Ordering number : EN*A1630

Preliminary

SANYO Semiconductors
DATA SHEET

Thick-Film Hybrid IC

STK433-290-E — 3-channel class AB audio power IC, 80W+80W+80W

Overview

The STK433-290-E is a hybrid IC designed to be used in 80W × 3ch class AB audio power amplifiers.

Applications

- Audio power amplifiers.

Features

- Pin-to-pin compatible outputs ranging from 80W to 150W.
- Can be used to replace the STK433-000/-100 series (30W to 150W × 2ch) and STK433-200(A) series (30W to 60W × 3ch) due to its pin compatibility.
- Miniature package (64.0mm × 36.6mm × 9.0mm)
- Output load impedance: R_L = 6Ω to 4Ω supported
- Allowable load shorted time: 0.3 second
- Allows the use of predesigned applications for standby and mute circuits.

Series Models

	STK433-290-E	STK433-300-E	STK433-320-E	STK433-330-E
Output 1 (10%/1kHz)	80W×3ch	100W×3ch	120W×3ch	150W×3ch
Output 2 (0.4%/20Hz to 20kHz)	50W×3ch	60W×3ch	80W×3ch	100W×3ch
Maximum rating V_{CC} max (no sig.)	±54V	±57V	±65V	±71.5V
Maximum rating V_{CC} max (6Ω)	±47V	±50V	±57V	±63V
Recommended operating V_{CC} (6Ω)	±33V	±36V	±41V	±44V
Dimensions (excluding pin height)	64.0mm×36.6mm×9.0mm			

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Specifications

Absolute maximum ratings at Ta=25°C, Unless otherwise specified Tc=25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum power supply voltage	V_{CC} max (0)	Non signal	±54	V
Maximum power supply voltage	V_{CC} max (1)	R_L≥6Ω	±47	V
Minimum operating supply voltage	V_{CC} min		±10	V
#13 Operating voltage	VST OFF max		-0.3 to +5.5	V
Thermal resistance	θj-c	Per one power transistor	2.1	°C/W
Junction temperature	Tj max	Should satisfy Tj max and Tc max	150	°C
Operating substrate temperature	Tc max		125	°C
Storage temperature	Tstg		-30 to +125	°C
Allowable time for load short-circuit	ts	V_{CC}=±33V, R_L=6Ω, f=50Hz, P_O=50W, 1-channel active	0.3	s

Operating Characteristics at Unless otherwise specified Tc=25°C, R_L=6Ω (Non-inductive Load), Rg=600Ω, VG=30dB

Parameter	Symbol	Conditions *2					Ratings			unit
		V_{CC} (V)	f (Hz)	P_O (W)	THD (%)		min	typ	max	
Output power *1	P_O (1)	±33	20 to 20k		0.4		47	50		W
	P_O (2)	±33	1k		10			80		
Total harmonic distortion *1	THD (1)	±33	20 to 20k	5.0		VG=30dB			0.4	%
	THD (2)	±33	1k					0.01		
Frequency characteristics *1	f_L, f_H	±33		1.0		+0 -3dB	20 to 50k			Hz
Input impedance	ri	±33	1k	1.0				55		kΩ
Output noise voltage *3	V_{NO}	±39				Rg=2.2kΩ			1.0	mVrms
Quiescent current	I_{CCO}	±39				No loading	30	70	120	mA
Output neutral voltage	V_N	±39					-70	0	+70	mV
#13 Stand-by ON threshold *5	VST ON	±33				Stand-by		0	0.6	V
#13 Stand-by OFF threshold *5	VST OFF	±33				Operation	2.5	3.0		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 transformer power supply circuit shown in the figure below for allowable load shorted time and output noise voltage measurement.

*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'.

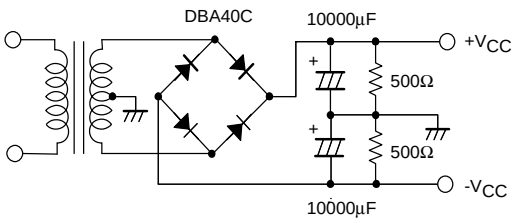
*6: Please connect -PreV_{CC} pin (#1 pin)with the stable minimum voltage, and connect so that current does not flow in by reverse bias.

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

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

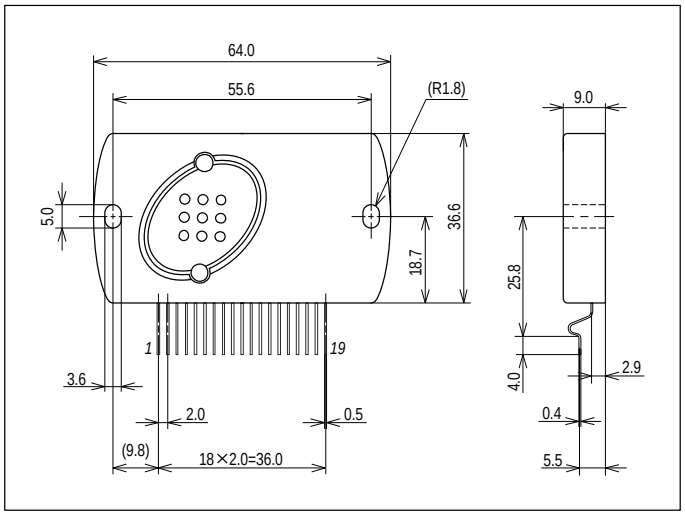
*9: Weight of HIC: 24.8g
Outer carton dimensions (W×L×H): 452mm×325mm×192mm

Designated transformer power supply
(MG-200 equivalent)



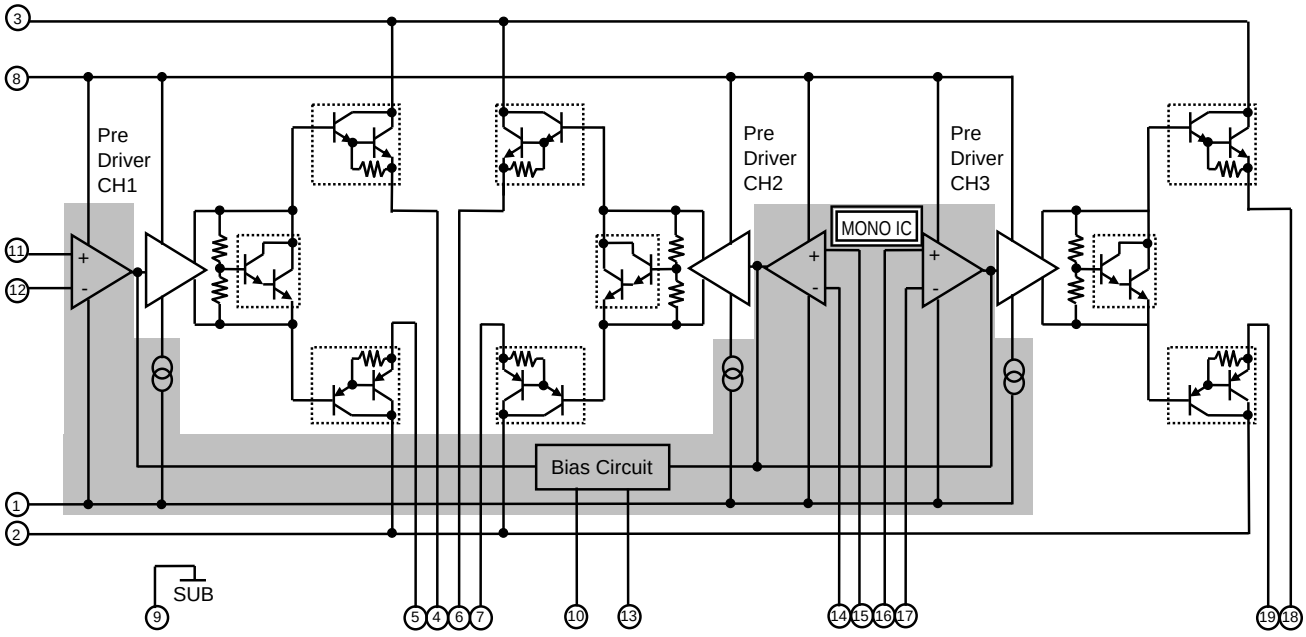
Package Dimensions

unit:mm (typ)

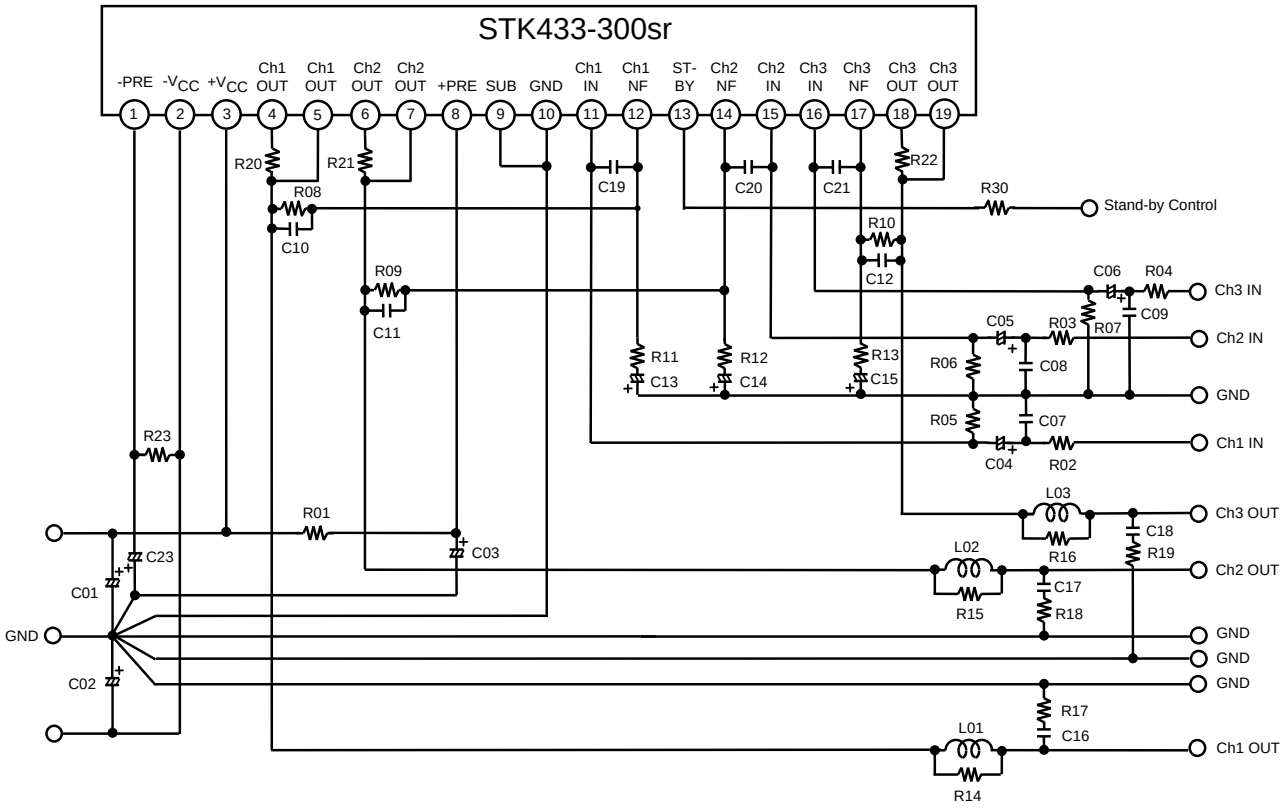


RoHS DIRECTIVE PASS

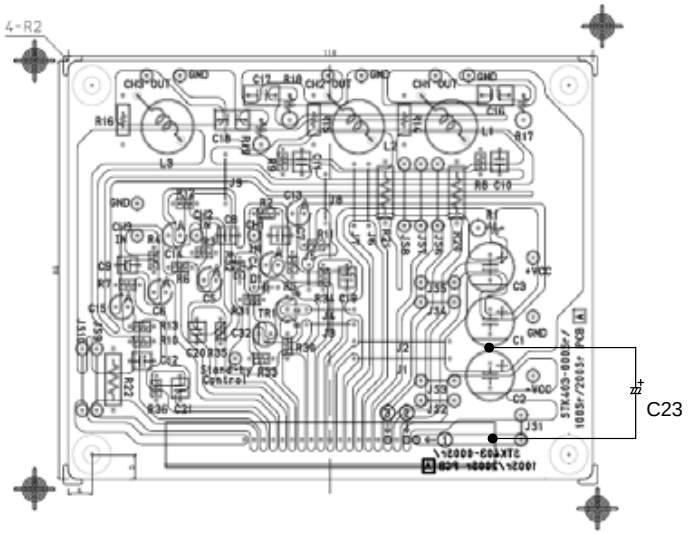
Equivalent Circuit



Application Circuit



PCB Layout Example



Recommended External Components

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 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, R07=R10)	
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	Noise absorption resistance.	-	-
R17, R18, R19	4.7Ω/1W	Resistance for oscillation prevention.	-	-
R20, R21, R22	0.22Ω ±10%, 5W	Output emitter resistor (Metal-plate resistor is recommended.)	Decrease of maximum output Power	It may cause thrmal 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/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, C23	100μF/100V	Decoupling capacitor • The ripple ingredient mixed in an input side is removed from a power supply line. (Ripple filter is constituted with R03, R04.)	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/(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.
C16, C17, C18	0.1μF	Capacitor for oscillation prevention.	It may oscillate.	
C19, C20, C21	68pF	Capacitor for oscillation prevention.	It may oscillate.	
L01, L02, L03	3μH	Coil for oscillation prevention.	With especially no problem	It may oscillate.

STK433-100/-300sr PCB PARTS LIST

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

Location No. (*2) 2ch Amp doesn't mount parts of ( ).		PARTS	RATING	Component	
Hybrid IC#1 Pin Position		-	-	①	
				STK433-100Sr (*2)	STK433-300Sr
R01		ERG1SJ101	100Ω, 1W	enabled	
R02, R03, (R04)		RN16S102FK	1kΩ, 1/6W	enabled	
R05, R06, (R07), R08, R09, (R10)		RN16S563FK	56kΩ, 1/6W	enabled	
R11, R12, (R13)		RN16S182FK	1.8kΩ, 1/6W	enabled	
R14, R15, (R16)		RN14S4R7FK	4.7Ω, 1/4W	enabled	
R17, R18, (R19)		ERX1SJ4R7	4.7Ω, 1W	enabled	
R20, R21, (R22)		Metal-plate resistor is recommended	0.22Ω, 5W	enabled	
C01, C02, C03, C23	(*3)	100MV100HC	100μF, 100V	enabled	
C04, C05, (C06)		50MV2R2HC	2.2μF, 50V	enabled (*1)	
C07, C08, (C09)		DD104-63B471K50	470pF, 50V	enabled	
C10, C11, (C12)		DD104-63CJ030C50	3pF, 50V	enabled	
C13, C14, (C15)		10MV10HC	10μF, 10V	enabled (*1)	
C16, C17, (C18)		ECQ-V1H104JZ	0.1μF, 50V	enabled	
C19, C20, (C21)		DD104-63B***K50	***pF, 50V	100pF	68pF
R34, R35, (R36)		RN16S302FK	3kΩ, 1/6W	Short	
L01, L02, (L03)		-	3μH	enabled	
Stand-By Control Circuit	Tr1	2SC3332 (Reference)	V_{CE}≥75V, I_C≥1mA	enabled	
	D1	GMB01(Reference)	Di	enabled	
	R30 (*4)	RN16S***FK	***kΩ, 1/6W	13kΩ	2.7kΩ
	R31	RN16S333FK	33kΩ, 1/6W	enabled	
	R32	RN16S102FK	1kΩ, 1/6W	enabled	
	R33	RN16S202FK	2kΩ, 1/6W	enabled	
	C32	10MV33HC	33μF, 10V	enabled	
J1, J2, J3, J4, J5, J6, J8, J9		-	-	enabled	
J7, JS2, JS3, JS4, JS5, JS7, JS8, JS9		-	-	-	
JS6, JS10		-	-	enabled	
JS1		ERG1SJ101	100Ω, 1W	enabled	

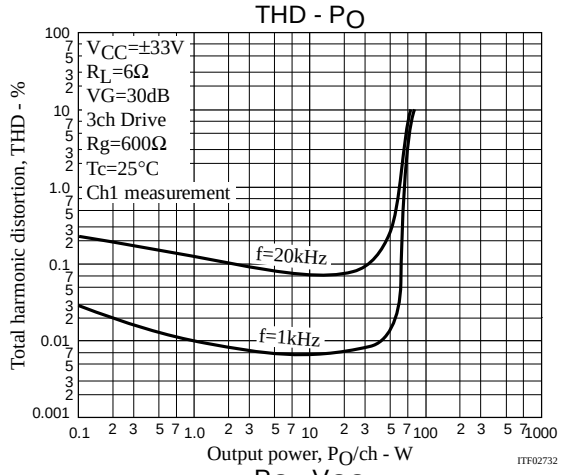
(*1) Capacitor mark “A” side is “-” (negative).
(*2) STK433-100Sr (2ch AMP) doesn’t mount parts of ( ).
(*3) Add parts C23 to the other side of PCB.
(*4) Recommended standby circuit is used.

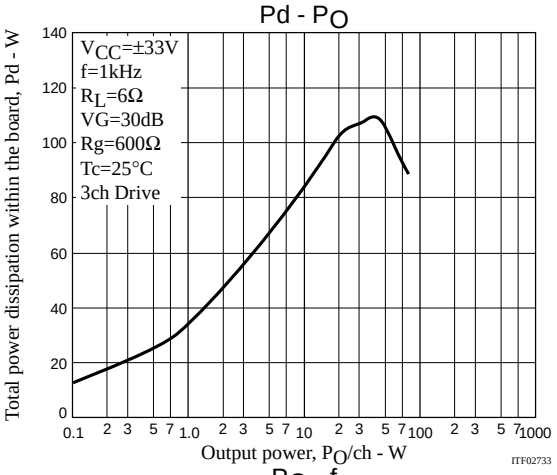
Pin Assignments

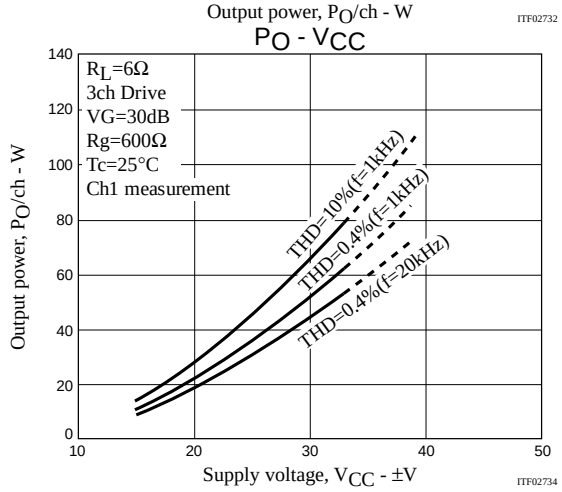
[STK433-000/-100/-200Sr & STK415/416-100Sr Pin Layout]

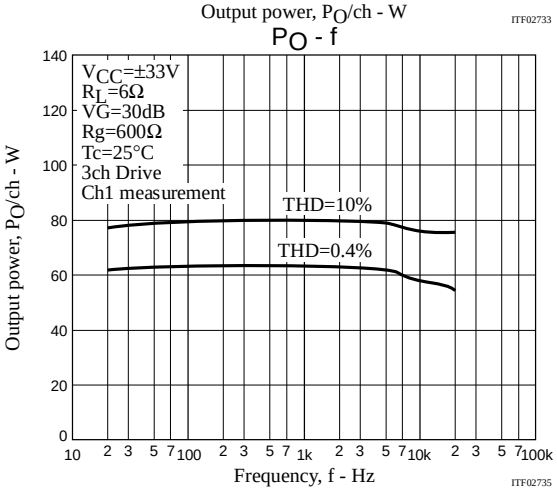
2ch class-AB			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
(Size) 47.0×25.6×9.0	2ch classAB/2.00mm																				
STK433-030-E 30W/JEITA STK433-040-E 40W/JEITA STK433-060-E 50W/JEITA STK433-070-E 60W/JEITA			-PRE	-VCC	+VCC	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB•GND	GND	IN/CH1	NF/CH1	STAND|BY	NF/CH2	IN/CH2				
(Size) 67.0×25.6×9.0																					
STK433-090-E 80W/JEITA STK433-100-E 100W/JEITA STK433-120-E 120W/JEITA STK433-130-E 150W/JEITA																					
3ch class-AB			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
(Size) 67.0×25.6×9.0	3ch classAB/2.00mm																				
STK433-230A-E 30W/JEITA STK433-240A-E 40W/JEITA STK433-260A-E 50W/JEITA STK433-270-E 60W/JEITA			-PRE	-VCC	+VCC	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB•GND	GND	IN/CH1	NF/CH1	STAND|BY	NF/CH2	IN/CH2	IN/CH3	NF/CH3	OUT/CH3+	OUT/CH3-
(Size) 64.0×36.6×9.0																					
STK433-290-E 80W/JEITA STK433-300-E 100W/JEITA STK433-320-E 120W/JEITA STK433-330-E 150W/JEITA																					
2ch class-H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
(Size) 64.0×31.1×9.0	2ch classH/2.00mm																				
STK415-090-E 80W/JEITA STK415-100-E 90W/JEITA STK415-120-E 120W/JEITA STK415-130-E 150W/JEITA STK415-140-E 180W/JEITA	+VL	-VL	+OFFSET	-OFFSET	-PRE	-VH	+VH	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB•GND	GND	IN/CH1	NF/CH1	STAND|BY	NF/CH2	IN/CH2		
3ch class-H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
(Size) 64.0×31.1×9.0	3ch classH/2.00mm																						
STK416-090-E 80W/JEITA STK416-100-E 90W/JEITA STK416-120-E 120W/JEITA STK416-130-E 150W/JEITA	+VL	-VL	+OFFSET	-OFFSET	-PRE	-VH	+VH	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB•GND	GND	IN/CH1	NF/CH1	STAND|BY	NF/CH2	IN/CH2	IN/CH3	NF/CH3	OUT/CH3+	OUT/CH3-

Evaluation Board Characteristics









[Thermal Design Example for STK433-290-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.

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

Ta: Guaranteed ambient temperature for the end product

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

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

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.

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

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

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}, is ±33V and R_L is 6Ω, the total power dissipation, Pd, within the hybrid IC, will be a maximum of 109.7W 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 ≈ 85.0W (when 1/8P_O max. = 10W, P_O max. = 80W).

The number of power transistors in audio amplifier block of these hybrid ICs, N, is 6, and the thermal resistance per transistor, θj-c, is 2.1°C/W. Therefore, the required heat sink thermal resistance for a guaranteed ambient temperature, Ta, of 50°C will be as follows.

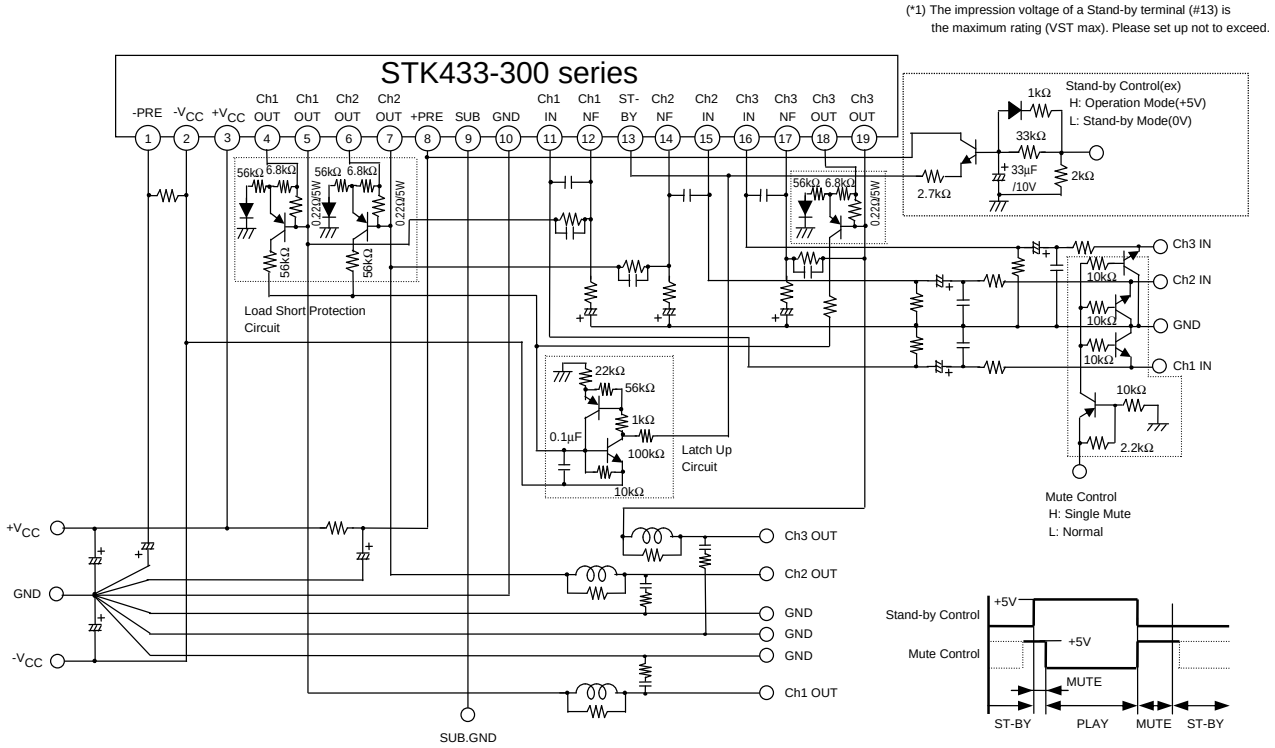
From formula (1)' θc-a < (125 – 50)/85.0
< 0.88

From formula (2)' θc-a < (150 – 50)/85.0 – 2.1/6
< 0.82

Therefore, the value of 0.82°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.

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

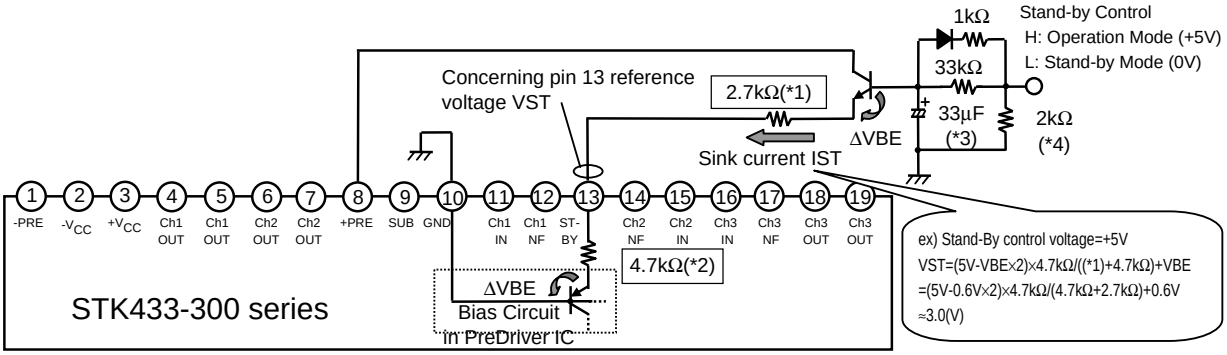


[STK433-300 series Stand-By Control Using Example]

Characteristic

- It can largely improve a pop noise to occur in power supply ON/OFF by using recommended Stand-By Control Application.
- Because It can perform Stand-By Control by regulating limit resistance to the voltage such as used microcomputers, a set design is easy.

(ex) STK433-300series test circuit. When impressed by Stand-by control control [+5V].



Operation Explanation

(1) Concerning pin 13 reference voltage VST

<1> Operation mode

The SW transistor of bias circuit is turned on at VST≥2.5V, and the amplifier becomes operation mode.

ex) VST=2.5V

VST=(*2)×IST+0.6V→2.5V=4.7kΩ×IST+0.6V, IST≈0.40mA

<2> Standby mode

The SW transistor of Pre-driver IC is turned off at VST≤0.6V (typ0V), and the amplifier becomes Stand-By Mode.

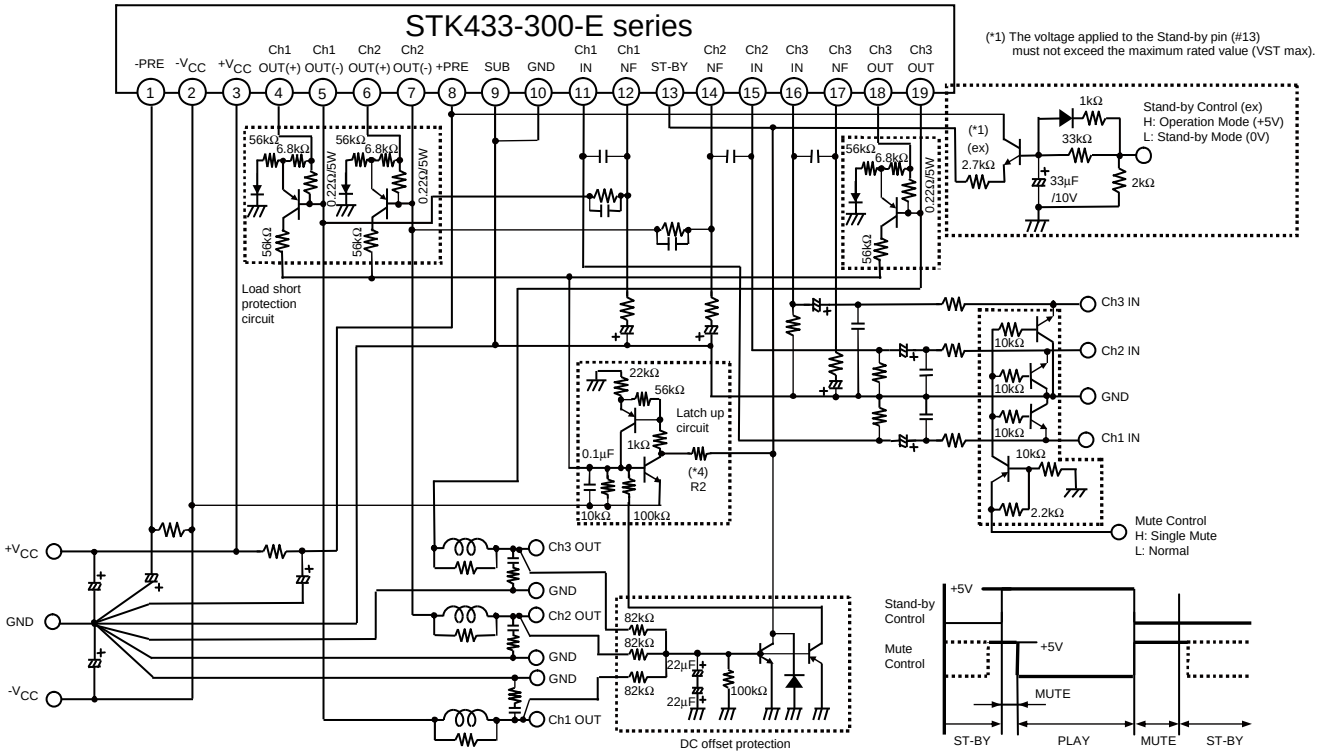
ex) VST=0.6V

VST=(*2)×IST+0.6V→0.6V=4.7kΩ×IST+0.6V, IST≈0mA

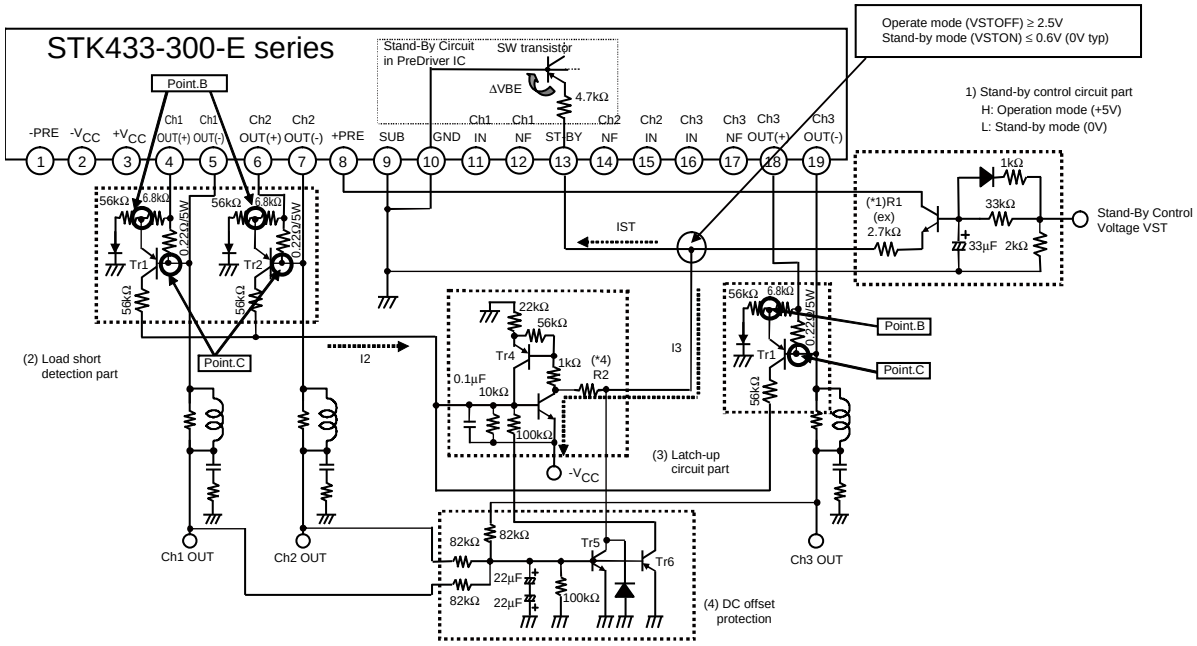
(*3) It can improve a pop noise at power up time by giving a time constant of the condenser during operation.

(*4) Please decide a time constant to discharge the condenser during standby.

STK433-300-E series Stand-by control, Mute control, Load-short protection & DC offset protection application



STK433-300-E Application Explanation

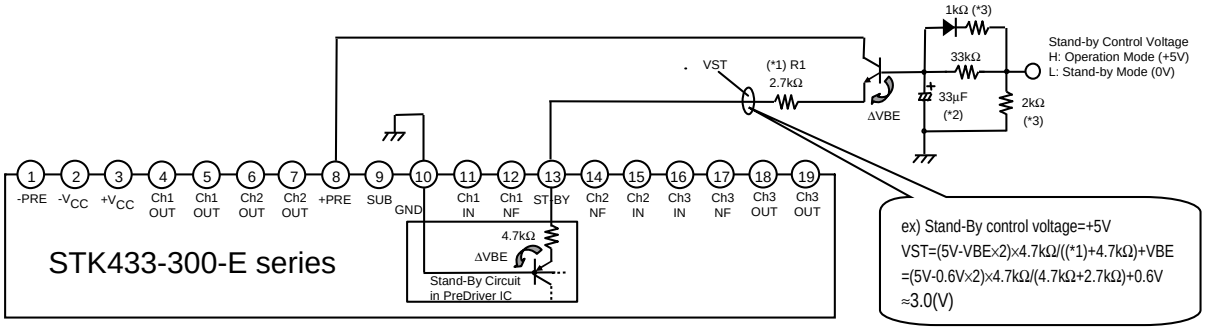


The protection circuit application for the STK433-300-Esr consists of the following blocks (blocks (1) to (4)).

(1) Standby control circuit block
(2) Load short-circuit detection block
(3) Latch-up circuit block
(4) DC voltage protection block

1) Stand-by control circuit block

(Reference example) STK433-300-E series test circuit (when +5V is applied to Stand-by control.)



Concerning pin 13 reference voltage VST

<1> Operation Mode

The switching transistor in the bias circuit turns on and places the amplifier into the operating mode when the voltage flowing into pin 13 (VST) becomes 0.25V or greater.

<2> Stand-By Mode

When the voltage flowing into pin 13 (VST) is stopped (=0V), the switching transistor in the bias circuit turns off, placing the amplifier into the standby mode.

(*1) The current limiting resistor (R1) must be used to ensure that the voltage flowing into the stand-by pin (pin 13) does not exceed its maximum rated value VST max.

(*2) The pop noise level when the power is turned on can be reduced by setting the time constant with a capacitor in operating mode.

(*3) Determines the time constant at which the capacitor (*2) is discharged in standby mode.

2) Load short detection block

Since the voltage between point B and point C is less than 0.6V in normal operation mode (V_{BE} < 0.6V) and TR1 (or TR2) is not activated, the load short-circuit detection block does not operate.

When a load short-circuit occurs, however, the voltage between point B and point C becomes larger than 0.6V, causing TR1 (or TR2) to turn on (V_{BE} > 0.6V), and current I2 to flows

3) Latch-up circuit block

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 block

The DC offset protection circuit is activated when ±0.5V (typ) voltage is applied to either "OUT CH1" or "OUT CH2," or "OUT CH3," and the hybrid IC is shut down (standby mode). To release the IC from the standby mode and reactivate the power amplifier, it is necessary to set the standby control voltage temporarily low (0V). Subsequently, when the standby control is returned to high (+5V, for example), the power amplifier will become active again.

The protection level must be set using the 82kΩ resistor. Furthermore, the time constant must be determined using 22μ//22μ capacitors to prevent the amplifier from malfunctioning due to the audio signal.