



STK433-060N-E

Thick-Film Hybrid IC

2ch class-AB Audio Power IC 50W+50W

ON Semiconductor®

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Overview

The STK433-060N-E is a hybrid IC designed to be used in 50W × 2ch 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 |
|-------------------------------------|---------------------|---------------|---------------------|
| Output1 (10%/1kHz) | 40W × 2ch | 50W × 2ch | 150W × 2ch |
| Output2 (0.4%/20Hz to 20kHz) | 25W × 2ch | 35W × 2ch | 100W × 2ch |
| Max. rating V_{CC} (quiescent) | ±38V | ±46V | ±71.5V |
| Max. rating V_{CC} (6Ω) | ±36V | ±40V | ±63V |
| Recommended operating V_{CC} (6Ω) | ±24V | ±27V | ±44V |
| Dimensions (excluding pin height) | 47.0mm×25.6mm×9.0mm | | 67.0mm×25.6mm×9.0mm |

| | STK433-330N-E | STK433-840N-E | STK433-890N-E |
|-------------------------------------|---------------------|---------------------|---------------------|
| Output1 (10%/1kHz) | 150W × 3ch | 40W × 4ch | 80W × 4ch |
| Output2 (0.4%/20Hz to 20kHz) | 100W × 3ch | 25W × 4ch | 50W × 4ch |
| Max. rating V_{CC} (quiescent) | ±71.5V | ±38V | ±54V |
| Max. rating V_{CC} (6Ω) | ±63V | ±36V | ±47V |
| Recommended operating V_{CC} (6Ω) | ±44V | ±25V | ±34V |
| Dimensions (excluding pin height) | 64.0mm×36.6mm×9.0mm | 64.0mm×31.1mm×9.0mm | 78.0mm×44.1mm×9.0mm |

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 | ±46 | V |
| | V_{CC} max (1) | Signal, $R_L \geq 6\Omega$ | ±40 | V |
| | V_{CC} max (2) | Signal, $R_L \geq 4\Omega$ | ±33 | V |
| Minimum operation supply voltage | V_{CC} min | | ±10 | V |
| #13 Operating voltage *5 | VST OFF max | #13 voltage | -0.3 to +5.5 | V |
| Thermal resistance | θ_{j-c} | Per one power transistor | 3.5 | $^\circ\text{C}/\text{W}$ |
| 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 | $V_{CC} = \pm 27\text{V}$, $R_L = 6\Omega$, $f = 50\text{Hz}$ $P_O = 35\text{W}$, 1ch drive | 0.3 | s |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

ORDERING INFORMATION

See detailed ordering and shipping information on page 11 of this data sheet.

STK433-060N-E

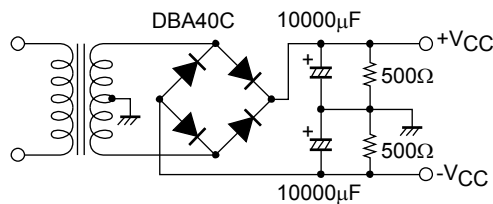
Operating Characteristics at $T_c = 25^\circ\text{C}$, $R_L = 6\Omega$ (Non-inductive Load), $R_g = 600\Omega$, $V_G = 30\text{dB}$

| Parameter | Symbol | Conditions *2 | | | | Ratings | | | Unit | |
|-------------------------------|------------|-----------------|-----------|--------------|------------|---------------------------|-----------|-----|------------|---------------------|
| | | V_{CC} [V] | f [Hz] | P_O [W] | THD [%] | min | typ | max | | |
| Output power *1 | P_{O1} | ± 27 | 20 to 20k | | 0.4 | 33 | 35 | | W | |
| | P_{O2} | ± 27 | 1k | | 10 | | 50 | | | |
| | P_{O3} | ± 22 | 1k | | 1 | $R_L = 4\Omega$ | 35 | | | |
| Total harmonic distortion *1 | THD 1 | ± 27 | 20 to 20k | 5.0 | | | | 0.4 | % | |
| | THD 2 | ± 27 | 1k | | | | | | | $V_G = 30\text{dB}$ |
| Frequency characteristics *1 | f_L, f_H | ± 27 | | 1.0 | | +0 -3dB | 20 to 50k | | Hz | |
| Input impedance | r_i | ± 27 | 1k | 1.0 | | | 55 | | k Ω | |
| Output noise voltage *3 | V_{NO} | ± 33 | | | | $R_g = 2.2\text{k}\Omega$ | | 1.0 | mVrms | |
| Quiescent current | I_{CCO} | ± 33 | | | | No load | 15 | 30 | 70 | mA |
| Quiescent current at stand-by | I_{CST} | ± 33 | | | | $V_{ST} = 0\text{V}$ | | | 1.0 | mA |
| Output neutral voltage | V_N | ± 33 | | | | | -70 | 0 | +70 | mV |
| #13 Stand-by ON threshold *5 | VST ON | ± 27 | | | | Stand-by | | 0 | 0.6 | V |
| #13 Stand-by OFF threshold *5 | VST OFF | ± 27 | | | | 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) 12.0g
Outer carton dimensions (W×L×H) : 452mm×325mm×192mm

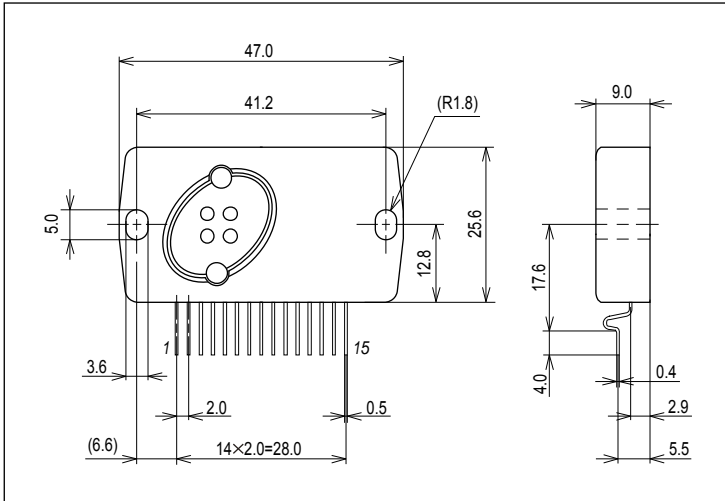
Specified transformer power supply
(Equivalent to MG-200)



STK433-060N-E

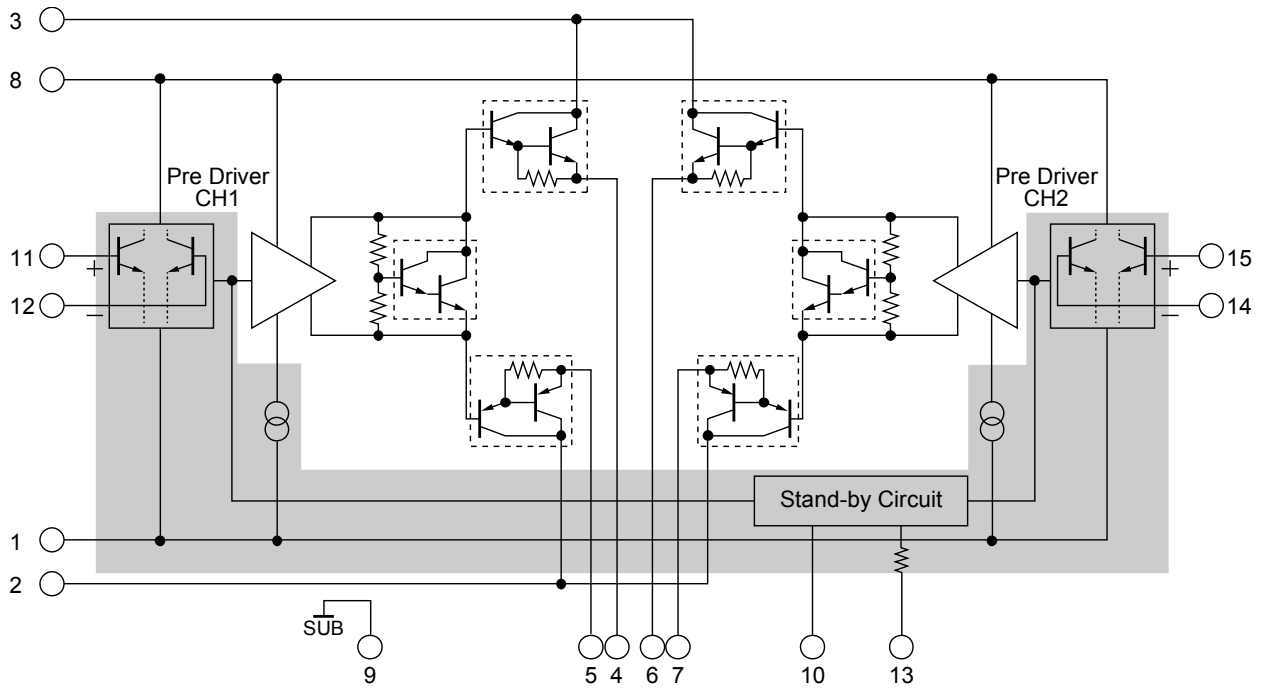
Package Dimensions

unit : mm (typ)



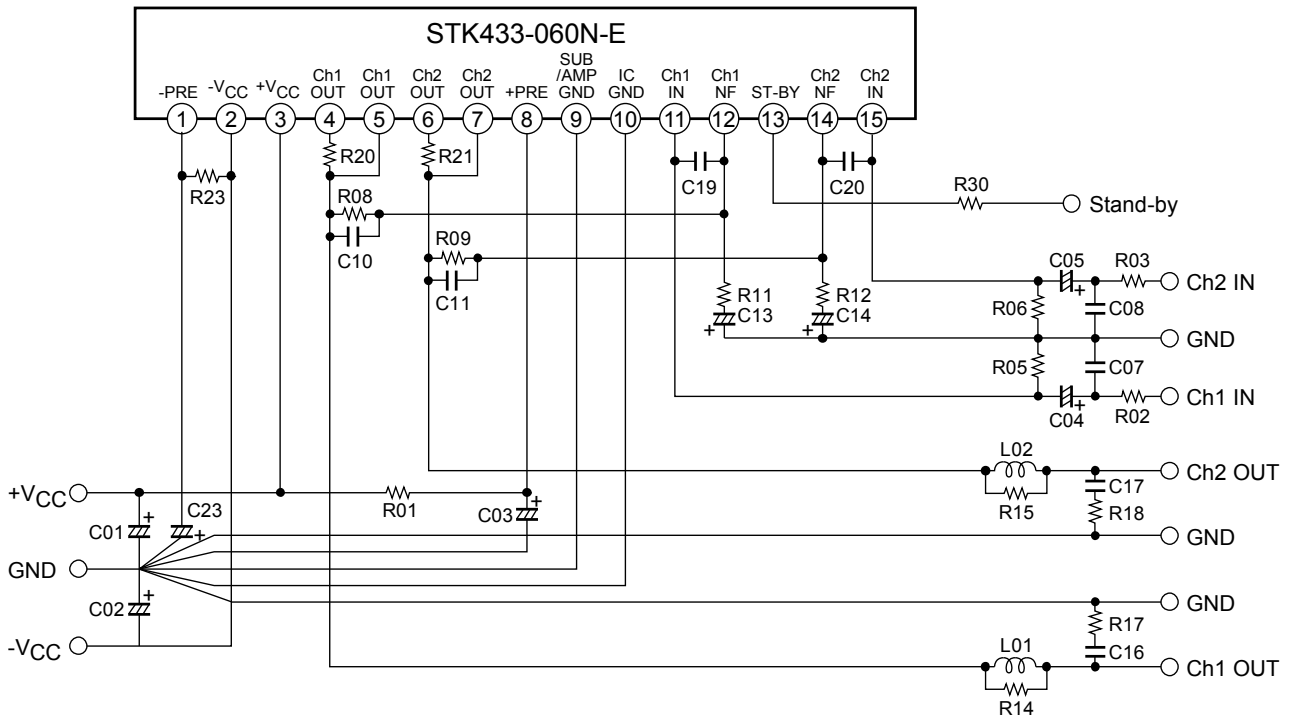
RoHS directive pass

Equivalent Circuit



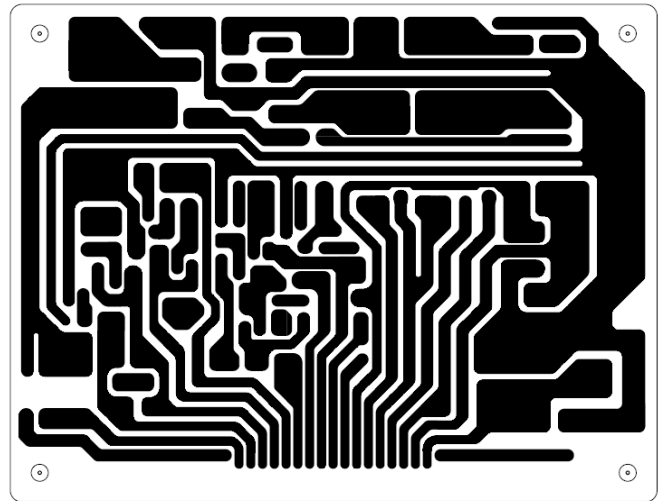
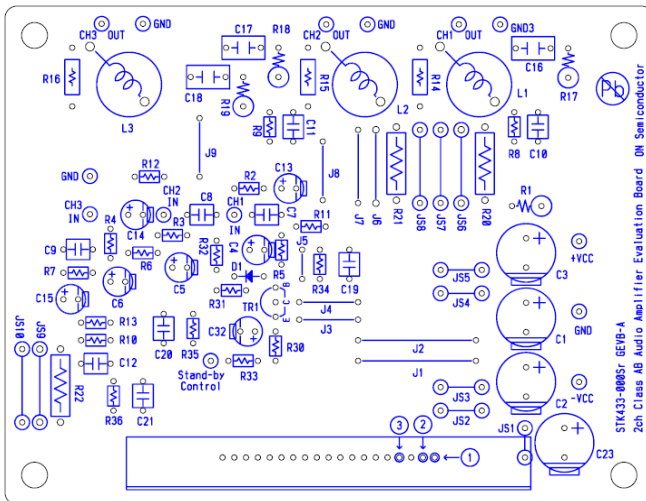
STK433-060N-E

Application Circuit



PCB Layout Example

Top view



STK433-060N-E

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

PCB Name : STK433 - 000Sr GEVB - 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, 2W | ○ | ○ | - |
| | 0.22Ω, 5W | - | - | ○ |
| C01, C02, C03, C23 | 100μF, 100V | ○ | | |
| C04, C05, (C06) | 2.2μF, 50V | ○ | | |
| C07, C08, (C09) | 470pF, 50V | ○ | | |
| C10, C11, (C12) | 3pF, 50V | ○ | | |
| C13, C14, (C15) | 10μF, 16V | ○ | | |
| C16, C17, (C18) | 0.1μF, 50V | ○ | | |
| C19, C20, (C21) | ***pF, 50V | 100pF | 56pF | N.C. |
| R34, R35, (R36) | Jumper | Short | | |
| L01, L02, (L03) | 3μH | ○ | | |
| Stand-By Control Circuit | Tr1 | VCE ≥ 75V, IC ≥ 1mA | | |
| | D1 | Di | | |
| | R30 (*2) | 2.7kΩ, 1/6W | | |
| | R31 | 33kΩ, 1/6W | | |
| | R32 | 1kΩ, 1/6W | | |
| | R33 | 2kΩ, 1/6W | | |
| C32 | 33μF, 10V | | | |
| J1, J2, J3, J4, J5, J6, J8, J9 | Jumper | ○ | | |
| J7, JS2, JS3, JS4, JS5, JS7 JS8, JS9 | - | - | | |
| JS6, JS10 | Jumper | ○ | | |
| JS1 (R23) | 100Ω, 1W | ○ | | |

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

(*2) Recommended standby circuit is used.

STK433-060N-E

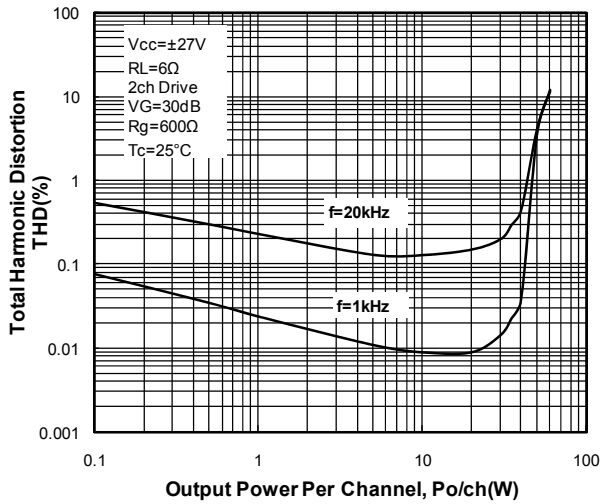
Recommended external components

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

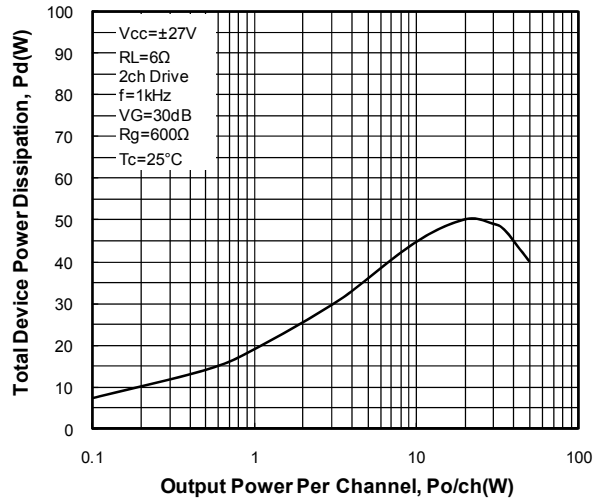
| Parts Location | Recommended value | Circuit purpose | Above Recommended value | Below Recommended value |
|----------------|---|--|--|---|
| R01, R23 | 100Ω/1W | Resistance for Ripple filter. (Fuse resistance is recommended. Ripple filter is constituted with C03, C23.) | Short-through current may 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 (040N-E,060N-E) 0.22Ω/5W (130N-E,330N-E) | 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

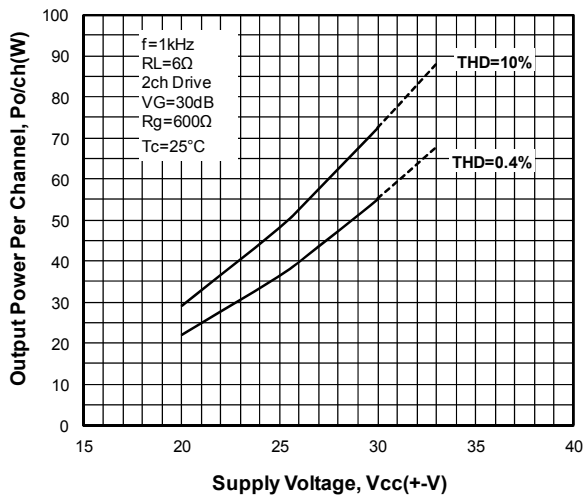
THD-Po
STK433-060N-E



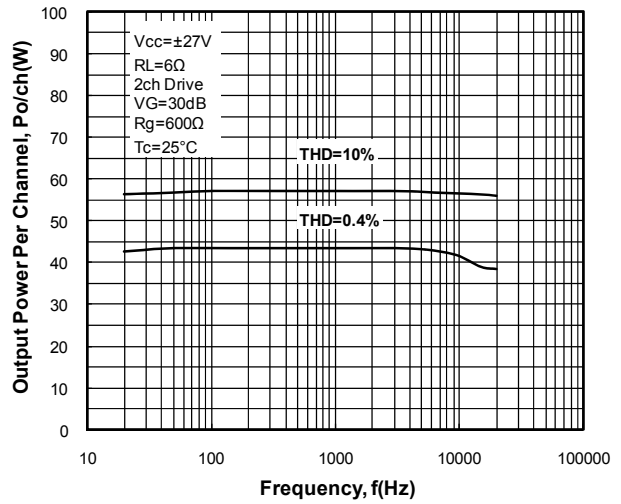
Pd-Po
STK433-060N-E



Po-Vcc
STK433-060N-E



Po-f
STK433-060N-E



A Thermal Design Tip For STK433-060N-E Amplifier

[Thermal Design Conditions]

The thermal resistance (θ_{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

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

Where T_a : the ambient temperature for the system

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

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

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

θ_{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:

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

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

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 $P_{O\text{ max}}$. (Note that the value of 1/8 $P_{O\text{ max}}$ may be varied from the country to country.)

(Sample of STK433-060N-E ; 35W×2ch)

If V_{CC} is ±27V, and R_L is 6Ω, then the total power dissipation (P_d) of inside Hybrid IC is as follow;

$$P_d = 33\text{W (at 4.375W output power, 1/8 of } P_{O\text{ max}})$$

There are four (4) transistors in Audio Section of this Hybrid IC, and thermal resistance (θ_{j-c}) of each transistor is 3.5°C/W. If the ambient temperature (T_a) is guaranteed for 50°C, then the thermal resistance (θ_{c-a}) of a desired heat-sink should be;

$$\begin{aligned} \text{From (1)'} \quad \theta_{c-a} &< (125 - 50)/33 \\ &< 2.27 \end{aligned}$$

$$\begin{aligned} \text{From (2)'} \quad \theta_{c-a} &< (150 - 50)/33 - 3.5/4 \\ &< 2.16 \end{aligned}$$

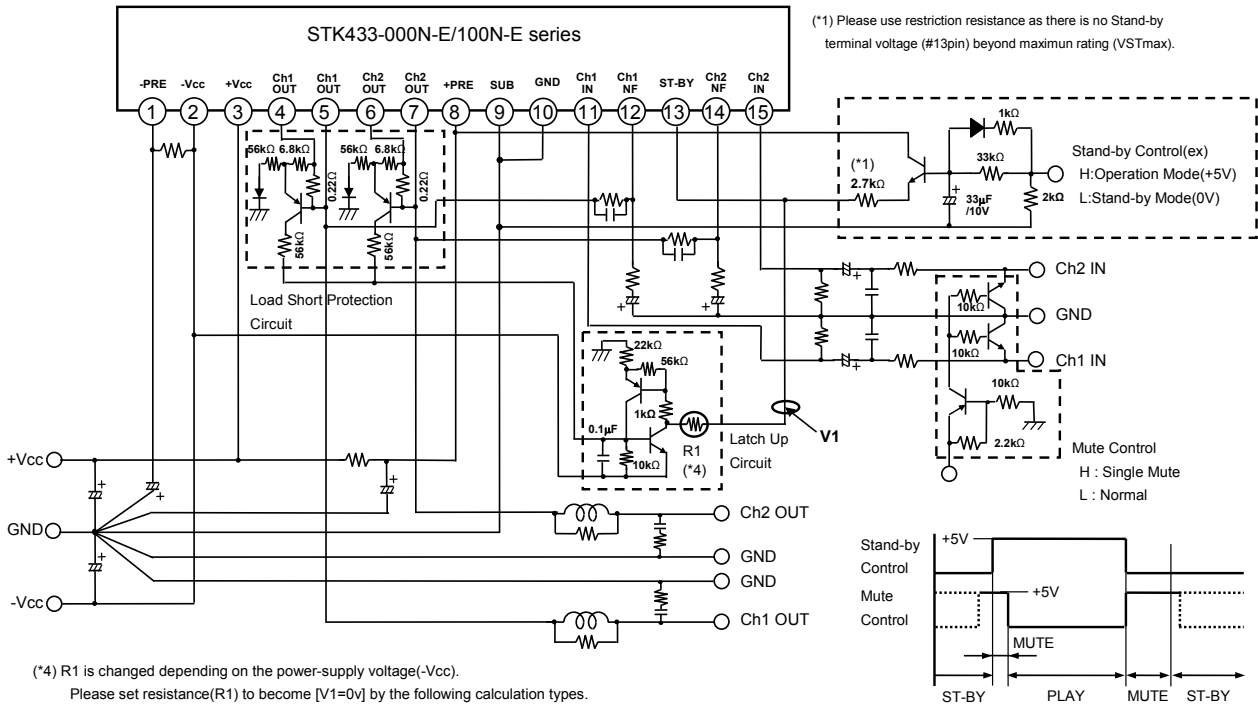
Therefore, in order to satisfy both (1)' and (2)', the thermal resistance of a desired Heat-sink will be 2.16°C/W.

[Note]

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

STK433-060N-E

STK433-000N-E/100N-E series Stand-by Control & Mute Control & Load-Short Protection Application

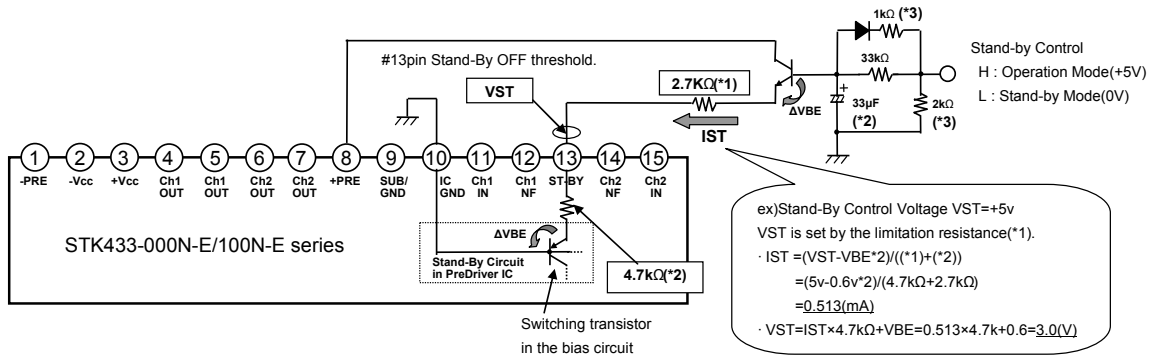


[STK433-000N-E/100N-E series Stand-By Control Example]

[Feature]

- The pop noise which occurs to the time of power supply on/off can be improved substantially by recommendation Stand-By Control Application.
- Stand-By Control can be done by additionally adjusting the limitation resistance to the voltage such as micom, the set design is easy.

(Reference circuit) STK433-000N-E/100N-E series test circuit To Stand-By Control added +5V.



[Operation explanation] #13pin Stand-By Control Voltage VST

(1) Operation Mode

The switching transistor in the bias circuit turns on and places the amplifier into the operating mode, when 13pin (VST) voltage added above 2.5V (typ 3.0V).

(2) Stand-By Mode

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

- (*1) The current limiting resistor must be used to ensure that stand-by pin (13pin) voltage 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 stand-by mode.

STK433-060N-E

ORDERING INFORMATION

| Device | Package | Shipping (Qty / Packing) |
|---------------|--------------------|--------------------------|
| STK433-060N-E | SIP15 (Pb-Free) | 25 / Bulk Box |

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