



BIPOLAR ANALOG INTEGRATED CIRCUIT

μ PC1857A

SOUND CONTROL IC WITH SURROUND AND I²C BUS

DESCRIPTION

The μ PC1857A is a sound control IC with I²C bus.

It has functions to control volume, balance, and tone, and a phase shift matrix surround function.

The surround function achieves wide sound expansion using only two front speakers. Three modes can be selected: movie mode that increases the presence of sound with stereo sound input, music mode emphasizing vocal music, and simulated mode that gives expansion and left and right sound depth with monaural sound input.

The μ PC1857A can perform all control (mode switching, volume control and so on) using I²C.

FEATURES

- Volume control function : Attenuation adjustable from 0 to -80 dB in 64 steps
- Balance control function : The difference in attenuation adjustable from 0 to -80 dB in 64 steps
- Tone (bass, treble) control function : Adjustable in 32 steps from +10 to -10 dB
- Surround function (gain adjustable) : Three modes (movie, music, and simulated)
- Mute function
- Mixing function
- Output selection function (for two mono channels input)
- All parameters can be controlled via I²C bus.

APPLICATIONS

- TV, PC monitor

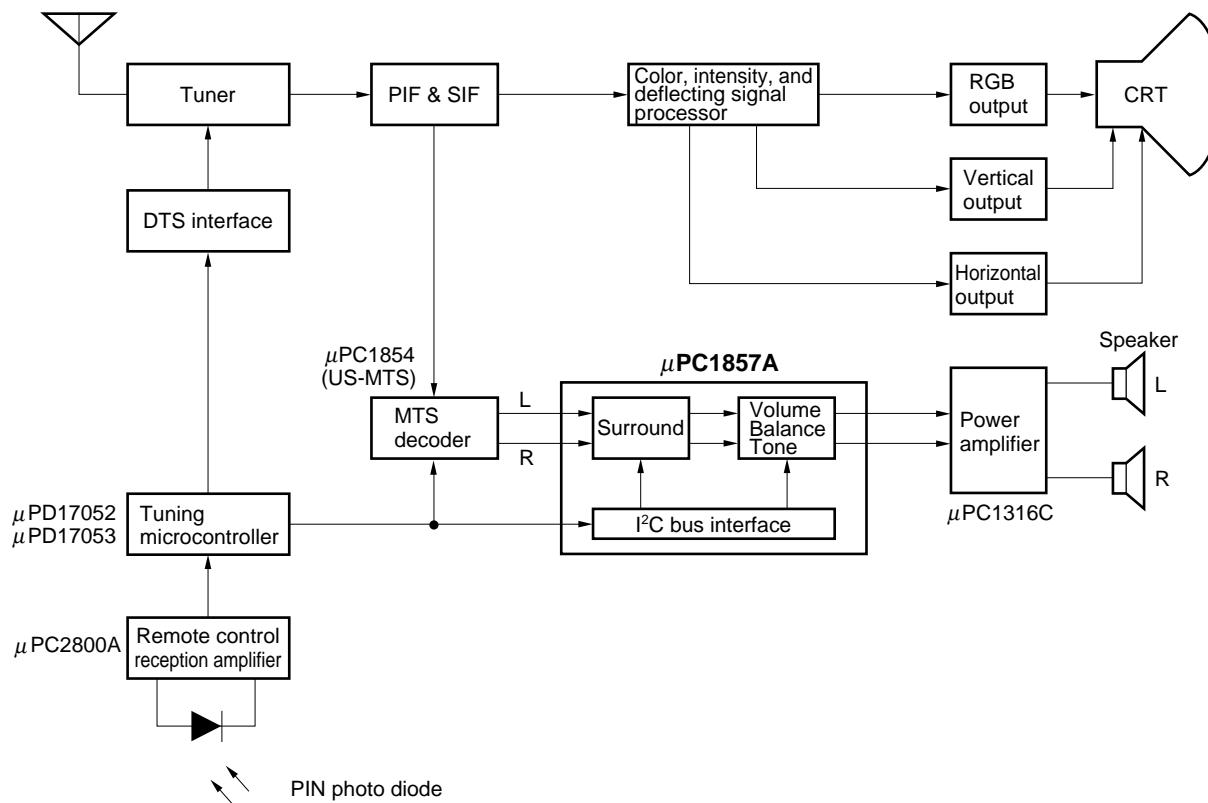
ORDERING INFORMATION

Part Number	Package
μ PC1857ACT	30-pin plastic shrink DIP (400 mil)

The information in this document is subject to change without notice.

SYSTEM BLOCK DIAGRAM

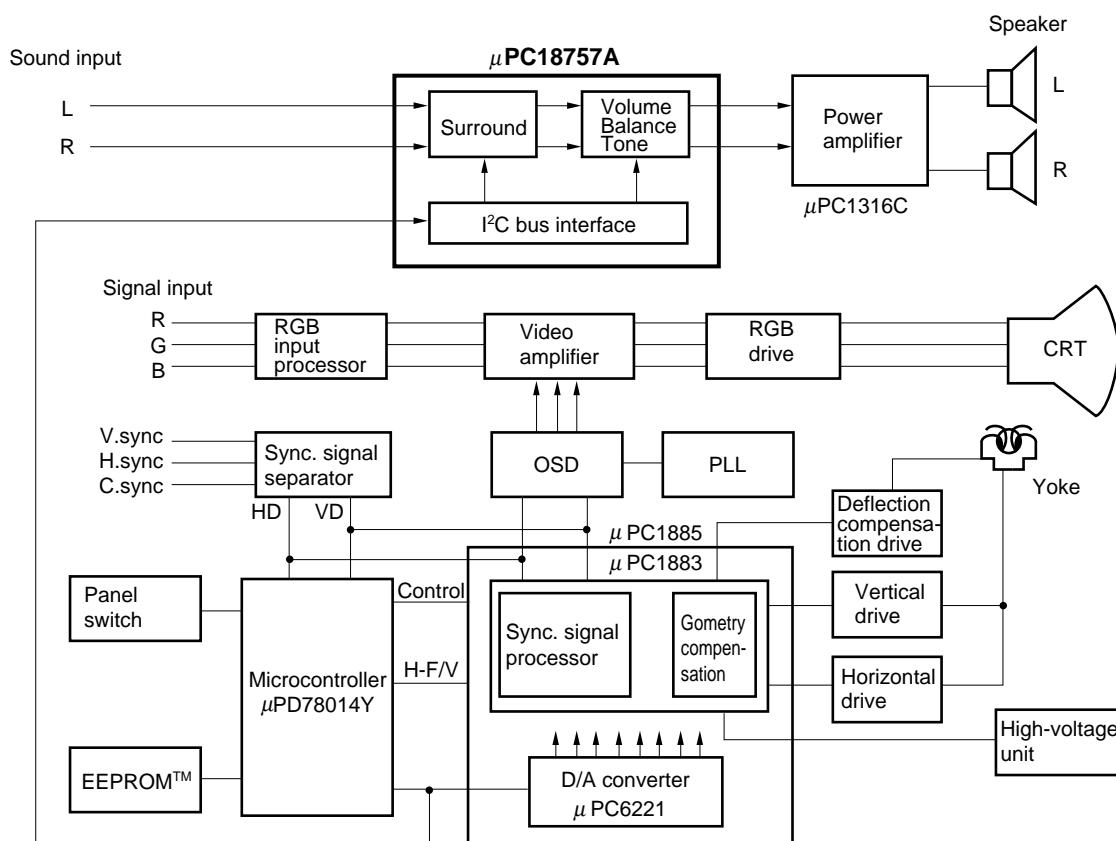
• TV



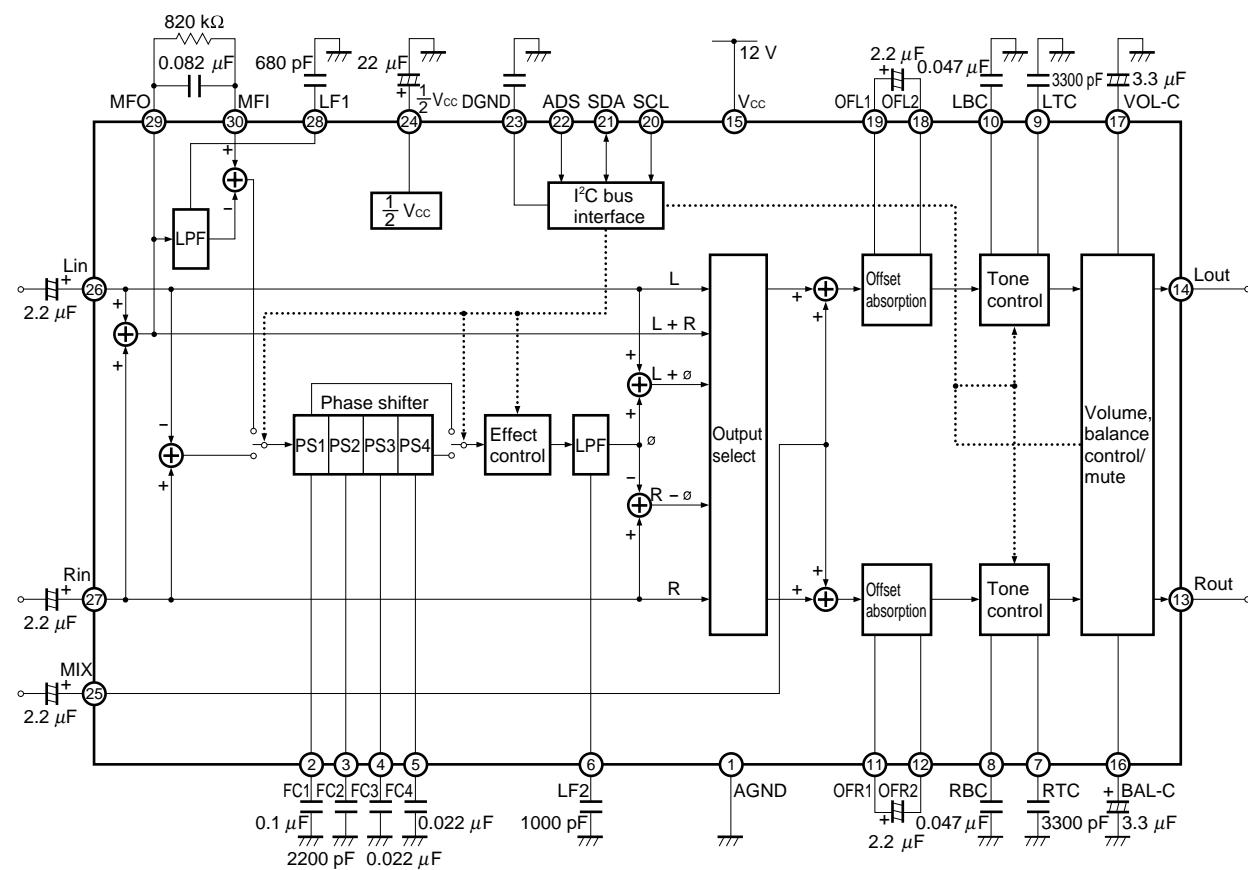
Remark DTS: Digital Tuning System

MTS: Multichannel Television Sound

- PC monitor

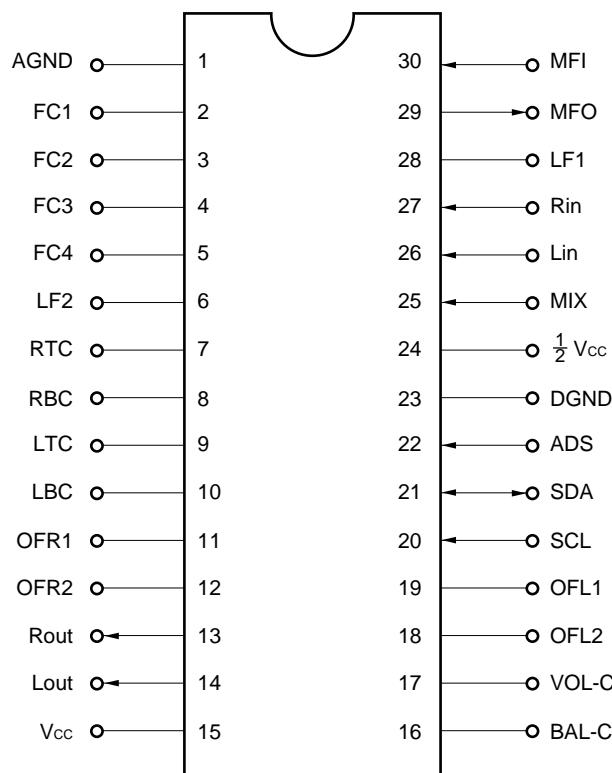


BLOCK DIAGRAM



PIN CONFIGURATION (Top View)

30-pin plastic shrink DIP (400 mil)



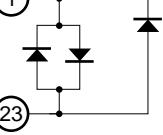
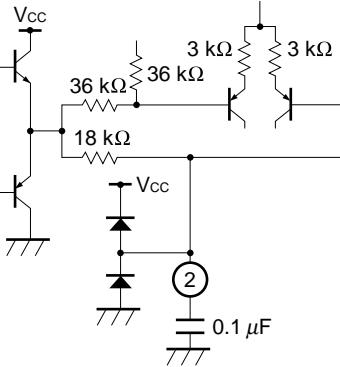
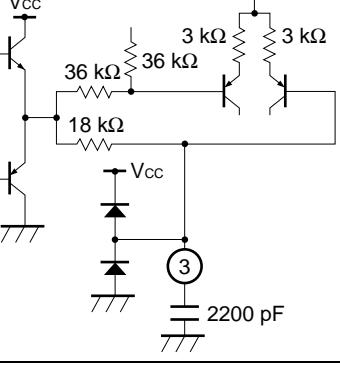
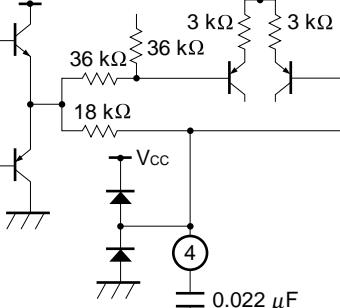
$\frac{1}{2}$ Vcc	: Reference Voltage Filter	MFO	: Monaural Filter Output
ADS	: Slave Address Select	MIX	: Mixer Input
AGND	: Analog Ground	OFL1, OFL2	: L-channel Offset Absorption
BAL-C	: Balance Control Offset Absorption	OFR1, OFR2	: R-channel Offset Absorption
DGND	: Ground for I ² C Bus	RBC	: R-channel Bass Capacitor
FC1-FC4	: Phase Shift Filter	Rin	: R-channel Signal Input
LBC	: L-channel Bass Capacitor	Rout	: R-channel Signal Output
LF1, LF2	: Low-pass Filter	RTC	: R-channel Treble Capacitor
Lin	: L-channel Signal Input	SCL	: Serial Clock for I ² C Bus
Lout	: L-channel Signal Output	SDA	: Serial Data for I ² C Bus
LTC	: L-channel Treble Capacitor	Vcc	: Power Supply
MFI	: Monaural Filter Input	VOL-C	: Volume Control Offset Absorption

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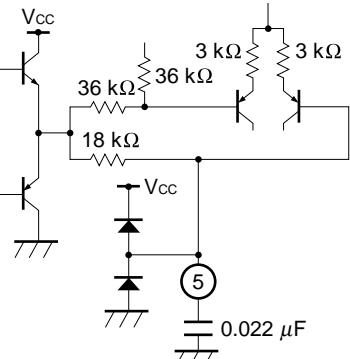
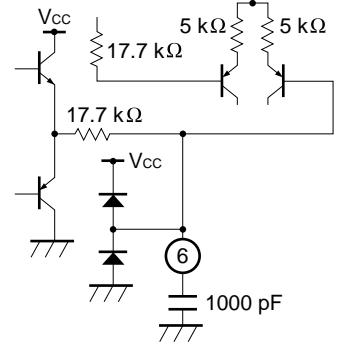
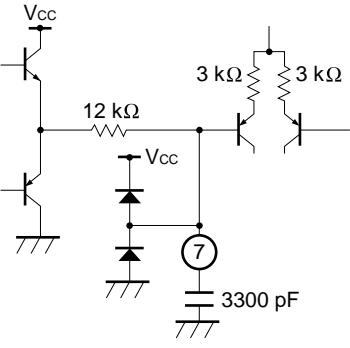
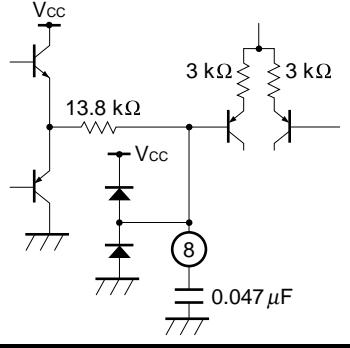
1. PIN FUNCTIONS

Table 1-1. Pin Function List (1/7)

Pin Number	Pin Name	Equivalent Circuit	Description
1	AGND		Ground for analog signal. Pin voltage: approx. 0.0 V
2	FC1		Connection pin for capacitor which determines time constant of phase shifter. Pin voltage: approx. 6.0 V
3	FC2		
4	FC3		

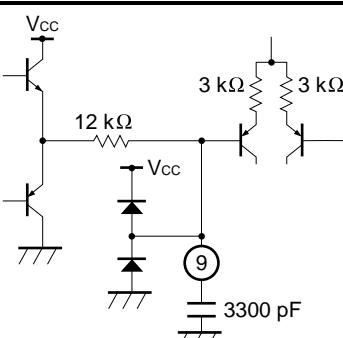
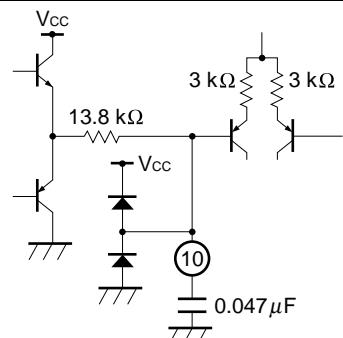
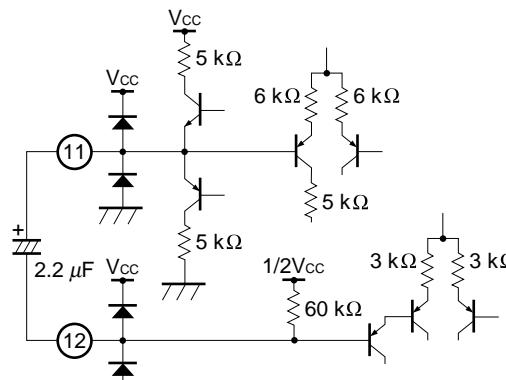
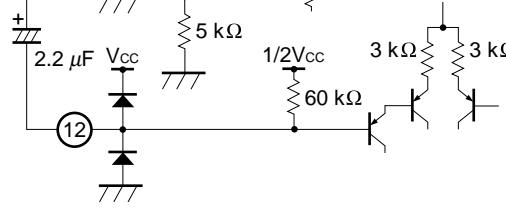
Remark Pin voltage is the reference value when $V_{CC} = 12$ V.

Table 1-1. Pin Function List (2/7)

Pin Number	Pin Name	Equivalent Circuit	Description
5	FC4		Connection pin for capacitor which determines time constant of phase shifter. Pin voltage: approx. 6.0 V
6	LF2		Low-pass filter. Pin voltage: approx. 6.0 V
7	RTC		Connection pin for capacitor for treble boost/cut frequency characteristic of R-channel signal. Pin voltage: approx. 6.0 V
8	RBC		Connection pin for capacitor for bass boost/cut frequency characteristic of R-channel signal. Pin voltage: approx. 6.0 V

Remark Pin voltage is the reference value when $V_{cc} = 12$ V.

Table 1-1. Pin Function List (3/7)

Pin Number	Pin Name	Equivalent Circuit	Description
9	LTC		Connection pin for capacitor for treble boost/cut frequency characteristic of L-channel signal. Pin voltage: approx. 6.0 V
10	LBC		Connection pin for capacitor for bass boost/cut frequency characteristic of L-channel signal. Pin voltage: approx. 6.0 V
11	OFR1		Pin that absorbs offset voltage of R channel. Pin voltage: approx. 6.0 V
12	OFR2		

Remark Pin voltage is the reference value when $V_{cc} = 12$ V.

Table 1-1. Pin Function List (4/7)

Pin Number	Pin Name	Equivalent Circuit	Description
13	Rout		R-channel signal output pin. Pin voltage: approx. 6.0 V
14	Lout		L-channel signal output pin. Pin voltage: approx. 6.0 V
15	Vcc		Supply voltage. Pin voltage: approx. 12.0 V
16	BAL-C		Pin for D/A converter capacitor for balance control. Pin voltage: approx. 4.8 V

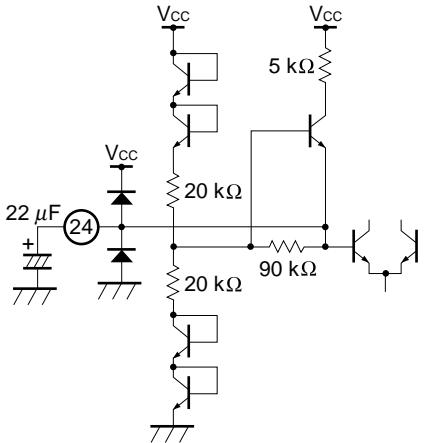
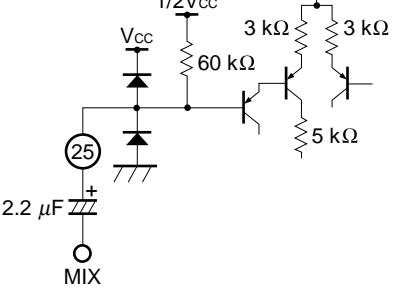
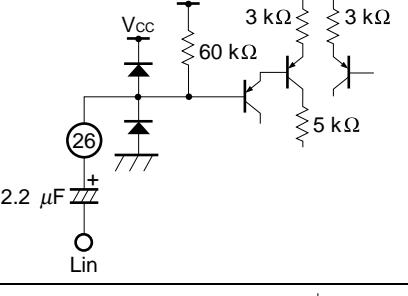
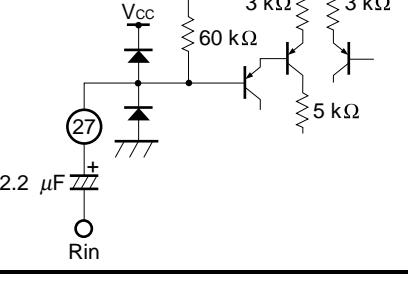
Remark Pin voltage is the reference value when $V_{cc} = 12$ V.

Table 1-1. Pin Function List (5/7)

Pin Number	Pin Name	Equivalent Circuit	Description
17	VOL-C		Pin for D/A converter capacitor for volume control. Pin voltage: approx. 6.0 V
18	OFL2		Pin that absorbs offset voltage of L channel. Pin voltage: approx. 6.0 V
19	OFL1		
20	SCL		Serial clock line (I²C bus clock Input) pin. Pin voltage: approx. 0.0 V
21	SDA		Serial data line (I²C bus data I/O) pin Pin voltage: approx. 0.2 V
22	ADS		Slave address select pin. Pin voltage: approx. 0.0 V
23	DGND		GND for I²C bus signal. Pin voltage: approx. 0.0 V

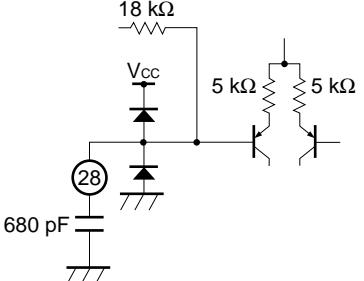
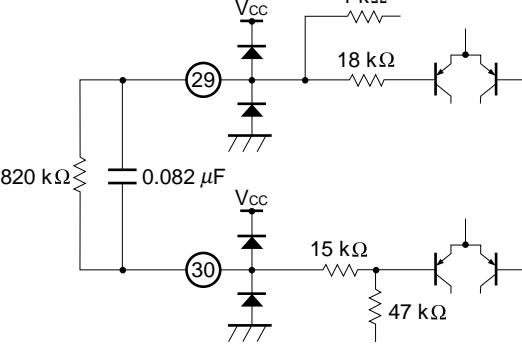
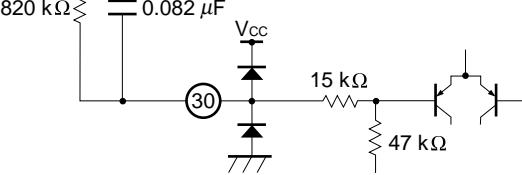
Remark Pin voltage is the reference value when $V_{cc} = 12$ V.

Table 1-1. Pin Function List (6/7)

Pin Number	Pin Name	Equivalent Circuit	Description
24	$\frac{1}{2} V_{cc}$		Filter pin for middle point of supply voltage. Pin voltage: approx. 6.0 V
25	MIX		Mixing signal input pin. Input impedance: 60 kΩ Pin voltage: approx. 6.0 V
26	Lin		L-channel signal input pin. Input impedance: 60 kΩ Pin voltage: approx. 6.0 V
27	Rin		R-channel signal input pin. Input impedance: 60 kΩ Pin voltage: approx. 6.0 V

Remark Pin voltage is the reference value when $V_{cc} = 12$ V.

Table 1-1. Pin Function List (7/7)

Pin Number	Pin Name	Equivalent Circuit	Description
28	LF1		Low-pass filter. Pin voltage: approx. 6.0 V
29	MFO		Filter output pin for surround function (simulated mode) (see 4.3 Surround Function). Pin voltage: approx. 6.0 V
30	MFI		Filter input pin for surround function (simulated mode) (see 4.3 Surround Function). Pin voltage: approx. 6.0 V

Remark Pin voltage is the reference value when $V_{CC} = 12$ V.

2. ATTENTIONS

(1) Attention on Pop Noise Reduction

When changing the surround mode, use the mute function (approx. 200 ms) for pop noise reduction (see **4.4.1 Mute**).

When turning ON/OFF power to the μ PC1857A, use the external mute function for pop noise reduction.

(2) Attention on Supply Voltage

Drive data on the I²C bus after supply voltage of total application system becomes stable.

3. I²C BUS INTERFACE

The μ PC1857A has serial bus function.

This serial bus (I²C bus) is a double-wired bus developed by Philips. It is composed of 2 wires: serial clock line (SCL) and serial data line (SDA).

The μ PC1857A has built-in I²C bus interface circuit, and five rewritable registers (8 bits).

SCL (Serial Clock Line)

The host CPU outputs a serial clock to synchronize with the data. The μ PC1857A takes in the serial data based on this clock.

Input level is compatible with CMOS.

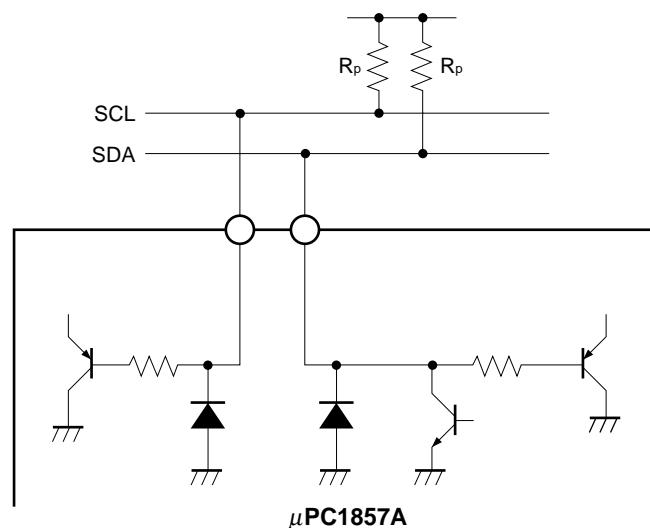
Clock frequency is 0 to 100 kHz.

SDA (Serial Data Line)

The host CPU outputs the data which is synchronized with the serial clock. The μ PC1857A takes in this data based on the clock.

Input level is compatible with CMOS.

Figure 3-1. Internal Equivalent Circuit of Interface Pin



3.1 Data Transfer

3.1.1 Start condition

Start condition is made by SDA falling from "High" to "Low" while SCL is "High" as shown in Figure 3-2.

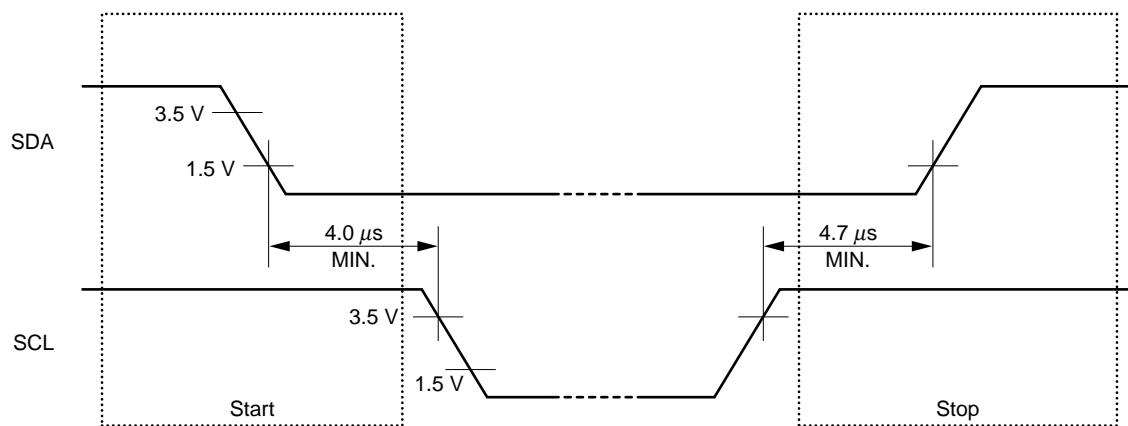
When this start condition is received, the μ PC1857A takes in the data synchronized with the serial clock after that.

3.1.2 Stop condition

Stop condition is made by SDA rising from “Low” to “High” while SCL is “High” as shown in Figure 3-2.

When this stop condition is received, the μ PC1857A stops taking in or outputting data.

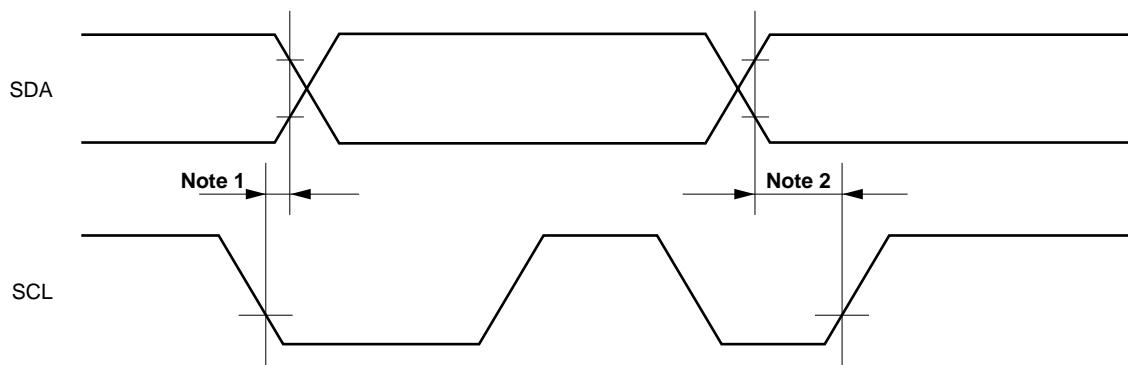
Figure 3-2. Start/Stop Condition of Data Transfer



3.1.3 Data transfer

When transferring data, the data must be changed while SCL is “Low” as shown in Figure 3-3. Never change the data while SCL is “High”.

Figure 3-3. Data Transfer



Notes 1. Data hold time for I²C device: 300 ns MIN., Data hold time for CPU: 5 μ s MIN.

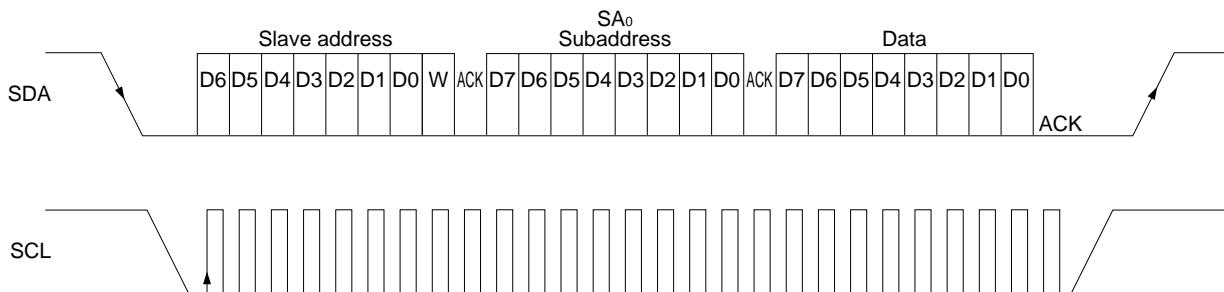
2. Data setup time: 250 ns MIN.

Remark Clock frequency: 0 to 100 kHz

3.2 Data Transfer Format

Figure 3-4 shows an example of data transfer in write mode.

Figure 3-4. Example of Data Transfer in Write Mode



Remark W: Write mode, ACK: Acknowledge bit

Data is composed of 8 bits. One acknowledge bit always follows these 8 bits of data. Data must be transferred starting from the MSB.

The 1 byte immediately following the start condition specifies a slave address (chip address). This slave address is composed of 7 bits.

Table 3-1 shows the slave address of the μPC1857A. This slave address is registered by Philips.

Table 3-1. Slave Address of μPC1857A

Bias Voltage of ADS (Pin 22)	Slave Address						
	D6	D5	D4	D3	D2	D1 ^{Note}	D0
5 V	1	0	0	0	1	1	0
GND	1	0	0	0	1	0	0

Note The user can set bit D1 freely.

0: Bias voltage of ADS (pin 22) is 0 V.

1: Bias voltage of ADS (pin 22) is 5 V.

The 1 bit following the slave address is a read/write bit which specifies the direction of the data to be subsequently transferred. Write "0" to this read/write bit because the μPC1857A is write mode only.

The byte following the slave address is the subaddress byte of the μPC1857A.

The μPC1857A has five subaddresses, from SA₀ to SA₄, and each of these addresses is composed of 8 bits. The data to be set to a subaddress follows this subaddress byte.

3.2.1 1-byte data transfer

The format in which 1-byte data is to be transferred is as follows:

Start	Slave address	Write mode	ACK	Subaddress	ACK	Data	ACK	Stop
-------	---------------	------------	-----	------------	-----	------	-----	------

3.2.2 Successive data transfer

The μ PC1857A has an automatic increment function which can be used to transfer successive data (refer to **4.4.6 Automatic increment**).

By using this function, the internal subaddress is automatically incremented if a slave address and a subaddress have been set, so that the data from subsequent subaddresses can be transferred in succession.

Incrementing the subaddress of the μ PC1857A is stopped when the subaddress reaches "04H".

The format in which 5 bytes of data are to be transferred in succession by using the automatic increment function is as follows:

Start	Slave address	Write mode	ACK	Subaddress	ACK	Data 1	ACK	Data 2	ACK	-----	Data 5	ACK	Stop
{ } { }										{ } { }			

The host CPU transfers "00H" as subaddress SA_0 after start and slave addresses, as shown above. Data SA_0 is transferred after this subaddress SA_0 , and without transferring the stop condition the data SA_1 , SA_2 , SA_3 , and SA_4 are transferred successively, and then the stop condition is transferred.

To successively change data at a fixed subaddress, for example to turn up/down the volume, turn off the automatic increment function.

3.2.3 Acknowledge

On the I²C bus, an acknowledge bit is appended to the 9th bit following the data. This acknowledge bit is used to judge whether data transfer has been successful. The host CPU judges whether data transfer has been successful or not, depending on whether the status of the acknowledge bit is "H" or "L".

When the acknowledge bit is "L", it indicates success. When the acknowledge bit is "H", it indicates failure of transfer or forced release of bus (NAK status). The NAK status occurs when a wrong slave address is transferred to a slave IC or data transfer from slave side is finished in the read status.

4. EXPLANATION OF EACH COMMAND

4.1 Subaddress List

Bit Subaddress	MSB D7	D6	D5	D4	D3	D2	D1	LSB D0
00H	Output mute 0: OFF 1: ON	0	Output select			Surround mode		
			D5	D4	Lout	Rout	D3	D2 Mode
			0	0	L	R	0	0 Simulated
			0	1	L	L	0	1 Music
			1	0	R	R	1	0 Movie
			1	1	L + R	L + R	1	1 OFF
01H	Mix 0: OFF 1: ON	Automatic increment 0: OFF 1: ON	Volume level					
			Volume : MAX to MIN					
			Data : 111111 to 000000					
02H	0	Automatic increment 0: OFF 1: ON	Balance					
			L volume : MIN to MAX to MAX					
			R volume : MAX to MAX to MIN					
			Data : 111111 to 100000 to 000000					
03H	0	Automatic increment 0: OFF 1: ON	0	Bass level				
				Gain : Boost to 0 to Cut				
				Data : 11111 to 10000 to 00000				
04H	0	Automatic increment 0: OFF 1: ON	0	Treble level				
				Gain : Boost to 0 to Cut				
				Data : 11111 to 10000 to 00000				

Cautions

1. Be sure to write "0" to bit D7 of subaddresses 02H through 04H, bit D6 of subaddress 00H, and bit D5 of subaddresses 03H and 04H.
2. The surround mode is OFF: 00H (D3, D2 = 11) in any mode other than stereo mode is selected for output: 00H (D5, D4 = 00).

4.2 Initialization

After power application, be sure to initialize the subaddresses as shown below.

Table 4-1. Initialization of μPC1857A (recommendation value)

Subaddress \ Bit	MSB D7	D6	D5	D4	D3	D2	D1	LSB D0
00H	0	0	0	0	1	1	0	0
01H	0	–	–	–	–	–	–	–
02H	0	–	1	0	0	0	0	0
03H	0	–	0	1	0	0	0	0
04H	0	–	0	1	0	0	0	0

Caution Until initialization is completed, mute using an external unit.

Remark – : Don't care.

4.3 Surround Function

For how to set the surround mode, refer to the table below.

Table 4-2. Setting Surround Mode

Surround Mode \ Setting	Subaddress: 00H		Description	
	D3	D2	Units of Phase Shifter	Effect
Simulated	0	0	4 units	Monaural to pseudo-stereo
Music	0	1	1 unit	Stereo sound to surround
Movie	1	0	4 units	
OFF	1	1	–	Through

Caution When changing the surround mode, use the mute function (approx. 200 ms) for pop noise reduction.

4.4 Explanation of Each Command

4.4.1 Mute

The mute function can be turned ON/OFF by using data of bit D7 of subaddress 00H.

Figure 4-1. Mute

Subaddress	D7	D6	D5	D4	D3	D2	D1	D0
00H	Mute	0		Output selection		Surround mode		Surround effect
Output mute								
	0	Mute: OFF						
	1	Mute: ON						

Caution When changing the surround mode, and when turning ON/OFF power, use the mute function (approx. 200 ms) for pop noise reduction.

4.4.2 Output selection

Output can be selected by using data of bits D5 and D4 of subaddress 00H.

Figure 4-2. Output Selection

Subaddress	D7	D6	D5	D4	D3	D2	D1	D0
00H	Mute	0		Output selection		Surround mode		Surround effect
Output selection								
Data Output								
	D5	D4	Lout	Rout				
	0	0	L	R				
	0	1	L	L				
	1	0	R	R				
	1	1	L + R	L + R				

Caution The surround mode is OFF (D3, D2 = 11) in modes other than the stereo mode (D5, D4 = 00).

4.4.3 Surround mode

The following surround modes can be selected by using data of bits D3 and D2 of subaddress 00H.

Simulated : Simulated stereo sound for monaural source. The difference between the signal that has gone through HPF and the signal that has gone through LPF is calculated, and the phase of the difference is shifted and added to the original signal. The simulated stereo effect is created if the output frequency characteristics of the L-channel and R-channel signals is comb-shaped.

Music : Surround sound for stereo source. The phase of the differential signal between L and R channels (L-R signal) is rotated by a phase shifter (1-unit), and is added to the original signal.

Movie : Surround sound for stereo source. The phase of the differential signal between L and R channels (L-R signal) is rotated by a phase shifter (4-unit), and is added to the original signal.

OFF : Original signal as is.

Figure 4-3. Surround Mode

Subaddress 00H	D7	D6	D5	D4	D3	D2	D1	D0				
	Mute	0	Output selection		Surround mode		Surround effect					
Surround mode												
							Data	Mode				
							D3	D2				
							0	0				
							1	1				
							Simulated	Music				
							1	0				
							0	1				
							Movie	OFF				

Caution The surround mode is OFF (D3, D2 = 11) if the stereo mode is not selected by the output selection bits (D5, D4 = 00).

4.4.4 Surround effect

The surround effect can be changed in four steps by using the data of bits D1 and D0 of subaddress 00H.

Figure 4-4. Surround Effect

Subaddress	D7	D6	D5	D4	D3	D2	D1	D0
00H	Mute	0	Output selection		Surround mode		Surround effect	
Surround effect								
Data								
D1 D0								
0 0 0 dB								
0 1 -3 dB								
1 0 -6 dB								
1 1 -12 dB								

4.4.5 Mix

Mixing of the signal input to the MIX pin can be turned ON/OFF by using the data of bit D7 of subaddress 01H.

Figure 4-5. Mix

Subaddress	D7	D6	D5	D4	D3	D2	D1	D0
01H	Mix		Automatic increment				Volume level	
Mix								
0 Mix: OFF								
1 Mix: ON								

4.4.6 Automatic increment

The automatic increment function can be turned ON/OFF by using the data of bit D6 of subaddresses 01H through 04H.

This is effective when transmitting data successively (refer to **3.2.2 Successive data transfer**).

Figure 4-6. Automatic Increment

Subaddress 01H-04H	D7	D6	D5	D4	D3	D2	D1	D0
	Don't care	Automatic increment					Don't care	
Automatic increment								
		0	Automatic increment: OFF					
		1	Automatic increment: ON					

Caution Subaddress 00H does not have an automatic increment function. It is always set to ON.

The automatic increment function automatically increments the subaddress when data is transferred successively.

Automatic increment ON : The subaddress is automatically incremented immediately after byte data with D6 = 1 has been transferred.

This setting is useful if the data at every subaddress is to be set at once for initialization. The subaddress is always incremented immediately after the data of subaddress: 00H has been transferred.

Automatic increment OFF : The subaddress is fixed immediately after byte data with D6 = 0 has been transferred. This setting is useful when the data at the same subaddress is to be successively changed, for example to turn up/down the volume.

There is an automatic increment function ON/OFF bit in subaddresses 01H through 04H. Incrementing subaddresses is individually controlled by the automatic increment function ON/OFF bit of each subaddress.

For example, if the automatic increment function of subaddress 01H is turned ON, and that of subaddress 02H is turned OFF, the subaddress is automatically incremented from 01H to 02H, and is fixed to 02H.

Even if the automatic increment function ON/OFF bit of subaddress 04H is set to ON, the subaddress is not incremented. If the next data is transferred after the data of 04H has been set (acknowledge bit: L), acknowledge enters the NAK status (acknowledge bit: H), and data transfer from the host CPU is stopped.

4.4.7 Volume level

The volume of output can be controlled in 64 steps by using the data of bits D5 through D0 of subaddress 01H.

Figure 4-7. Volume Level

Subaddress	D7	D6	D5	D4	D3	D2	D1	D0
01H	Mix	Automatic increment						Volume level

Volume level	
Data	Volume
D5-D0	
000000	MIN.
to	to
111111	MAX.

4.4.8 Balance

The balance of output of the Lout and Rout pins can be controlled in 64 steps by using the data of bits D5 through D0 of subaddress 02H.

Figure 4-8. Balance

Subaddress	D7	D6	D5	D4	D3	D2	D1	D0
02H	0	Automatic increment						Balance

Balance		
Data	Volume	
D5-D0	Lout	Rout
000000	MAX.	MIN.
to	to	to
100000	MAX.	MAX.
to	to	to
111111	MIN.	MAX.

4.4.9 Bass level

The bass level of output can be controlled in 32 steps by using the data of bits D4 through D0 of subaddress 03H.

Figure 4-9. Bass Level

Subaddress	D7	D6	D5	D4	D3	D2	D1	D0
03H	0	Automatic increment	0					Bass level
Bass level								
Data Gain								
D4-D0								
00000 Cut								
to to								
10000 0								
to to								
11111 Boost								

4.4.10 Treble level

The treble level of output can be controlled in 32 steps by using the data of bits D4 through D0 of subaddress 04H.

Figure 4-10. Treble Level

Subaddress	D7	D6	D5	D4	D3	D2	D1	D0
04H	0	Automatic increment	0					Treble level
Treble level								
Data Gain								
D4-D0								
00000 Cut								
to to								
10000 0								
to to								
11111 Boost								

5. ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings (Unless otherwise specified, $T_A = 25^\circ\text{C}$)

Parameter	Symbol	Condition	Rating	Unit
Supply voltage	V_{CC}	Without signal	14.0	V
Input signal voltage	V_{IN}	Pins Lin, Rin, MIX	V_{CC}	V
I^2C bus input signal voltage	V_{CNT}	Pins SDA, SCL	$V_{CC} + 0.2$	V
Permissible package dissipation	P_D	$T_A = 75^\circ\text{C}$	500	mW
Operating temperature	T_A	$V_{CC} = 12\text{ V}$	-20 to +75	$^\circ\text{C}$
Storage temperature	T_{STG}		-40 to +125	$^\circ\text{C}$

Caution If any of the parameters exceeds the absolute maximum ratings, even momentarily, the quality of the product may be impaired. The absolute maximum ratings are values that may physically damage the product(s). Be sure to use the product(s) within the ratings.

Recommended Operating Conditions (Unless otherwise specified, $T_A = 25^\circ\text{C}$)

Parameter	Symbol	Condition	Rating			Unit
			MIN.	TYP.	MAX.	
Supply voltage	V_{CC}	Gain between input and output: 0 dB	8.1	12.0	13.2	V
Input signal voltage	V_{IN}	$V_{CC} = 12\text{ V}$, gain between input and output: 0 dB	0.0	1.4	7.9	V_{P-P}
I^2C bus input voltage (H)	V_{CNTH}	Pins SDA, SCL	3.5	5.0	6.0	V
I^2C bus input voltage (L)	V_{CNTL}		-0.1	0	+1.5	V

Electrical Characteristics (1/5)(Unless otherwise specified, $V_{CC} = 12\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, $RH \leq 70\%$, $f = 1\text{ kHz}$, $V_{IN} = 0.5\text{ V}_{\text{r.m.s.}}$, no load)

Parameter	Symbol	Test Condition	Subaddress Data					Rating			Unit
			00	01	02	03	04	MIN.	TYP.	MAX.	
Circuit current	I_{CC}	No signal	0D	3F	20	10	10	12	18	25	mA
Maximum input voltage $L_{in} \rightarrow L_{out}$	VOM-L	$L_{in} = \text{variable (tested)}$ $L_{out} = \text{THD } 1\%$	0D	3F	20	10	10	2.8	3.1	—	$V_{\text{r.m.s.}}$
Maximum input voltage $R_{in} \rightarrow R_{out}$	VOM-R	$R_{in} = \text{variable (tested)}$ $R_{out} = \text{THD } 1\%$						2.8	3.1	—	$V_{\text{r.m.s.}}$
Distortion rate $L_{in} \rightarrow L_{out}$	THDL	$L_{in} = 2.0\text{ V}_{\text{r.m.s.}}$ $R_{in} = \text{GND}$	0D	2B	20	10	10	—	0.1	0.5	%
Distortion rate $R_{in} \rightarrow R_{out}$	THDR	$L_{in} = \text{GND}$ $R_{in} = 2.0\text{ V}_{\text{r.m.s.}}$						—	0.1	0.5	%
Voltage gain $L_{in} \rightarrow L_{out}$	GV-LL	$L_{in} = 0.5\text{ V}_{\text{r.m.s.}}$ $R_{in} = \text{GND}$	0D	3F	20	10	10	-1.0	0	+1.0	dB
Voltage gain $R_{in} \rightarrow R_{out}$	GV-RR	$L_{in} = \text{GND}$ $R_{in} = 0.5\text{ V}_{\text{r.m.s.}}$						-1.0	0	+1.0	dB
Voltage gain $M_{IX} \rightarrow L_{out}$	GV-ML	$M_{IX} = 0.5\text{ V}_{\text{r.m.s.}}$ $L_{in}, R_{in} = \text{GND}$	0D	BF	20	10	10	5.0	6.0	7.0	dB
Voltage gain $M_{IX} \rightarrow R_{out}$	GV-MR							5.0	6.0	7.0	dB
Ripple rejection ratio $V_{CC} \rightarrow L_{out}$	SVRR-L	$V_{CC} = 100\text{ mV}_{\text{r.m.s.}}$ $f = 100\text{ Hz}$ $L_{in}, R_{in} = \text{GND}$	0D	14	20	10	10	—	—	-50	dB
Ripple rejection ratio $V_{CC} \rightarrow R_{out}$	SVRR-R							—	—	-50	dB
Output noise voltage (surround OFF) L_{out}	V_{n-L} (OFF)	$R_g = 0\text{ }\Omega$, JIS-A	0D	3F	20	10	10	—	—	50	$\mu\text{V}_{\text{r.m.s.}}$
Output noise voltage (surround OFF) R_{out}	V_{n-R} (OFF)							—	—	50	$\mu\text{V}_{\text{r.m.s.}}$
Cross talk $L_{in} \rightarrow R_{out}$	CT-L	$L_{in} = 0.5\text{ V}_{\text{r.m.s.}}$ $R_{in} = \text{GND}$	0D	3F	20	10	10	—	-80	-70	dB
Cross talk $R_{in} \rightarrow L_{out}$	CT-R							—	-80	-70	dB

Electrical Characteristics (2/5)(Unless otherwise specified, $V_{CC} = 12$ V, $T_A = 25$ °C, $RH \leq 70\%$, $f = 1$ kHz, $V_{IN} = 0.5$ V_{r.m.s.}, no load)

Parameter	Symbol	Test Condition	Subaddress Data					Rating			Unit				
			00	01	02	03	04	MIN.	TYP.	MAX.					
Volume attenuation 1 Lin → Lout1	VOL-L1	Lin = 0.5 V _{r.m.s.} Rin = GND	0D	3F	20	10	10	-1.5	0	+1.5	dB				
Volume attenuation 2 Lin → Lout2	VOL-L2			20				-20.0	-14.0	-7.0	dB				
Volume attenuation 3 Lin → Lout3	VOL-L3			00				-	-	-80.0	dB				
Volume attenuation deviation Rin → R/Lout1	VOL-RL1			0D	3F	20	10	10	-1.0	0	+1.0	dB			
Volume attenuation deviation Rin → R/Lout2	VOL-RL2	Lin = GND Rin = 0.5 V _{r.m.s.} Difference from VOL-L1	20	20							dB				
Volume attenuation deviation Rin → R/Lout3	VOL-RL3										dB				
Mute attenuation Lin → Lout	MUTE-L			8D	3F	20	10	10	-	-	-80.0	dB			
Mute attenuation Rin → Rout	MUTE-R	Lin = GND Rin = 2.0 V _{r.m.s.}										-	-	-80.0	dB
Balance attenuation L1 Lin → Lout1	BAL-L1	Lin = 0.5 V _{r.m.s.} Rin = GND	0D	3F	01	10	10	-1.5	0	+1.5	dB				
Balance attenuation L2 Lin → Lout2	BAL-L2			28	-2.5							-0.5	+1.0	dB	
Balance attenuation L3 Lin → Lout3	BAL-L3			30	-15.0							-10.0	-5.0	dB	
Balance attenuation L4 Lin → Lout4	BAL-L4			3F	-							-	-80.0	dB	
Balance attenuation R1 Rin → Rout1	BAL-R1	Lin = GND Rin = 0.5 V _{r.m.s.}	0D	3F	10	10	-1.5	0	+1.5	dB					
Balance attenuation R2 Rin → Rout2	BAL-R2			18	-2.5						-0.5	+1.0	dB		
Balance attenuation R3 Rin → Rout3	BAL-R3			10	-15.0						-10.0	-5.0	dB		
Balance attenuation R4 Rin → Rout4	BAL-R4			01	-						-	-80.0	dB		

Electrical Characteristics (3/5)(Unless otherwise specified, $V_{CC} = 12\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, $RH \leq 70\%$, $f = 1\text{ kHz}$, $V_{IN} = 0.5\text{ V}_{\text{r.m.s.}}$, no load)

Parameter	Symbol	Test Condition	Subaddress Data					Rating			Unit
			00	01	02	03	04	MIN.	TYP.	MAX.	
Tone control, bass characteristic $Lin \rightarrow Lout_1$	BASS-L1	$f = 100\text{ Hz}$ $Lin = 0.5\text{ V}_{\text{r.m.s.}}$ $Rin = \text{GND}$	0D	3F	20	1F	10	7.0	10.0	13.0	dB
Tone control, bass characteristic $Lin \rightarrow Lout_2$	BASS-L2					10		-2.0	0	+2.0	dB
Tone control, bass characteristic $Lin \rightarrow Lout_3$	BASS-L3					01		-13.0	-10.0	-7.0	dB
Tone control, bass characteristic deviation $Rin \rightarrow Rout_1/Lout_1$	BASS-RL1	$f = 100\text{ Hz}$, $Lin = \text{GND}$ $Rin = 0.5\text{ V}_{\text{r.m.s.}}$ Difference from BASS-L1	0D	3F	20	1F	10	-1.0	0	+1.0	dB
Tone control, bass characteristic deviation $Rin \rightarrow Rout_2/Lout_2$	BASS-RL2					10		-1.0	0	+1.0	dB
Tone control, bass characteristic deviation $Rin \rightarrow Rout_3/Lout_3$	BASS-RL3					01		-1.0	0	+1.0	dB
Tone control, treble characteristic $Lin \rightarrow Lout_1$	TREB-L1	$f = 10\text{ kHz}$ $Lin = 0.5\text{ V}_{\text{r.m.s.}}$ $Rin = \text{GND}$	0D	3F	20	10	1F	7.0	10.0	13.0	dB
Tone control, treble characteristic $Lin \rightarrow Lout_2$	TREB-L2					10		-2.0	0	+2.0	dB
Tone control, treble characteristic $Lin \rightarrow Lout_3$	TREB-L3					01		-13.0	-10.0	-7.0	dB
Tone control, treble characteristic deviation $Rin \rightarrow Rout_1/Lout_1$	TREB-RL1	$f = 10\text{ kHz}$, $Lin = \text{GND}$ $Rin = 0.5\text{ V}_{\text{r.m.s.}}$ Difference from TREB-L1	0D	3F	20	10	1F	-1.0	0	+1.0	dB
Tone control, treble characteristic deviation $Rin \rightarrow Rout_2/Lout_2$	TREB-RL2					10		-1.0	0	+1.0	dB
Tone control, treble characteristic deviation $Rin \rightarrow Rout_3/Lout_3$	TREB-RL3					01		-1.0	0	+1.0	dB

Electrical Characteristics (4/5)(Unless otherwise specified, $V_{CC} = 12\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, $RH \leq 70\%$, $f = 1\text{ kHz}$, $V_{IN} = 0.5\text{ V}_{\text{r.m.s.}}$, no load)

Parameter	Symbol	Test Condition	Subaddress Data					Rating			Unit
			00	01	02	03	04	MIN.	TYP.	MAX.	
Surround voltage gain, music mode $\text{Lin} \rightarrow \text{Lout}$	MUS-L	$f = 1\text{ kHz}$ $\text{Lin} = 0.5\text{ V}_{\text{r.m.s.}}$ $\text{Rin} = \text{GND}$	05	3F	20	10	10	3.5	5.5	7.5	dB
Surround voltage gain, music mode $\text{Lin} \rightarrow \text{Rout}$	MUS-R							-2.5	-0.5	+1.5	
Surround voltage gain, movie mode $\text{Lin} \rightarrow \text{Lout}$	MOV-L	$f = 1\text{ kHz}$ $\text{Lin} = 0.5\text{ V}_{\text{r.m.s.}}$ $\text{Rin} = \text{GND}$	09	3F	20	10	10	3.0	7.0	11.0	dB
Surround voltage gain, movie mode $\text{Lin} \rightarrow \text{Rout}$	MOV-R							0	4.0	8.0	
Surround voltage gain, simulated mode $\text{LRin} \rightarrow \text{Lout1}$	SIM-L1	$f = 250\text{ Hz}$ $\text{Lin} = 0.5\text{ V}_{\text{r.m.s.}}$ $\text{Rin} = 0.5\text{ V}_{\text{r.m.s.}}$	01	3F	20	10	10	-0.5	+3.5	+6.5	dB
Surround voltage gain, simulated mode $\text{LRin} \rightarrow \text{Lout2}$	SIM-L2							-	-3.0	+4.5	
Surround voltage gain, simulated mode $\text{LRin} \rightarrow \text{Lout3}$	SIM-L3							2.0	6.0	10.0	
Surround voltage gain, simulated mode $\text{LRin} \rightarrow \text{Rout1}$	SIM-R1	$f = 250\text{ Hz}$ $\text{Lin} = 0.5\text{ V}_{\text{r.m.s.}}$ $\text{Rin} = 0.5\text{ V}_{\text{r.m.s.}}$	01	3F	20	10	10	-	-5.5	-1.0	dB
Surround voltage gain, simulated mode $\text{LRin} \rightarrow \text{Rout2}$	SIM-R2							0	3.0	6.0	
Surround voltage gain, simulated mode $\text{LRin} \rightarrow \text{Rout3}$	SIM-R3							-	-7.0	+5.0	

Remark For the surround mode, refer to **4.3 Surround Function**.

Electrical Characteristics (5/5)(Unless otherwise specified, $V_{CC} = 12\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, $RH \leq 70\%$, $f = 1\text{ kHz}$, $V_{IN} = 0.5\text{ V}_{\text{r.m.s.}}$, no load)

Parameter	Symbol	Test Condition	Subaddress Data					Rating			Unit
			00	01	02	03	04	MIN.	TYP.	MAX.	
Output selector, DC offset $\text{Lin} \rightarrow \text{Lout}$	OFST LRL	No signal Voltage conversion of Lout $\text{Lout: L output} \rightarrow \text{R output}$	1D ↓ 2D	3F	20	10	10	-100	0	+100	mV
Output selector, DC offset $\text{Lin} \rightarrow \text{Lout}$	OFST LL + RL	No signal Voltage conversion of Lout $\text{Lout: L output} \rightarrow \text{L+R output}$	1D ↓ 3D					-100	0	+100	mV
Output selector, DC offset $\text{Rin} \rightarrow \text{Lout}$	OFST RL + RL	No signal Voltage conversion of Lout $\text{Lout: R output} \rightarrow \text{L+R output}$	2D ↓ 3D	3F	20	10	10	-100	0	+100	mV
Output selector, DC offset $\text{Rin} \rightarrow \text{Rout}$	OFST RLR	No signal Voltage conversion of Rout $\text{Rout: R output} \rightarrow \text{L output}$	2D ↓ 1D					-100	0	+100	mV
Output selector, DC offset $\text{Rin} \rightarrow \text{Rout}$	OFST RL + RR	No signal Voltage conversion of Rout $\text{Rout: R output} \rightarrow \text{L+R output}$	2D ↓ 3D	3F	20	10	10	-100	0	+100	mV
Output selector, DC offset $\text{Lin} \rightarrow \text{Rout}$	OFST LL + RR	No signal Voltage conversion of Rout $\text{Rout: L output} \rightarrow \text{L+R output}$	1D ↓ 3D					-100	0	+100	mV

6. CHARACTERISTIC CURVES

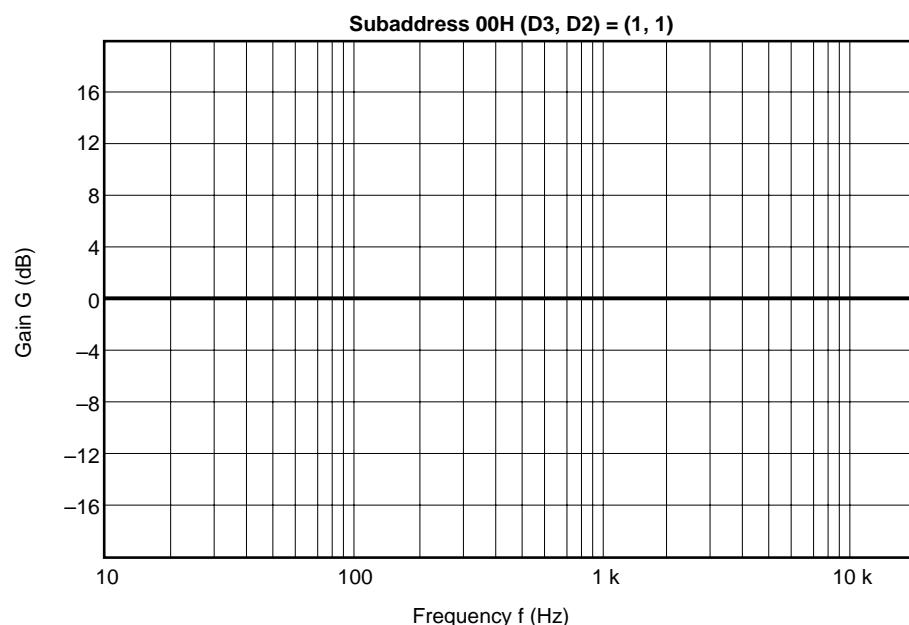
6.1 Frequency Characteristic in Each Mode

$V_{CC} = 12$ V, $V_{IN} = 0.5$ V_{r.m.s.}

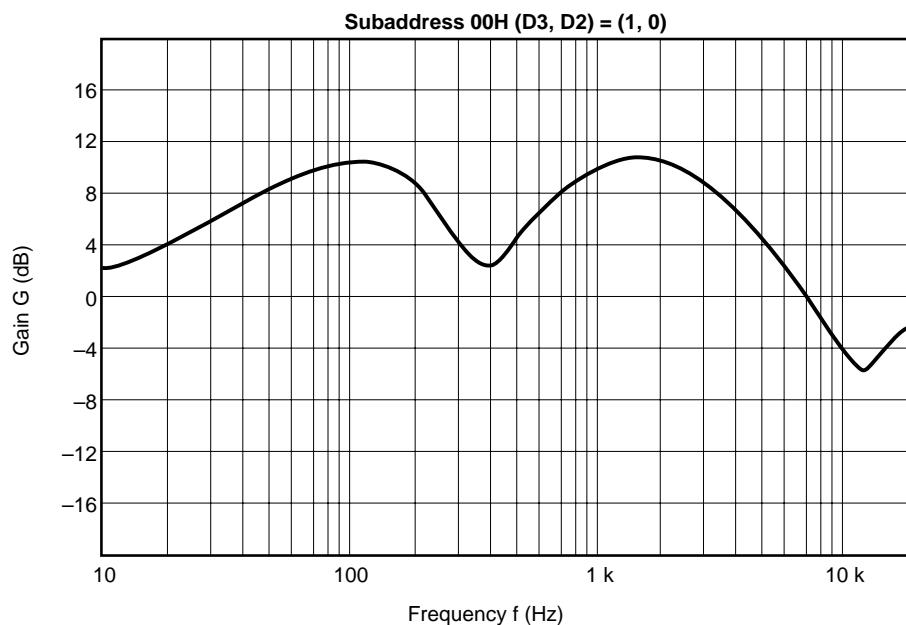
Stereo mode: subaddress 00H (D5, D4) = (0,0)

Surround effect (0 dB attenuation): subaddress 00H (D1, D0) = (0,0)

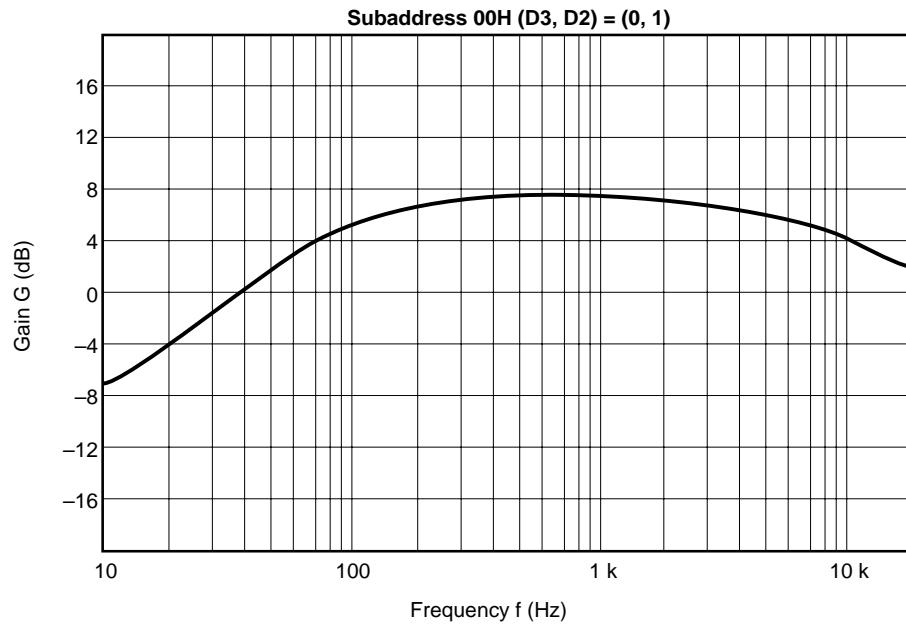
(1) OFF mode Lch/Rch



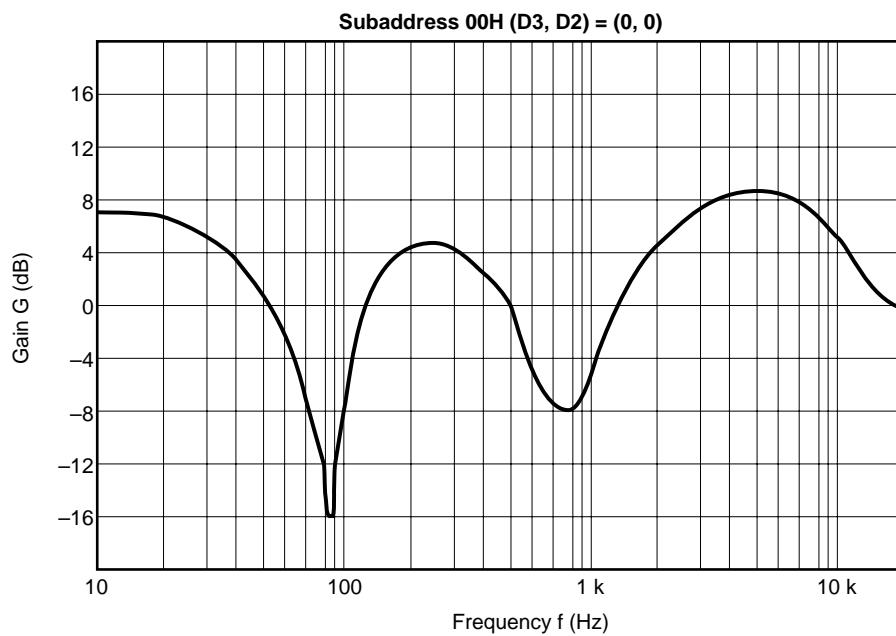
(2) Movie mode Lch/Rch



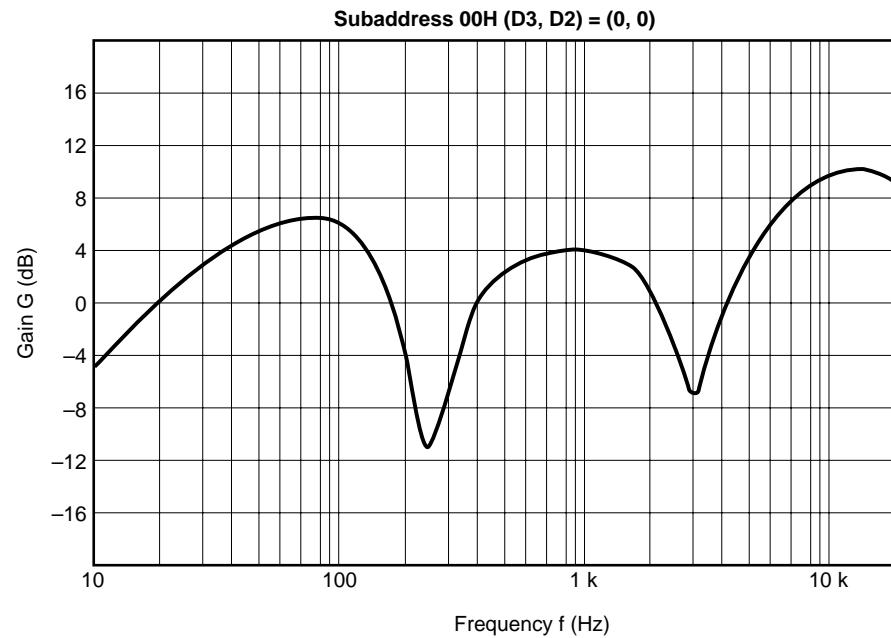
(3) Music mode Lch/Rch



(4) Simulated mode Lch



(5) Simulated mode Rch

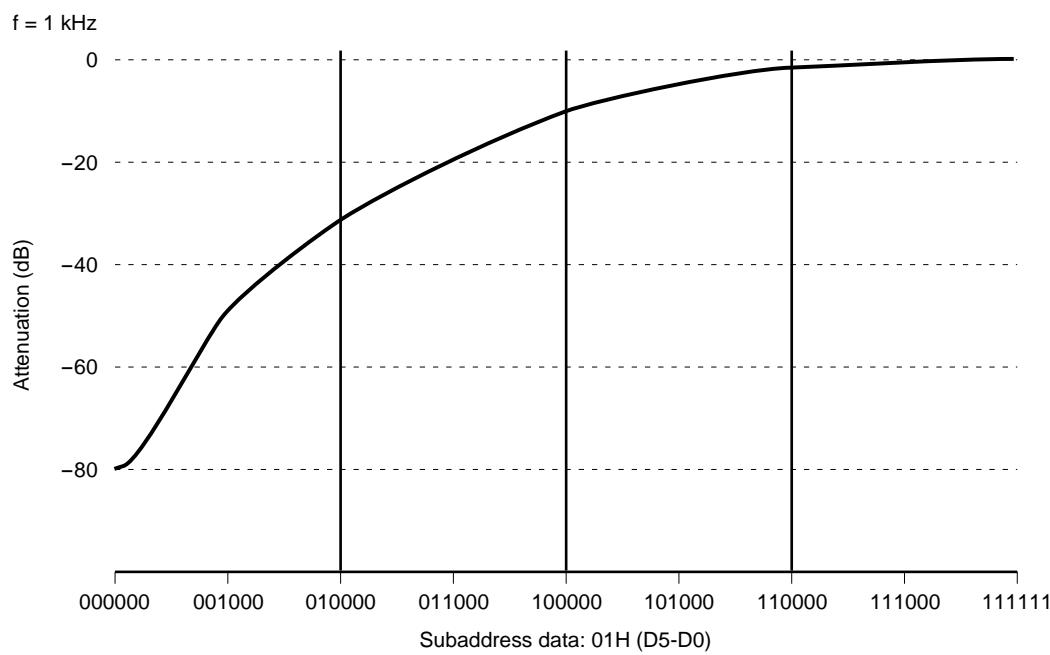


6.2 Control Characteristic

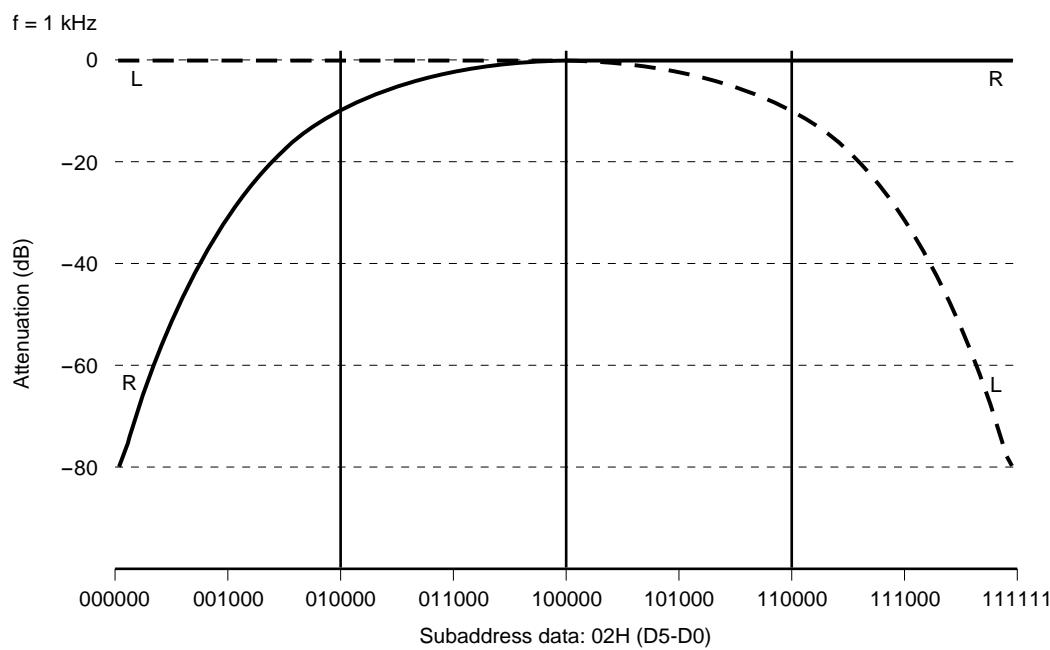
$V_{CC} = 12 \text{ V}$, $V_{IN} = 0.5 \text{ V}_{\text{r.m.s}}$

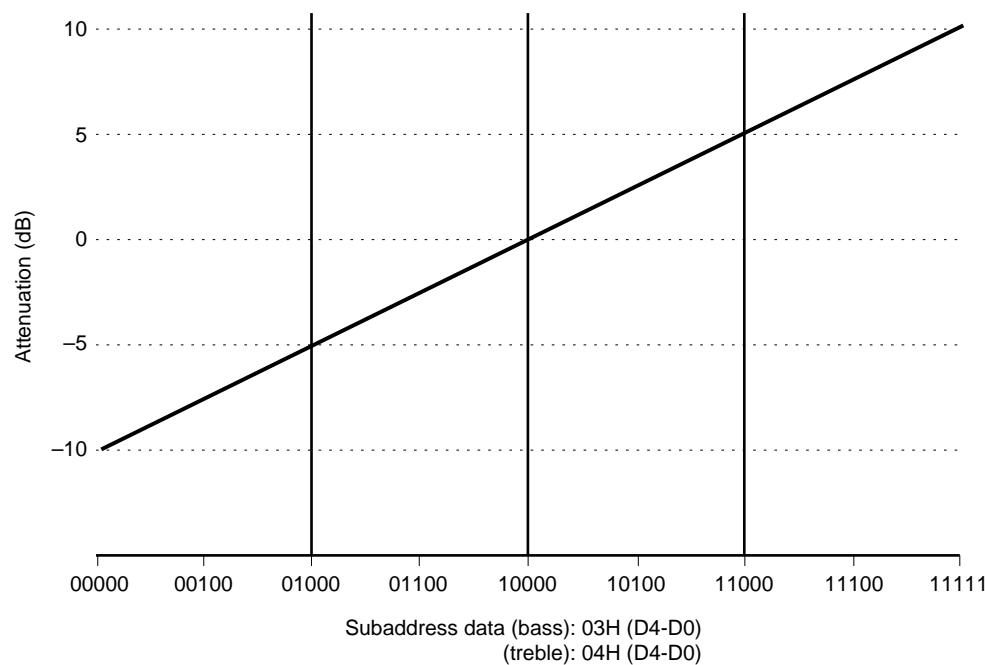
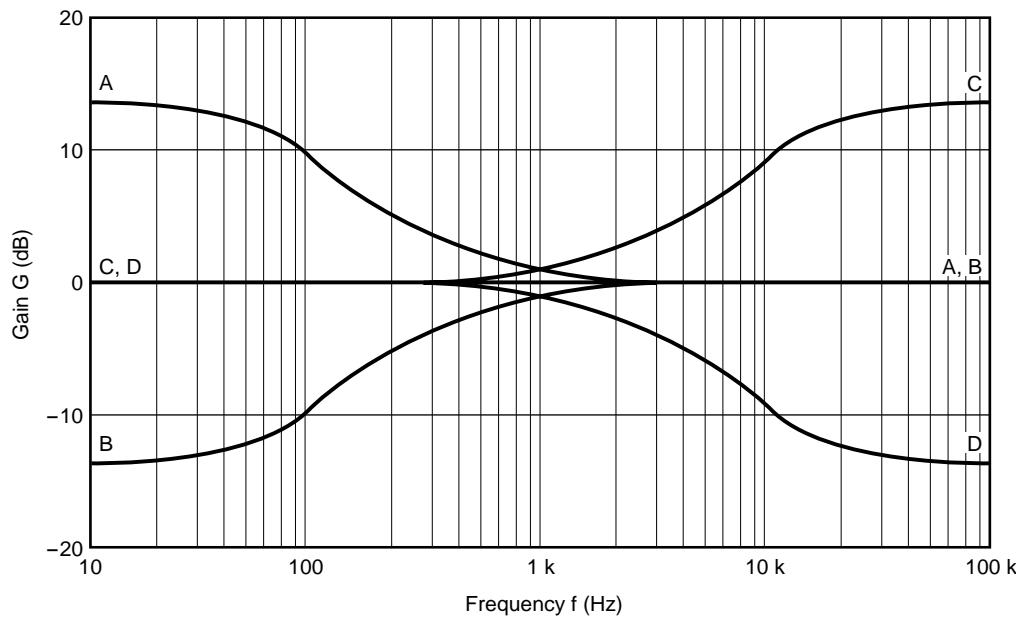
Surround mode (OFF): subaddress 00H (D3, D2) = (1, 1)

(1) Volume control characteristic



(2) Balance control characteristic



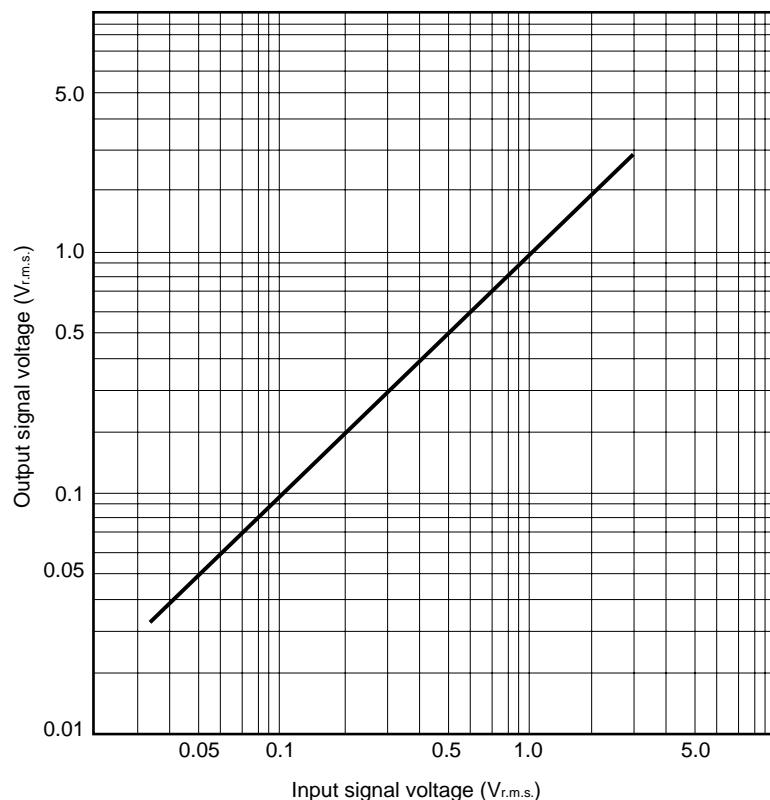
(3) Tone control characteristic (bass/treble)Bass: $f = 100$ Hz, treble: $f = 10$ kHz**(4) Tone frequency characteristic**

Curve	Subaddress	Data (D4-D0)
A	03H	11111
B		00001
C	04H	11111
D		00001

6.3 I/O Characteristic

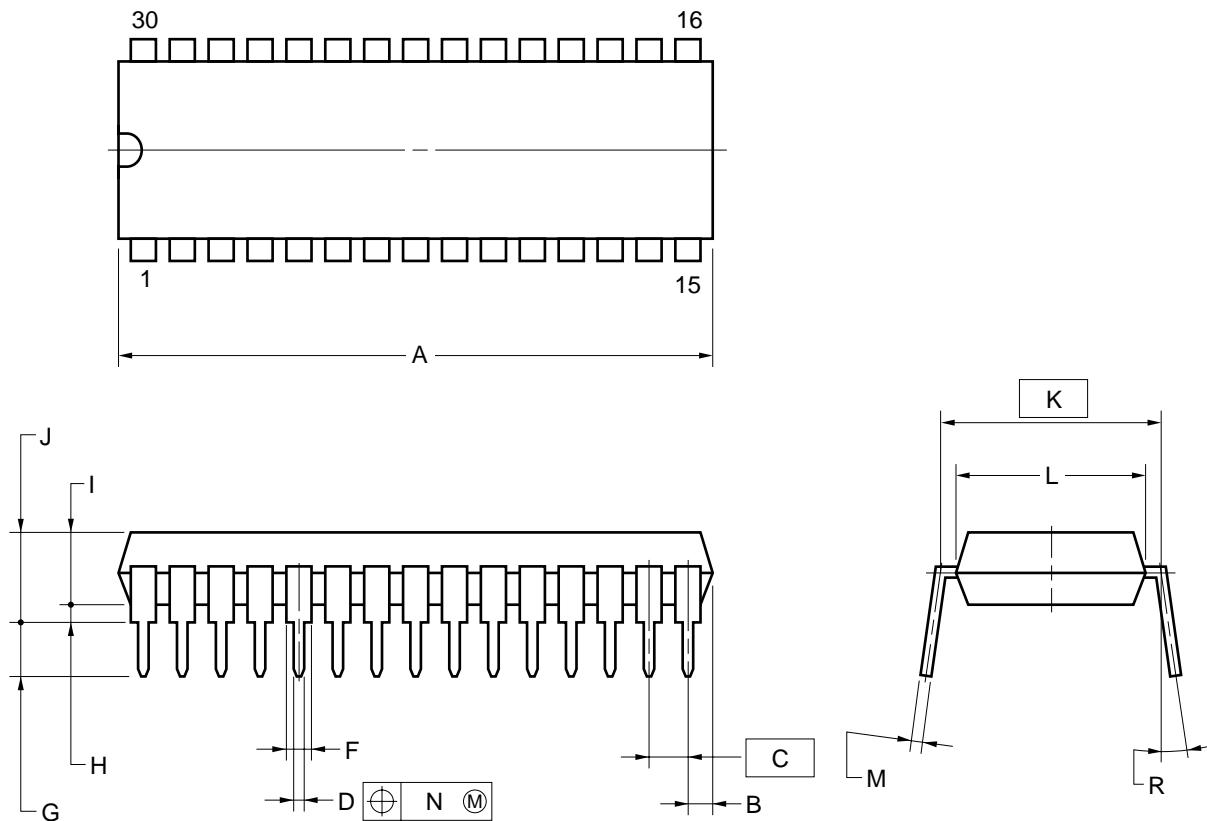
$V_{cc} = 12 \text{ V}$

- Volume (MAX.) : Subaddress 01H (D5-D0) = (111111)
- Balance (center) : Subaddress 02H (D5-D0) = (100000)
- Bass (FLAT) : Subaddress 03H (D4-D0) = (10000)
- Treble (FLAT) : Subaddress 04H (D4-D0) = (10000)
- Surround mode (OFF) : Subaddress 00 (D3, D2) = (1, 1)



7. PACKAGE DRAWING

30 PIN PLASTIC SHRINK DIP (400 mil)



NOTES

1. Controlling dimension — millimeter.
2. Each lead centerline is located within 0.17 mm (0.007 inch) of its true position (T.P.) at maximum material condition.
3. Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	27.3 ± 0.2	$1.075^{+0.008}_{-0.009}$
B	1.78 MAX.	0.070 MAX.
C	1.778 (T.P.)	0.070 (T.P.)
D	0.50 ± 0.10	$0.020^{+0.004}_{-0.005}$
F	1.0 ± 0.15	$0.039^{+0.007}_{-0.006}$
G	3.2 ± 0.3	0.126 ± 0.012
H	0.51 MIN.	0.020 MIN.
I	3.45 ± 0.2	$0.136^{+0.008}_{-0.009}$
J	5.08 MAX.	0.200 MAX.
K	10.16 (T.P.)	0.400 (T.P.)
L	8.6 ± 0.2	$0.339^{+0.008}_{-0.009}$
M	$0.25^{+0.10}_{-0.05}$	$0.010^{+0.004}_{-0.003}$
N	0.17	0.007
R	$0 \sim 15^\circ$	$0 \sim 15^\circ$

S30C-70-400B-2

8. RECOMMENDED SOLDERING CONDITIONS

It is recommended to solder this product under the conditions described below.

For details of the recommended soldering conditions, refer to the **Semiconductor Device Mounting Technology Manual (C10535E)**.

For soldering methods and conditions other than those recommended, consult NEC.

Soldering condition of through-hole type

μPC1857ACT: 30-pin plastic shrink DIP (400 mil)

Soldering Method	Soldering Condition
Wave soldering (only pins)	Soldering bath temperature: 260 °C MAX., Time: 10 seconds
Partial heating	Pin temperature: 300 °C MAX., Time: 3 seconds MAX. (per pin)

Caution **Apply wave soldering only to the pins, and exercise care that solder does not directly contact the package.**

[MEMO]

[MEMO]

[MEMO]

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NEC devices are classified into the following three quality grades:

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Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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