N$  : the number of transistors (two for 1 channel , ten for channel)

$\theta_{j-c}$  : the thermal resistance of each transistor (see specification)

Note that the power consumption of each power transistor is assumed to be equal to the total power dissipation ( $P_d$ ) divided by the number of transistors ( $N$ ).

From the formula (1) and (2), we will obtain:

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

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

The value which satisfies above formula (1)' and (2)' will be the thermal resistance for a desired heat-sink.

Note that all of the component except power transistors employed in the Hybrid IC comply with above conditions.

[Example of Thermal Design]

Generally, the power consumption of actual music signals are being estimated by the continuous signal of 1/8  $P_{O\ max}$ . (Note that the value of 1/8  $P_{O\ max}$  may be varied from the country to country.)

(Sample of STK433-330N-E ; 100W×3ch)

If  $V_{CC}$  is ±44V, and  $R_L$  is 6Ω, then the total power dissipation ( $P_d$ ) of inside Hybrid IC is as follow;

$P_d = 139W$  (at 12.5W output power, 1/8 of  $P_{O\ max}$ )

There are six (6) transistors in Audio Section of this Hybrid IC, and thermal resistance ( $\theta_{j-c}$ ) of each transistor is 1.6°C/W. If the ambient temperature ( $T_a$ ) is guaranteed for 50°C, then the thermal resistance ( $\theta_{c-a}$ ) of a desired heat-sink should be;

From (1)'  $\theta_{c-a} < (125 - 50)/139$   
 $< 0.54$

From (2)'  $\theta_{c-a} < (150 - 50)/139 - 1.6/6$   
 $< 0.45$

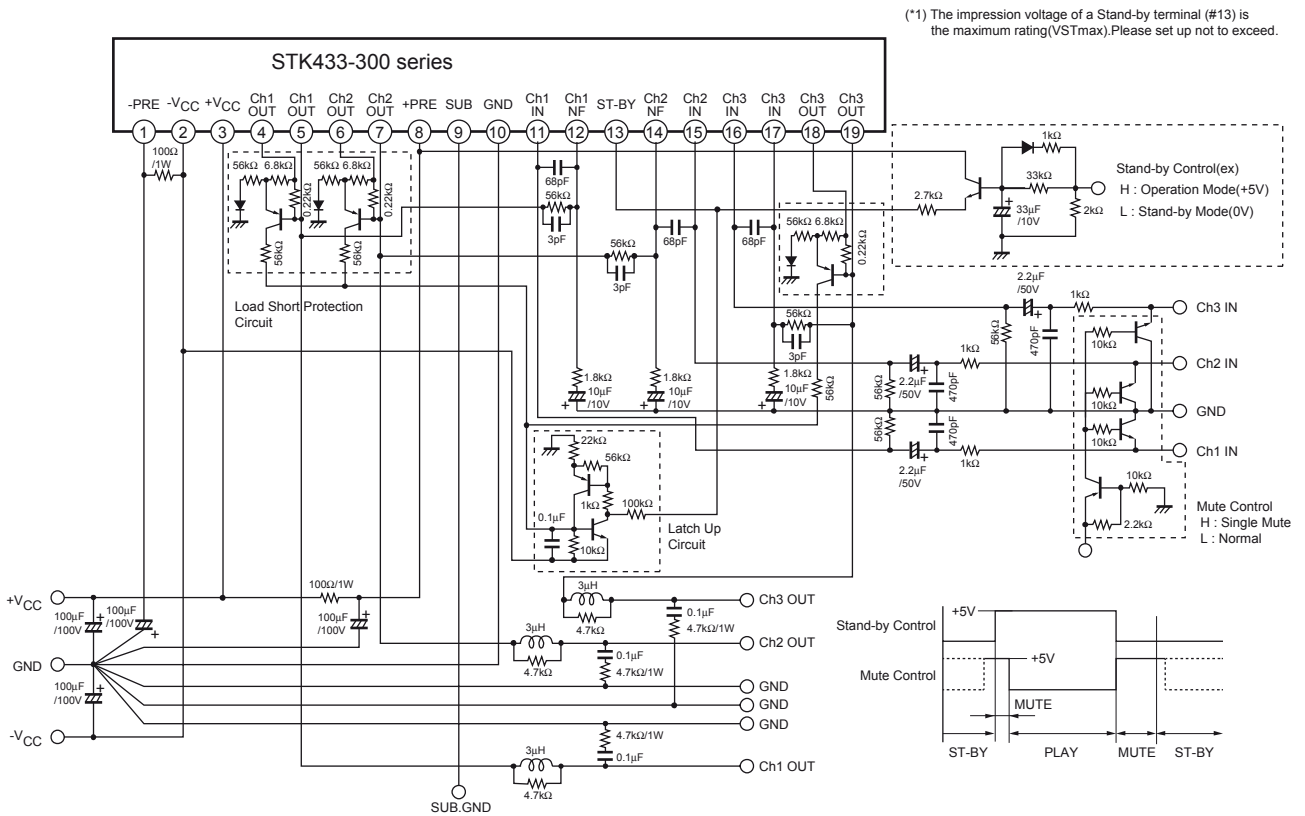
Therefore, in order to satisfy both (1)' and (2)', the thermal resistance of a desired Heat-sink will be 0.45°C/W.

[Note]

Above are reference only. The samples are operated with a constant power supply. Please verify the conditions when your system is actually implemented.

# STK433-330N-E

## STK433-300 series Stand-by Control & Mute Control & Load-Short Protection Application

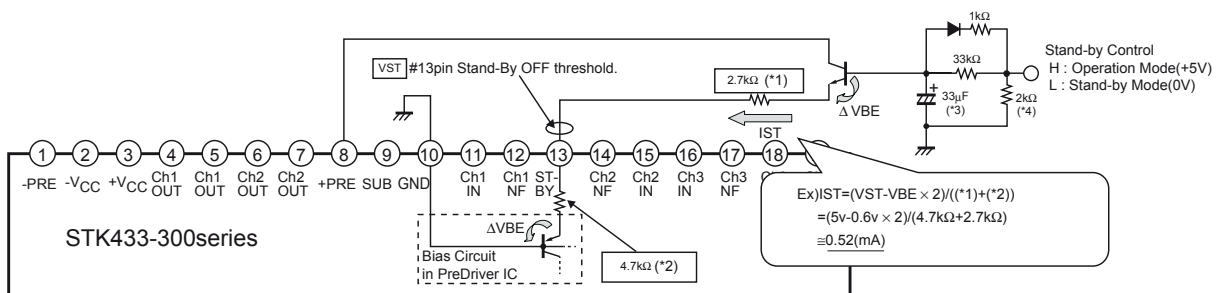


### [STK433-300 series Stand-By Control Example]

#### [Feature]

- The pop noise generated when power supply ON/OFF by using recommendation Stand-By Control Application can be improved.
- Stand-By Control can be done by additionally adjusting the limitation resistance (\*1) to the voltage such as Micro computer, the set design is easy.

(Reference circuit) STK433-300 series test circuit To Stand-By Control added +5V.



#### [Operation explanation]

##### 1) #13pin Stand-By Control Voltage VST

###### (1) Operation Mode

SW transistor of Stand-By Circuit is turned on when  $VST \geq 2.5V$  or more is impressed, and the power amplifier works.

ex)  $VST = 2.5V$

$$VST = (*2) \times IST + 0.6V \rightarrow 2.5V = 4.7k\Omega \times IST + 0.6V \quad \text{Therefore, } \underline{IST \approx 0.40mA}$$

###### (2) Stand-By Mode

$VST \leq 0.6V$  or less turns off the SW transistor of Stand-By Circuit by (typ 0V), and the amplifier stops.

ex)  $VST = 0.6V$

$$VST = (*2) \times IST + 0.6V \rightarrow 0.6V = 4.7k\Omega \times IST + 0.6V \quad \text{Therefore, } \underline{IST \approx 0mA}$$

- (\*3) When the power supply is turned on by giving the time constant with the capacitor (\*3) when the amplifier works, the pop noise is improved.
- (\*4) When capacitor (\*3) is discharged when the amplifier operation stops, the constant is decided.

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