



SANYO Semiconductors DATA SHEET

STK404-000N-E series **Thick-Film Hybrid IC** 1ch class-AB Audio Power IC from 60W to 180W

Overview

The STK404-000N-E series is hybrid IC for the audio power amplifier that mounts discrete components as the audio power amplifier circuit in small space using the original Insulated Metal Substrate Technology IMST. The compact package has been achieved by adopting the low thermal resistance substrate (our conventional model kind ratio).

Application

- Audio Power use

Features

- Pin-to-pin compatible outputs ranging from 60W to 180W
- Miniature package (44.0×25.6×8.5mm, 46.6×25.5×8.5mm, 59.2×25.5×8.5mm)
- Output load impedance $R_L=6\Omega$ recommended.
- Allowable load shorted time: 0.3 second
- Allows the use of predesigned applications for standby, mute, and the load short protection circuit.

Selection Guide

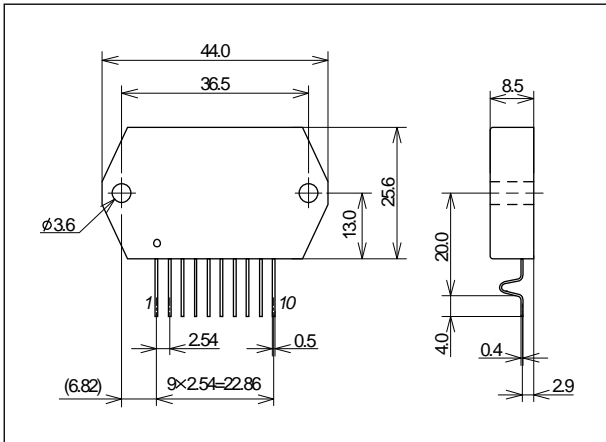
	STK404-070N-E	STK404-120N-E	STK404-140N-E
Output1 (10%/1kHz)	60W × 1ch	120W × 1ch	180W × 1ch
Output2 (1%/20Hz to 20kHz)	40W × 1ch	80W × 1ch	120W × 1ch
Maximum rating V_{CC} max (no sig.)	±46V	±65V	±78V
Maximum rating V_{CC} (6Ω)	±39V	±59V	±73V
Recommended operating V_{CC} (6Ω)	±30V	±41V	±51V
Package size	44.0mm×25.6mm×8.5mm	46.6mm×25.5mm×8.5mm	59.2mm×25.5mm×8.5mm

Package Dimensions

RoHS DIRECTIVE PASS

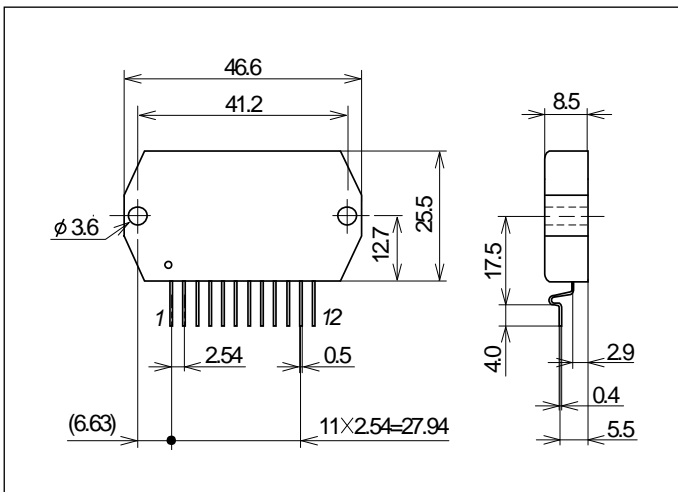
STK404-070N-E

unit : mm (typ)



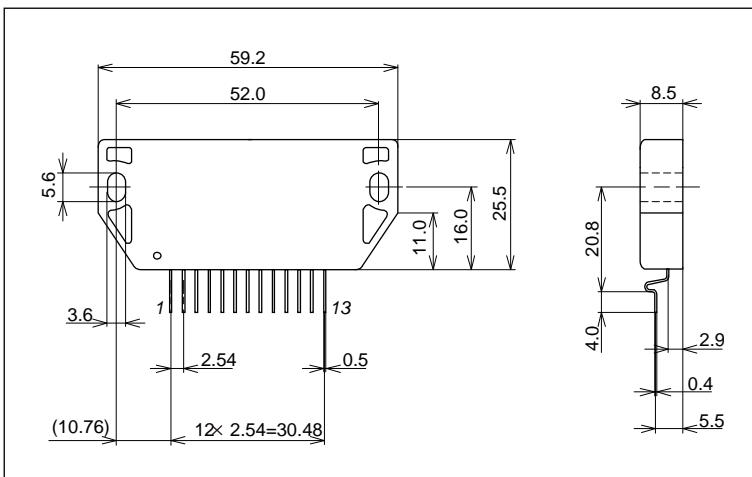
STK404-120N-E

unit : mm (typ)



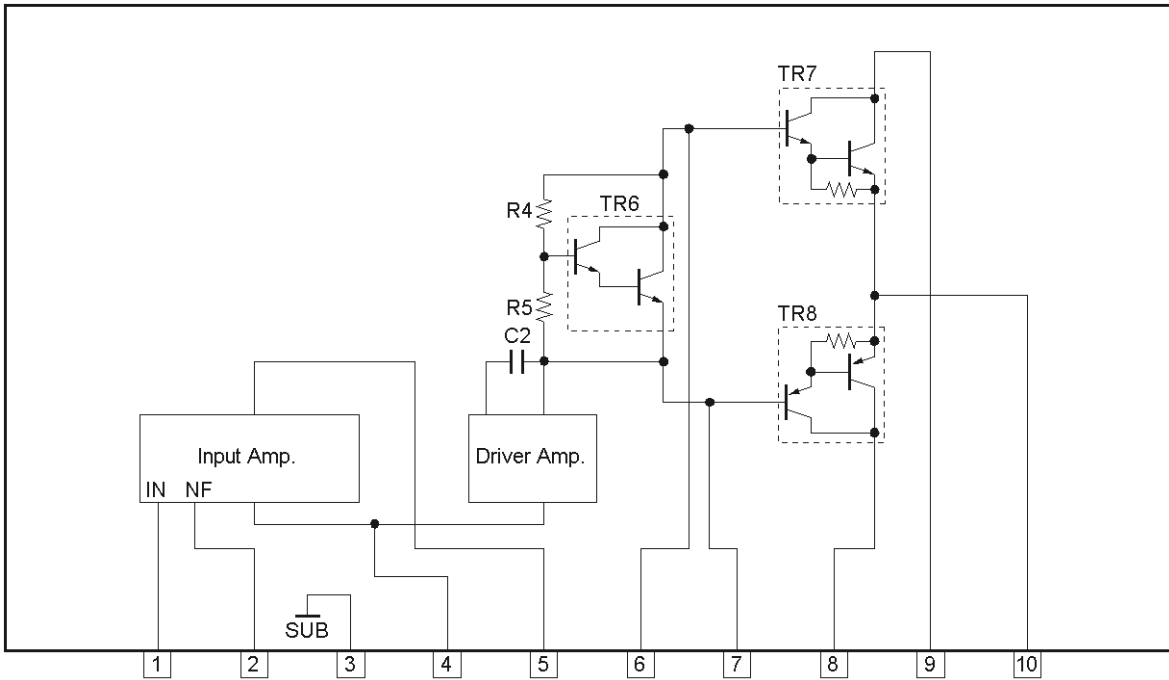
STK404-140N-E

unit : mm (typ)

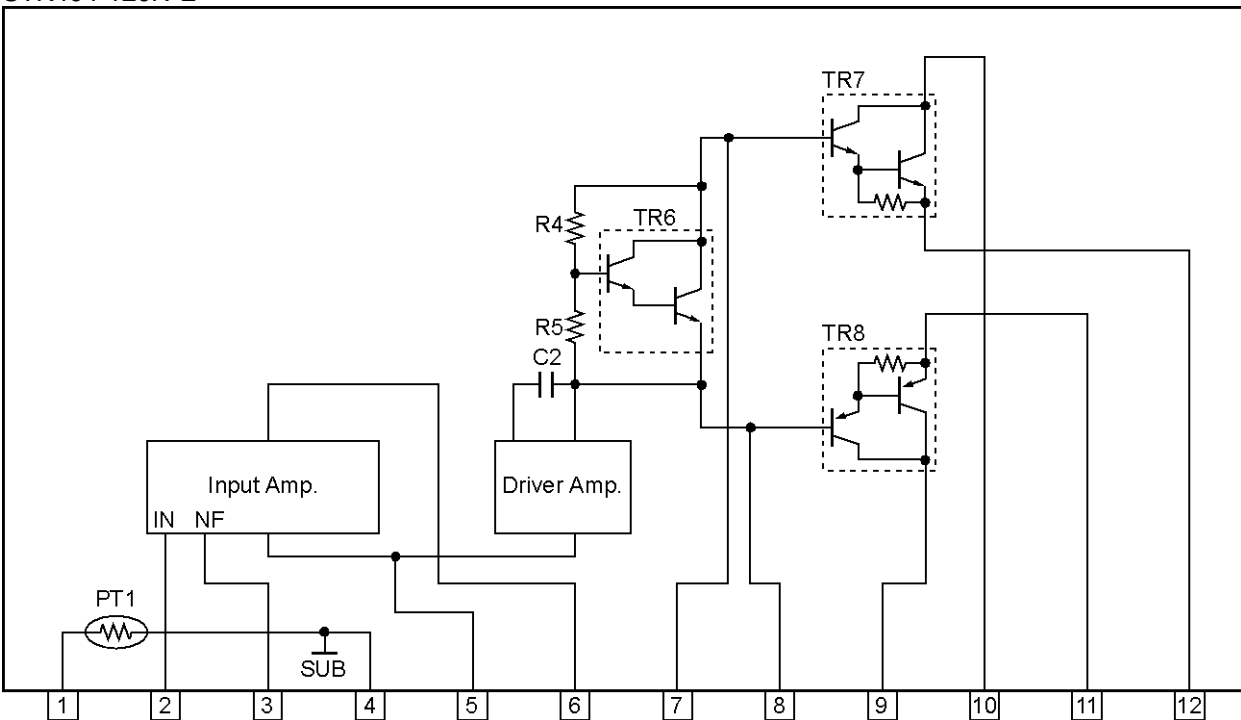


Equivalent Circuit

STK404-070N-E

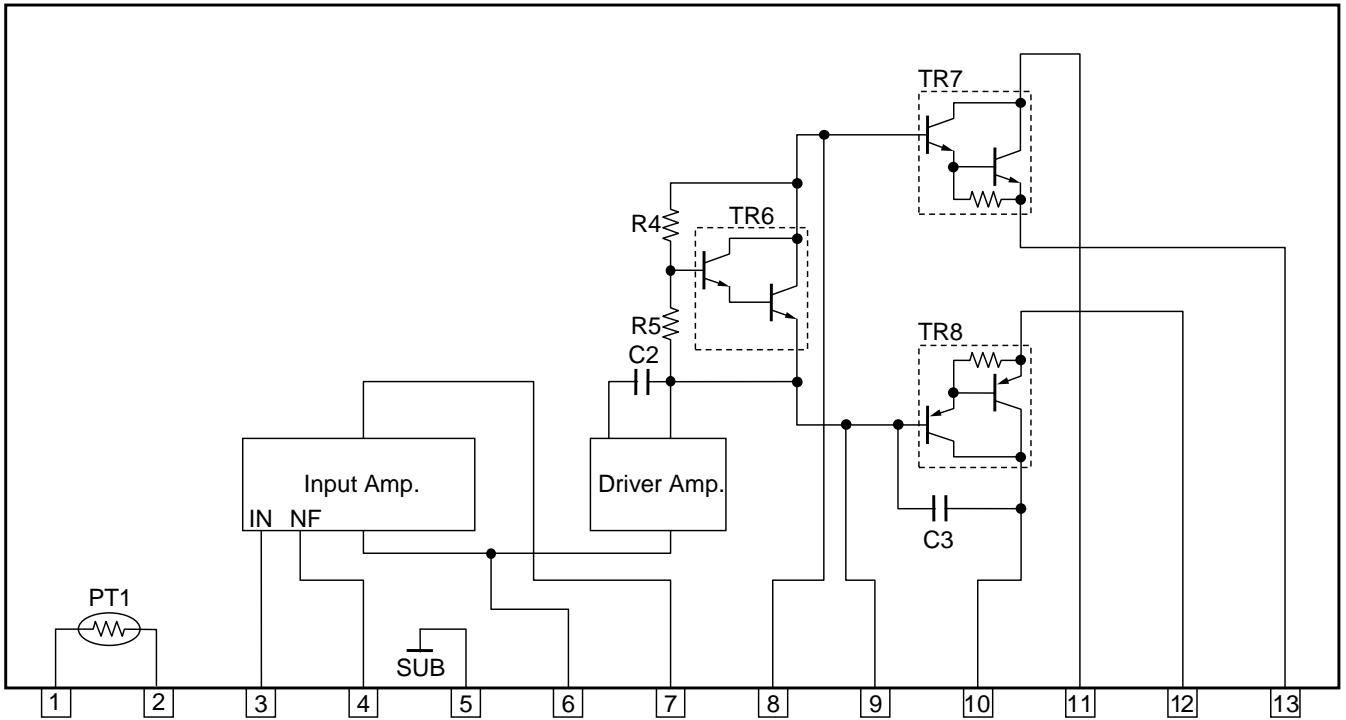


STK404-120N-E



Equivalent Circuit

STK404-140N-E



STK404-000N-E series

STK404-070N-E

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
Power supply voltage 1	$V_{CC\ max1}$	Non-signal	± 46	V
Power supply voltage 2	$V_{CC\ max2}$	Signal, $R_L = 6\Omega$	± 39	V
Thermal resistance	θ_{j-c}	Per one power transistor	3.0	$^\circ\text{C}/\text{W}$
Junction temperature	$T_j\ max$		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 *3	t_s	$V_{CC} = \pm 28\text{V}$, $R_L = 6\Omega$, $f = 50\text{Hz}$ $P_O = 40\text{W}$	0.3	s

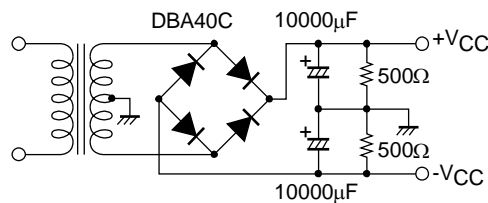
Operating Characteristics at $T_c = 25^\circ\text{C}$, $R_L = 6\Omega$ (Non-inductive load), $R_g = 600\Omega$, $V_G = 30\text{dB}$

Parameter	Symbol	Conditions					Ratings			Unit
		V_{CC} [V]	f [Hz]	P_O [W]	THD [%]		min	typ	max	
Output power	$P_{O\ 1}$	± 30	20 to 20k		0.4		40			W
	$P_{O\ 2}$	± 30	1k		10			60		
Frequency characteristics	f_L, f_H	± 30		1.0		+0 -3dB	20 to 20k			Hz
Input impedance	r_i	± 30	1k	1.0				55		$k\Omega$
Output noise voltage *2	V_{NO}	± 36				$R_g = 10k\Omega$		1.2		mVrms
Output neutral voltage	V_N	± 36					-100	0	+100	mV
Quiescent current	I_{CCO}	± 36				No load	4		14	mA

[Note]

- *1. All tests are measured using a constant-voltage supply unless otherwise specified.
- *2. 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.
- *3. Allowable time for load short-circuit and output noise voltage are measured using the specified transformer power supply. About the load short circuit, it is designed assuming protecting by cut-off within 0.3 second.
- *4. Weight of 1 HIC : (Typ) 10.4g Outer carton dimensions (W×L×H) : 420mm×233mm×277mm

Specified transformer power supply
(Equivalent to MG-200)



STK404-000N-E series

STK404-120N-E

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
Power supply voltage 1	$V_{CC\ max1}$	Non- signal	± 65	V
Power supply voltage 2	$V_{CC\ max2}$	Signal, $R_L = 6\Omega$	± 59	V
Thermal detector maximum voltage	V_p	1-4pin	16	V
Thermal detector maximum current	I_p	1-4pin	30	mA
Thermal resistance	θ_{j-c}	Per one power transistor	1.7	$^\circ\text{C}/\text{W}$
Junction temperature	$T_j\ max$		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	$V_{CC} = \pm 41\text{V}$, $R_L = 6\Omega$, $f = 50\text{Hz}$ $P_O = 80\text{W}$	0.3	s

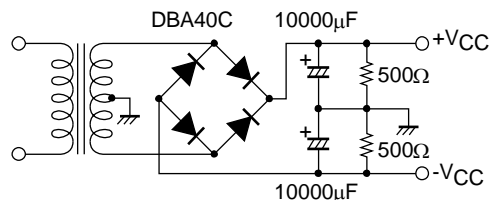
Operating Characteristics at $T_c = 25^\circ\text{C}$, $R_L = 6\Omega$ (Non-inductive load), $R_g = 600\Omega$, $V_G = 30\text{dB}$

Parameter	Symbol	Conditions					Ratings			Unit	
		V_{CC} [V]	f [Hz]	P_O [W]	THD [%]		min	typ	max		
Output power	$P_{O\ 1}$	± 41	20 to 20k		1.0		80			W	
	$P_{O\ 2}$	± 41	1k		10			120			
Frequency characteristics	f_L, f_H	± 41		1.0		+0 -3dB	20 to 20k			Hz	
Input impedance	r_i	± 41	1k	1.0				55		k Ω	
Output noise voltage *3	V_{NO}	± 49				$R_g=10\text{k}\Omega$		1.2		mVrms	
Output neutral voltage	V_N	± 49					-100	0	+100	mV	
Quiescent current	I_{CCO}	± 49				No load			60	mA	
Thermal detector resistance *2	R_p	$T_p=25^\circ\text{C}$, 1-4pin							470		Ω
Thermal detector operate temperature *2	T_p	$R_p=4.7\text{k}\Omega$, 1-4pin							135		$^\circ\text{C}$

[Note]

- *1. All tests are measured using a constant-voltage supply unless otherwise specified.
- *2. Thermal Detector temperature ($+135^\circ\text{C} \pm 5^\circ\text{C}$) indicates the value at unusual operation, therefore, does not indicate the guaranteed value at usual operation.
Thermal Detector is PRF18series (AS characteristic) manufactured by MURATA.
- *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. About the load short circuit, it is designed assuming protecting by cut-off within 0.3 second.
- *5. Weight of 1 HIC : 12.6g Outer carton dimensions (W×L×H) : 420mm×233mm×277mm

(Equivalent to MG-250)



STK404-000N-E series

STK404-140N-E

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
Power supply voltage 1	$V_{CC\ max1}$	Non- signal	± 78	V
Power supply voltage 2	$V_{CC\ max2}$	Signal, $R_L = 6\Omega$	± 73	V
Thermal detector maximum voltage	V_p	1-2pin	16	V
Thermal detector maximum current	I_p	1-2pin	30	mA
Thermal resistance	θ_{j-c}	Per one power transistor	1.1	$^\circ\text{C}/\text{W}$
Junction temperature	$T_j\ max$		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	$V_{CC} = \pm 51\text{V}$, $R_L = 6\Omega$, $f = 50\text{Hz}$ $P_O = 120\text{W}$	0.3	s

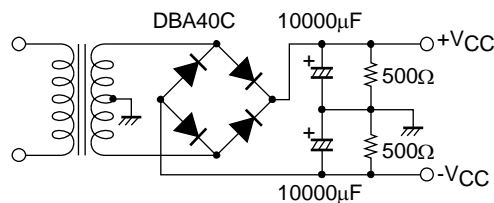
Operating Characteristics at $T_c = 25^\circ\text{C}$, $R_L = 6\Omega$ (Non-inductive load), $R_g = 600\Omega$, $V_G = 30\text{dB}$

Parameter	Symbol	Conditions				Ratings			Unit
		V_{CC} [V]	f [Hz]	P_O [W]	THD [%]	min	typ	max	
Output power	$P_{O\ 1}$	± 51	20 to 20k		1.0	120			W
	$P_{O\ 2}$	± 51	1k		10		180		
Frequency characteristics	f_L, f_H	± 51		1.0			+0 -3dB	20 to 20k	Hz
Input impedance	r_i	± 51	1k	1.0				55	k Ω
Output noise voltage *3	V_{NO}	± 62					$R_g=10\text{k}\Omega$	1.2	mVrms
Output neutral voltage	V_N	± 62						-100 0 +100	mV
Quiescent current	I_{CCO}	± 62					No load	60	mA
Thermal detector resistance *2	R_p	$T_p=25^\circ\text{C}$, 1-2pin						470	Ω
Thermal detector operate temperature *2	T_p	$R_p=4.7\text{k}\Omega$, 1-2pin						145	$^\circ\text{C}$

[Note]

- *1. All tests are measured using a constant-voltage supply unless otherwise specified.
- *2. Thermal Detector temperature ($+145^\circ\text{C}\pm 5^\circ\text{C}$) indicates the value at unusual operation, therefore, does not indicate the guaranteed value at usual operation.
Thermal Detector is PRF18series (AS characteristic) manufactured by MURATA.
- *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. About the load short circuit, it is designed assuming protecting by cut-off within 0.3 second.
- *5. Weight of 1 HIC : 17.2g Outer carton dimensions (W×L×H) : 502mm×247mm×282mm

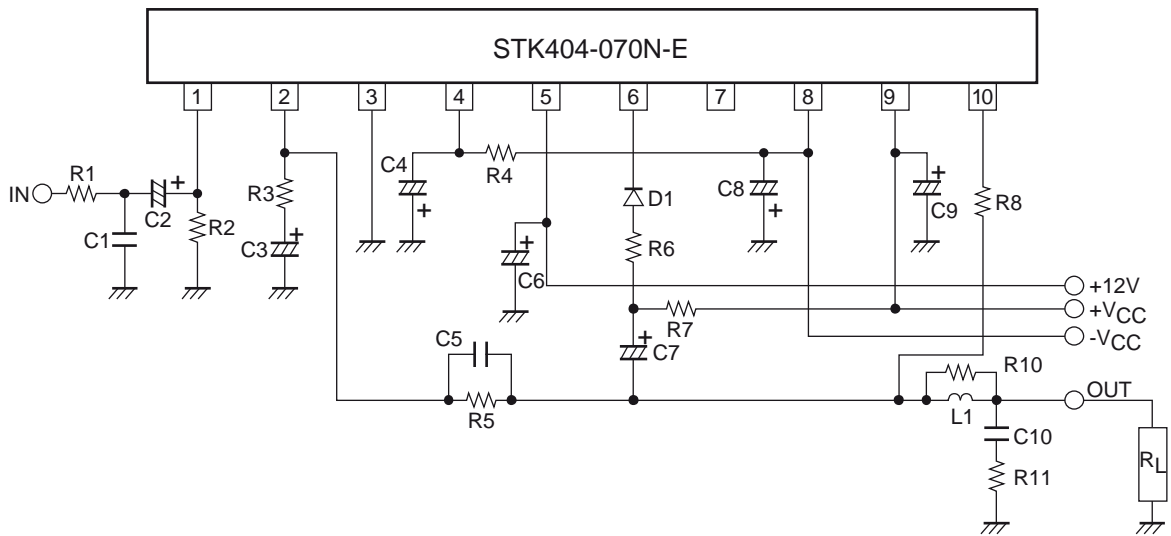
(Equivalent to MG-250)



STK404-000N-E series

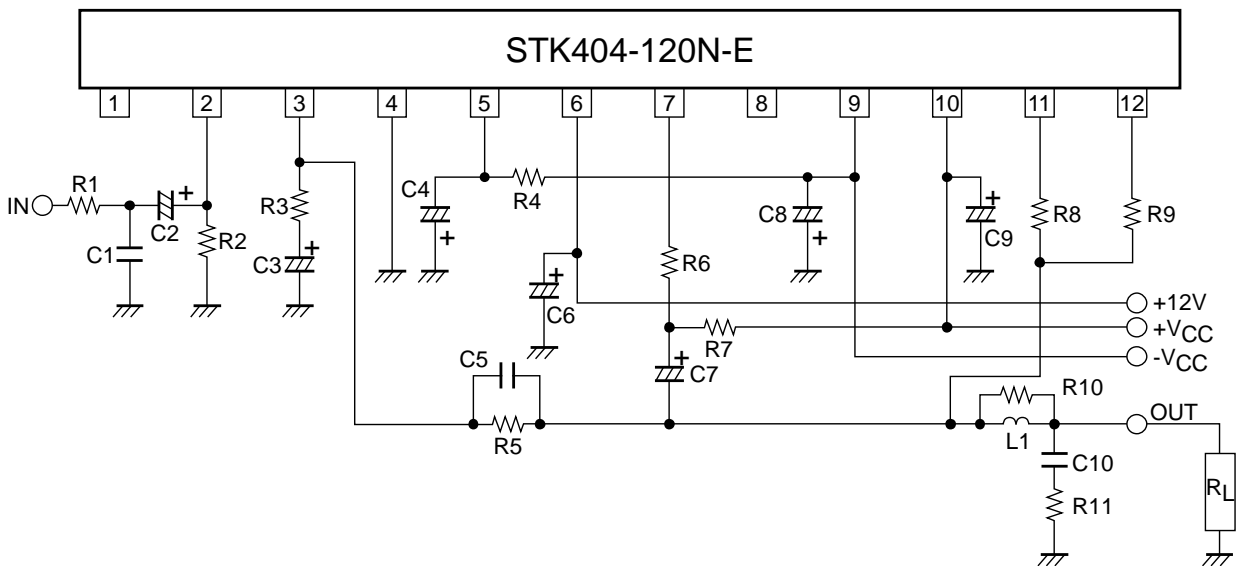
Test Circuit

STK404-070N-E



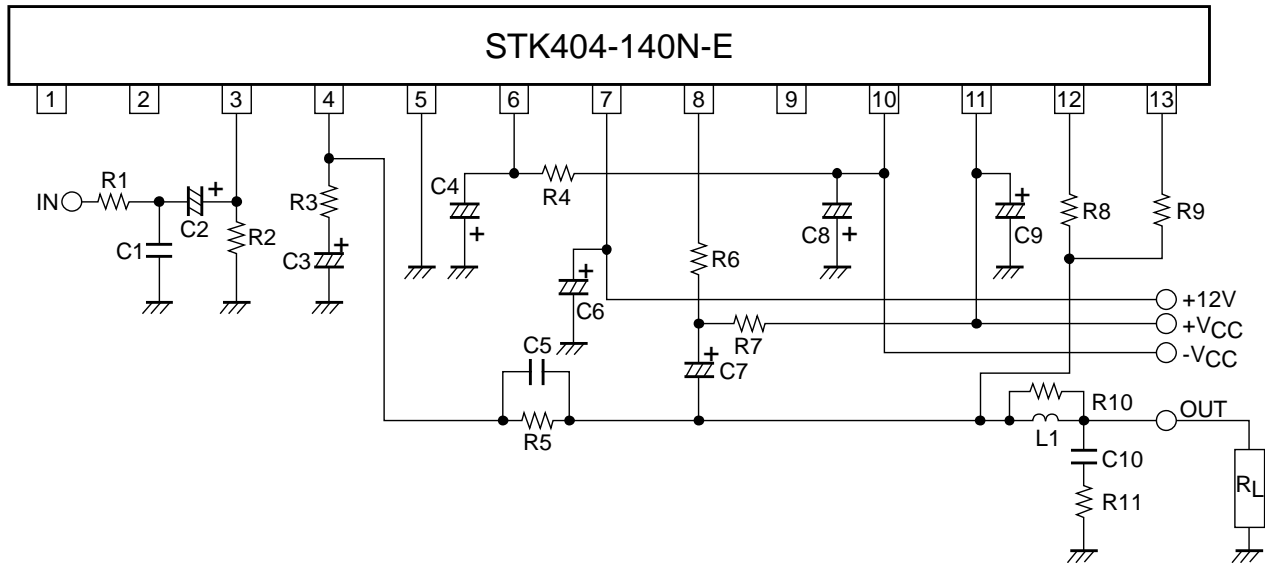
Test Circuit

STK404-120N-E



STK404-000N-E series

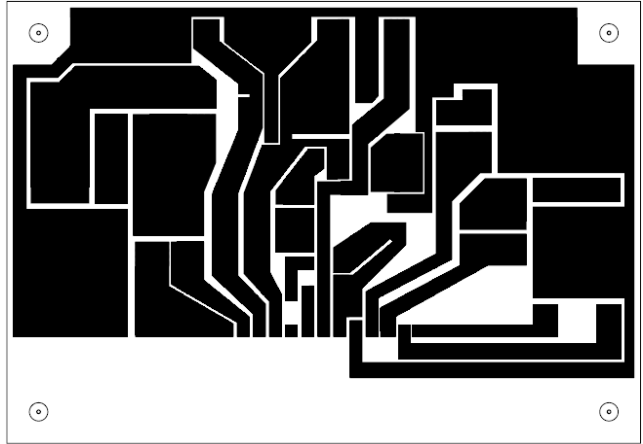
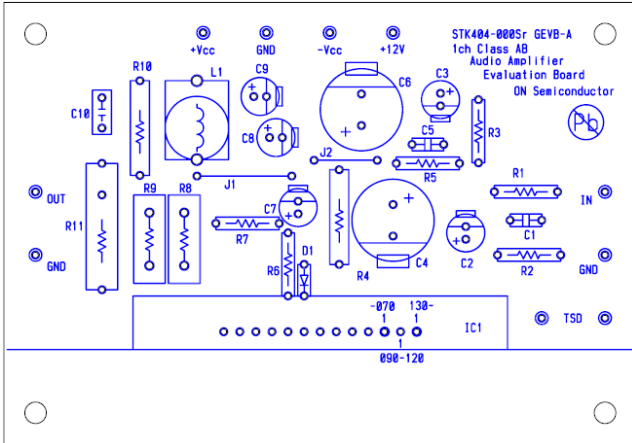
Test Circuit STK404-140N-E



STK404-000N-E series

PCB Layout Example

Top view



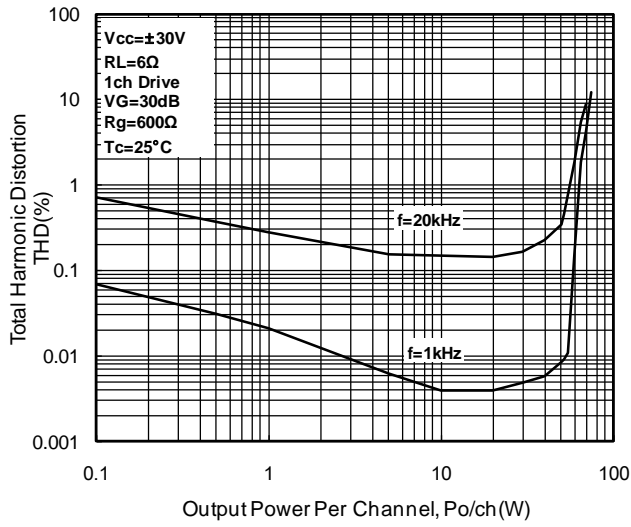
PCB parts list

Type (IC1)	STK404-070N-E	STK404-120N-E	STK404-140N-E
Position of (1)pin	Third from the right end	Second from the right end	The right end
Location			
R1	1kΩ	←	←
R2	56kΩ	←	←
R3	1.8kΩ	←	←
R4	100Ω/1W	←	←
R5	56kΩ	←	←
R6	10kΩ/1W	4.7kΩ/1W	5.1kΩ/1W
R7	10kΩ/1W	4.7kΩ/1W	5.1kΩ/1W
R8	0.22Ω/5W	←	←
R9	-	0.22Ω/5W	←
R10	4.7Ω/1W	←	←
R11	4.7Ω/1W	←	←
C1	470pF	←	←
C2	2.2μF/50V	←	←
C3	10μF/50V	←	←
C4	100μF/100V	←	←
C5	5pF	←	←
C6	100μF/50V	←	←
C7	47μF/100V	←	←
C8	10μF/100V	←	←
C9	10μF/100V	←	←
C10	0.1μF	←	←
D1	200V/0.5A	Short	Short
L1	2.2μH	←	←
J1	15mm	←	←
J2	10mm	←	←

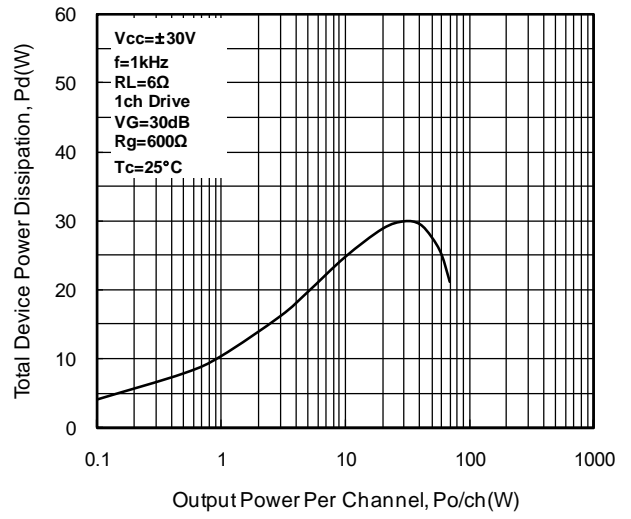
Characteristic of Evaluation Board

STK404-070N-E

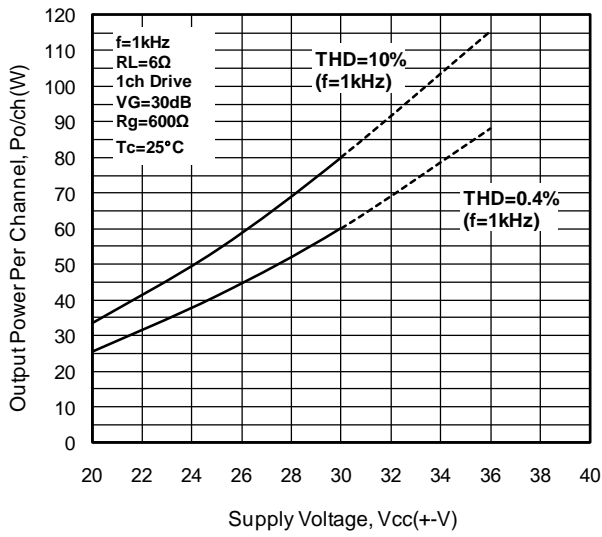
THD-Po
STK404-070N-E



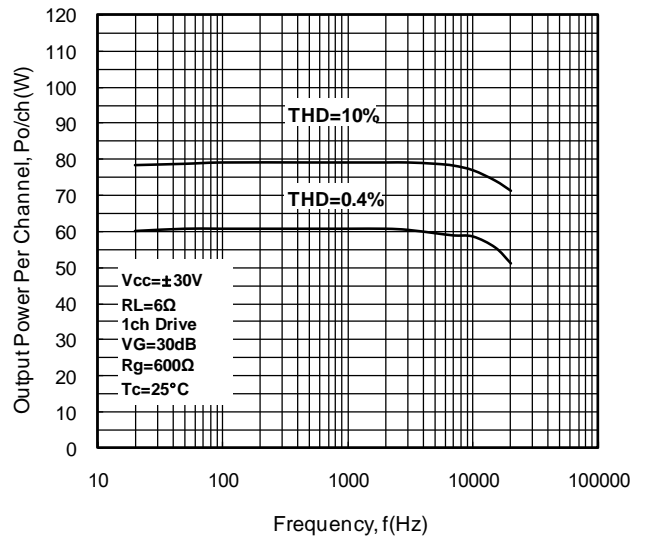
Pd-Po
STK404-070N-E



Po-Vcc
STK404-070N-E



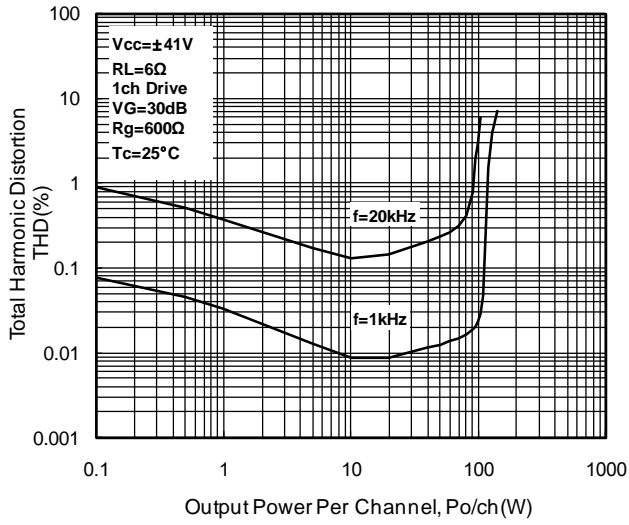
Po-f
STK404-070N-E



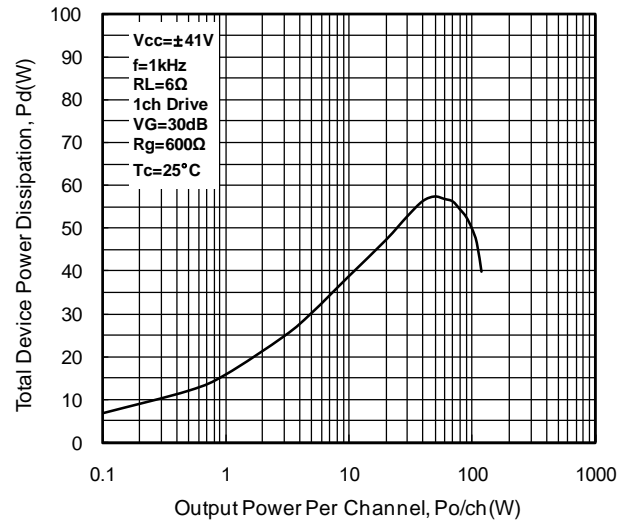
Characteristic of Evaluation Board

STK404-120N-E

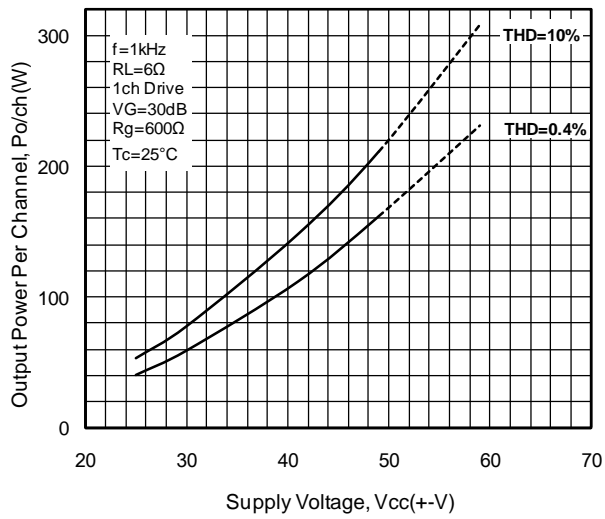
THD-Po
STK404-120N-E



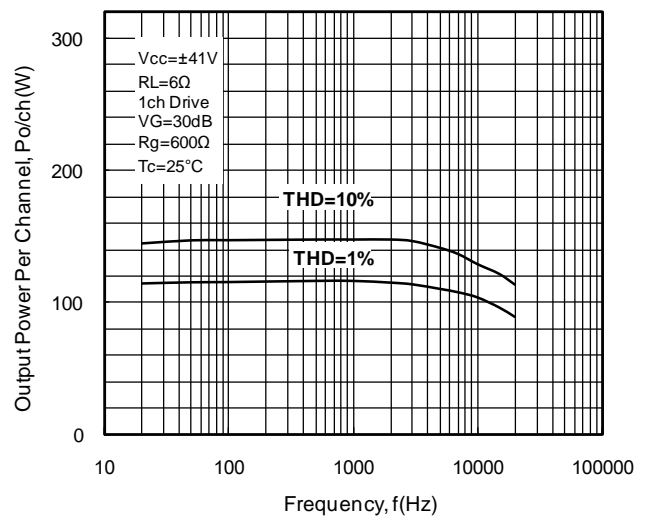
Pd-Po
STK404-120N-E



Po-Vcc
STK404-120N-E



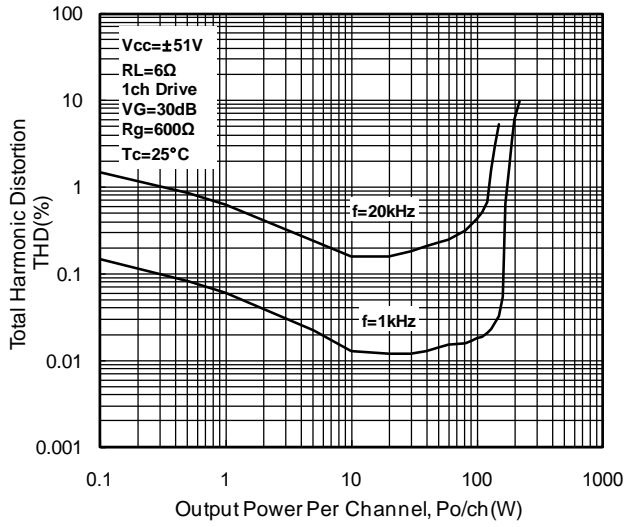
Po-f
STK404-120N-E



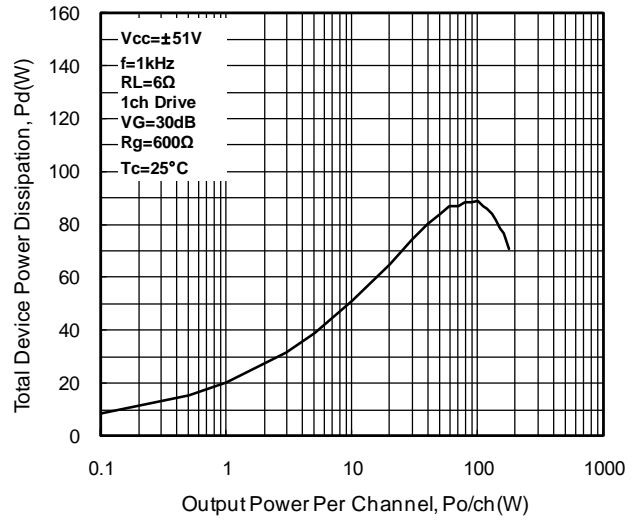
Characteristic of Evaluation Board

STK404-140N-E

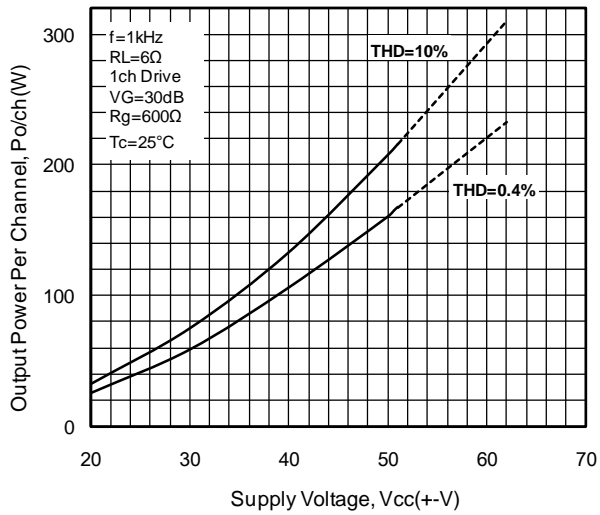
THD-Po
STK404-140N-E



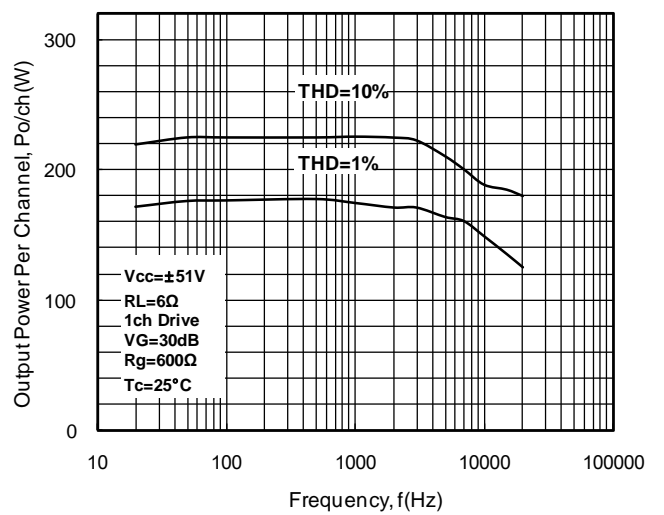
Pd-Po
STK404-140N-E



Po-Vcc
STK404-140N-E



Po-f
STK404-140N-E



A Thermal Design Tip For STK404-070N-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 max. (Note that the value of 1/8 P_O max may be varied from the country to country.)

(Sample of STK404-070N-E ; 40W×1ch)

If V_{CC} is $\pm 30V$, and R_L is 6Ω , then the total power dissipation (P_d) of inside Hybrid IC is as follow;

$$P_d = 19.6W \text{ (at } 5W \text{ output power, } 1/8 \text{ of } P_O \text{ max)}$$

There are two (2) transistors in Audio Section of this Hybrid IC, and thermal resistance (θ_{j-c}) of each transistor is 3.0°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;

$$\begin{aligned} \text{From (1)'} \quad \theta_{c-a} &< (125 - 50)/19.6 \\ &< 3.83 \end{aligned}$$

$$\begin{aligned} \text{From (2)'} \quad \theta_{c-a} &< (150 - 50)/19.6 - 3.0/2 \\ &< 3.60 \end{aligned}$$

Therefore, in order to satisfy both (1)' and (2)', the thermal resistance of a desired Heat-sink will be 3.60°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.

A Thermal Design Tip For STK404-120N-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 max. (Note that the value of 1/8 P_O max may be varied from the country to country.)

(Sample of STK404-120N-E ; 80W×1ch)

If V_{CC} is $\pm 41V$, and R_L is 6Ω , then the total power dissipation (P_d) of inside Hybrid IC is as follow;

$$P_d = 37.5W \text{ (at 10W output power, 1/8 of } P_O \text{ max)}$$

There are four (2) transistors in Audio Section of this Hybrid IC, and thermal resistance (θ_{j-c}) of each transistor is 1.7°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;

$$\begin{aligned} \text{From (1)'} \quad \theta_{c-a} &< (125 - 50)/37.5 \\ &< 2.00 \end{aligned}$$

$$\begin{aligned} \text{From (2)'} \quad \theta_{c-a} &< (150 - 50)/37.5 - 1.7/2 \\ &< 1.82 \end{aligned}$$

Therefore, in order to satisfy both (1)' and (2)', the thermal resistance of a desired Heat-sink will be 1.82°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.

A Thermal Design Tip For STK404-140N-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 max. (Note that the value of 1/8 P_O max may be varied from the country to country.)

(Sample of STK404-140N-E ; 120W×1ch)

If V_{CC} is $\pm 51V$, and R_L is 6Ω , then the total power dissipation (P_d) of inside Hybrid IC is as follow;

$$P_d = 57.2W \text{ (at 15W output power, 1/8 of } P_O \text{ max)}$$

There are four (2) transistors in Audio Section of this Hybrid IC, and thermal resistance (θ_{j-c}) of each transistor is 1.1°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;

$$\begin{aligned} \text{From (1)'} \quad \theta_{c-a} &< (125 - 50)/57.2 \\ &< 1.31 \end{aligned}$$

$$\begin{aligned} \text{From (2)'} \quad \theta_{c-a} &< (150 - 50)/57.2 - 1.1/2 \\ &< 1.19 \end{aligned}$$

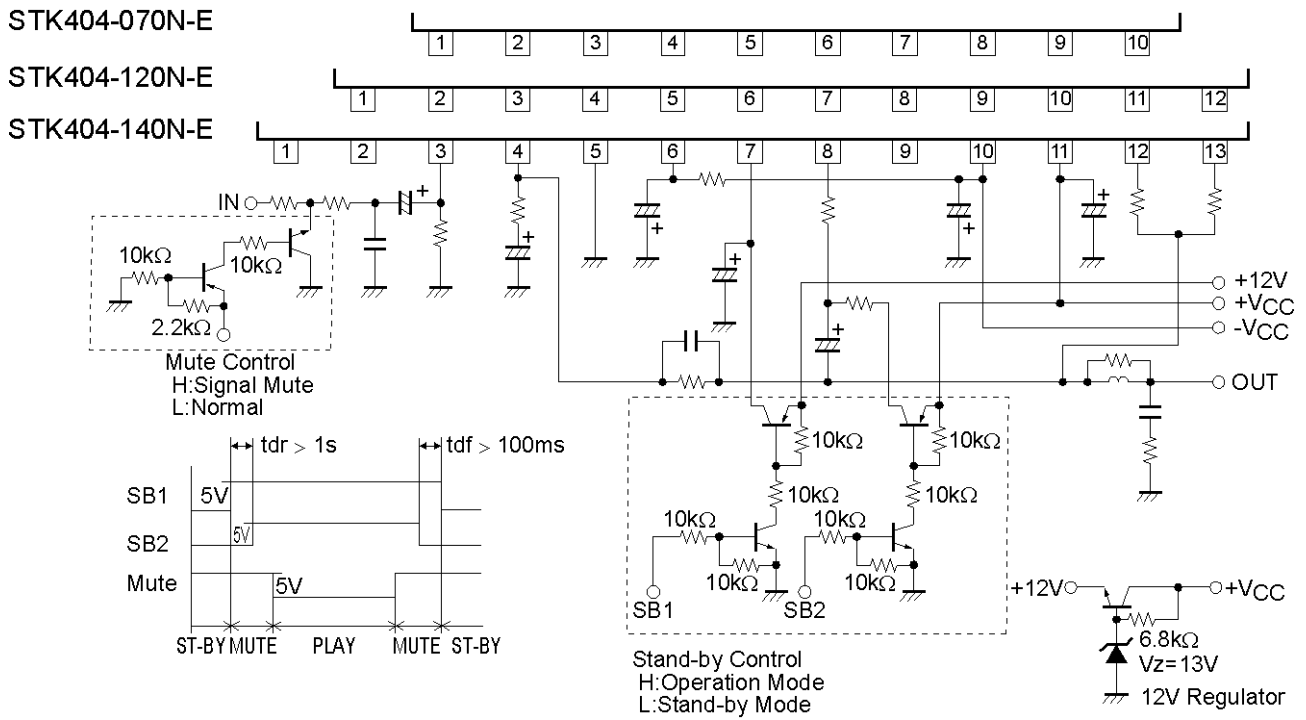
Therefore, in order to satisfy both (1)' and (2)', the thermal resistance of a desired Heat-sink will be 1.19°C/W.

[Note]

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

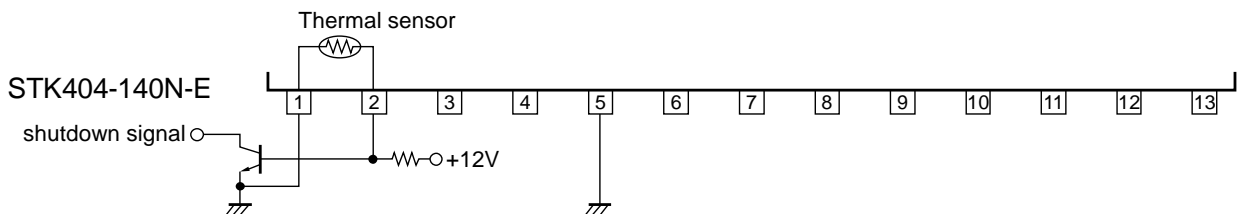
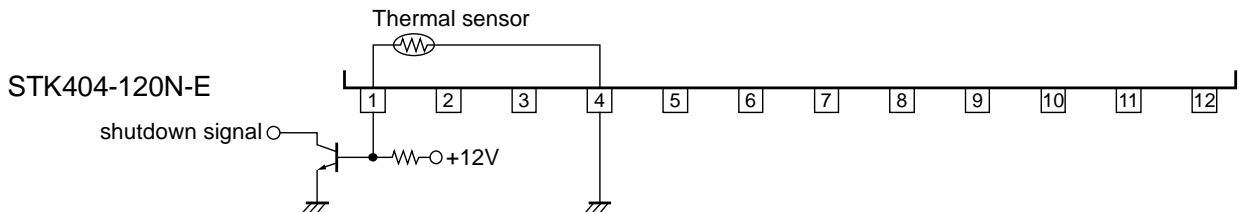
STK404-000N-E series

STK404-000N-Ese Stand-by control & Mute control Application



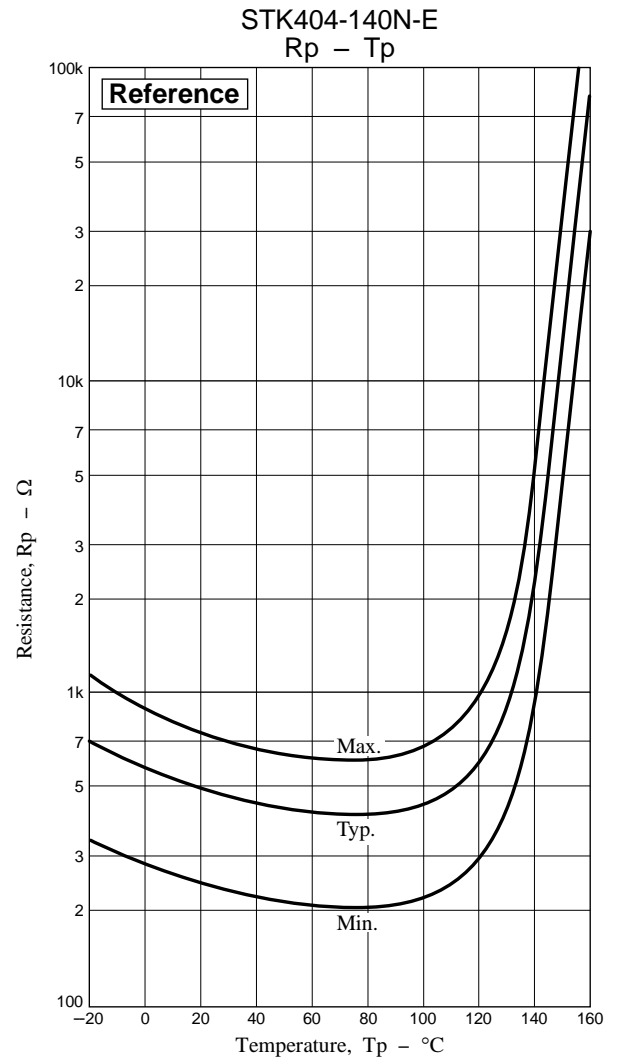
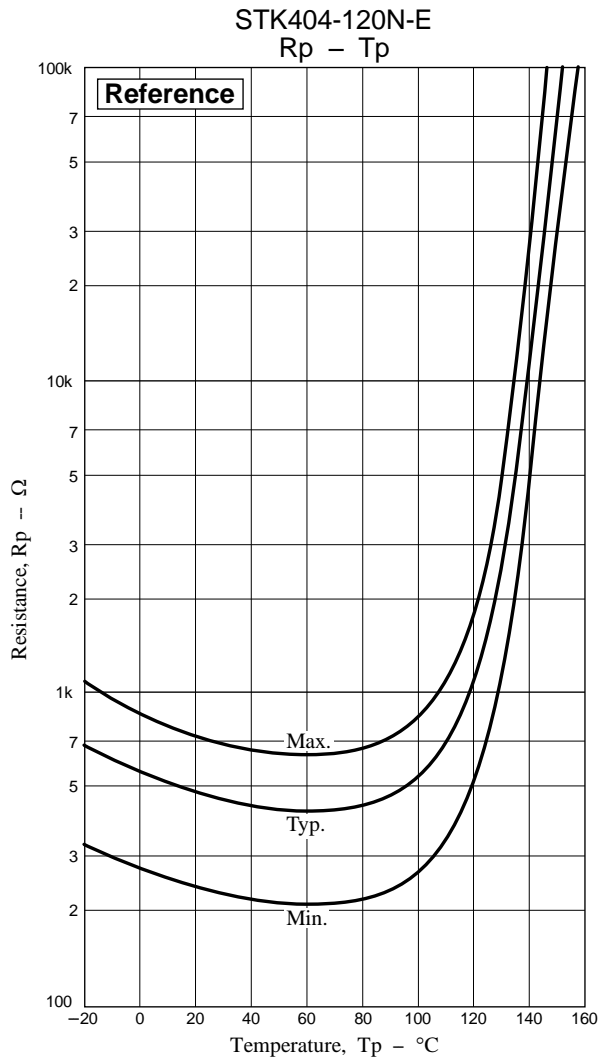
STK404-000N-Esr Thermal shut down Application

STK404-070N-E No thermal sensor



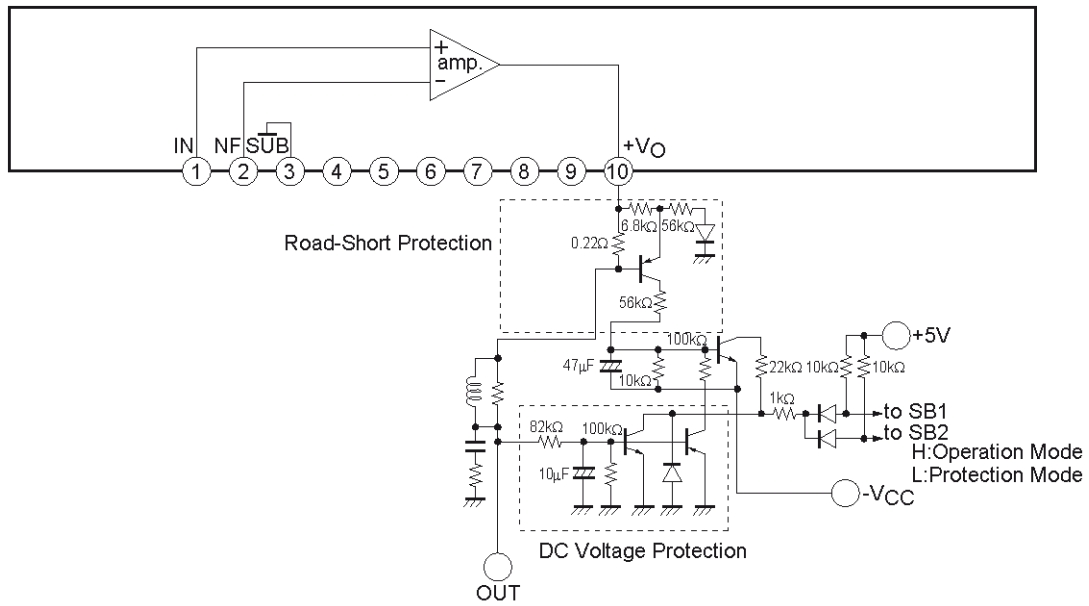
STK404-000N-E series

Thermal Sensor Characteristic

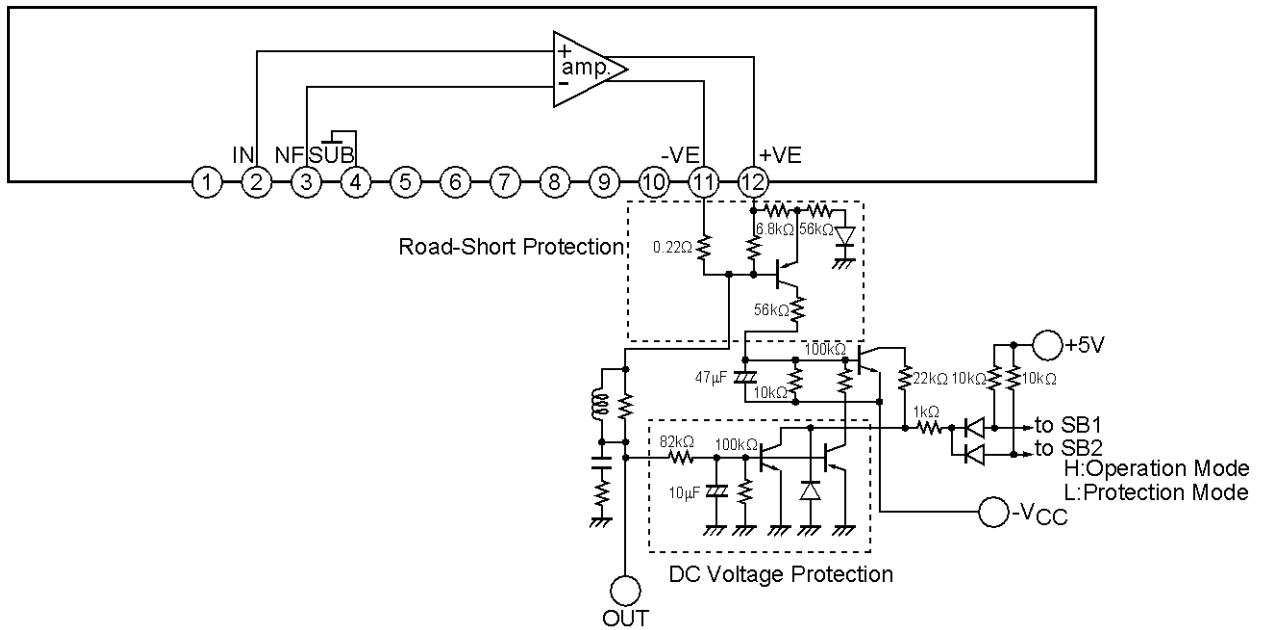


STK404-000N-E series

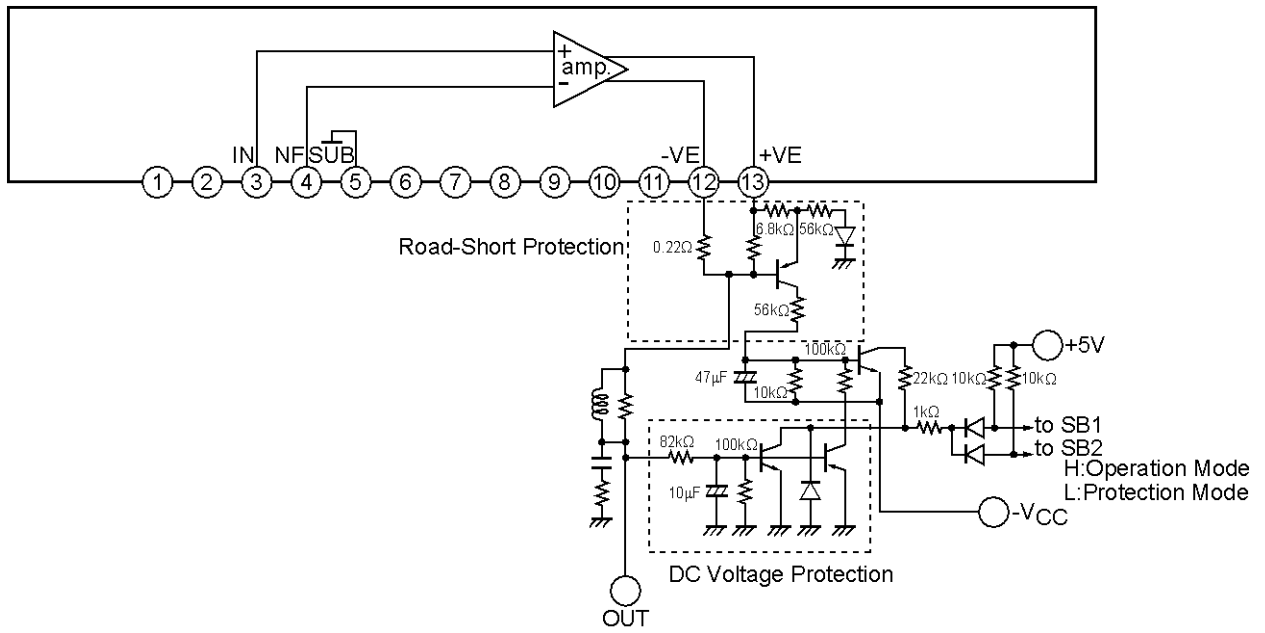
STK404-070N-E Road-Short & DC Voltage Protection Application



STK404-120N-E Road-Short & DC Voltage Protection Application



STK404-140N-E Road-Short & DC Voltage Protection Application



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