M65846FP

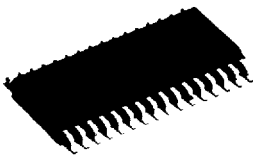
SINGLE CHIP SURROUND PROCESSOR

DESCRIPTION

This CMOS LSI is for producing surround effects with a built-in delay circuit and mixing amplifiers. The device is suitable for adding surround effects to CD radio cassette players and miniature component stereo sets.

FEATURES

- Built-in digital delay, delay volume controller, and line mixing amplifiers make it possible to construct a surround-sound or echo system using only one chip.
- Low noise and low distortion are realized by a digital delay with built-in 16-kbit RAM.
- Two control modes, microcomputer mode and easy mode, are available to choose from. In the easy mode, disco, hall, live, and echo operation modes are preset.
- An auto mute function is built in to suppress shock noise occurring at powering up and changing mode.
- An auto reset circuit is built in, which functions at power up.
- 5V single power supply.



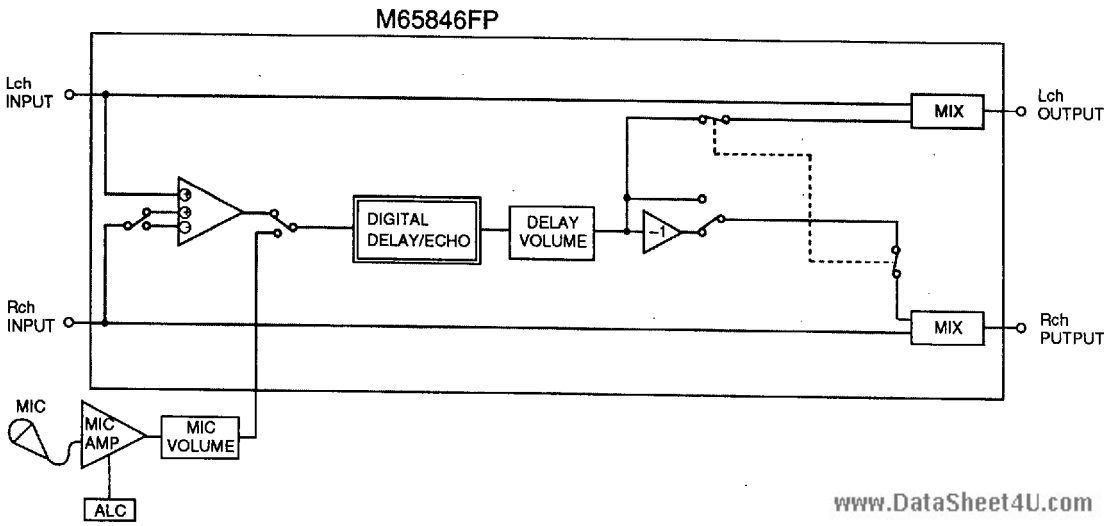
Outline 32P2W-A

1.27mm pitch 450mil SOP
(8.4mm × 20.0mm × 2.0mm)

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ..... Vcc 4.5 to 5.5V
Rated supply voltage ..... Vcc =5V
Rated clock frequency 4MHz

SYSTEM CONFIGURATION



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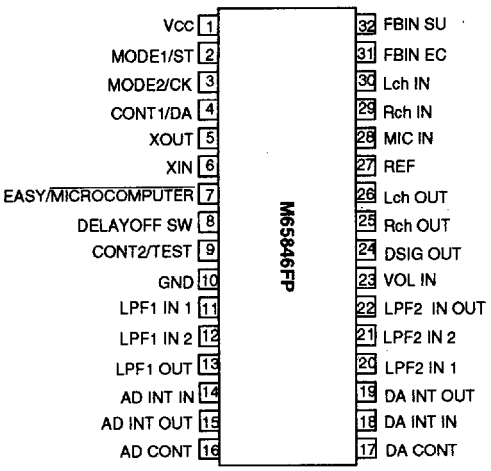
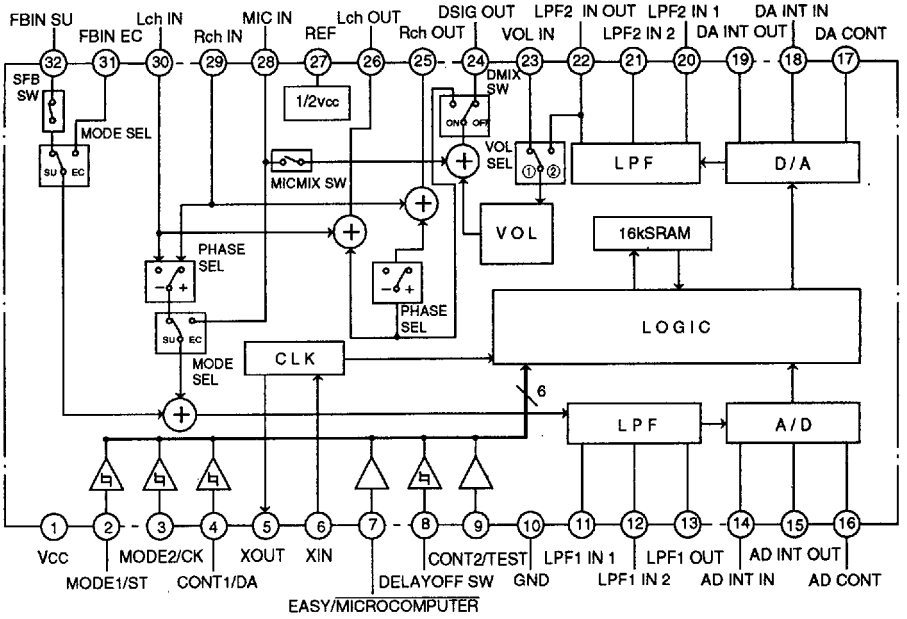
SINGLE CHIP SURROUND PROCESSOR

PIN CONFIGURATION (TOP VIEW)



Outline 32P2W-A

IC INTERNAL BLOCK DIAGRAM



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PIN DESCRIPTION

Pin No.	Symbol	Name	I/O	Function
①	Vcc	Power supply	–	
②	MODE1/ST	Mode selector 1/Strobe	I↓	Easy mode: Input of mode setting data 1 Microcomputer mode: Strobe input via serial bus
③	MODE2/CK	Mode selector 2/clock	I↓	Easy mode: Input of mode setting data 2 Microcomputer mode: Clock input via serial bus
④	CONT1/DA	Control 1/data	I↓	Easy mode: Input of control data 1 Microcomputer mode: Data input via serial bus
⑤	XOUT	Oscillator output	O	Connect a 4-MHz ceramic filter
⑥	XIN	Oscillator input	I	
⑦	EASY/$\overline{\text{MICROCOMPUTER}}$	Easy/Microcomputer	I↓	H: Easy mode L: Microcomputer mode
⑧	DELAYOFF SW	Delay off switch	I↓	H: Delay off mode L: Normal mode
⑨	CONT2/TEST	Control 2/Test	I↓	Easy mode: Input of control data 2 Microcomputer mode: Fixed to L
⑩	GND	Ground	–	
⑪	LPF1 IN 1	Low pass filter 1 input 1	I	Prefilter placed before A/D converter for digital delay
⑫	LPF1 IN 2	Low pass filter 1 input 2	I	
⑬	LPF1 OUT	Low pass filter 1 output	O	
⑭	AD INT IN	A/D integrator input	I	With an external capacitor, these construct an integrator used as A/D converter
⑮	AD INT OUT	A/D integrator output	O	
⑯	AD CONT	A/D control	–	Determines an adaptive time constant for ADM A/D conversion
⑰	DA CONT	D/A control	–	Determines an adaptive time constant for ADM D/A conversion
⑱	DA INT IN	D/A integrator input	I	With an external capacitor, these construct an integrator used as D/A converter
⑲	DA INT OUT	D/A integrator output	O	
⑳	LPF 2 IN 1	Low pass filter 2 input 1	I	Postfilter placed after D/A converter for digital delay
㉑	LPF 2 IN 2	Low pass filter 2 input 2	I	
㉒	LPF 2 OUT	Low pass filter 2 output	O	
㉓	VOL IN	Volume input	I	Volume input
㉔	DSIG OUT	Delay signal output	O	Delay signal output
㉕	Rch OUT	R-ch output	O	R-ch mixing output
㉖	Lch OUT	L-ch output	O	L-ch mixing output
㉗	REF	Reference	–	1/2 Vcc output. Connect a filter capacitor.
㉘	MIC IN	Microphone input	I	Microphone input
㉙	Rch IN	R-ch input	I	R-ch input
㉚	Lch IN	L-ch input	I	L-ch input
㉛	FBIN EC	Feedback input of echo effect	I	Feedback signal input of echo effect
㉜	FBIN SU	Feedback input of surround-sound effect	I	Feedback signal input of surround-sound effect

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SINGLE CHIP SURROUND PROCESSOR

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C, unless otherwise noted)

Symbol	Parameter	Ratings	Unit
Vcc	Supply voltage	6.5	V
Icc	Circuit current	100	mA
Pd	Power dissipation	650	mW
Topr	Operating temperature	−20 to +75	°C
Tstg	Storage temperature	−40 to +125	°C

RECOMMENDED OPERATING CONDITIONS

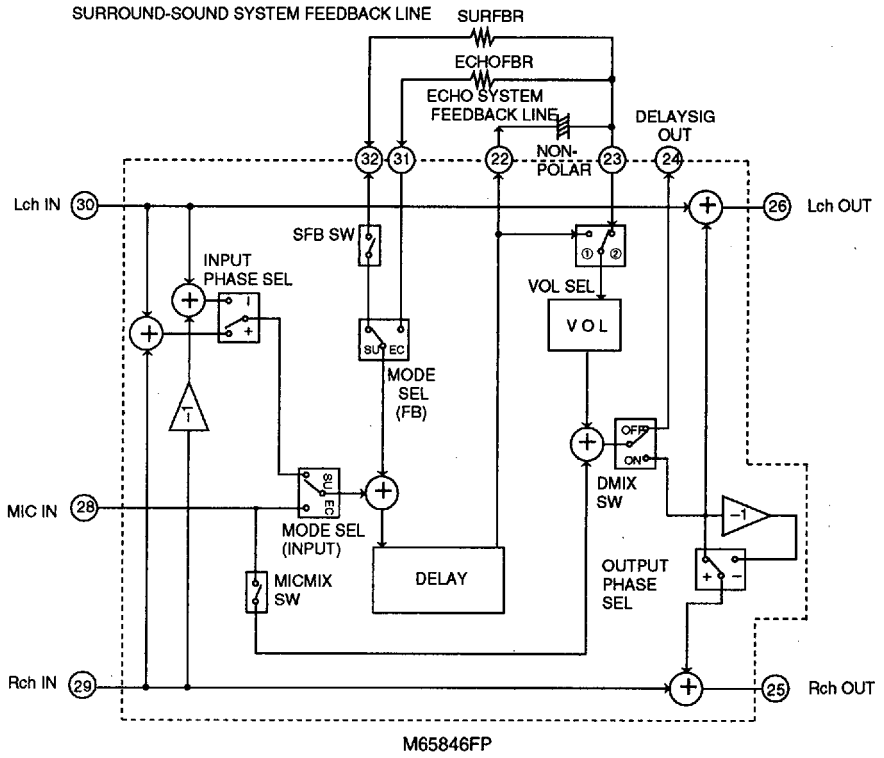
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
Vcc	Supply voltage		4.5	5.0	5.5	V
VIH	Input voltage ("H" level)	⑦ ⑨	0.7Vcc	–	Vcc	V
		② ③ ④ ⑧	2.4	–	Vcc	
VIL	Input level ("L" level)	⑦ ⑨	0	–	0.3Vcc	V
		② ③ ④ ⑧	0	–	0.8	
fck	Clock frequency		3	4	5	MHz

ELECTRICAL CHARACTERISTICS (Ta = 25°C, Vcc=5V, f=1kHz, Vi=200mVrms, and fck=4MHz unless otherwise noted)

Symbol		Parameter	Test conditions	Limits			Unit
				Min	Typ	Max	
Icc	All blocks	Circuit current	With no signal	–	32	70	mA
Td	Digital delay	Delay time	See Delay Time Control for delay time setting	5.3	12.3	11.3	msec
				11.4	18.4	25.4	
				23.8	32.8	41.8	
				32.0	41.0	50.0	
				40.2	49.2	58.2	
				88.3	98.3	108.3	
				116.1	131.1	146.1	
Gv		Input-output gain	Td=12.3msec 30kHz LPF	–3	0	3	dB
THD		Output distortion	Td=18.4msec 30kHz LPF	–	0.3	0.6	%
			Td=32.8msec 30kHz LPF	–	0.3	0.6	
			Td=42.0msec 30kHz LPF	–	0.5	1.0	
			Td=49.2msec 30kHz LPF	–	0.6	1.2	
			Td=98.3msec 30kHz LPF	–	0.6	1.2	
			Td=131.1msec 30kHz LPF	–	1.0	2.0	
			30kHz LPF	–	1.5	3.0	
VOmax		Maximum output voltage	THD=10% Td=12.3msec	0.7	1.0	–	Vrms
No		Output noise voltage	Vi=0mVrms JIS-A Td=18.4msec	–	–92	–80	dBV
			Vi=0mVrms JIS-A Td=32.8msec	–	–92	–80	
			Vi=0mVrms JIS-A Td=42.0msec	–	–92	–80	
			Vi=0mVrms JIS-A Td=49.2msec	–	–90	–75	
			Vi=0mVrms JIS-A Td=98.3msec	–	–90	–75	
			Vi=0mVrms JIS-A Td=131.1msec	–	–87	–72	
			Vi=0mVrms JIS-A Volume max.	–	–85	–70	
Gv	Delay voltage	Input-output gain	DELAYOFF MODE	0	3	6	dB
ATTMAX		Maximum attenuation	Volume min. 30kHz LPF	–	–70	–60	dB
THD		Output distortion	Volume max.	–	0.15	0.3	%
Vomax		Maximum output voltage	30kHz LPF THD=10% DELAYOFF MODE	1.1	1.4	–	Vrms
No		Output noise voltage	JIS-A	–	–98	–90	dBV
Gv	Line amplifier	Input-output gain	30kHz LPF	–3	0	–3	dB
THD		Output distortion	30kHz LPF ZOUT=10kΩ	–	0.01	0.03	%
VoMax		Maximum output voltage	THD=10% DELAYOFF MODE	1.2	1.8	–	Vrms
No		Output noise voltageLime amplifier	JIS-A DMIXSWOFF	–	–98	–90	dBV
CS		Channel separation	LchIN f=400Hz RchOUT JIS-A	–	–80	–60	dB
ZI		Input impedance		21	30	–	kΩ

FUNCTIONAL DESCRIPTION

Block configuration



• DELAY

Creates seven kinds of delay signals between 12.3 msec and 131.1 msec.

• VOL

Sets volume attenuation in 8 steps between +3 dB and -∞ .

• INPUT PHASE SEL(IPS)

Selectes the L + R signal(+ line)or L-R signal(- line) of the input mixing amplifier.

• OUTPUT PHASE SEL(OPS)

Whether to make the R channel of the VOL output signal in-phase (+ line)or antiphase (- line)with respect to the L channel is selected.

• MODE SEL(MOS)

INPUT : Selects between input mixing amplifier signal(SU line)and microphone input signal(EC line).

FB : Selects between inputting feedback signals to surround-sound and echo lines.

*These two MODE SELs synchronize in operation.

• DMIX SW(MIX)

Selector switch for turning on/off of delay signal mixing.(Delay signals are output via pin ㉔ DSIGOUT under mixing off condition.)

• MICMIX SW(MIC)

Selector switch for turning on/off of microphone signal mixing.

• SFB SW(SFS)

Selector switch for turning feedback on/off in surround-sound mode.

(Echo mode always carries out feedback.)

• VOL SEL

Selects in easy mode between outputting delay signals to pin ㉒ LPF2OUT(line ①) with the polarities of pins ④ CONT 1 AND ① CONT ② and making direct connections in the IC(line ②).

(The selector is fixed to line ① in microcomputer mode.)

CONTROL MODE

⑦ EASY/ MICROCOMPUTER	② MODE1/ ST	③ MODE2/ CK	④ CONT1/ DA	⑨ CONT2/ TEST	Control mode	Internal VOL setting	Operation mode
L	Serial data input			L	Microcomputer mode In this mode control is carried out by serial data inputted to pins ②, ③, and ④. 8-step VOL setting is available (with VOL SEL set to line ①). Insert a capacitor between pins ㉒ and ㉓.	8-step setting by serial data	–
	–			H	Test mode	–	Test mode
H	L	L	L	L	Easy mode 1 In this mode control is carried out by parallel data inputted to pins ② and ③. Fixed setting for VOL in each mode (with VOL SEL set to line ①). Insert an external capacitor between pins ㉒ and ㉓.	0dB	Disco mode
	L	H				0dB	Hall mode
	H	L				0dB	Live mode
	H	H				–3dB	Echo mode
	L	L	L	H	Easy mode 2 In this mode control is carried out by parallel data inputted to pins ② and ③.An external VOL is used to make adjustments for VOL setting only in echo mode (with VOL SEL set to line ②). In other modes, fixed setting is made for VOL (with VOL SEL set to line ②) Insert a VOL between pins ㉒ and ㉓.	0dB	Same as above.
	L	H				0dB	
	H	L				0dB	
	H	H				+3dB	
	L	L	H	L	Easy mode 3 In this mode control is carried out by parallel data inputted to pins ② and ③. In all the modes, an external VOL is used to make adjustments for VOL setting (with VOL SEL set to line ①). Insert a VOL between pins ㉒ and ㉓.	+3dB	Same as above.
	L	H					
	H	L					
	H	H					
	*	*	H	H	Test mode	–	Test mode

OPERATION MODE SETTINGS (EASY MODE)

If ⑦ EASY/ microcomputer=H,operation mode settings as shown in table below are available by parallel data given to each pin.

Operation mode settings

Symbol	Control pin ② MODE 1	Control pin ③ MODE 2	Control pin ⑧ DELAY OFF SW	DELAY TIME (Sampling frequency)	Status of each selector and switch: MODE SEL	INPUT PHASE SEL	OUTPUT PHASE SEL	SFB SW	DMIX SW	MIC MIX SW	Delay LPF cut-off frequency
Disco mode	L	L	L	18.4 msec (667kHz)	SU line	– line	– line	ON	ON	ON	7.0kHz
			H	Through outputs of input signals (R-ch IN and L-ch IN) (with clock off).							
Hall mode	L	H	L	49.2 msec (333kHz)	SU line	– line	– line	ON	ON	ON	
			H	Through outputs of input signals (R-ch IN and L-ch IN) (with clock off).							
Live mode	H	L	L	32.8 msec (500kHz)	SU line	+ line	– line	OFF	ON	ON	
			H	Through outputs of input signals (R-ch IN and L-ch IN) (with clock off).							
Echo mode	H	H	L	131.1 msec (125kHz)	EC line	+ line	+ line		ON	ON	3.0kHz
			H	Through outputs of input signals. (Delay signals are output at pin ㉔.)							

If pin ⑧ DELAY OFF SW is at H, the delay off mode takes place and input signals are transmitted as through outputs.

* Values for DELAY TIME and sampling frequencies are those obtained under the condition fck=4MHz.

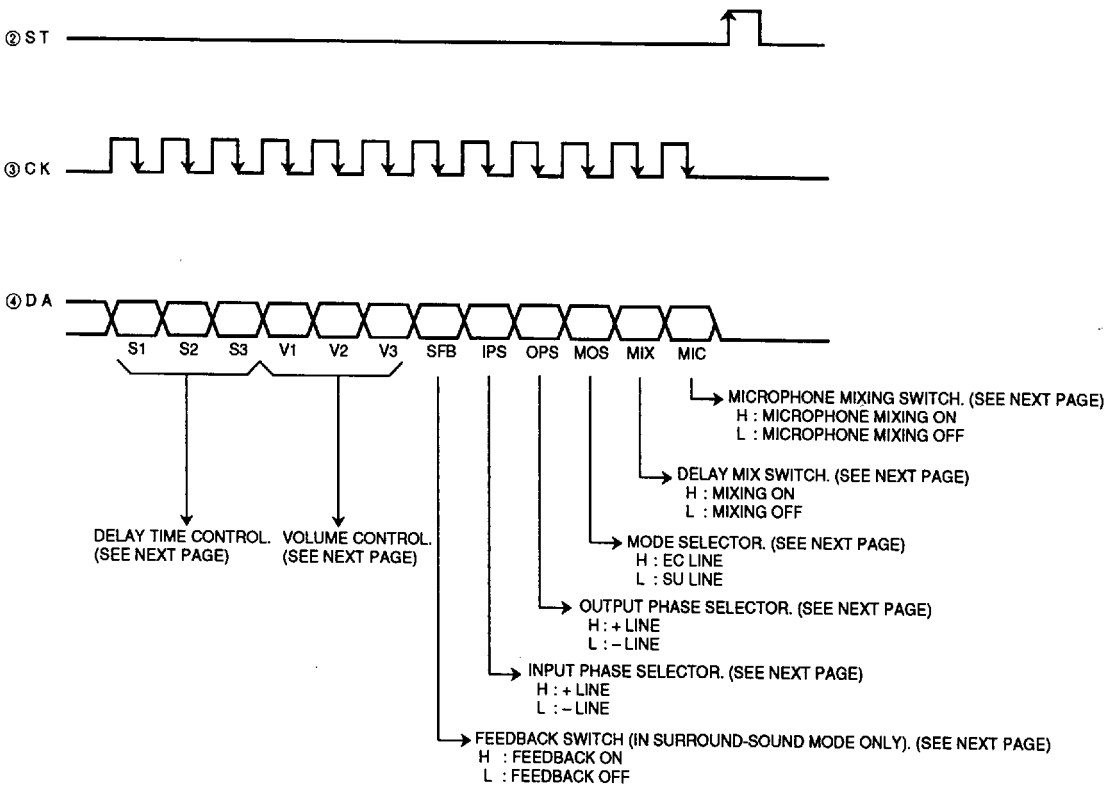
VOL Settings (The table below shows setting values of internal VOL in each mode.)

Control mode / Operation mode		Easy mode 1	Easy mode 2	Easy mode 3
	④ CONT1	L	L	H
	⑨ CONT2	L	H	L
Disco mode		0 dB	0 dB	+3 dB
Hall mode		0 dB	0 dB	
Live mode		0 dB	0 dB	
Echo mode		–3 dB	+3 dB	

* VOL attenuation in easy mode 3 and easy mode 2(echo mode)is controlled by an external VOL.

OPERATION MODE SETTINGS (MICROCOMPUTER MODE)

If ⑦ EASY/ microcomputer=L, operation mode is controlled by 12-bit serial data inputted in accordance with the following timing.



DA(data)is read at the falling edge of CK(clock). Preceding 12 bits are loaded at the rising edge of ST(strobe).

DELAY TIME CONTROL

Control Data			DELAY TIME	Delay LPF
S1	S2	S3	(Sampling frequency)	cut-off frequency
L	L	L	12.3 msec (1MHz)	7.0kHz
L	L	H	18.4 msec (667kHz)	
L	H	L	32.8 msec (500kHz)	
L	H	H	41.0 msec (400kHz)	
H	L	L	49.2 msec (333kHz)	
H	L	H	98.3 msec (167kHz)	3.0kHz
H	H	L	131.3 msec (125kHz)	
H	H	H	Delay off mode	(with clock off)

* When powered up, the auto reset function makes settings:S1=L, S2=L, and S3=L.

VOLUME CONTROL

Control Data			VOL attenuation
V1	V2	V3	
H	H	H	+3dB
H	H	H	0dB
H	L	H	–3dB
H	L	L	–6dB
L	H	H	–9dB
L	H	L	–12dB
L	L	L	–15dB
L	L	L	$-\infty$

* When powered up, the auto reset function makes settings:V1=L, V2=L, and V3=L

FEEDBACK SWITCH (In surround mode only)

Control Data	Operation switch	Remark
SFB	SFB SW	
L	OFF	Feedback OFF
H	ON	Feedback ON

* When powered up, the auto reset function makes setting:SFB=L.

INPUT PHASE SELECTOR

Control Data	Operation selector	Remark
IPS	INPUT PHASESEL	
L	– line	L–R signal is selected
H	+ line	L+R signal is selected

* When powered up, the auto reset function makes setting:IPS=L.

OUTPUT PHASE SELECTOR

Control Data	Operation selector	Remark
OPS	INPUT PHASESEL	
L	– line	L and R channels are in antiphase
H	+ line	L and R channels are in phase

* When powered up, the auto reset function makes setting:OPS=L.

MODE SELECTOR

Control Data	Operation selector
MOS	MODESEL
L	SU line
H	EC line

* When powered up, the auto reset function makes setting:MOS=L.

DELAY MIX SWITCH

Control Data	Operation switch	Remark
MIX	DMIXSW	
L	OFF	Mixing OFF
H	ON	Mixing ON

* When powered up, the auto reset function makes setting:MIX=L.

MICROPHONE MIXING SWITCH

Control Data	Operation switch	Remark
MIC	MICMIXSW	
L	OFF	Microphone mixing OFF
H	ON	Microphone mixing ON

* When powered up, the auto reset function makes setting:MIC=L.

DELAY OFF MODE

The delay off mode is for the MIX amplifier to avoid the influences of digital noise when the digital delay is not in use.

- In easy mode(pin⑦=H) : If DELAY OFF SW(pin⑧)=H, delay off mode takes place.)

Operation mode	⑧ DELAY OFFSW	IC operation
Disco	H	Clock and delay function stopped. (through outputs of input signals)
Hall		
Live		
Echo	H	DMIXSW=OFF (Through outputs of input signals)

*In echo mode delay signals are output at pin ㉔.

- In microcomputer mode(pin⑦=L) : If DELAY OFF SW(pin⑧)=H, or S1=S2=S3=H in serial data, the delay off mode takes place.)

Serial data S1=S2=S3	⑧ DELAY OFFSW	IC operation
H	L	Clock and delay function stopped. (Through outputs of input signals)
—	H	

AUTO RESET

Settings are reset automatically when the IC is powered up. The reset state is automatically canceled approximately 120 msec*1 after powering up(Vcc=5V and the capacitor connected to pin C ㉗ =47μF).

By auto reset, operation mode settings become as follows.

- Easy mode(pin ⑦ =H)

  MODE 1=Polarity of pin ②

  MODE 2=Polarity of pin ③

- Microcomputer mode(pin ⑦ =L)

S1=L	V1=L	SFB=L	MOS=L
S2=L	V2=L	IPS=L	MIX=L
S3=L	V3=L	OPS=L	MIC=L

*1About reset time

Reset time is determined by the IC's internal resistance and the value of the capacitor connected to pin ㉗. It is obtained by the following equation.

Reset time(msec)=2.5×C(μF)

Example:If C=47μF,

Reset time=2.5×47=117.5(msec)

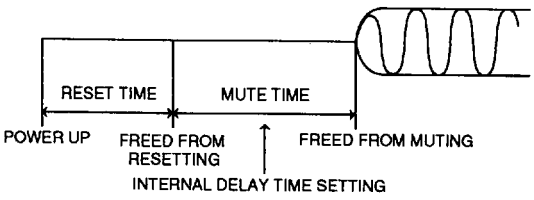
As shown above, reset time is approximately 120 msec.

AUTO MUTE FUNCTION

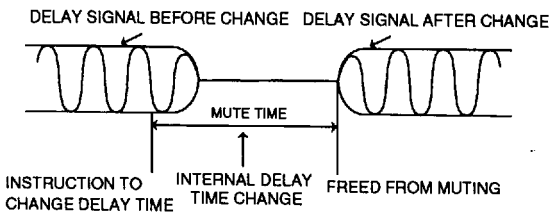
The IC carries out auto mute function at the time of powering up, delay time setting change, and canceling delay off mode, in order to suppress shock noise that the digital delay may produce.

- At power up

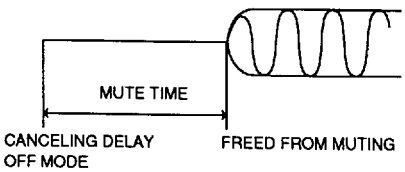
  * Transient noise common with power up occurs.



- At delay time setting change



- At canceling delay off mode



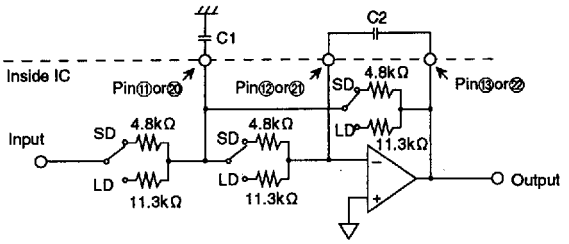
Mute time changes depending on set(or preset)delay time.

DELAY TIME	Mute time
12.3-49.2 msec	123 msec
98.3, 131.1 msec	328 msec

INPUT AND OUTPUT LPFS FOR THE DIGITAL DELAY

The input and output LPFs for the digital delay are configured as shown in figure below.

C1 and C2 are external capacitors.



The accuracy of the internal resistance of the IC is approximately ±30%.

DELAY TIME	S W
12.3 to 49.2 msec	SD line (SHORT DELAY)
98.3, 131.1 msec	LD line (LONG DELAY)

Cut-off frequencies(fc)are given as follows.

• Short delay(SD)

$$fc=\frac{1}{2\pi\times 4.8k\Omega\times\sqrt{C1\times C2}}$$

• Long delay(LD)

$$fc=\frac{1}{2\pi\times 11.3k\Omega\times\sqrt{C1\times C2}}$$

Quality factor(Q)is given by the following equation for both short and long delays.

$$Q=\frac{1}{3}\sqrt{\frac{C1}{C2}}$$

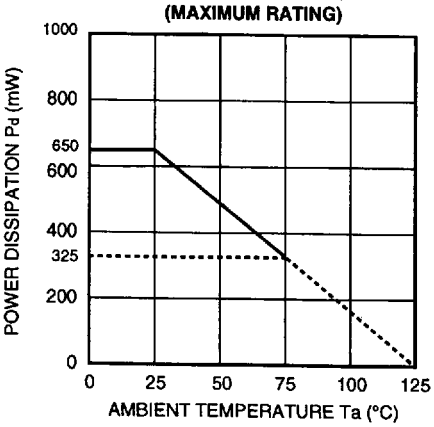
External capacitors determine the cut-off frequencies. Under the condition C1=0.01μF and C2=0.0022μF, constants set to the M65846FP are:

Short delay:fc=7.0kHz;Q=0.71

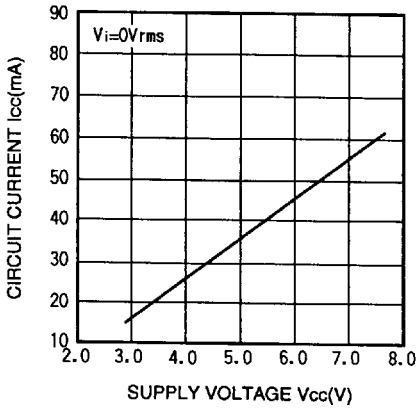
Long delay:fc=3.0kHz

TYPICAL CHARACTERISTICS

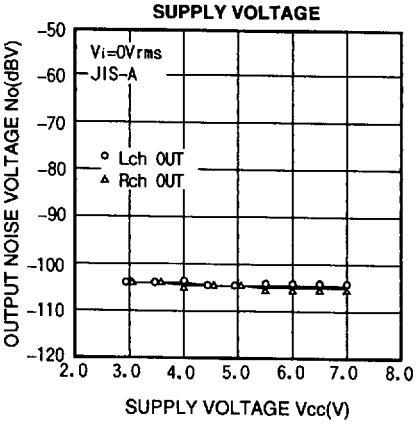
THERMAL DERATING (MAXIMUM RATING)



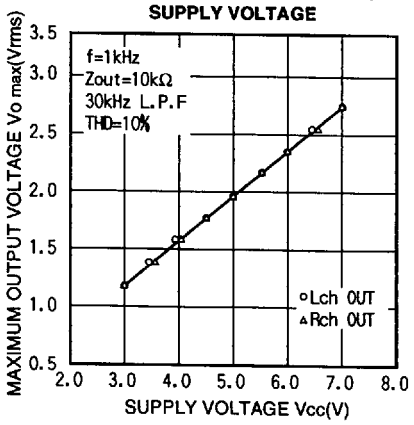
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



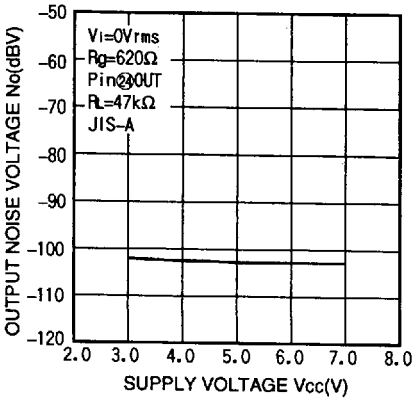
(LINE AMP) OUTPUT NOISE VOLTAGE VS. SUPPLY VOLTAGE



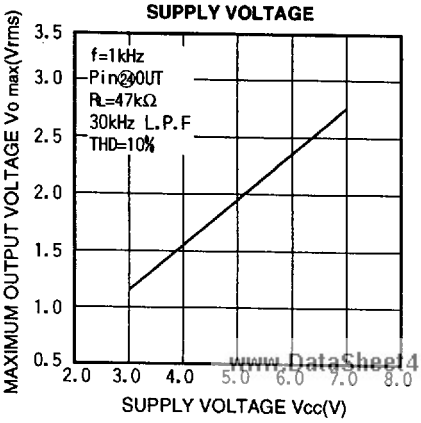
(LINE AMP) MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



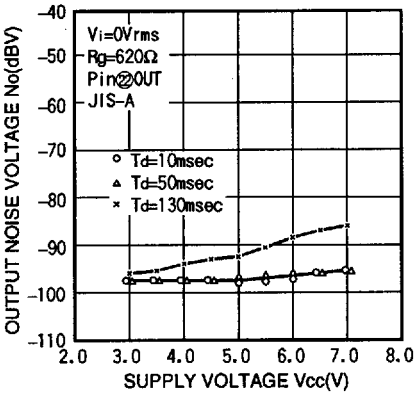
(DELAY VOLUME) OUTPUT NOISE VOLTAGE VS. SUPPLY VOLTAGE



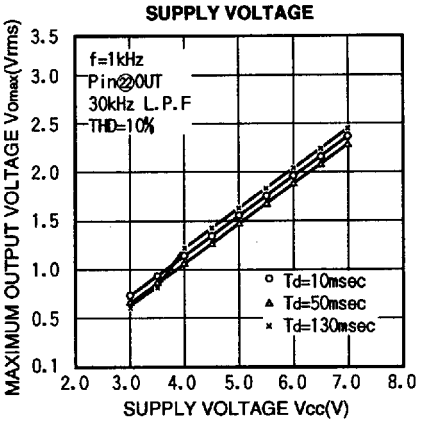
(DELAY VOLUME) MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



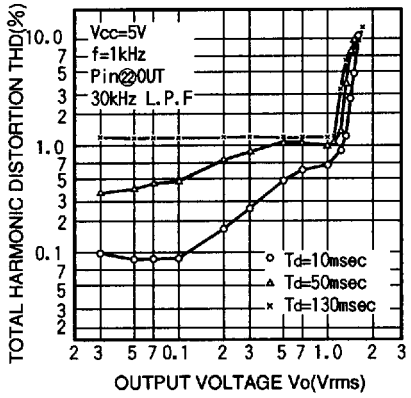
(DIGITAL DELAY)
OUTPUT NOISE VOLTAGE VS.
SUPPLY VOLTAGE



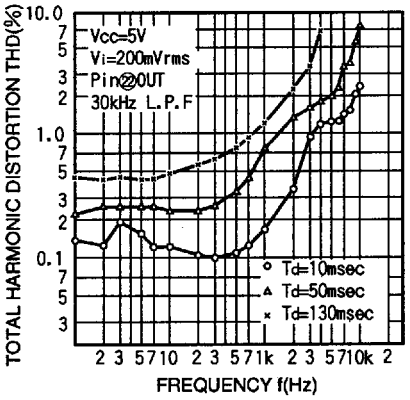
(DIGITAL DELAY)
MAXIMUM OUTPUT VOLTAGE VS.
SUPPLY VOLTAGE



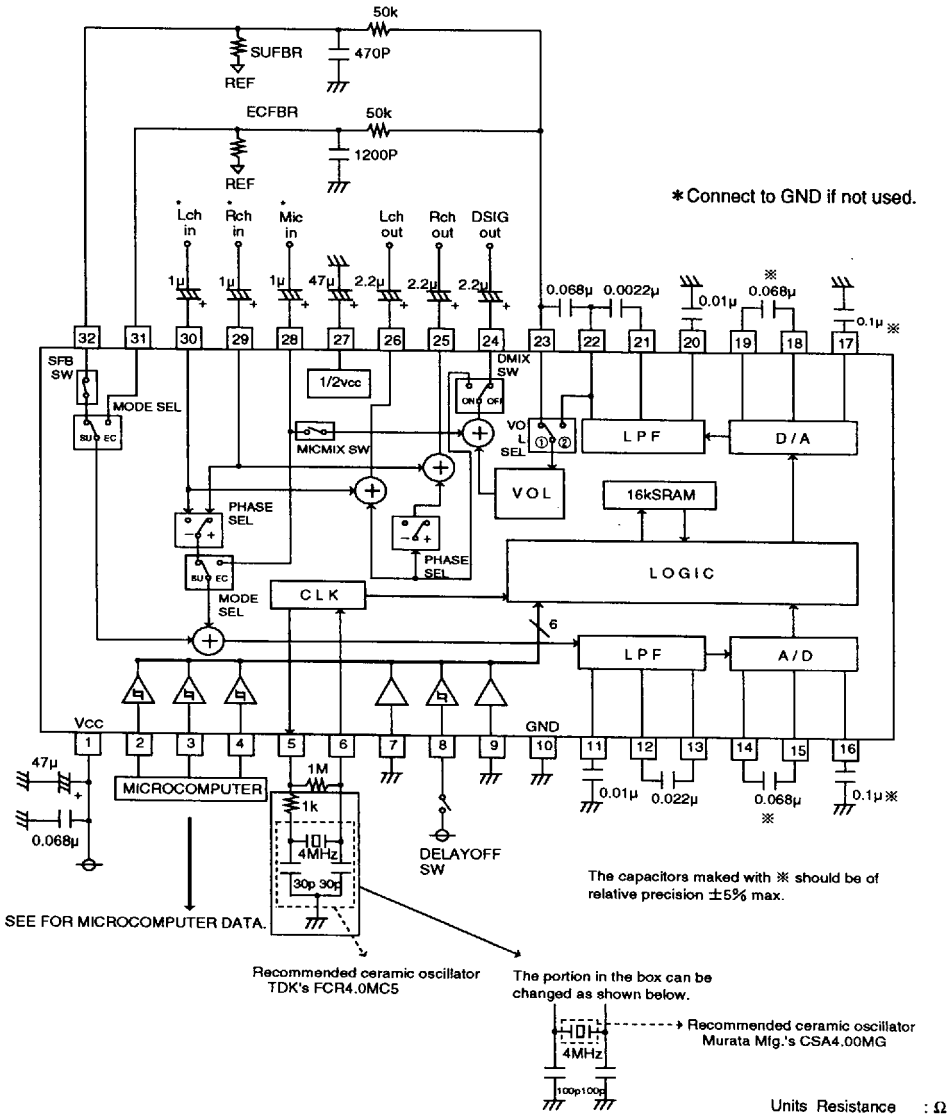
(DIGITAL DELAY)
TOTAL HARMONIC DISTORTION VS.
OUTPUT VOLTAGE



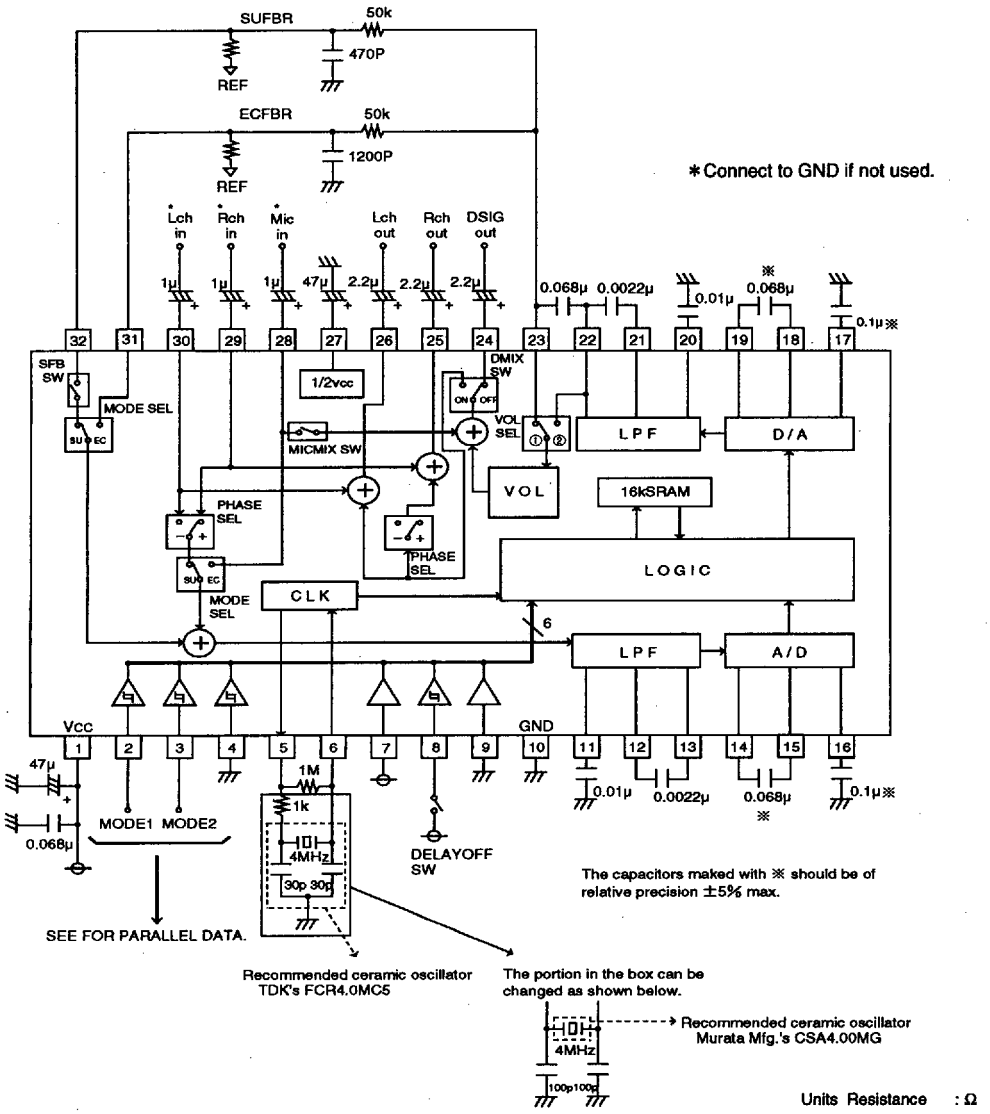
(DIGITAL DELAY)
TOTAL HARMONIC DISTORTION VS.
FREQUENCY



APPLICATION EXAMPLES
Microcomputer mode

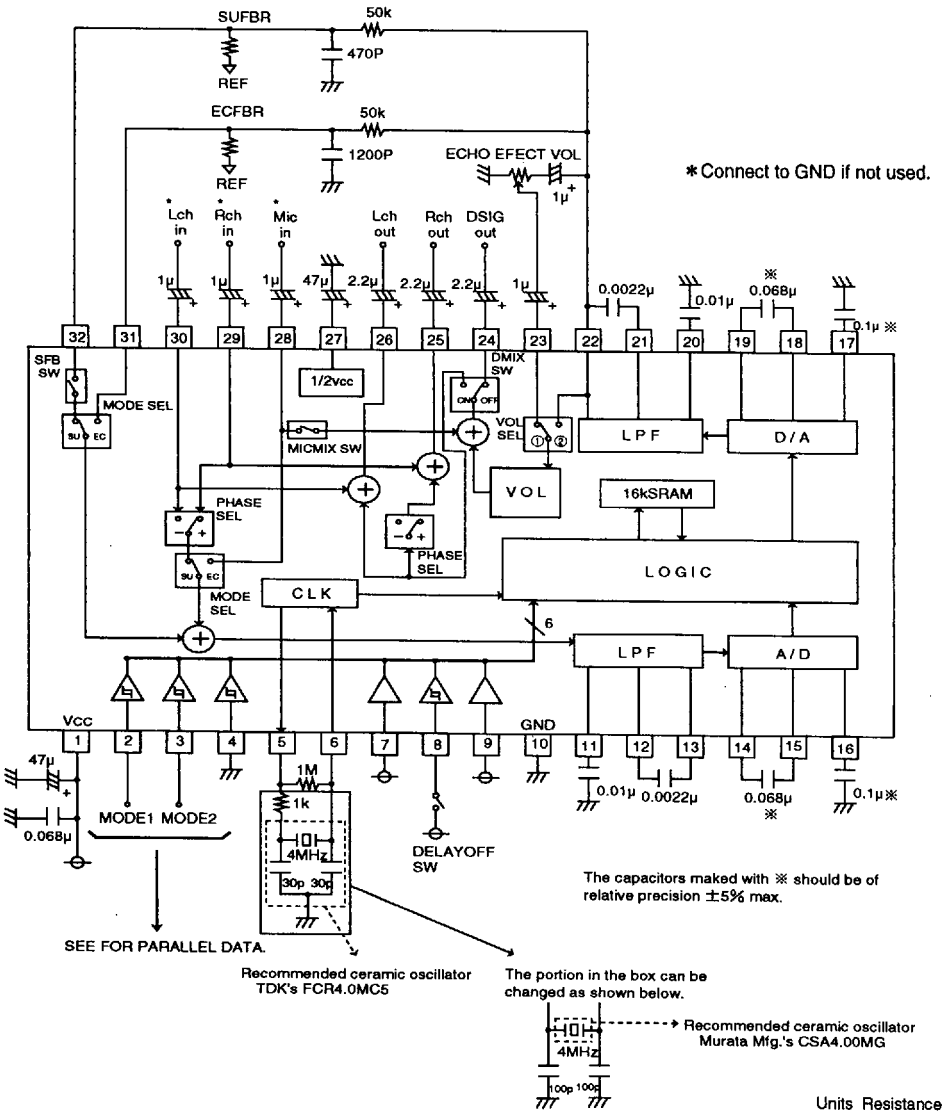


Easy mode 1



Operation mode	VOL set value	VOL SEL operation
Disco mode	0dB	Line ①
Hall mode	0dB	
Live mode	0dB	
Echo mode	–3dB	

Easy mode 2

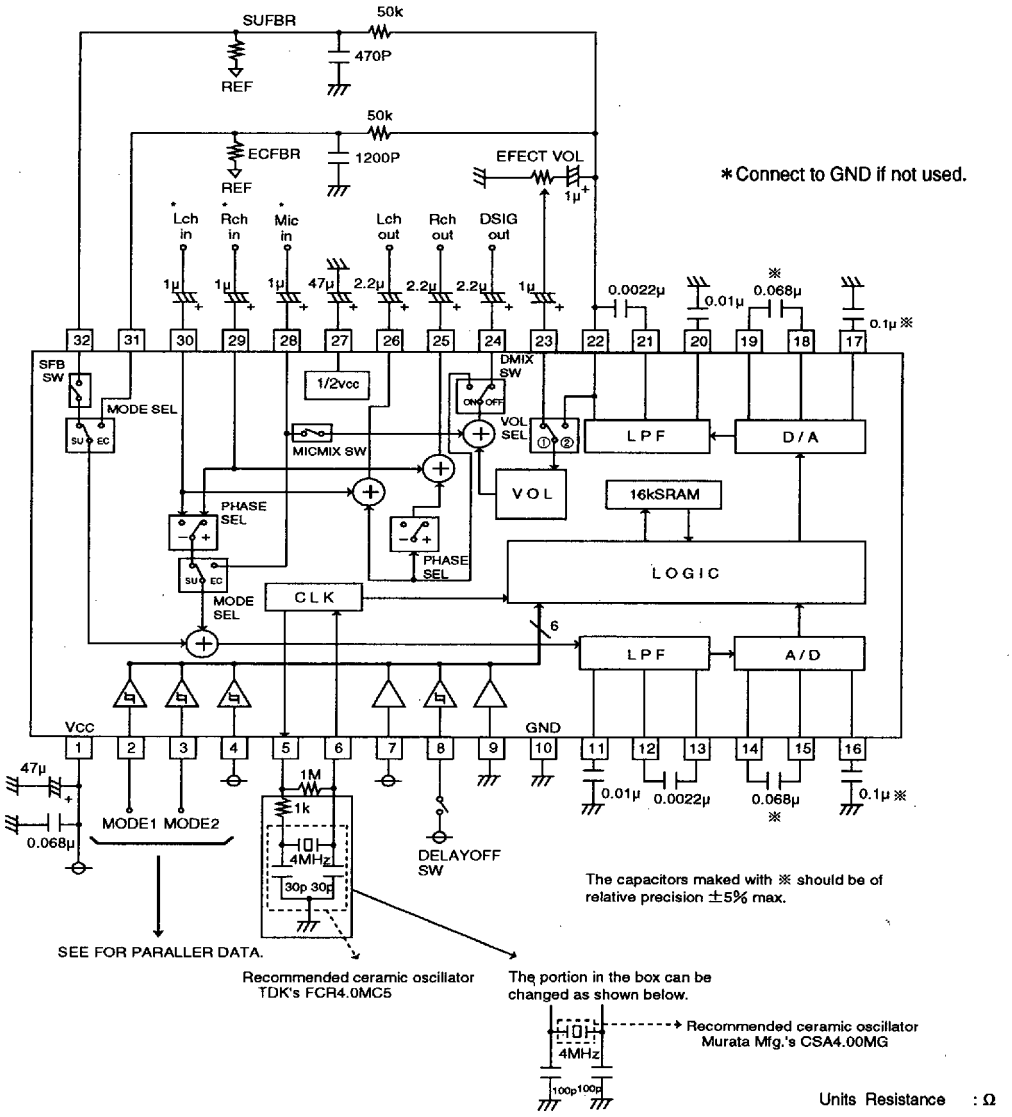


Operation mode	VOL set value	VOL SEL operation
Disco mode	0dB	Line ②
Hall mode	0dB	
Live mode	0dB	
Echo mode	Adjust by ECHO EFFECT VOL.	Line ①

M65846FP

SINGLE CHIP SURROUND PROCESSOR

Easy mode 3



Operation mode	VOL set value	VOL SEL operation
Disco mode	Adjust by EFFECT VOL.	Line ①
Hall mode		
Live mode		
Echo mode		