GPM8903

Non-Clip,Low EMI Audio Class D Amplifier

General Description

The GPM8903 is a Class D amplifiers provide high performance, thermally efficient amplifier solutions. The GPM8903 delivers 1*4.5W into a 2Ω load.

An integrated limiting circuit prevents output clipping distortion, that makes GPM8903 has excellent sound reproduction and protects small speakers from transient volt-ages, reduces power dissipation.

The GPM8903 has a 2:1 input MUX for audio source selection. The MUX was selected by an external pin. Both input channels have a 32-step Up/Down volume control.

Filter-less modulation allows the IC to pass EMI limits with 1m cables using only a low-cost ferritebead and small-value capacitor on each output.

Built-in fade in and fade out circuit to minimize click-and-pop noise coming into and out of shutdown.

The GPM8903 features over current protection, short circuit protection, over temperature protection and UVLO.

The GPM8903 is available in SOP16 package.

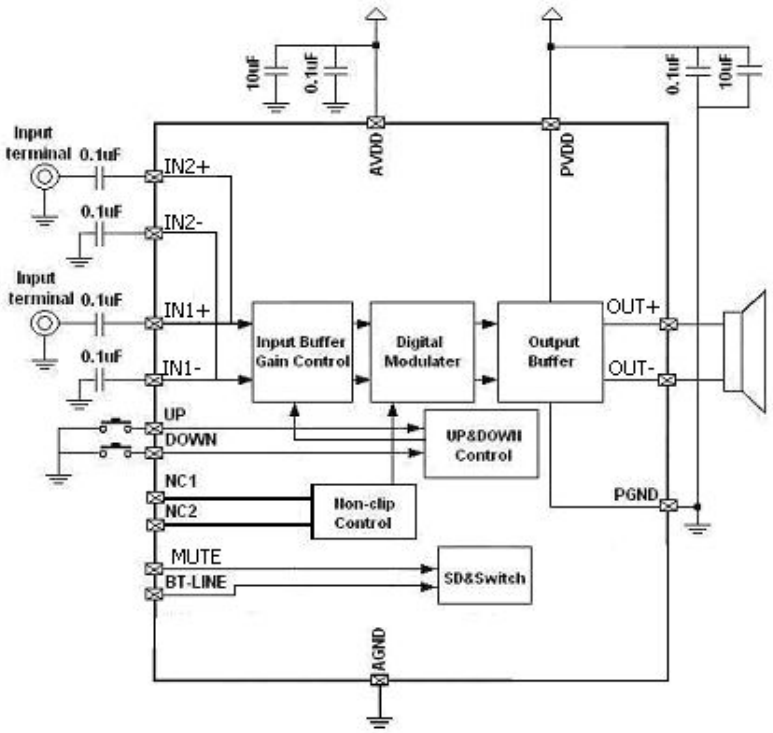
Features

- High Output Power:
  4.5W@V_{DD}=5.0V, R_L=2Ω, THD+N=10%
  3.0W@V_{DD}=5.0V, R_L=4Ω, THD+N=10%
  1.8W@V_{DD}=5.0V, R_L=8Ω, THD+N=10%
- 32-Step Up/Down Volume Control
- 2:1 input MUX for Audio Source Selection
- Low THD+N:
  0.07%@V_{DD}=5.0V, R_L=4Ω, Po=1.5W
- Fade-in and Fade-out Function
- Minimized Click-and-Pop Noise
- Thermal Shutdowns
- Under-Voltage-Lockout
- Over-Current Protection
- SOP-16 Pb Free Package

Applications

- Portable Speakers
- Blue Tooth Speakers
- FM System
- Audio System

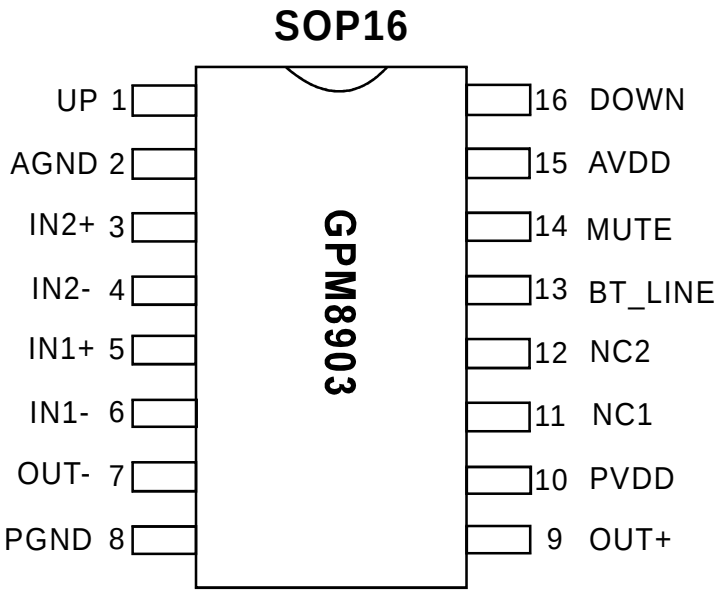
Typical Application



Ordering Inforamtion

Part Number	Temp Range	Package	Pins	Marking
GPM8903	-40℃ to 85℃	SOP	16	GPM8903

Pin Configuration



Pin Descriptions

Pin	Name	I/O	Description
1	UP		Volume Up, Internal Pull-up
2	AGND	GND	Analog GND
3	IN2+		Audio Source 2 Positive Input
4	IN2-		Audio Source 2 Negative Input
5	IN1-		Audio Source 1 Negative Input
6	IN1+		Audio Source 1 Positive Input
7	OUT-		Negative Output
8	PGND	GND	Power GND
9	OUT+		Positive Output
10	PVDD	Power	Power Supply Input
11	NC1		Non-clip Timing Setting 1
12	NC2		Non-clip Timing Setting 2
13	BT_LINE		Audio Source Selection, Internal Pull-up
14	MUTE		Mute Control Input, Internal Pull-up
15	AVDD	Power	Analog Power Bias
16	DOWN		Volume down, Internal Pull-up

Absolute Maximum Ratings

Parameters	Symbol	Min.	Max.	Unit
PVDD	PVDD	−0.3	6.5	V
AVDD	AVDD	−0.3	6.5	V
IN1+, IN-, IN2+ and IN2-	IN	VSS−0.6	VDD+0.6	V
Up, Down, NC1, NC2 and MUTE		VSS−0.3	VDD+0.3	V
Junction Temperature Range	TJMAX		125	℃
Storage Temperature Range	TSTG	−50	125	℃

Recommend Operation Ratings

Parameters	Symbol	Min.	Typ.	Max.	Unit
PVDD	VDDP	2.7	3.6	5.5	V
AVDD	VDDA	2.7	3.6	5.5	V
Operation Temperature	Ta	-40	25	85	℃

DC Electrical Characteristic

T_A=25°C ,V_{DD}=2.7V to 5.5V,unless otherwise specified.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
AVDD UVLO	VUVLH			2.2		V
AVDD UVLO Hysterisis	VUVLL			0.2		V
BTLINE,MUTE,UP,DOWN Input High	VIH		1.9			V
BTLINE,MUTE,UP,DN input Low	VIL				0.35	V
Quiescent Current	IAVDD	VDDA =5V,No Load		6.0		mA
Mute Current	IPD	MUTE=VDD		0.1		μA
Start Up Time	Ton			32		mS
Frequency	fosc			250		KHz

AC Electrical Characteristic

At T_A=25°C ,V_{DD}=5.0V,,unless otherwise specified.

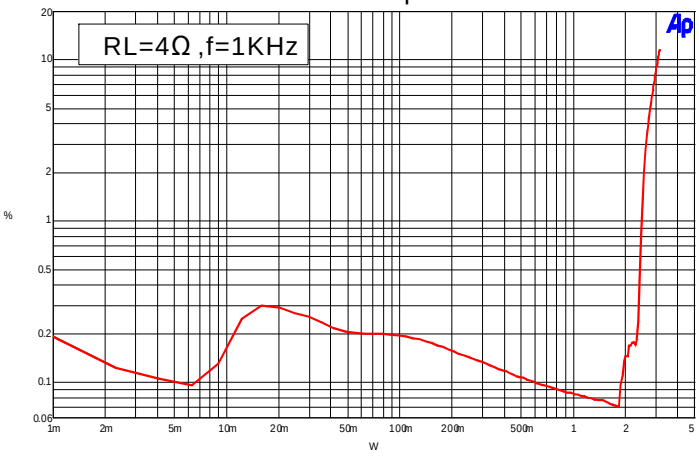
Parameter	Symbol	Test Conditions		Min.	Typ.	Max.	UNIT
Output Power	Po	RL=2Ω	THD+N=10%		4.5		W
		RL=4Ω			3.0		W
		RL=8Ω			1.8		W
Volume Control	Av			-34	10*2	24	dB
Total Harmonic Distortion	THD+N	RL=8Ω, P o=0.5W	f=1kHz		0.08		%
		RL=4Ω, P o=1.0W	f=1kHz		0.09		%
Signal to Noise Ratio	SNR	Av=10dB			90		dB
Input Channel Separation	CS	f=1kHz, Av=10dB			80		dB
Power Supply Ripple Rejection	PSRR	f=1kHz,200mVp-p			-67		dB
Efficiency	η	RL=4Ω, P o=1.0W			85		%
		RL=8Ω, P o=0.5W			90		%
Offset Voltage	V_{OS}				±5		mV
Frequency Response	f_{RES}	C_{IN} =1μF, Av=18dB, f=100Hz to 20KHz		-0.4	-	0.4	dB
NCN Attenuation Range	AT				-10		dB

*: Default Gain at power on

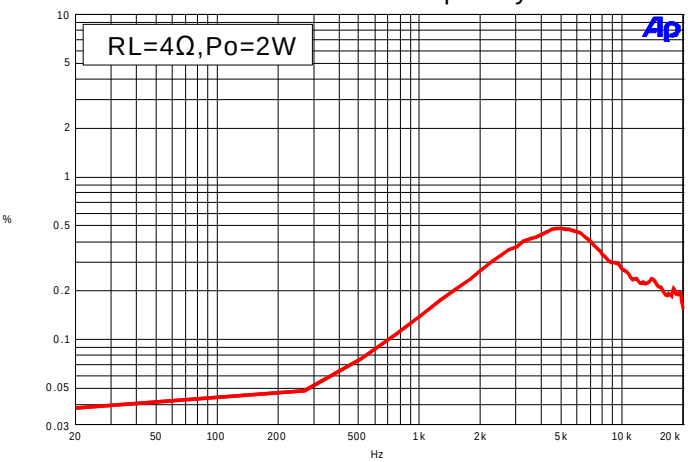
Typical Operating Characteristics

At T_A=25°C ,VDD=5V,V_{FREQ}=0V,unless otherwise specified.

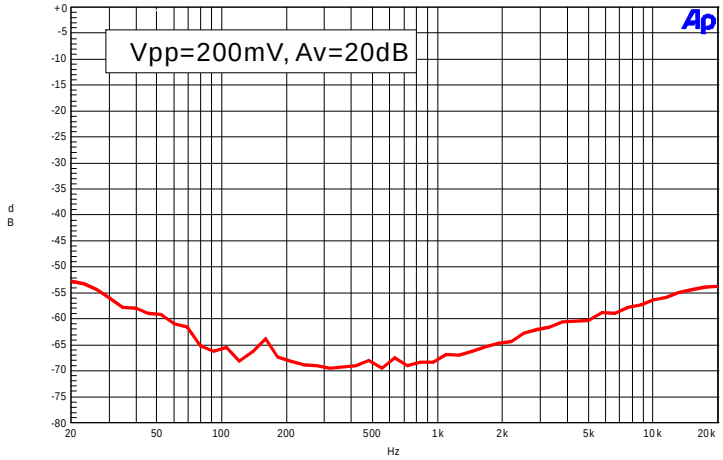
THD+N vs Output Power



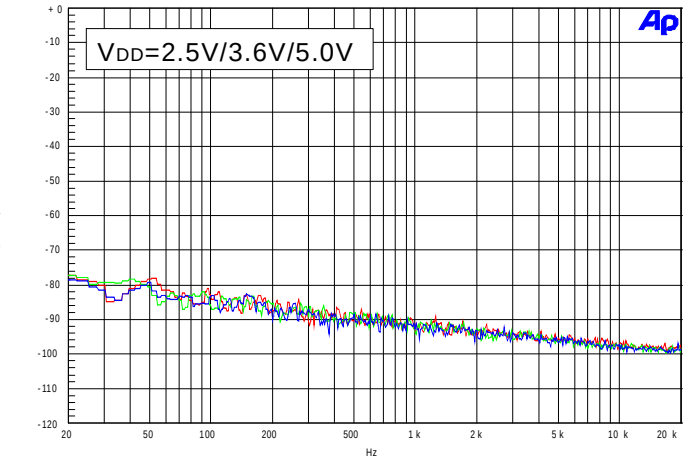
THD+N vs Frequency



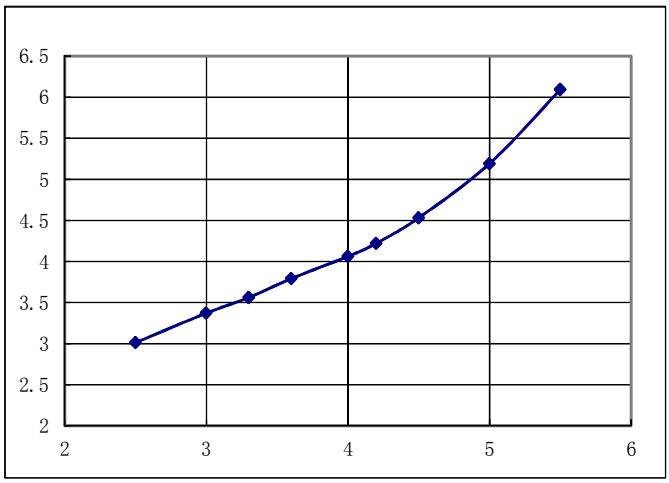
PSRR



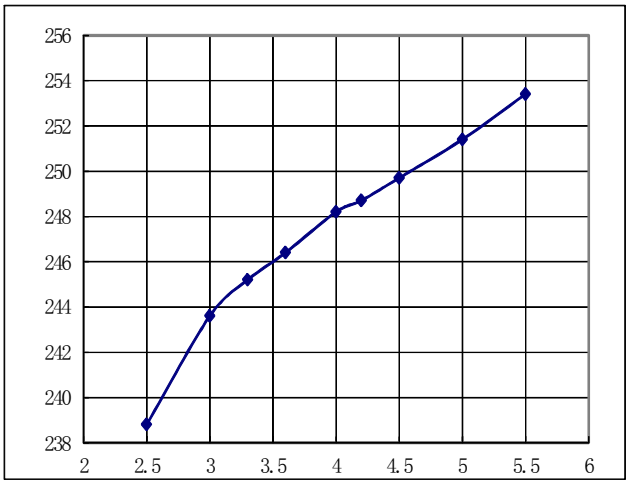
Noise Floor



Quiescent Current vs Supply Voltage



Frequency vs Supply Voltage



Application Information

Up/Down Volume Control

The GPM8903 features a Up/Down volume control which consists of the UP and Down pins. An internal clock is used where the clock frequency value is determined from the following formula:

$$f_{CLK} = f_{OSC} / 2^{13}$$

The oscillator frequency f_{OSC} value is 250kHz typical,with ±20% tolerance. The clock frequency is 30Hz (cycle time 32ms) typical.

Volume changes are then effected by toggling either the UP or DOWN pins with a logic low. After a period of 2 clocks pulses with either the UP or DOWN pins held low, the volume will change to the next specified step, either UP or DOWN, and followed by a short delay. This delay decreases the longer the line is held low, eventually reaching a delay of zero. The delay allows the user to pull the UP or DOWN terminal low once for one volume change, or hold down to ramp several volume changes. The delay is optimally configured for push button volume control.

If either the UP or DOWN pin remains low after the first volume transition the volume will change again, but this time after 8 clock pulses. The followed transition occurs at 2 clock pulses for each volume transition. This is intended to provide the user with a volume control that pauses briefly after initial application, and then slowly increases the rate of volume change as it is continuously applied. This cycle is shown in the timing diagram shown in figure 1.

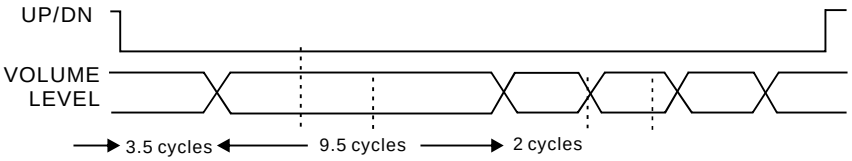


Fig-1

There are 32 discrete gain settings ranging from +24dB maximum to -85dB minimum. Upon device power on, the amplifier's gain is set to a default value of 10dB. However, when coming out of mute mode, the GPM8903 will revert back to its previous gain setting. Volume levels for each step vary and are specified in Gain Setting table 1 below.

Step	Av (dB)	Step	Av(dB)	Step	Av(dB)
1	-85	12	-16	23	6
2	-36	13	-14	24	8
3	-34	14	-12	25	10
4	-32	15	-10	26	12
5	-30	16	-8	27	14
6	-28	17	-6	28	16
7	-26	18	-4	29	18
8	-24	19	-2	30	20
9	-22	20	0	31	22
10	-20	21	2	32	24
11	-18	22	4		

Table 1: 32-Step Volume Control

If both the UP and DN pins are held high, no volume change will occur. Trigger points for the UP and DOWN pins are at 70% of V_{DD} minimum for a logic high, and 20% of V_{DD} maximum for a logic low. It is recommended, however, to toggle UP and DN between V_{DD} and GND for best performance.

Application Information

Non-Clip Function

This is the function to control the output in order to obtain a maximum output level without distortion when an excessive input which causes clipping at the differential signal output is applied. That is, with the Non-Clip function, GPM8903 lowers the Gain of the digital amplifier to an appropriate value so as not to cause the clipping at the differential signal output. GPM8903 follows also to the clip of the output wave form due to the decrease in the power-supply voltage. Table 2 shows the working mode of GPM8903.

MUTE	NC1, NC2	Mode
L	NC1,NC2 are Floating or High	Typical
L	NC1 or/and NC2 is/are Low	Non-Clip
H	-	Muting

Table 2: GPM8903 Working Mode

The attack time and the release time of Non-Clip control are fixation two levels, and selects with the CTRL terminal.The Attack time is a time interval until gain falls to target attenuation gain -3dB with a big signal input enough. The Release Time is a time from target attenuation gain to not working of Non-Clip.

NC1, NC2 Status	THD+N(%)	Attack/Release Time (mS)
NC1=L,NC2=L	10	0.5/4
NC1=L,NC2=H	5	1/16
NC1=H,NC2=L	1	2/32
NC1=H,NC2=H	Non-clip off	Non-clip off

Table 3: Non-clip Timing

Input MUX

The GPM8903 has a 2:1 input MUX for audio source selection. The MUX was selected by an external pin. Both input channels have a 32-step Up/Down volume control. The audio source is selected by an external pin, BT/LINE.

Mute Operation

The MUTE pin is an input for controlling the Class D output state of the GPM8903. A logic low on this pin enables the outputs, and a logic high on this pin disables the outputs. This pin may be used as a quick disable or enable of the outputs without a volume fade. Quiescent current is listed in the electrical characteristic table. The MUTE pin can be left floating due to the internal pull-down.

Fade-In and Fade-Out

The FADE controls the operation of the volume control circuitryduring transitions to and from the shutdown state and during power-up. During power-up or recovery from the shutdown state, the volume is smoothly ramped up from the mute state, -85dB, to the desired volume set by the voltage on the volume control terminal. Conversely, the volume is smoothly ramped down from the current state to the mute state when a logic high is applied to the MUTE terminal. During power-up or recovery from the MUTE state (a logic low is applied to the MUTE terminal), the transition from the mute state, -85dB, to the desired volume setting is less than 1ms. Conversely, the volume ramps down from current state to the mute state within 1ms when a logic high is applied to the MUTE terminal.

Application Information

Protect Function

GPM8903 has the following protection functions for the digital amplifier: Over-current Protection function, Thermal Protection function, and Low Voltage Lock-out function.

Over-current Protection function

This is the function to establish the over-current protection mode when detecting a short circuit between GPM8903 differential output terminal and VSS, VDD, or another differential output. In the over current protection mode, the differential output terminal becomes a high impedance state. The over current protection mode can be cancelled by power down or turning on the power again.

Thermal Protection function

This is the function to establish the thermal protection mode when detecting excessive high temperature of GPM8903 itself. In the thermal protection mode, when GPM8903 gets out of such condition, the protection mode is cancelled.

Low Voltage Lock-out function

This is the function to establish the low voltage protection mode when VDD terminal voltage becomes lower than the detection voltage for the low voltage malfunction prevention and to cancel the protection mode when VDD terminal voltage becomes higher than the threshold voltage and by return procedure from power down for its deactivation. (In sag state, this function works, and GPM8903 becomes a low voltage protection mode.）

In the low voltage protection mode, the differential output pin becomes high impedance state. The low voltage protection mode can be cancelled by power down or turning on the power again. GPM8903 will start up within the start-up time when the low voltage protection mode is cancelled. A delay circuit as Fig 2 in MUTE pin will eliminate the UVLO during power on.

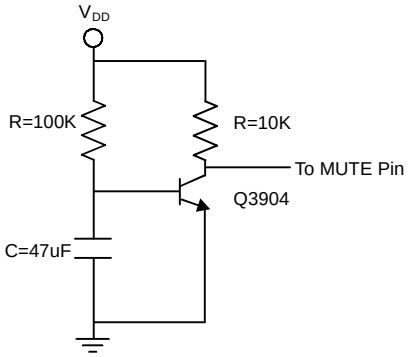
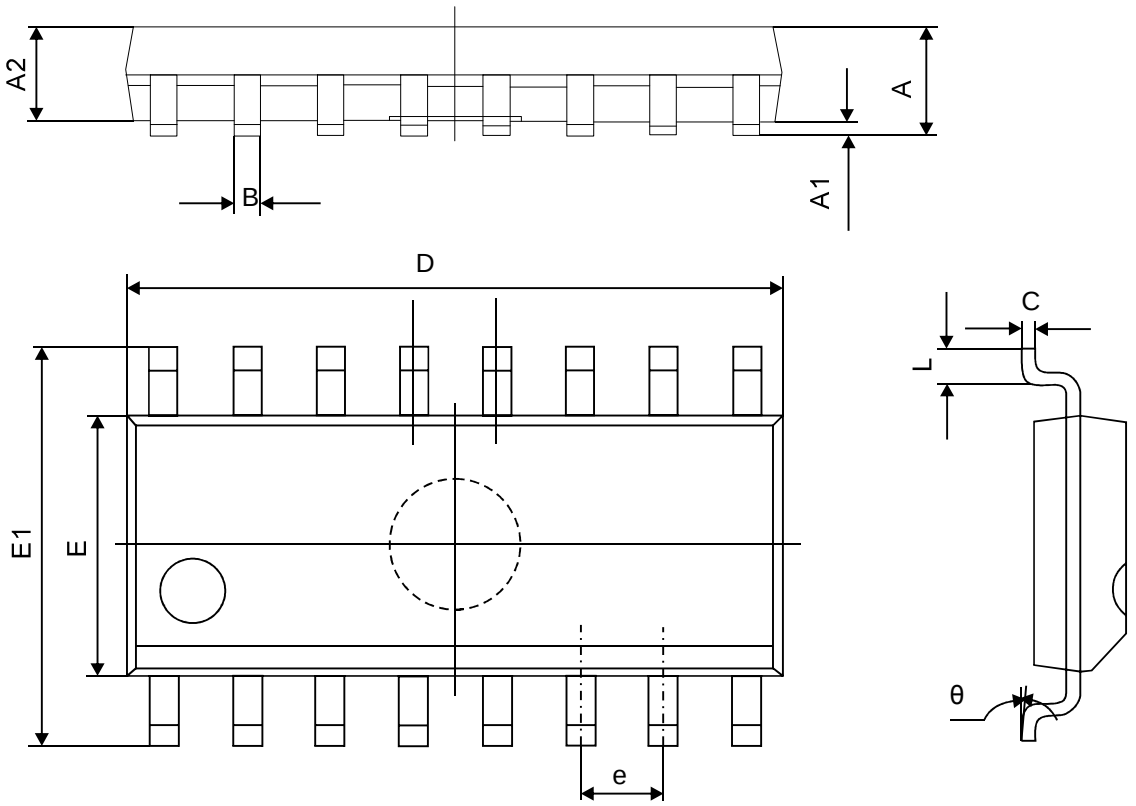


Fig 2: Delay Circuit at MUTE Pin

Outline Dimension

SOP-16L



Symbol	Dimensions Millimeters	
	Min	Max
A	1.350	1.750
A1	0.100	0.250
A2	1.350	1.550
B	0.330	0.510
C	0.190	0.250
D	9.800	10.000
E	3.800	4.000
E1	5.800	6.300
e	1.270(TYP)	
L	0.400	1.270
θ	0°	8°