



SANYO Semiconductors

# DATA SHEET

## STK416-090-E — Thick-Film Hybrid IC 3-Channel Power Switching Audio Power IC, 80W+80W+80W

### Overview

The STK416-090-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 80W to 180W.
- Can be used to replace the STK415-100 series (2-channel models) 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
- Using insulated metal substrate that features superlative heat dissipation characteristics that are among the highest in the industry.

### Series Models

	STK416-090-E	STK416-100-E	STK416-120-E	STK416-130-E
Output 1 (10%/1kHz)	80W×3ch	90W×3ch	120W×3ch	150W×3ch
Output 2 (0.8%/20Hz to 20kHz)	50W×3ch	60W×3ch	80W×3ch	100W×3ch
Max. rated $V_H$ (quiescent)	±60V	±65V	±73V	±80V
Max. rated $V_L$ (quiescent)	±41V	±42V	±45V	±46V
Recommended operating $V_H$ (8Ω)	±38V	±39V	±46V	±51V
Recommended operating $V_L$ (8Ω)	±27V	±29V	±32V	±34V
Dimensions (excluding pin height)	78.0mm×44.1mm×9.0mm			

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# STK416-090-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	$\pm 60$	V
$V_H$ maximum supply voltage 2	$V_H$ max (2)	$R_L \geq 6\Omega$	$\pm 53$	V
$V_H$ maximum supply voltage 3	$V_H$ max (3)	$R_L \geq 4\Omega$	$\pm 43$	V
$V_L$ maximum quiescent supply voltage 1	$V_L$ max (1)	When no signal	$\pm 41$	V
$V_L$ maximum supply voltage 2	$V_L$ max (2)	$R_L \geq 6\Omega$	$\pm 36$	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	2.1	$^\circ\text{C/W}$
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	$t_s$	$V_H=\pm 38\text{V}$ , $V_L=\pm 27\text{V}$ , $R_L=8\Omega$ , $f=50\text{Hz}$ , $P_O=50\text{W}$ , 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)	$V_H$ $V_L$	$\pm 38$ $\pm 27$	20 to 20k		0.8		50			W
	$P_O$ (2)	$V_H$ $V_L$	$\pm 30$ $\pm 23$	1k		0.8	$R_L=4\Omega$	50			
Total harmonic distortion	THD	$V_H$ $V_L$	$\pm 38$ $\pm 27$	20 to 20k	50			0.4			%
Frequency characteristics	$f_L, f_H$	$V_H$ $V_L$	$\pm 38$ $\pm 27$		1.0		+0 -3dB	20 to 50k			Hz
Input impedance	$r_i$	$V_H$ $V_L$	$\pm 38$ $\pm 27$	1k	1.0			55			$\text{k}\Omega$
Output noise voltage *2	$V_{NO}$	$V_H$ $V_L$	$\pm 45$ $\pm 30$				$R_g=2.2\text{k}\Omega$			1.0	mVrms
Quiescent current	$I_{CCO}$	$V_H$	$\pm 45$				$R_L=\infty$			40	mA
		$V_L$	$\pm 30$							150	
Output neutral voltage	$V_N$	$V_H$ $V_L$	$\pm 45$ $\pm 30$					-70	0	+70	mV
Pin 17 voltage when standby ON *7	VST ON	$V_H$ $V_L$	$\pm 38$ $\pm 27$				Standby	0		0.6	V
Pin 17 voltage when standby OFF *7	VST OFF	$V_H$ $V_L$	$\pm 38$ $\pm 27$				Operating	2.5	3.0		V

[Remarks]

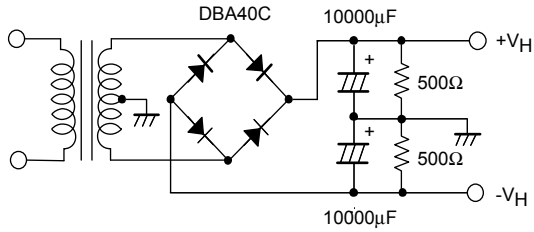
- \*1: Unless otherwise specified, use a constant-voltage power supply to supply power when inspections are carried out.
- \*2: The output noise voltage values shown are peak values read with a VTVM. However, an AC stabilized (50Hz) power supply should be used to minimize the influence of AC primary 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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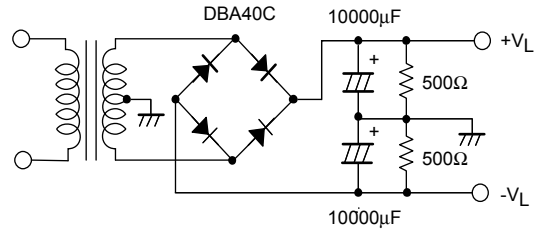
# STK416-090-E

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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



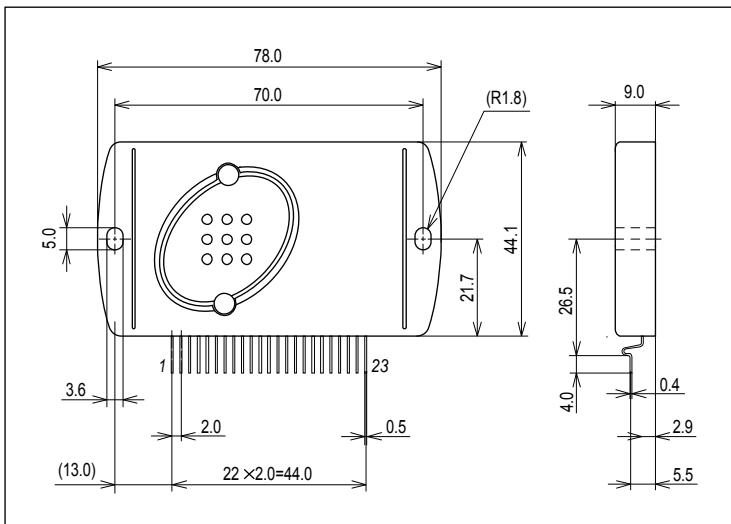
Designated transformer power supply  
(MG-250 equivalent)



Designated transformer power supply  
(MG-200 equivalent)

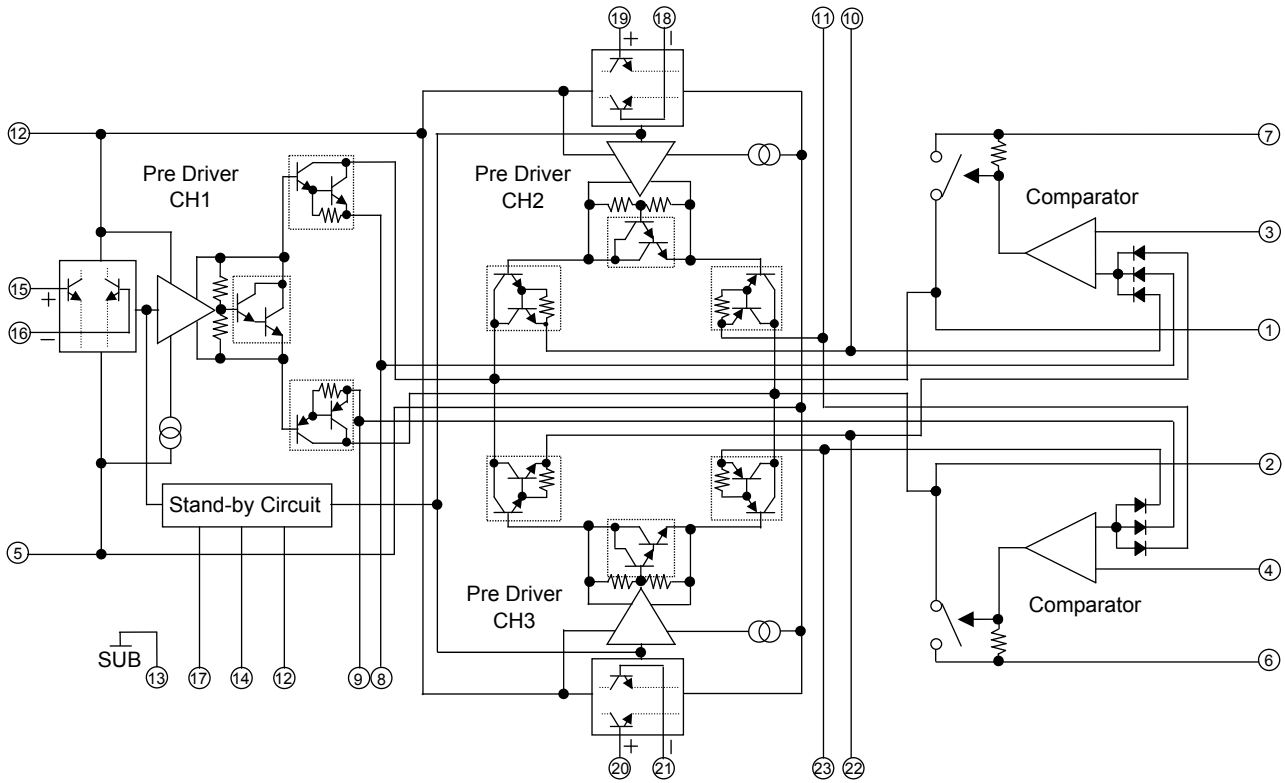
## Package Dimensions

unit:mm (typ)

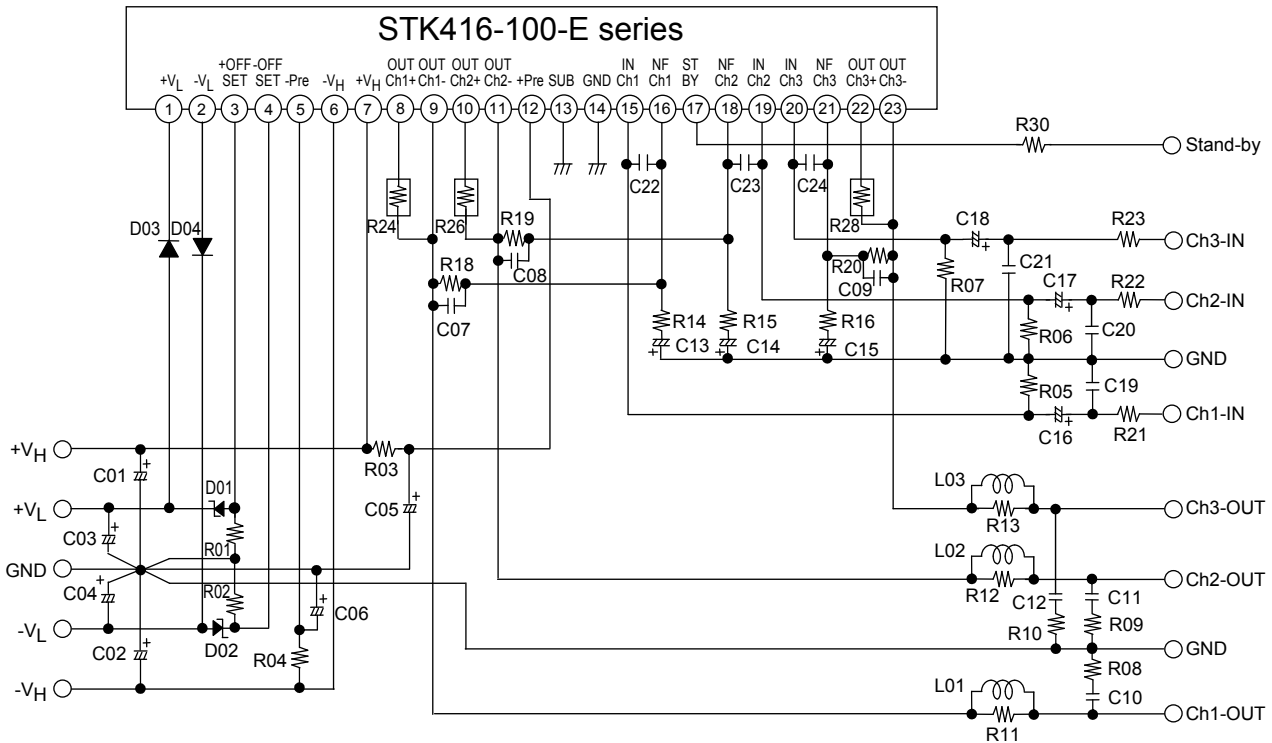


# STK416-090-E

## Internal Equivalent Circuit



## Test Circuit



# STK416-090-E

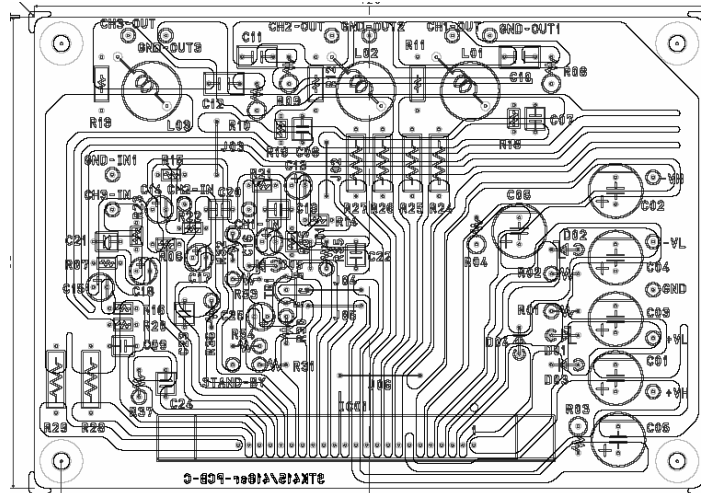
## Recommended External Components

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. (Fuse resistance is recommended. Ripple filter is constituted with C05, C06.)	-	Short-through current may increase at high frequency.
R05, R06, R07	56kΩ	Input impedance is determined.	Output neutral voltage (VN) shift. (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. (As for VG, it is desirable to set up by R14, R15, R16.)	It may oscillate. (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 ±10%, 5W	Output emitter resistor (Metal-plate Resistor is recommended.)	Decrease of maximum output power	It may cause thermal runaway
R30	Note*6	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, C04	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.)	-	-
C05, C06	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	
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. •The cutoff frequency of a low cycle changes. ( $f_L = 1/(2\pi \cdot C13 \cdot R14)$ )	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 •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 (FRD is recommended)	-	-
L01, L02, L03	3μH	Coil for oscillation prevention.	With especially no problem	It may oscillate.

# STK416-090-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. (*2) 2ch Amp doesn't mount parts of ( ).	PARTS	RATING	Component	
R01, R02	ERG1SJ152	1.5k $\Omega$ , 1W	enabled	
R03, R04	ERG1SJ101	100 $\Omega$ , 1W	enabled	
R05, R06, (R07), R18, R19, (R20)	RN16S563FK	56k $\Omega$ , 1/6W	enabled	
R08, R09, (R10)	ERX1SJ4R7	4.7 $\Omega$ , 1W	enabled	
R11, R12, (R13)	RN14S4R7FK	4.7 $\Omega$ , 1/4W	enabled	
R14, R15, (R16)	RN16S561FK	560 $\Omega$ , 1/6W	enabled	
R21, R22, (R23)	RN16S102FK	1k $\Omega$ , 1/6W	enabled	
R24, R26, (R28)	ERX2SJR22	0.22 $\Omega$ , 5W (*1)	enabled	
R25, R27, (R29)	-	-	Short	
R35, R36, (R37)	-	-	Short	
C01, C02, C05, C06	100MV100HC	100 $\mu$ F, 100V	enabled	
C03, C04	100MV50HC	100 $\mu$ F, 63V	enabled	
C07, C08, (C09)	DD104-63CJ030C50	3pF, 50V	enabled	
C10, C11, (C12)	ECQ-V1H104JZ	0.1 $\mu$ F, 50V	enabled	
C13, C14, (C15)	10MV22HC	22 $\mu$ F, 10V	enabled	
C16, C17, (C18)	50MV2R2HC	2.2 $\mu$ F, 50V	enabled	
C19, C20, (C21)	DD104-63B471K50	470pF, 50V	enabled	
C22, C23, (C24)	DD104-63B101K50	100pF, 50V	enabled	
D01, D02 (*3)	GZA15X	VZ=15V	enabled	
D03, D04	ERC91-02SC	60V, 3A (FRD)	enabled	
L01, L02, (L03)	-	3 $\mu$ H	enabled	
Stand-by Control Circuit	Tr1	2SC1209 (Reference)	V <sub>CE</sub> ≥80V, I <sub>C</sub> ≥10mA	enabled
	D05	GMB05 (Reference)	Di	enabled
	R30	RN16S512FK	2.7k $\Omega$ , 1/6W	enabled
	R32	RN16S102FK	1k $\Omega$ , 1/6W	enabled
	R33	RN16S333FK	33k $\Omega$ , 1/6W	enabled
	R34	RN16S202FK	2k $\Omega$ , 1/6W	enabled
C25	10MV47HC	47 $\mu$ F, 10V	enabled	
J01, 02, J03, J04, J05, J06	-	-	enabled	

(\*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.

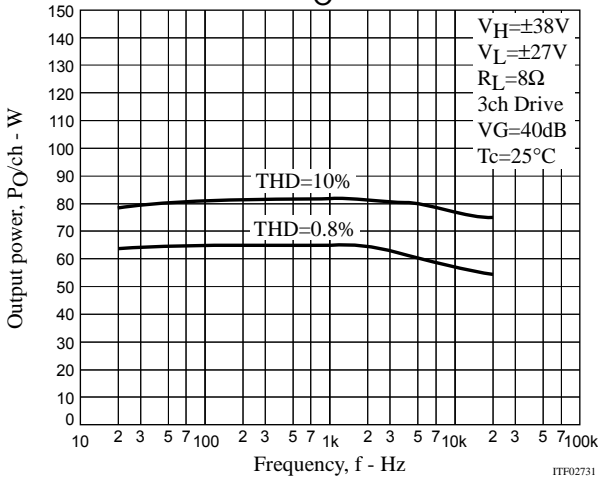
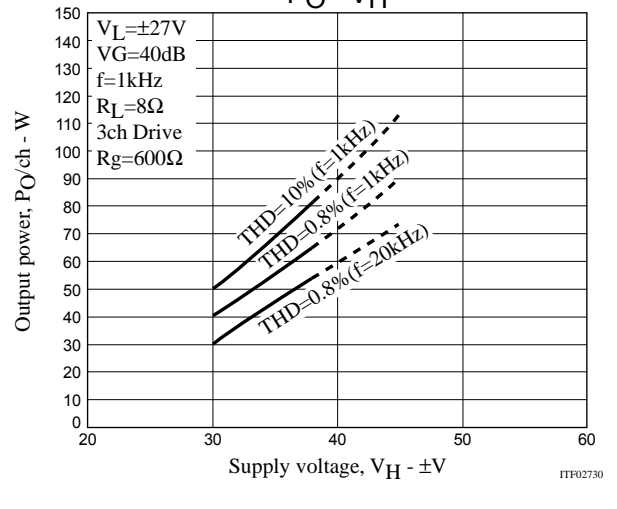
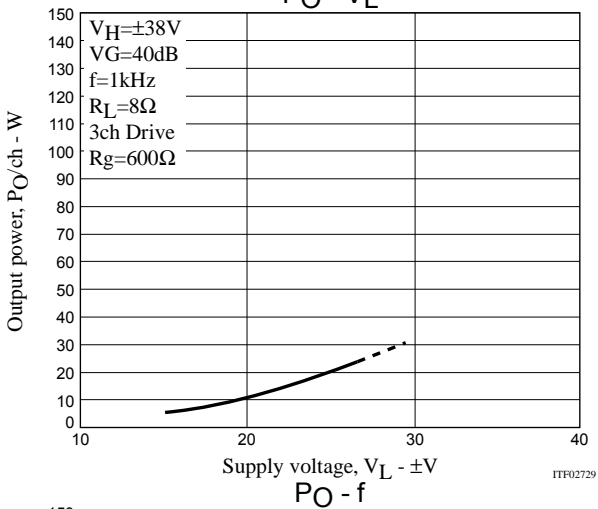
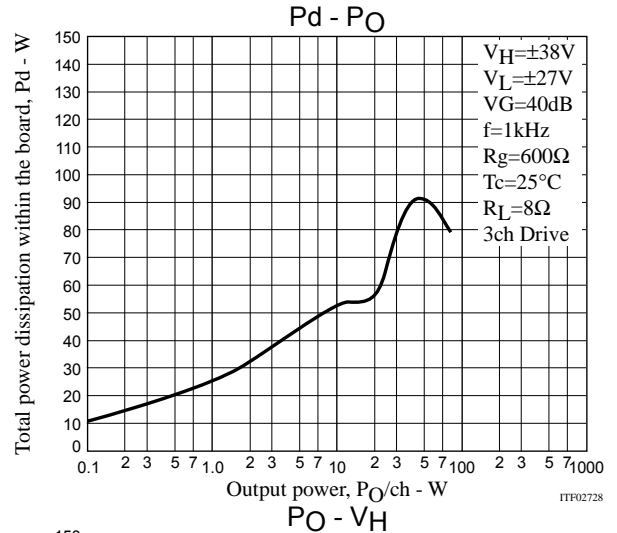
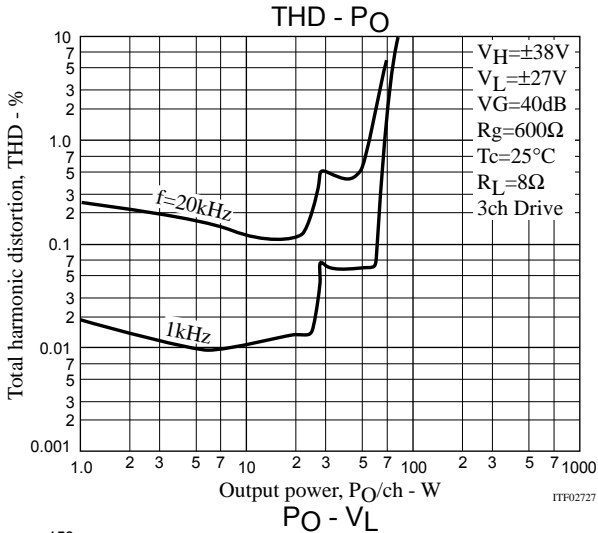
# STK416-090-E

## 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								
STK433-090-E 80W/JEITA					C	C	C	C	•		H	H	D	H	H									
STK433-100-E 100W/JEITA					H	H	H	H	G		1	1		2	2									
STK433-120-E 120W/JEITA					1	1	2	2	N				B											
STK433-130-E 150W/JEITA					+	-	+	-	D				Y											
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		-	-	+	O	O	O	O	+			I	N	S	N	I	I	N	O	O				
STK433-240A-E 40W/JEITA		P	V	V	U	U	U	U	P	S	G	N	F	T	F	N	N	F	U	U				
STK433-260A-E 50W/JEITA		R	C	C	T	T	T	T	R	U	/	/	A	/	/	/	/	T	T					
STK433-270-E 60W/JEITA		E	C	C	/	/	/	/	E	B	D	C	C	N	C	C	C	/	/					
STK433-290-E 80W/JEITA					C	C	C	C	•		H	H	D	H	H	H	H	C	C					
STK433-300-E 100W/JEITA					H	H	H	H	G		1	1		2	2	3	3	H	H					
STK433-320-E 120W/JEITA					1	1	2	2	N				B				3	3						
STK433-330-E 150W/JEITA					+	-	+	-	D				Y				+	-						
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				B								
								+	-	+	-	D				Y								
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																						
<b>STK416-090-E 80W/JEITA</b>		+	-	+	-	-	+	O	O	O	O	+			I	N	S	N	I	I	N	O	O	
STK416-100-E 90W/JEITA		V	V	O	O	P	V	V	U	U	U	U	P	S	G	N	F	T	F	N	N	F	U	U
STK416-120-E 120W/JEITA		L	L	F	F	R	H	H	T	T	T	T	R	U	/	/	A	/	/	/	/	T	T	
STK416-130-E 150W/JEITA				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				B				3	3			
								+	-	+	-	D				Y				+	-			

Evaluation Board Characteristics





## STK416-090-E

[Thermal Design Example for STK416-090-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,  $V_H = \pm 38\text{V}$ ,  $V_L = \pm 27\text{V}$  and  $R_L$  is  $8\Omega$ , the total power dissipation,  $P_d$ , within the hybrid IC, will be a maximum of  $91\text{W}$  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:

$$P_d \approx 45.0\text{W} \quad (\text{when } 1/8P_O \text{ max.} = 6.25\text{W}, P_O \text{ max.} = 50\text{W}).$$

The number of power transistors in audio amplifier block of these hybrid ICs,  $N$ , is 4, and the thermal resistance per transistor,  $\theta_{j-c}$ , is  $2.1^\circ\text{C/W}$ . Therefore, the required heat sink thermal resistance for a guaranteed ambient temperature,  $T_a$ , of  $50^\circ\text{C}$  will be as follows.

From formula (1)'  $\theta_{c-a} < (125 - 50)/45.0$   
 $< 1.67$

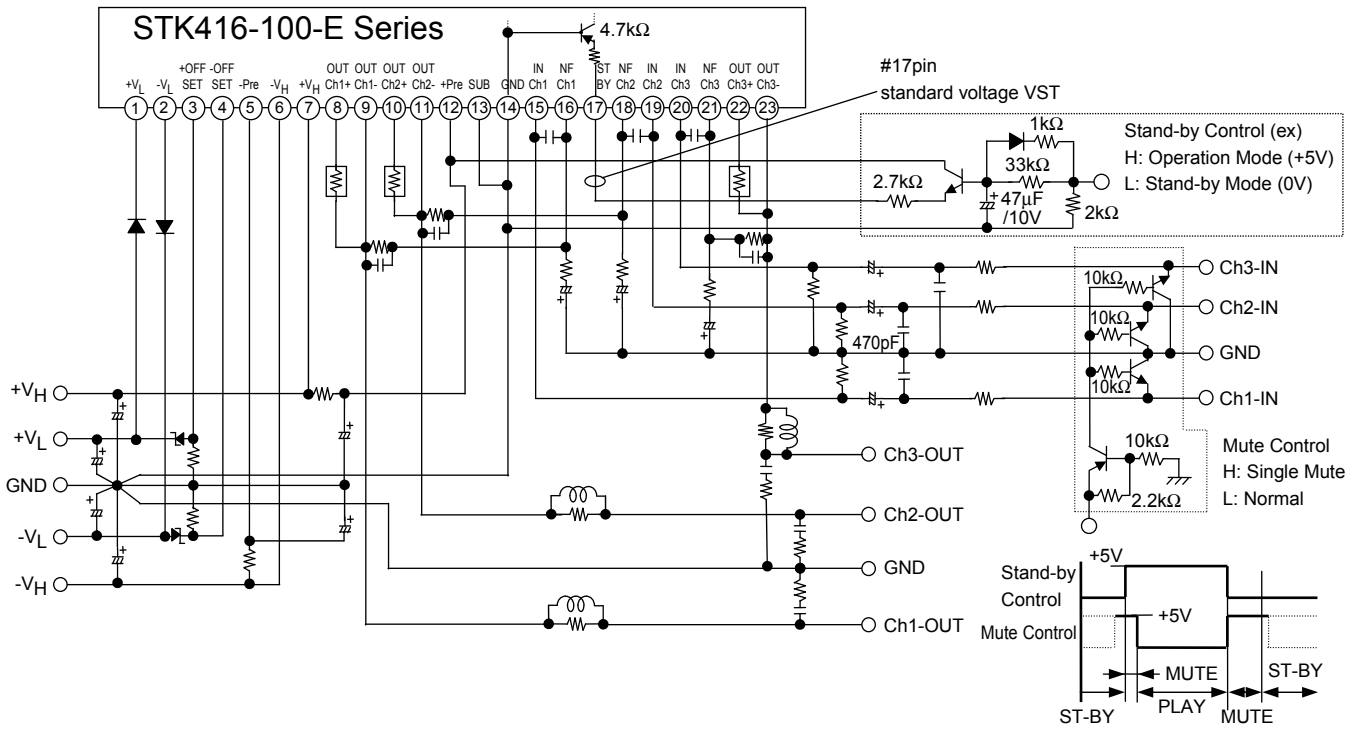
From formula (2)'  $\theta_{c-a} < (150 - 50)/45.0 - 2.1/6$   
 $< 1.87$

Therefore, the value of  $1.67^\circ\text{C/W}$ , which satisfies both of these formulae, is the required thermal resistance of the heat sink.

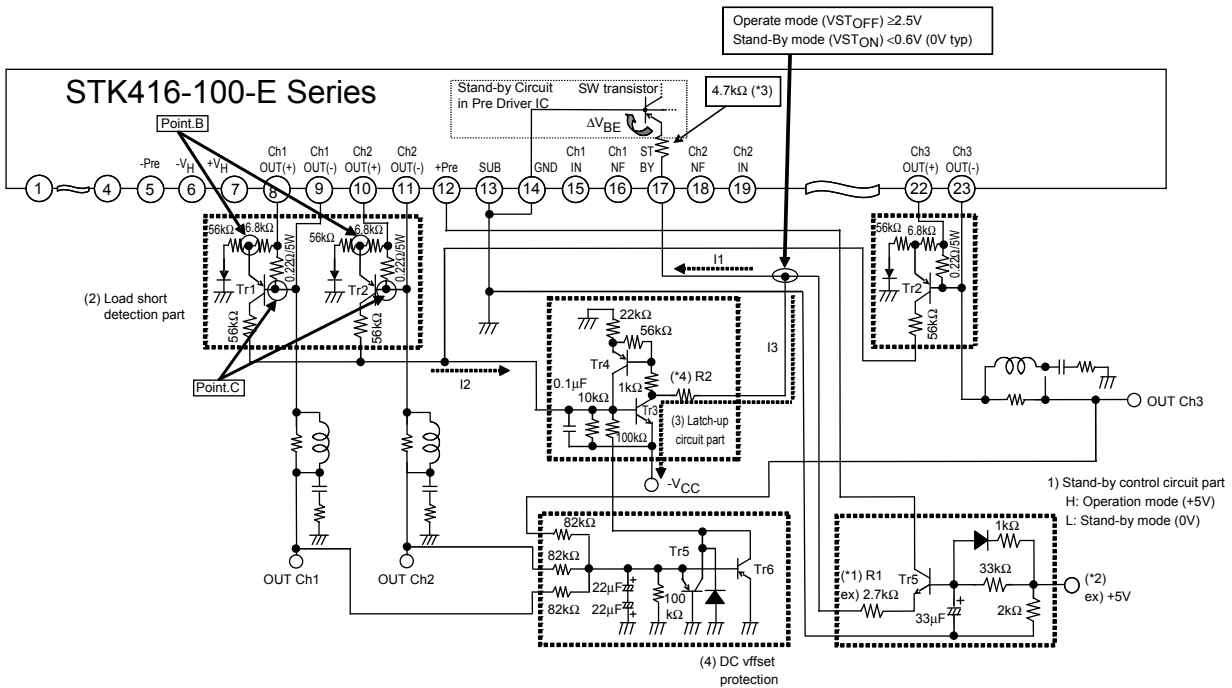
Note that this thermal design example assumes the use of a constant-voltage power supply, and is therefore not a verified design for any particular user's end product.

# STK416-090-E

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



## STK416-100-E Series Application explanation



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

Please refer to the attached paper (RL short protect explanation) for the operation explanation.

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', 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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