



SANYO Semiconductors

## DATA SHEET

# STK416-100-E

Thick-Film Hybrid IC  
— 3-Channel Power Switching  
Audio Power IC, 90W×3ch

## Overview

The STK416-100-E is a class H audio power amplifier hybrid IC that features a built-in power supply switching circuit. This IC provides high efficiency audio power amplification by controlling (switching) the supply voltage supplied to the power devices according to the detected level of the input audio signal.

## Applications

- Audio power amplifiers.

## Features

- Pin-to-pin compatible outputs ranging from 90W to 150W.
- Can be used to replace the STK415-100 series and the class-AB series (2, 3-channel models) due to its pin compatibility.
- Pure complementary construction by new Darlington power transistors
- Output load impedance:  $R_L = 8\Omega$  to  $4\Omega$  supported

## Series Models

|                                   | STK416-100-E        | STK416-120-E | STK416-130-E |
|-----------------------------------|---------------------|--------------|--------------|
| Output 1 (10%/1kHz)               | 90W×3ch             | 120W×3ch     | 150W×3ch     |
| Output 2 (0.8%/20Hz to 20kHz)     | 60W×3ch             | 80W×3ch      | 100W×3ch     |
| Max. rated $V_H$ (no sig.)        | ±65V                | ±73V         | ±80V         |
| Max. rated $V_L$ (no sig.)        | ±42V                | ±45V         | ±46V         |
| Recommended operating $V_H$ (8Ω)  | ±39V                | ±46V         | ±51V         |
| Recommended operating $V_L$ (8Ω)  | ±29V                | ±32V         | ±34V         |
| Dimensions (excluding pin height) | 78.0mm×44.1mm×9.0mm |              |              |

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## STK416-100-E

### Specifications

**Absolute maximum ratings** at  $T_a=25^\circ\text{C}$  (excluding rated temperature items),  $T_c=25^\circ\text{C}$  unless otherwise specified

| Parameter                                  | Symbol         | Conditions   | Ratings      | Unit               |
|--|----------------|--|--------------|--------------------|
| $V_H$ maximum quiescent supply voltage 1   | $V_H$ max (1)  | When no signal   | $\pm 65$     | V                  |
| $V_H$ maximum supply voltage 2             | $V_H$ max (2)  | $R_L \geq 6\Omega$   | $\pm 57$     | V                  |
| $V_H$ maximum supply voltage 3             | $V_H$ max (3)  | $R_L \geq 4\Omega$   | $\pm 46$     | V                  |
| $V_L$ maximum quiescent supply voltage 1   | $V_L$ max (1)  | When no signal   | $\pm 42$     | V                  |
| $V_L$ maximum supply voltage 2             | $V_L$ max (2)  | $R_L \geq 6\Omega$   | $\pm 37$     | V                  |
| $V_L$ maximum supply voltage 3             | $V_L$ max (3)  | $R_L \geq 4\Omega$   | $\pm 29$     | V                  |
| Maximum voltage between $V_H$ and $V_L$ *4 | $V_H-V_L$ max  | No loading   | 60           | V                  |
| Standby pin maximum voltage                | $V_{st}$ max   |  | -0.3 to +5.5 | V                  |
| Thermal resistance                         | $\theta_{j-c}$ | Per power transistor   | 1.8          | $^\circ\text{C/W}$ |
| Junction temperature                       | $T_j$ max      | Both the $T_j$ max and $T_c$ max conditions must be met.   | 150          | $^\circ\text{C}$   |
| IC substrate operating temperature         | $T_c$ max      |  | 125          | $^\circ\text{C}$   |
| Storage temperature                        | $T_{stg}$      |  | -30 to +125  | $^\circ\text{C}$   |
| Allowable load shorted time *3             | $t_s$          | $V_H=\pm 39\text{V}$ , $V_L=\pm 29\text{V}$ , $R_L=8\Omega$ , $f=50\text{Hz}$ ,<br>$P_O=60\text{W}$ , 1-channel active | 0.3          | s                  |

**Electrical Characteristics** at  $T_c=25^\circ\text{C}$ ,  $R_L=8\Omega$  (non-inductive load),  $R_g=600\Omega$ ,  $V_G=40\text{dB}$ ,  $V_Z=15\text{V}$

| Parameter                          | Symbol     | Conditions *1  |                      |           |           |         |                         | Ratings   |     |     | unit       |
|------------------------------------|------------|----------------|----------------------|-----------|-----------|---------|-------------------------|-----------|-----|-----|------------|
|                                    |            | V (V)          |                      | f (Hz)    | $P_O$ (W) | THD (%) |                         | min       | typ | max |            |
| Output power                       | $P_O$ (1)  | $V_H$<br>$V_L$ | $\pm 39$<br>$\pm 29$ | 20 to 20k |           | 0.8     |                         | 60        |     |     | W          |
|                                    | $P_O$ (2)  | $V_H$<br>$V_L$ | $\pm 32$<br>$\pm 24$ | 1k        |           | 0.8     | $R_L=4\Omega$           | 60        |     |     |            |
| Total harmonic distortion          | THD        | $V_H$<br>$V_L$ | $\pm 39$<br>$\pm 29$ | 20 to 20k | 60        |         |                         | 0.4       |     |     | %          |
| Frequency characteristics          | $f_L, f_H$ | $V_H$<br>$V_L$ | $\pm 39$<br>$\pm 29$ |           | 1.0       |         | +0 -3dB                 | 20 to 50k |     |     | Hz         |
| Input impedance                    | $r_i$      | $V_H$<br>$V_L$ | $\pm 39$<br>$\pm 29$ | 1k        | 1.0       |         |                         | 55        |     |     | k $\Omega$ |
| Output noise voltage *2            | $V_{NO}$   | $V_H$<br>$V_L$ | $\pm 47$<br>$\pm 31$ |           |           |         | $R_g=2.2\text{k}\Omega$ |           |     | 1.0 | mVrms      |
| Quiescent current                  | $I_{CCO}$  | $V_H$          | $\pm 47$             |           |           |         | $R_L=\infty$            |           |     | 40  | mA         |
|                                    |            | $V_L$          | $\pm 31$             |           |           |         |                         |           | 150 |     |            |
| Output neutral voltage             | $V_N$      | $V_H$<br>$V_L$ | $\pm 47$<br>$\pm 31$ |           |           |         |                         | -70       | 0   | +70 | mV         |
| Pin 17 voltage when standby ON *7  | VST ON     | $V_H$<br>$V_L$ | $\pm 39$<br>$\pm 29$ |           |           |         | Standby                 | 0         |     | 0.6 | V          |
| Pin 17 voltage when standby OFF *7 | VST OFF    | $V_H$<br>$V_L$ | $\pm 39$<br>$\pm 29$ |           |           |         | Operating               | 2.5       | 3.0 |     | V          |

[Remarks]

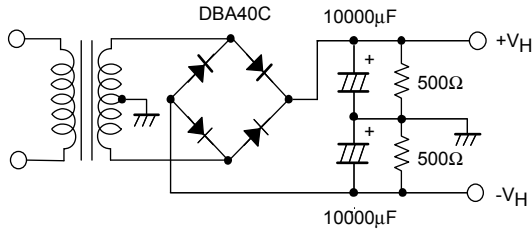
- \*1: Unless otherwise specified, use a constant-voltage power supply to supply power when inspections are carried out.
- \*2: The output noise voltage values shown are peak values read with a VTVM. However, an AC stabilized (50Hz) power supply should be used to minimize the influence of AC primary side flicker noise on the reading.
- \*3: Use the designated transformer power supply circuit shown in the figure below for the measurements of allowable load shorted time and output noise voltage.
- \*4: Design circuits so that  $(|V_H|-|V_L|)$  is always less than 40V when switching the power supply with the load connected.
- \*5: Set up the  $V_L$  power supply with an offset voltage at power supply switching ( $V_L-V_O$ ) of about 8V as an initial target.
- \*6: Please connect -Pre  $V_{CC}$  pin (#5 pin) with the stable minimum voltage and connect so that current does not flow in by reverse bias.
- \*7: Use the standby pin (pin 17) so that the applied voltage never exceeds the maximum rating.  
The power amplifier is turned on by applying +2.5V to +5.5V to the standby pin (pin 17).

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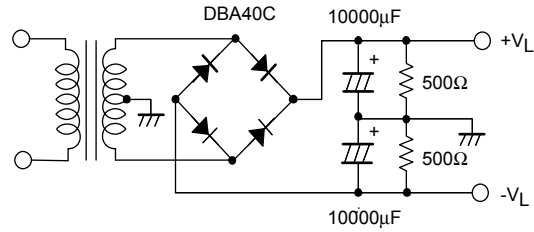
**STK416-100-E**

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- \*8: Thermal design must be implemented based on the conditions under which the customer's end products are expected to operate on the market.
- \*9: The thermoplastic adhesive is used to bond the case and the aluminum substrate, so, please be sure to fix the Hybrid IC on the heat sink before soldering and mount it. In addition, please attach and remove the heat sink at normal temperature.
- \*10: Weight of HIC: 36.8g  
Outer carton dimensions (W×L×H): 452mm×325mm×192mm



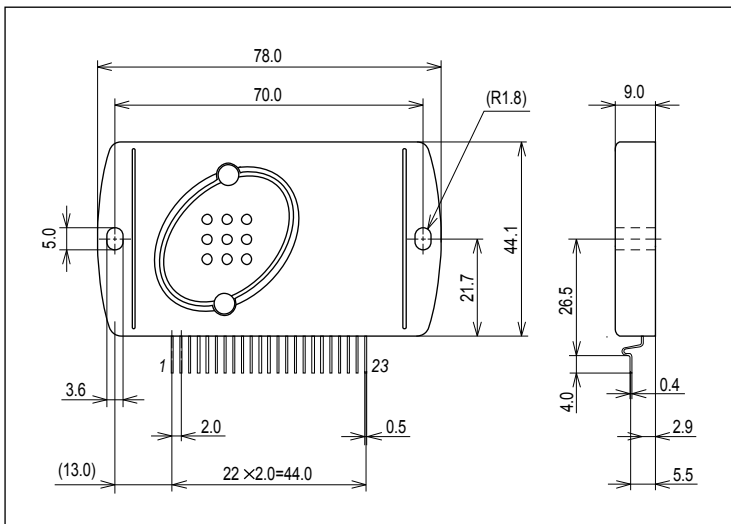
Designated transformer power supply  
(MG-250 equivalent)



Designated transformer power supply  
(MG-200 equivalent)

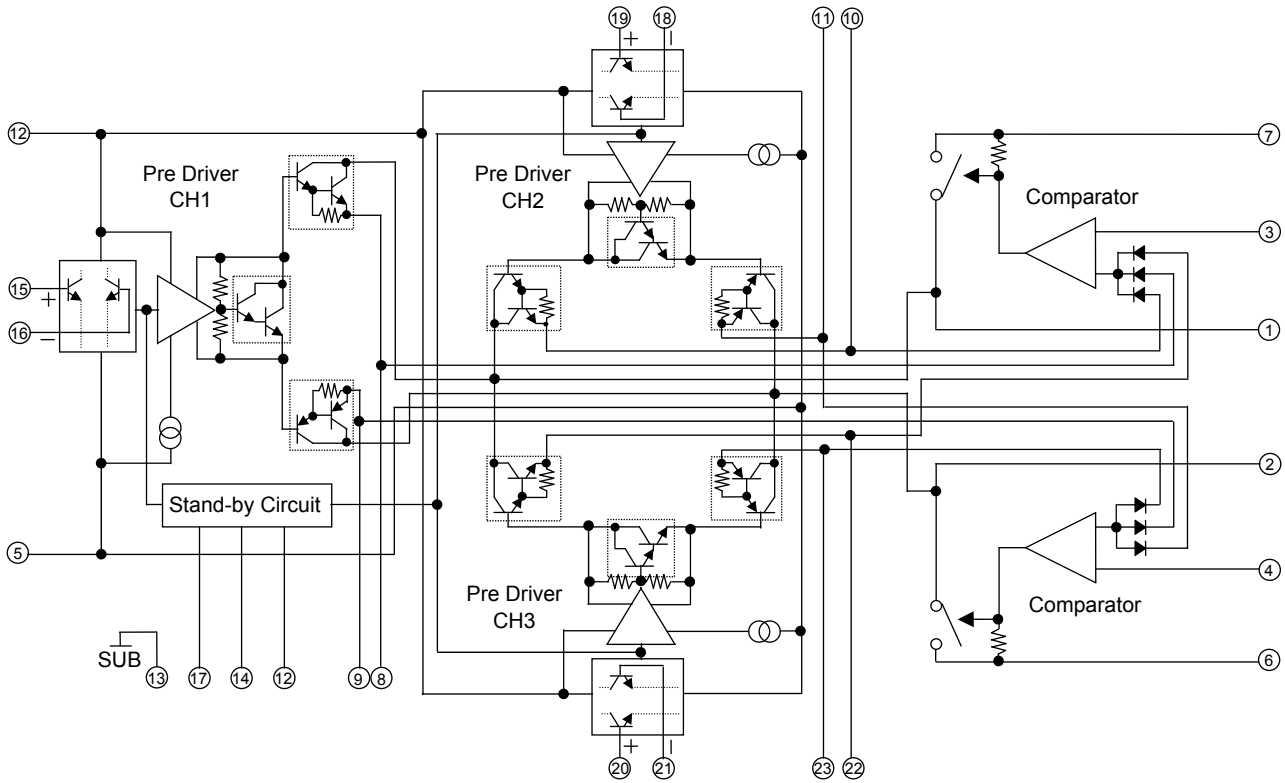
**Package Dimensions**

unit:mm (typ)

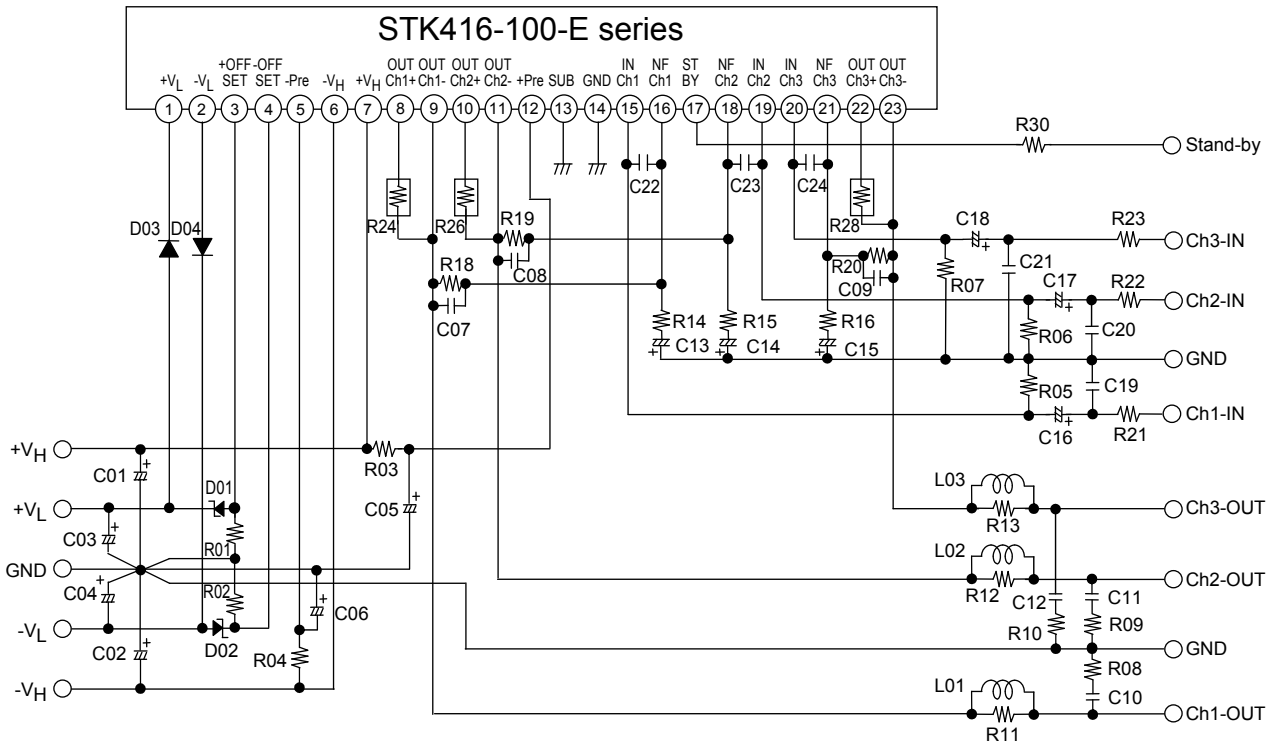


**STK416-100-E**

**Internal Equivalent Circuit**



**Test Circuit**



## STK416-100-E

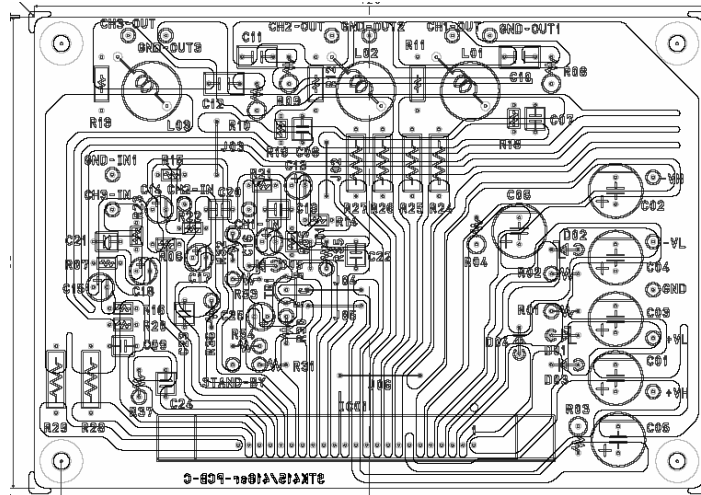
## Recommended External Components

| Parts Location | Recommended Value | Circuit Purpose   | Above Recommended Value  | Below Recommended Value                                |
|----------------|-------------------|---|--|--|
| R01, R02       | 1.5kΩ             | Current for supply switch circuit (comparator) is determined.   | V <sub>H</sub> holding frequency range becomes large.  | V <sub>H</sub> holding frequency range becomes narrow. |
| R03, R04       | 100Ω/1W           | Resistance for ripple filter.<br>(Fuse resistance is recommended. Ripple filter is constituted with C05, C06.)  | Short-through current may decrease at high frequency.  | Short-through current may increase at high frequency.  |
| R05, R06, R07  | 56kΩ              | Input impedance is determined.  | Output neutral voltage (VN) shift.<br>(It is referred that R05=R18, R06=R19, R07=R20)  |  |
| R08, R09, R10  | 4.7Ω/1W           | Resistance for oscillation prevention.  | -  | -  |
| R11, R12, R13  | 4.7Ω              | Noise absorption resistance.  | -  | -  |
| R14, R15, R16  | 560Ω              | Voltage gain (VG) is determined with R18, R19, R20.<br>(As for VG, it is desirable to set up by R14, R15, R16.)   | It may oscillate.<br>(VG<40dB)   | With especially no problem                             |
| R18, R19, R20  | 56kΩ              | Voltage gain (VG) is determined with R14, R15, R16  | -  | -  |
| R21, R22, R23  | 1kΩ               | Resistance for input filters.   | -  | -  |
| R24, R26, R28  | 0.22Ω<br>±10%, 5W | Output emitter resistor<br>(Metal-plate Resistor is recommended.)   | Decrease of maximum output power   | It may cause thermal runaway                           |
| R30            | Note*7            | 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.<br>•Locate near the HIC as much as possible.<br>•Power supply impedance is lowered and stable operation of the IC is carried out.<br>(Electrolytic capacitor is recommended.) | -  | -  |
| C03, C04       | 100μF/50V         | Capacitor for oscillation prevention.<br>•Locate near the HIC as much as possible.<br>•Power supply impedance is lowered and stable operation of the IC is carried out.<br>(Electrolytic capacitor is recommended.) | -  | -  |
| C05, C06       | 100μF/100V        | Decoupling capacitor<br>•The ripple ingredient mixed in an input side is removed from a power supply line.<br>(Ripple filter is constituted with R03, R04.)   | The change in the ripple ingredient mixed in an input side from a power supply line  |  |
| C07, C08, C09  | 3pF               | Capacitor for oscillation prevention.   | It may oscillate.  |  |
| C10, C11, C12  | 0.1μF             | Capacitor for oscillation prevention.   | It may oscillate.  |  |
| C13, C14, C15  | 22μF/10V          | Negative feedback capacitor.<br>•The cutoff frequency of a low cycle changes.<br>( $f_L = 1/(2\pi \cdot C13 \cdot R14)$ )   | 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  | 2.2μF/50V         | Input coupling capacitor (for DC current prevention.)   | -  | -  |
| C19, C20, C21  | 470pF             | Input filter capacitor<br>•A high frequency noise is reduced with the filter constituted by R21, R22, R23.  | -  | -  |
| C22, C23, C24  | 100pF             | Capacitor for oscillation prevention.   | It may oscillate.  |  |
| D01, D02       | 15V               | Decide offset voltage for supply voltage circuit.   | Decrease distortion at supply voltage shift  | Increase distortion at supply voltage shift            |
| D03, D04       | 3A/60V            | Adverse current prevention diode<br>(FRD is recommended)  | -  | -  |
| L01, L02, L03  | 3μH               | Coil for oscillation prevention.  | With especially no problem   | It may oscillate.                                      |

**STK416-100-E**

**Sample PCB Trace Pattern**

STK415-100-E-Sr/STK416-100-E-Sr PCB PARTS LIST



**STK415, 416-100-E Series PCB Parts List**

PCB Name: STK415/416sr-PCB C

| Location No.<br>(*2) 2ch Amp doesn't mount parts of ( ). | PARTS            | RATING              | Component                                  |   |
|--|------------------|---------------------|--|---|
| R01, R02   | ERG1SJ152        | 1.5kΩ, 1W           | ○  |   |
| R03, R04   | ERG1SJ101        | 100Ω, 1W            | ○  |   |
| R05, R06, (R07), R18, R19, (R20)                         | RN16S563FK       | 56kΩ, 1/6W          | ○  |   |
| R08, R09, (R10)  | ERX1SJ4R7        | 4.7Ω, 1W            | ○  |   |
| R11, R12, (R13)  | RN14S4R7FK       | 4.7Ω, 1/4W          | ○  |   |
| R14, R15, (R16)  | RN16S561FK       | 560Ω, 1/6W          | ○  |   |
| R21, R22, (R23)  | RN16S102FK       | 1kΩ, 1/6W           | ○  |   |
| R24, R26, (R28)  | ERX2SJR22        | 0.22Ω, 5W (*1)      | ○  |   |
| R25, R27, (R29)  | -                | -                   | Short                                      |   |
| R35, R36, (R37)  | -                | -                   | Short                                      |   |
| C01, C02, C05, C06                                       | 100MV100HC       | 100μF, 100V         | ○  |   |
| C03, C04   | 100MV50HC        | 100μF, 50V          | ○  |   |
| C07, C08, (C09)  | DD104-63CJ030C50 | 3pF, 50V            | ○  |   |
| C10, C11, (C12)  | ECQ-V1H104JZ     | 0.1μF, 50V          | ○  |   |
| C13, C14, (C15)  | 10MV22HC         | 22μF, 10V           | ○  |   |
| C16, C17, (C18)  | 50MV2R2HC        | 2.2μF, 50V          | ○  |   |
| C19, C20, (C21)  | DD104-63B471K50  | 470pF, 50V          | ○  |   |
| C22, C23, (C24)  | DD104-63B101K50  | 100pF, 50V          | ○  |   |
| D01, D02 (*3)  | GZA15X           | VZ=15V              | ○  |   |
| D03, D04   | ERC91-02SC       | 60V, 3A (FRD)       | ○  |   |
| L01, L02, (L03)  | -                | 3μH                 | ○  |   |
| Stand-by Control Circuit                                 | Tr1              | 2SC3332 (Reference) | V <sub>CE</sub> ≥80V, I <sub>C</sub> ≥10mA | ○ |
|  | D05              | GMB01 (Reference)   | Di   | ○ |
|  | R30              | RN16S272FK          | 2.7kΩ, 1/6W                                | ○ |
|  | R32              | RN16S102FK          | 1kΩ, 1/6W                                  | ○ |
|  | R33              | RN16S333FK          | 33kΩ, 1/6W                                 | ○ |
|  | R34              | RN16S202FK          | 2kΩ, 1/6W                                  | ○ |
| C25  | 10MV47HC         | 47μF, 10V           | ○  |   |
| J01, 02, J03, J04, J05, J06                              | -                | -                   | ○  |   |

(\*1) Metal Plate Cement Resistor use.

(\*2) STK415series (2ch Amp) doesn't mount parts of ( )

(\*3) STK415-140-E uses GZA18X (ZD=18X) for D01, D02.

**STK416-100-E**

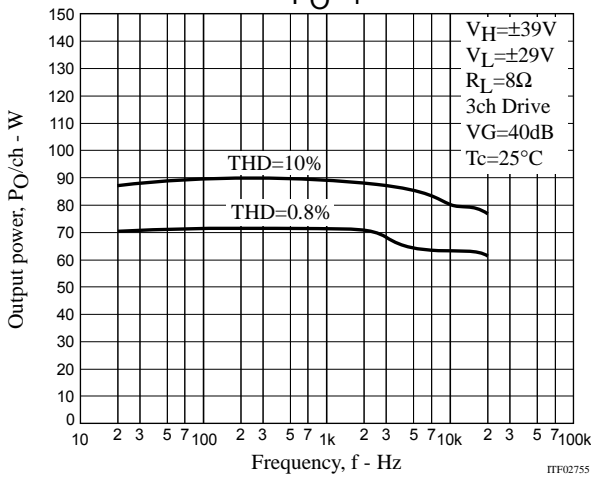
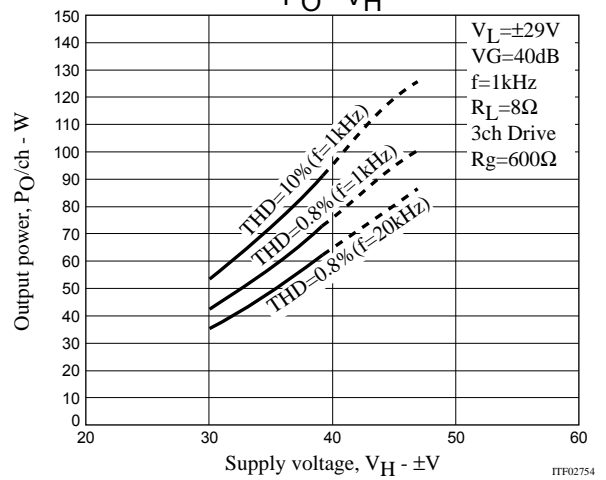
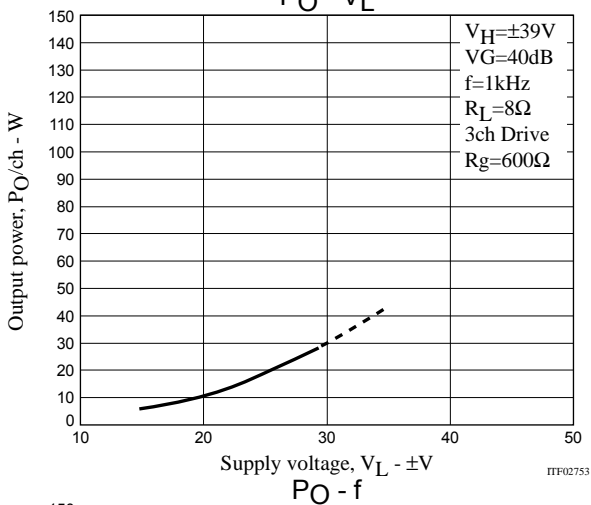
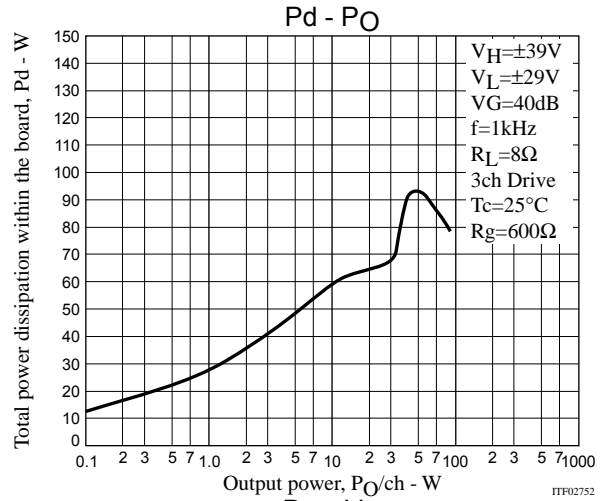
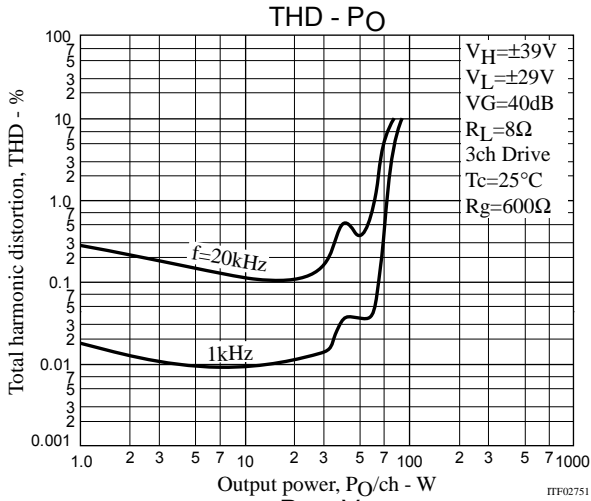
**Pin Assignments**

[STK433-000/-100/-200 Sr & STK415/416-100 Sr 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  |  | -                  | - | + | O | O | O | O | + |   | I  | N  | S  | N  | I  |    |    |    |    |    |    |    |    |    |
| STK433-040-E 40W/JEITA  |  | P                  | V | V | U | U | U | U | P | S | G  | N  | F  | T  | F  | N  |    |    |    |    |    |    |    |    |
| STK433-060-E 50W/JEITA  |  | R                  | C | C | T | T | T | T | R | U | /  | /  | /  | A  | /  | /  |    |    |    |    |    |    |    |    |
| STK433-070-E 60W/JEITA  |  | E                  | C | C | / | / | / | / | E | B | D  | C  | C  | N  | C  | C  | H  | H  |    |    |    |    |    |    |
| STK433-090-E 80W/JEITA  |  |                    |   |   | C | C | C | C | • |   | H  | H  | D  | H  | H  | 2  | 2  |    |    |    |    |    |    |    |
| STK433-100-E 100W/JEITA |  |                    |   |   | H | H | H | H | G |   | 1  | 1  |    | B  |    |    |    |    |    |    |    |    |    |    |
| STK433-120-E 120W/JEITA |  |                    |   |   | 1 | 1 | 2 | 2 | N |   |    |    |    | Y  |    |    |    |    |    |    |    |    |    |    |
| STK433-130-E 150W/JEITA |  |                    |   |   | + | - | + | - | D |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 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 |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| STK433-240A-E 40W/JEITA |  | -                  | - | + | O | O | O | O | + |   | I  | N  | S  | N  | I  | I  | N  | O  | O  |    |    |    |    |    |
| STK433-260A-E 50W/JEITA |  | P                  | V | V | U | U | U | U | P | S | G  | N  | F  | T  | F  | N  | F  | U  | U  |    |    |    |    |    |
| STK433-270-E 60W/JEITA  |  | R                  | C | C | T | T | T | T | R | U | /  | /  | A  | /  | /  | /  | /  | T  | T  |    |    |    |    |    |
| STK433-290-E 80W/JEITA  |  | E                  | C | C | / | / | / | / | E | B | D  | C  | C  | N  | C  | C  | C  | /  | /  |    |    |    |    |    |
| STK433-300-E 100W/JEITA |  |                    |   |   | C | C | C | C | • |   | H  | H  | D  | H  | H  | H  | H  | C  | C  |    |    |    |    |    |
| STK433-320-E 120W/JEITA |  |                    |   |   | H | H | H | H | G |   | 1  | 1  |    | 2  | 2  | 3  | 3  | H  | H  |    |    |    |    |    |
| STK433-330-E 150W/JEITA |  |                    |   |   | 1 | 1 | 2 | 2 | N |   |    |    |    | Y  |    |    |    | 3  | 3  |    |    |    |    |    |
|                         |  |                    |   |   | + | - | + | - | D |   |    |    |    |    |    |    |    | +  | -  |    |    |    |    |    |
| 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  |  | +                  | - | + | - | - | + | O | O | O | O  | +  |    | I  | N  | S  | N  | I  |    |    |    |    |    |    |
| STK415-100-E 90W/JEITA  |  | V                  | V | O | O | P | V | V | U | U | U  | U  | P  | S  | G  | N  | F  | T  | F  | N  |    |    |    |    |
| STK415-120-E 120W/JEITA |  | L                  | L | F | F | R | H | H | T | T | T  | T  | R  | U  | /  | /  | A  | /  | /  |    |    |    |    |    |
| STK415-130-E 150W/JEITA |  |                    |   | F | F | E |   | / | / | / | /  | E  | B  | D  | C  | C  | N  | C  | C  |    |    |    |    |    |
| STK415-140-E 180W/JEITA |  |                    |   | S | S |   |   | C | C | C | C  | •  |    | H  | H  | D  | H  | H  |    |    |    |    |    |    |
|                         |  |                    |   | E | E |   |   | H | H | H | H  | G  |    | 1  | 1  |    | 2  | 2  |    |    |    |    |    |    |
|                         |  |                    |   | T | T |   |   | 1 | 1 | 2 | 2  | N  |    |    |    |    | Y  |    |    |    |    |    |    |    |
|                         |  |                    |   |   |   |   |   | + | - | + | -  | D  |    |    |    |    |    |    |    |    |    |    |    |    |
| 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  |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| STK416-100-E 90W/JEITA  |  | +                  | - | + | - | - | + | O | O | O | O  | +  |    | I  | N  | S  | N  | I  | I  | N  | O  | O  |    |    |
| STK416-120-E 120W/JEITA |  | V                  | V | O | O | P | V | V | U | U | U  | U  | P  | S  | G  | N  | F  | T  | F  | N  | F  | U  | U  |    |
| STK416-130-E 150W/JEITA |  | L                  | L | F | F | R | H | H | T | T | T  | T  | R  | U  | /  | /  | A  | /  | /  | /  | /  | T  | T  |    |
|                         |  |                    |   | F | F | E |   | / | / | / | /  | E  | B  | D  | C  | C  | N  | C  | C  | C  | /  | /  |    |    |
|                         |  |                    |   | S | S |   |   | C | C | C | C  | •  |    | H  | H  | D  | H  | H  | H  | H  | C  | C  |    |    |
|                         |  |                    |   | E | E |   |   | H | H | H | H  | G  |    | 1  | 1  |    | 2  | 2  | 3  | 3  | H  | H  |    |    |
|                         |  |                    |   | T | T |   |   | 1 | 1 | 2 | 2  | N  |    |    |    |    |    |    |    |    | 3  | 3  |    |    |
|                         |  |                    |   |   |   |   |   | + | - | + | -  | D  |    |    |    |    |    |    |    |    | +  | -  |    |    |

**STK416-100-E**

**Evaluation Board Characteristics**





**STK416-100-E**

[Thermal Design Example for STK416-100-E ( $R_L = 8\Omega$ )]

The thermal resistance,  $\theta_{c-a}$ , of the heat sink for total power dissipation,  $P_d$ , within the hybrid IC is determined as follows.

Condition 1: The hybrid IC substrate temperature,  $T_c$ , must not exceed  $125^\circ\text{C}$ .

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

$T_a$ : Guaranteed ambient temperature for the end product

Condition 2: The junction temperature,  $T_j$ , of each power transistor must not exceed  $150^\circ\text{C}$ .

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

$N$ : Number of power transistors

$\theta_{j-c}$ : Thermal resistance per power transistor

However, the power dissipation,  $P_d$ , 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  $\theta_{c-a}$ .

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

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

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  $T_a$

[Example]

When the IC supply voltage,  $V_H = \pm 39\text{V}$ ,  $V_L = \pm 29\text{V}$  and  $R_L$  is  $8\Omega$ , the total power dissipation,  $P_d$ , within the hybrid IC, will be a maximum of  $93\text{W}$  at  $1\text{kHz}$  for a continuous sine wave signal according to the  $P_d$ - $P_O$  characteristics. For the music signals normally handled by audio amplifiers, a value of  $1/8P_O \text{ max}$  is generally used for  $P_d$  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:

$$P_d \approx 55.0\text{W} \quad (\text{when } 1/8P_O \text{ max.} = 7.5\text{W}, P_O \text{ max.} = 60\text{W}).$$

The number of power transistors in audio amplifier block of these hybrid ICs,  $N$ , is 6, and the thermal resistance per transistor,  $\theta_{j-c}$ , is  $1.8^\circ\text{C/W}$ . Therefore, the required heat sink thermal resistance for a guaranteed ambient temperature,  $T_a$ , of  $50^\circ\text{C}$  will be as follows.

$$\begin{aligned} \text{From formula (1)'} \quad \theta_{c-a} &< (125 - 50)/55.0 \\ &< 1.36 \end{aligned}$$

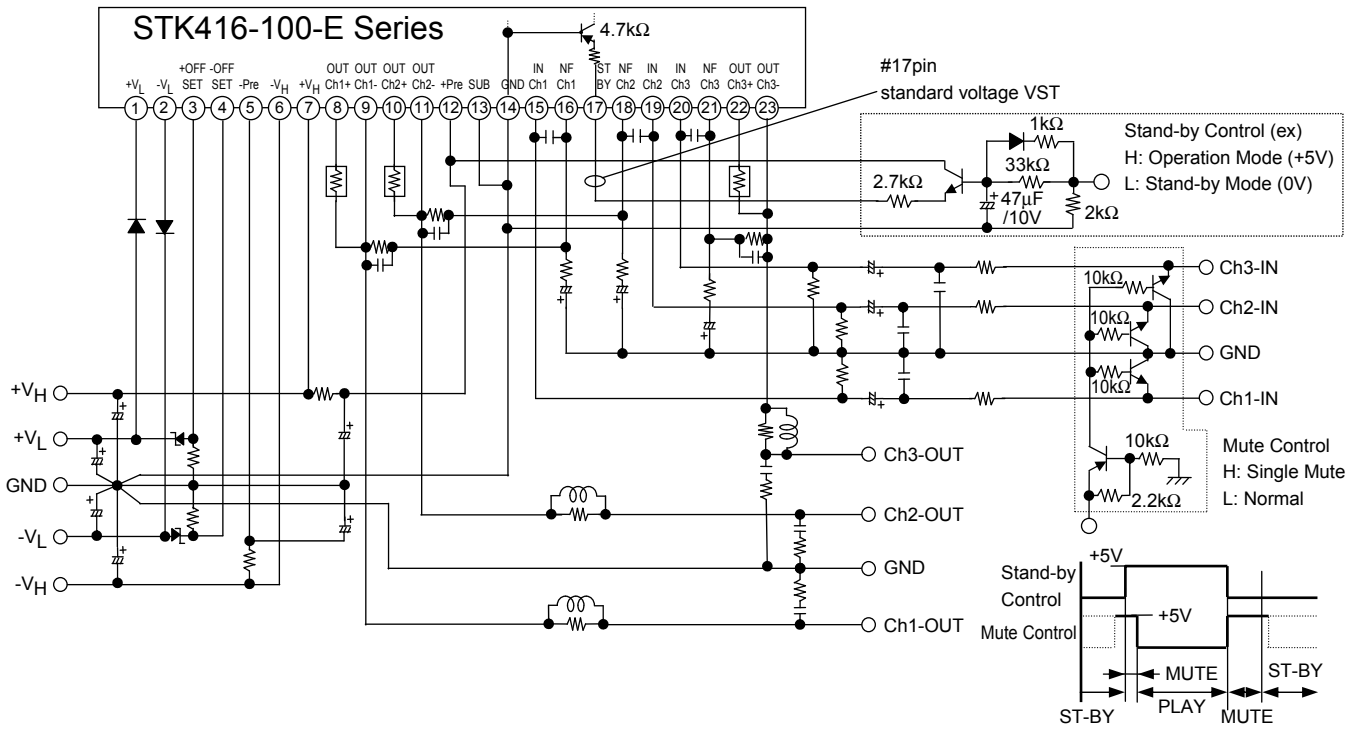
$$\begin{aligned} \text{From formula (2)'} \quad \theta_{c-a} &< (150 - 50)/55.0 - 1.8/6 \\ &< 1.52 \end{aligned}$$

Therefore, the value of  $1.36^\circ\text{C/W}$ , which satisfies both of these formulae, is the required thermal resistance of the heat sink.

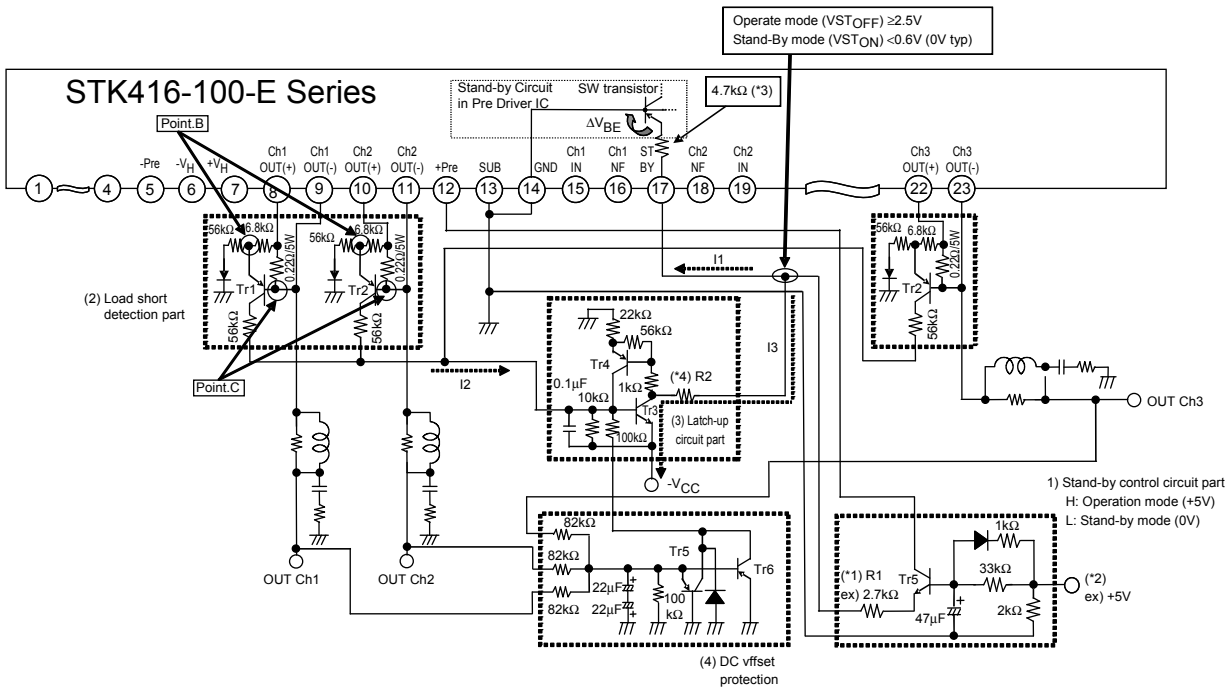
Note that this thermal design example assumes the use of a constant-voltage power supply, and is therefore not a verified design for any particular user's end product.

**STK416-100-E**

**STK416-100-E Series Stand-by Control & Mute Control Application**



**STK416-100-E Series Application explanation**



## STK416-100-E

A protection application circuit of STK416-100sr 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 #17 pin reference voltage VST.

##### <1> Operation mode

The SW transistor of pre-driver IC is turned on at  $VST \geq 2.5V$ , and the amplifier becomes operation mode.

ex) at  $VST(\min) = 2.5V$

$$VST = (*2) \times IST + 0.6V \rightarrow 2.5V = 4.7k\Omega \times IST + 0.6V, I1 \approx 0.40mA$$

##### <2> Stand-by mode

The SW transistor of pre-driver IC is turned off at  $VST \leq 0.6V$  (typ 0V), and the amplifier becomes stand-by mode.

ex) at  $VST = 0.6V$

$$VST = (*2) \times IST + 0.6V \rightarrow 0.6V = 4.7k\Omega \times IST + 0.6V, I1 \approx 0mA$$

##### (\*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 (#17pin) and 4.7k $\Omega$  is built into.

#### 2) Load short detection part

TR1 (or TR2) 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 (-)  $\approx 0.5V$  (typ) to 'OUT CH1' or 'OUT Ch2', 'OUT Ch3', 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 '82k $\Omega$ '.

Moreover, please set the time constant by '22 $\mu$ /22 $\mu$ ' so as not to mis-detect it when the audio signal is output.

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