Ordering number : EN*A1595

Preliminary

SANYO Semiconductors

DATA SHEET

STK433-120-E — Thick-Film Hybrid IC 2-channel class AB audio power IC, 120W+120W

Overview

The STK433-120-E is a hybrid IC designed to be used in 120W × 2ch 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 series (30W to 60W/2ch) and STK433-200/-300 series (3-channel) due to its pin compatibility.
- Miniature package (67.0mm × 25.6mm × 9.0mm)
- Output load impedance: R_L = 6Ω supported
- Allowable load shorted time: 0.3 second
- Allows the use of predesigned applications for standby and mute circuits.

Series Models

	STK433-090-E	STK433-100-E	STK433-120-E	STK433-130-E
Output 1 (10%/1kHz)	80W×2 channels	100W×2 channels	120W×2 channels	150W×2 channels
Output 2 (0.4%/20Hz to 20kHz)	50W×2 channels	60W×2 channels	80W×2 channels	100W×2 channels
Max. rated V_{CC} (quiescent)	±54V	±57V	±65V	±71.5V
Max. rated V_{CC} (6Ω)	±47V	±50V	±57V	±63V
Recommended operating V_{CC} (6Ω)	±33V	±35V	±40V	±44V
Dimensions (excluding pin height)	67.0mm×25.6mm×9.0mm			

SANYO Semiconductor Co., Ltd.
www.semiconductor-sanyo.com/network

Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum quiescent supply voltage 0	V_{CC} max (0)	When no signal	±65	V
Maximum supply voltage 1	V_{CC} max (1)	$R_L \geq 6\Omega$	±57	V
Minimum operating supply voltage	V_{CC} min		±10	V
Maximum operating flow-in current (pin 13) *7	IST OFF max		0.6	mA
Thermal resistance	θj-c	Per power transistor	1.8	°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 *4	ts	V_{CC}=±40V, R_L=6Ω, f=50Hz, P_O=80W, 1-channel active	0.3	s

Operating 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)	±40	20 to 20k		0.4		76	80		W
	P_O (2)	±40	1k		10			120		
Total harmonic distortion *1	THD (1)	±40	20 to 20k	5.0		VG=30dB			0.4	%
	THD (2)	±40	1k					0.01		
Frequency characteristics *1	f_L, f_H	±40		1.0		+0 -3dB	20 to 50k			Hz
Input impedance	ri	±40	1k	1.0				55		kΩ
Output noise voltage *3	V_{NO}	±48				Rg=2.2kΩ			1.0	mVrms
Quiescent current	I_{CCO}	±48				No loading	20	45	80	mA
Output neutral voltage	V_N	±48					-70	0	+70	mV
Current flowing into pin13 in standby mode *7	IST ON	±40				Voltage at pin13: 5V, Current limiting resistance R1: 13kΩ			0	mA
Current flowing into pin13 in operating mode *7	IST OFF	±40					0.25		0.6	mA

[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.

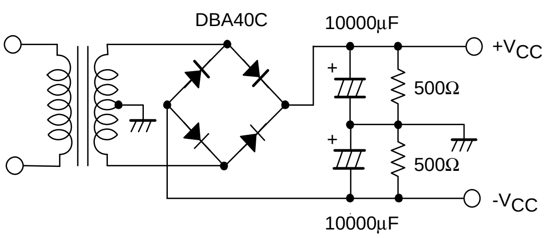
*5: Please connect –Pre V_{CC} pin (#1 pin) with the stable minimum voltage and connect so that current does not flow in by reverse bias.

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

*7: Be sure to use the current limiting resistor to prevent the current flowing into the standby pin (pin13) never exceeds the maximum rated value in operating mode.
The circuit is turned on by applying VBE (approximately 0.6V) or higher voltage to the standby pin (pin13).

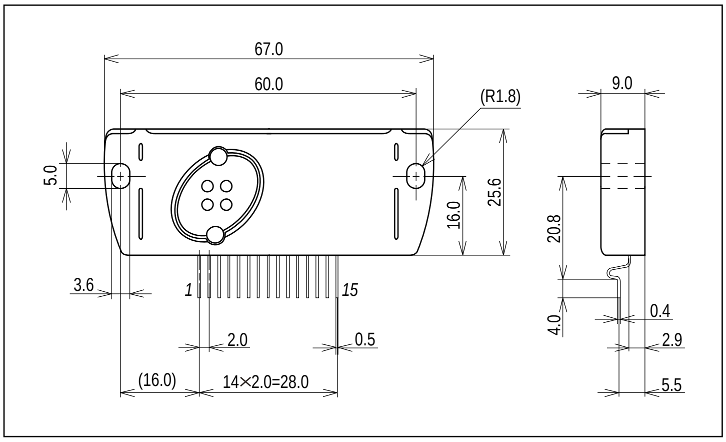
*8: A thermoplastic adhesive resin is used for this hybrid IC.

Designated transformer power supply (MG-200 equivalent)

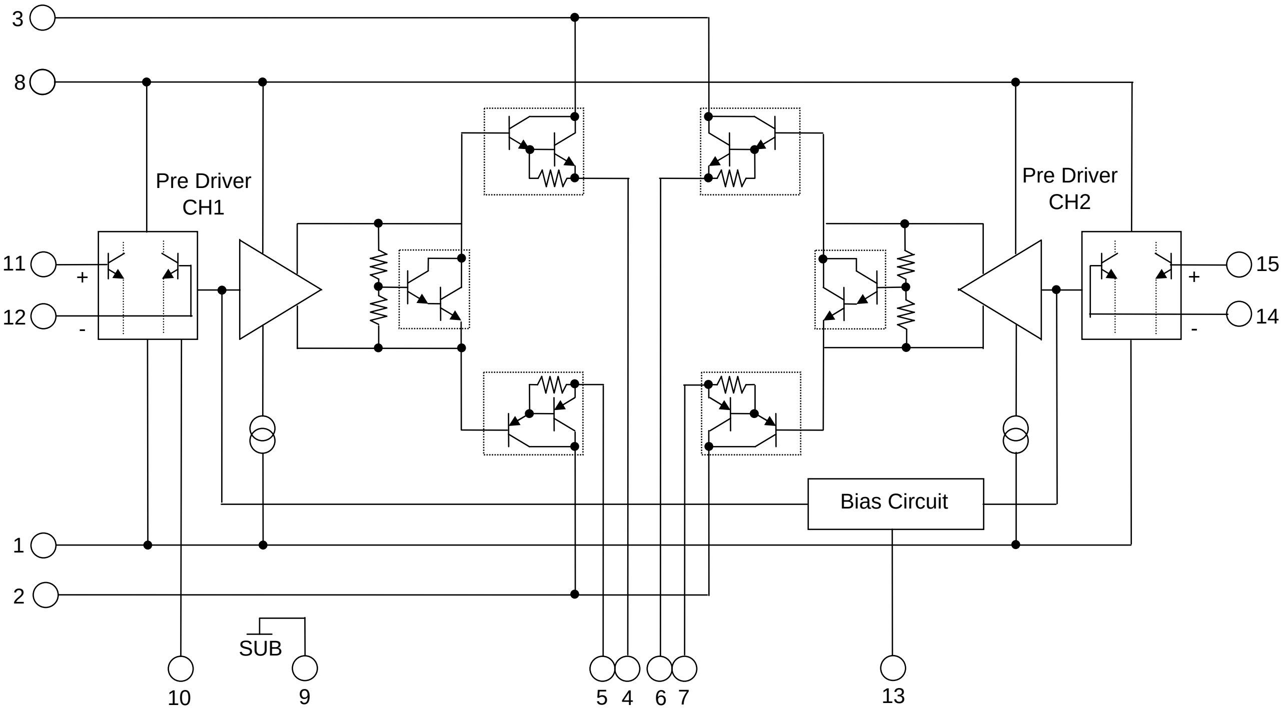


Package Dimensions

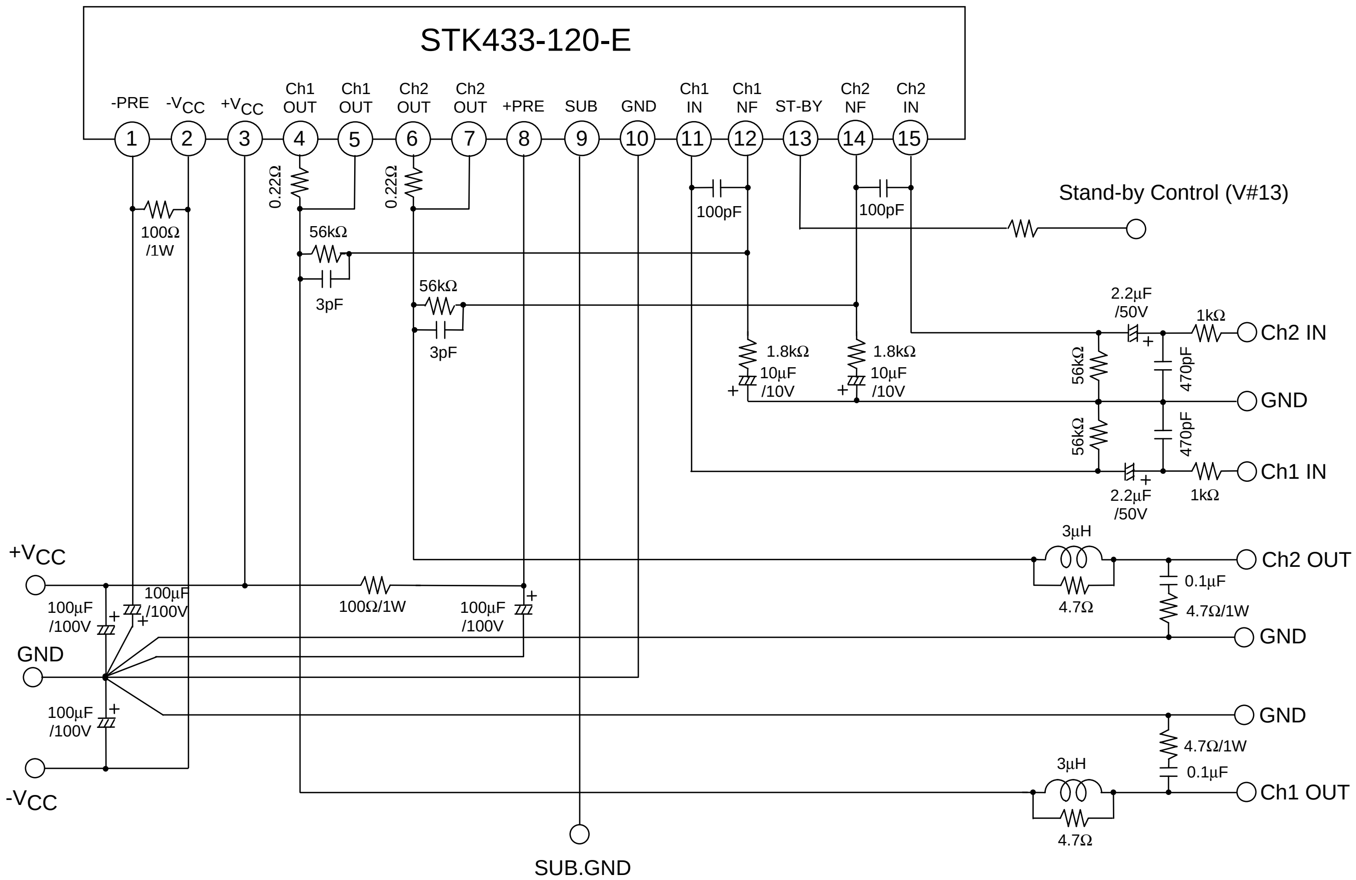
unit:mm (typ)



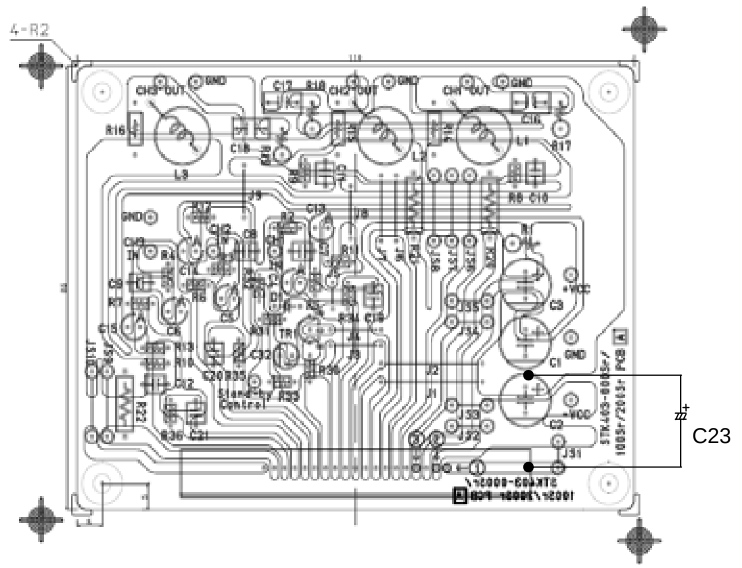
Internal Equivalent Circuit



Application Circuit Example



Sample PCB Trace Pattern



STK433-100/STK433-300Sr PCB PARTS LIST

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

<table>
<tr><th colspan="2">Location No.
* 2ch AMP doesn't mount parts of ( ).</th><th>PARTS</th><th>RATING</th><th colspan="2">Component</th></tr>
<tr><td colspan="2" rowspan="2">Hybrid IC#1 Pin Position</td><td rowspan="2">-</td><td rowspan="2">-</td><td colspan="2">①</td></tr>
<tr><td>STK433-100Sr (*2)</td><td>STK433-300Sr</td></tr>
<tr><td colspan="2">R01</td><td>ERG1SJ101</td><td>100Ω,1W</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">R02, R03 (R4)</td><td>RN16S102FK</td><td>1kΩ, 1/6W</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">R05, R06, R08, R09 (R7, R10)</td><td>RN16S563FK</td><td>56kΩ, 1/6W</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">R11, R12 (R13)</td><td>RN16S182FK</td><td>1.8kΩ, 1/6W</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">R14, R15 (R16)</td><td>RN14S4R7FK</td><td>4.7Ω, 1/4W</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">R17, R18 (R19)</td><td>ERX1SJ4R7</td><td>4.7Ω, 1W</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">R20, R21 (R22)</td><td>ERX2SJR22</td><td>0.22Ω, 2W</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">C01, C02, C03, C23</td><td>100MV100HC</td><td>100μF, 100V</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">C04, C05 (C06)</td><td>50MV2R2HC</td><td>2.2μF, 50V</td><td colspan="2">enabled (*1)</td></tr>
<tr><td colspan="2">C07, C08 (C09)</td><td>DD104-63B471K50</td><td>470pF, 50V</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">C10, C11 (C12)</td><td>DD104-63CJ030C50</td><td>3pF, 50V</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">C13, C14 (C15)</td><td>10MV10HC</td><td>10μF, 10V</td><td colspan="2">enabled (*1)</td></tr>
<tr><td colspan="2">C16, C17 (C18)</td><td>ECQ-V1H104JZ</td><td>0.1μF, 50V</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">C19, C20 (C21)</td><td>DD104-63B***K50</td><td>***pF, 50V</td><td>100pF</td><td>68pF</td></tr>
<tr><td colspan="2">R34, R35 (R36)</td><td>RN16S302FK</td><td>3kΩ, 1/6W</td><td colspan="2">Short</td></tr>
<tr><td colspan="2">L01, L02 (L3)</td><td>-</td><td>3μH</td><td colspan="2">enabled</td></tr>
<tr><td rowspan="7">Stand-By Control Circuit</td><td>Tr1</td><td>2SC3332 (Reference)</td><td>V_{CE}≥75V, I_C≥1mA</td><td colspan="2">enabled</td></tr>
<tr><td>D1</td><td>GMB01 (Reference)</td><td>Di</td><td colspan="2">enabled</td></tr>
<tr><td>R30</td><td>RN16S***FK</td><td>***kΩ, 1/6W</td><td>13kΩ</td><td>2.7kΩ</td></tr>
<tr><td>R31</td><td>RN16S333FK</td><td>33kΩ, 1/6W</td><td colspan="2">enabled</td></tr>
<tr><td>R32</td><td>RN16S102FK</td><td>1kΩ, 1/6W</td><td colspan="2">enabled</td></tr>
<tr><td>R33</td><td>RN16S202FK</td><td>2kΩ, 1/6W</td><td colspan="2">enabled</td></tr>
<tr><td>C32</td><td>10MV33HC</td><td>33μF, 10V</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">J1, J2, J3, J4, J5, J6, J8, J9</td><td>-</td><td>-</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">J7, JS2, JS3, JS4, JS5, JS7 JS8, JS9</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="2">JS6, JS10</td><td>-</td><td>-</td><td colspan="2">enabled</td></tr>
<tr><td colspan="2">JS1</td><td>ERG1SJ101</td><td>100Ω, 1W</td><td colspan="2">enabled</td></tr>
</table>

(*1) Capacitor mark “A” side is “-” (negative).
(*2) STK433-100Sr (2ch AMP) doesn’t mount parts of ( ).

Pin Assignments

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

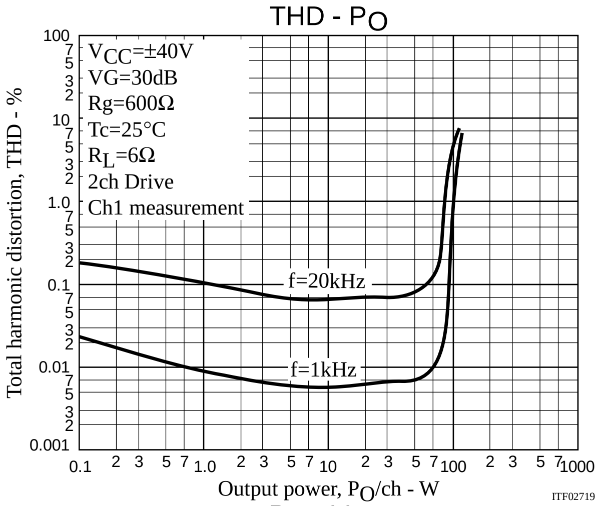
2ch class-AB	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2ch classAB/2.00mm														
STK433-030-E 30W/JEITA STK433-040-E 40W/JEITA STK433-060-E 50W/JEITA STK433-070-E 60W/JEITA STK433-090-E 80W/JEITA STK433-100-E 100W/JEITA **STK433-120-E 120W/JEITA** STK433-130-E 150W/JEITA	-PRE	-VCC	+VCC	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB•GND	GND	IN/CH1	NF/CH1	STAND-BY	NF/CH2	IN/CH2

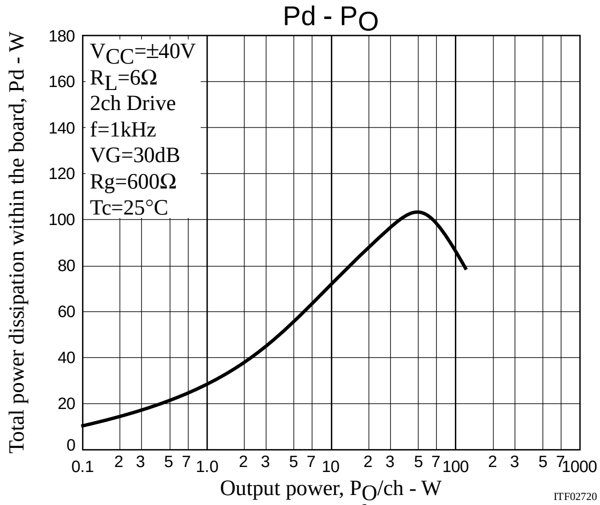
3ch class-AB	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	3ch classAB/2.00mm																		
STK433-230A-E 30W/JEITA STK433-240A-E 40W/JEITA STK433-260A-E 50W/JEITA STK433-270-E 60W/JEITA STK433-290-E 80W/JEITA STK433-300-E 100W/JEITA STK433-320-E 120W/JEITA STK433-330-E 150W/JEITA	-PRE	-VCC	+VCC	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-

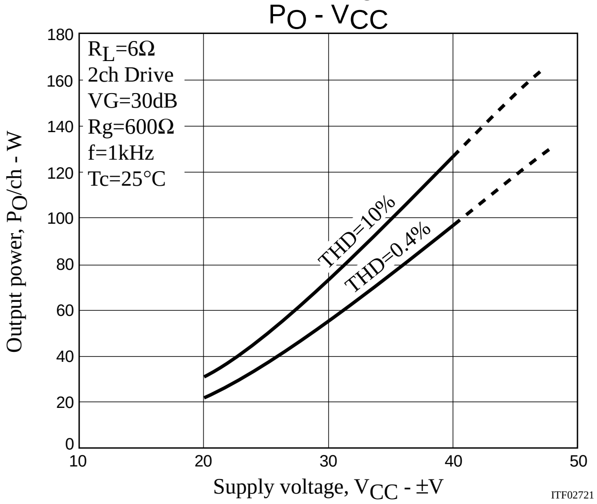
2ch class-H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	2ch classH/2.00mm																		
STK415-090-E 80W/JEITA STK415-100-E 90W/JEITA STK415-120-E 120W/JEITA STK415-130-E 150W/JEITA STK415-140-E 180W/JEITA	+VL	-VL	+OFFSET	-OFFSET	-PRE	-VH	+VH	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB•GND	GND	IN/CH1	NF/CH1	STAND-BY	NF/CH2	IN/CH2

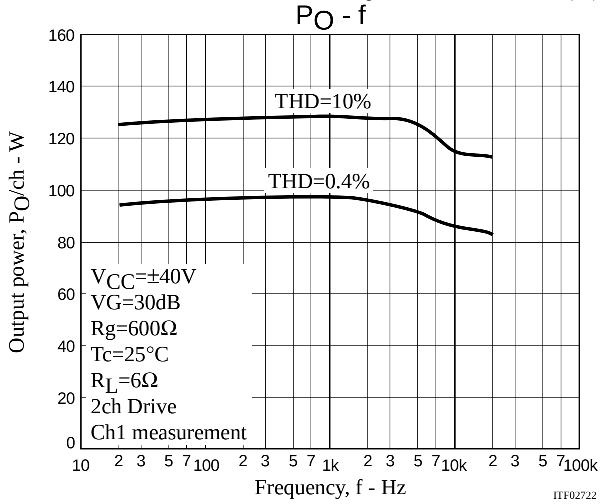
3ch class-H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	3ch classH/2.00mm																						
STK416-090-E 80W/JEITA STK416-100-E 90W/JEITA STK416-120-E 120W/JEITA STK416-130-E 150W/JEITA	+VL	-VL	+OFFSET	-OFFSET	-PRE	-VH	+VH	OUT/CH1+	OUT/CH1-	OUT/CH2+	OUT/CH2-	+PRE	SUB•GND	GND	IN/CH1	NF/CH1	STAND-BY	NF/CH2	IN/CH2	IN/CH3	NF/CH3	OUT/CH3+	OUT/CH3-

Evaluation Board Characteristics









[Thermal Design Example for STK433-120-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}, is ±40V and R_L is 6Ω, the total power dissipation, Pd, within the hybrid IC, will be a maximum of 104W 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 ≈ 82W (when 1/8P_O max. = 15W, P_O max. = 120W).

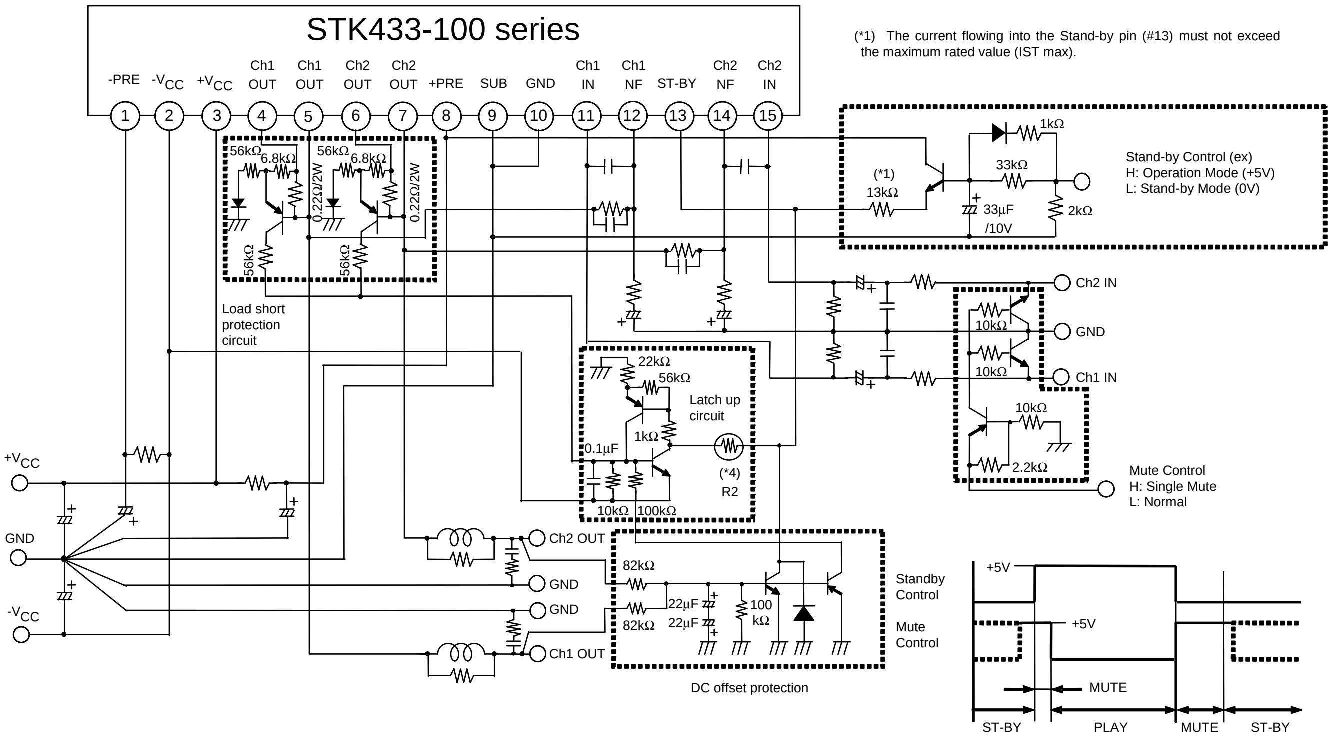
The number of power transistors in audio amplifier block of these hybrid ICs, N, is 4, and the thermal resistance per transistor, θj-c, is 1.8°C/W. Therefore, the required heat sink thermal resistance for a guaranteed ambient temperature, Ta, of 50°C will be as follows.

From formula (1)' θc-a < (125 – 50)/82
< 0.91

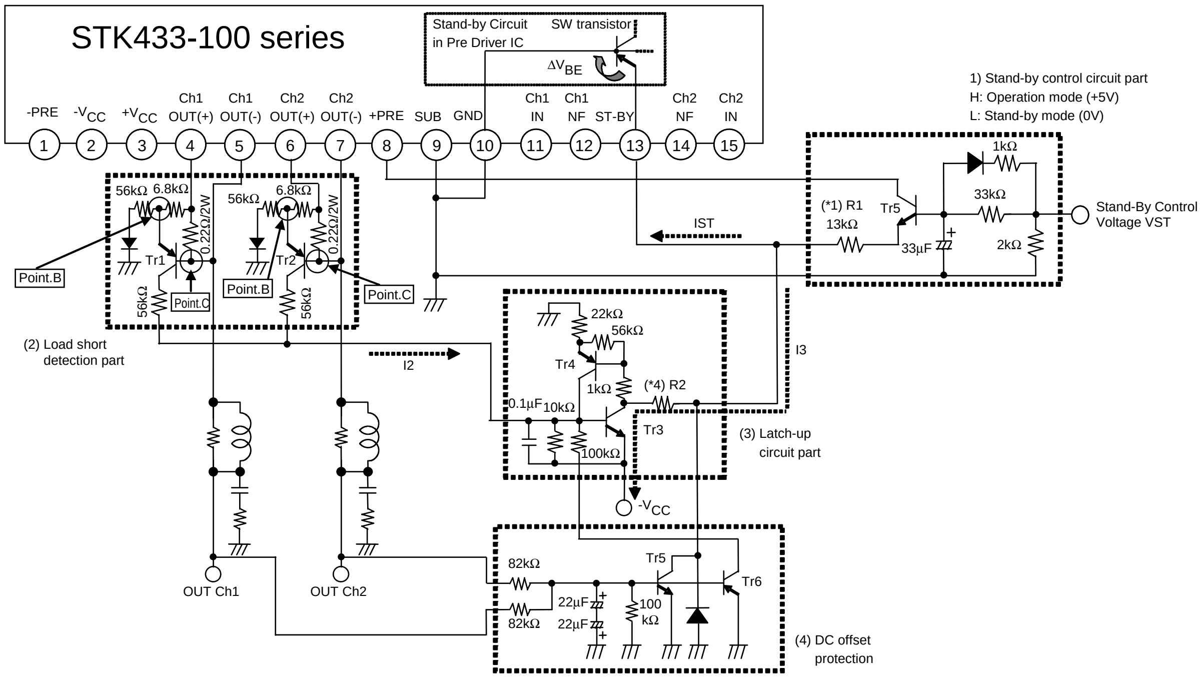
From formula (2)' θc-a < (150 – 50)/82 – 1.8/4
< 0.77

Therefore, the value of 0.77°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.

STK433-100 Series Standby Control, Mute Control, Load-short Protection & DC offset Protection application



STK433-100 Series Application Explanation

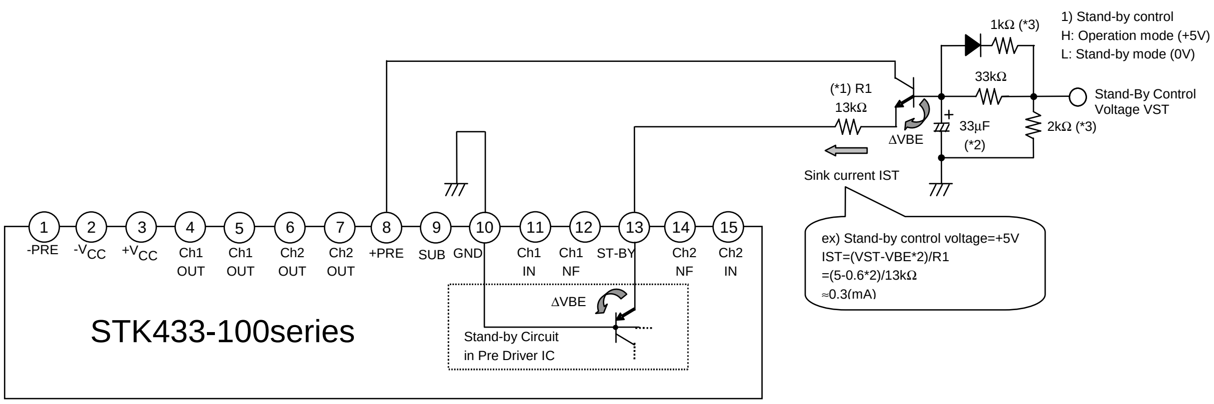


The protection circuit application for the STK433-100sr consists of the following blocks (blocks (1) to (4)).

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

1) Standby control circuit block

(Reference example) STK433-100 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 current flowing into pin 13 (IST) becomes 0.25mA or greater.

<2> Standby mode

When the current flowing into pin 13 (IST) is stopped (=0mA), 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 current flowing into the stand-by pin (pin 13) does not exceed its maximum rated value IST 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-circuit 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

TR3 is activated when I2 is supplied to the latch-up circuit.

When TR3 turns on and current I3 starts flowing, VST goes down to 0V (standby mode), protecting the power amplifier.

Since TR3 and TR4 configure a thyristor, once TR3 is activated, the IC is held in the standby mode.

To release 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, the power amplifier will become active again.

(*4) The I3 value varies depending on the supply voltage. Determine the value of R2 using the formula below, so that I1 is equal to or less than I3.

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

4) DC offset protection block

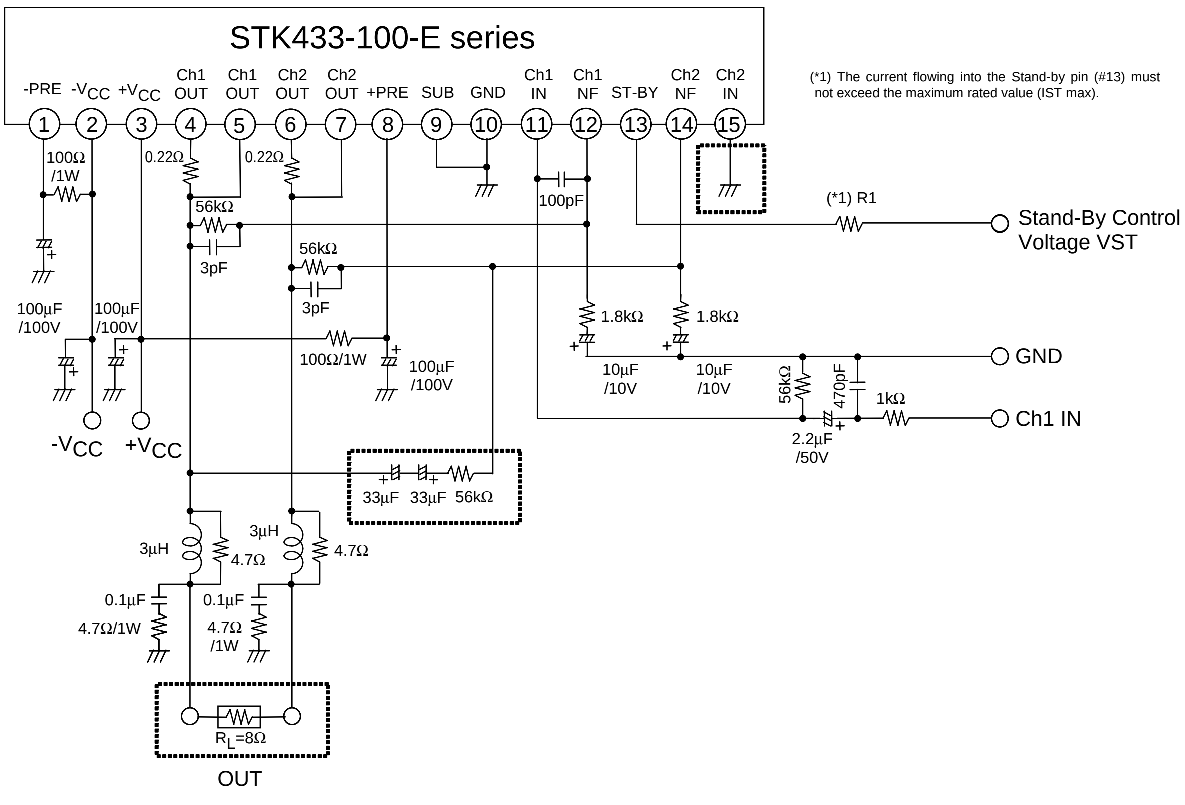
The DC offset protection circuit is activated when ±0.5V (typ) voltage is applied to either "OUT CH1" or "OUT CH2," and the hybrid IC is shut down (standby mode).

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.

STK433-100 Series BTL Application



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