M65841SP

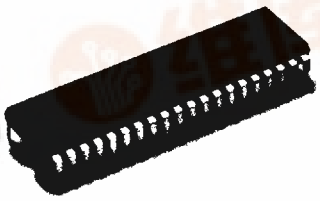
DIGITAL REVERBE (DIGITAL DELAY)

DESCRIPTION

The M65841SP is an IC to generate reverberation effect.
With synthesized outputs for five digital delay lines, this IC is capable of producing the same reverberation effect as that in a church and bathroom, and is suitable for application to the reverbe unit of mini-component stereo sets, laser disc players, "karaoke" equipment, electronic musical instruments etc.
Since this IC is a higher-performance and pin-compatible version of the conventional M-50194AP, it can replace the conventional one easily to improve the performance.

FEATURES

- Built-in input low-pass filter and memory
- Reverbe, echo or surround mode is selectable.
  - Reverbe mode ··· short : Five lines for 41.0 to 82.0msec
    Long : Five for 82.0 to 163.8msec
  - Echo mode ····· Eight steps for 20.5 to 163.8msec
  - Surround mode ····· Eight steps for 4.1 to 41.0msec
  - Feedback amount is adjustable for each mode.
- ADM digital delay allows a low-cost delay system with wide dynamic range and low distortion.
  (Reverbe mode : DR = 88dB as standard, THD = 0.7 % as standard, Surround mode : DR = 92dB as standard, THD = 0.3 % as standard)
- Operation mode and delay time can be selected in two modes, easy mode in which operation mode and delay time are controlled by 5-bit parallel data, and microcomputer mode in which they are controlled by serial data.



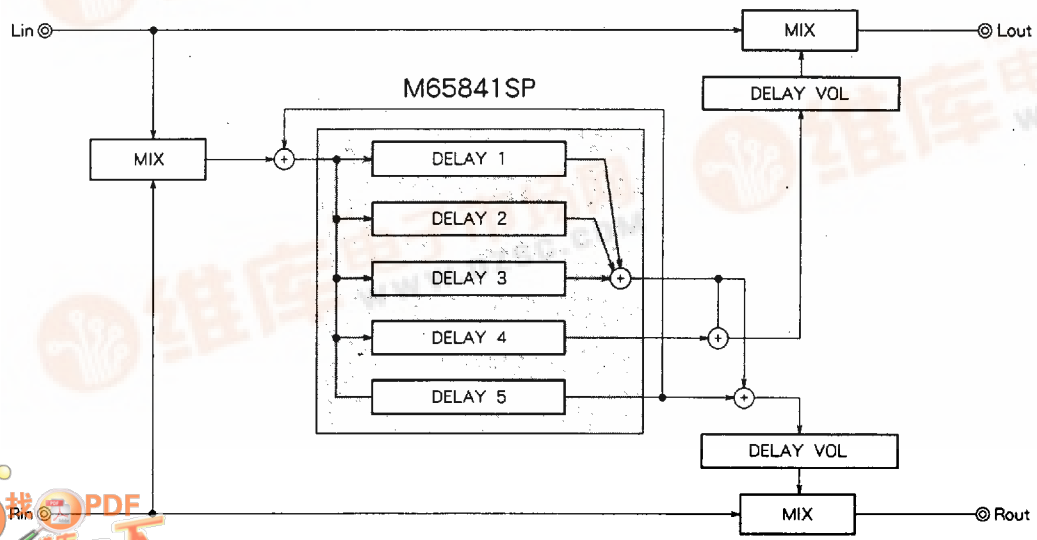
Outline 40P4B
1.778mm pitch 600mil SDIP
(13.0mm × 36.7mm × 3.8mm)

- Built-in auto mute function prevents noise generation when power is turned ON and when delay time is changed.
- Built-in auto reset circuit

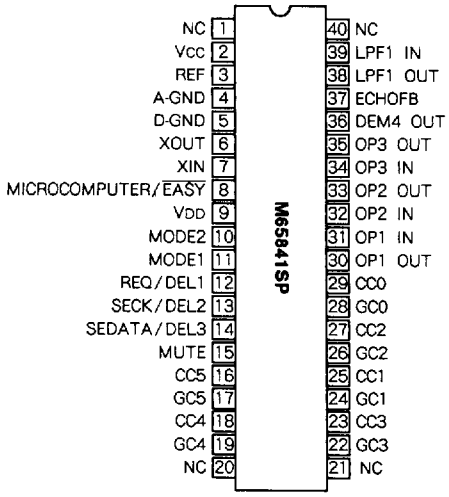
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ····· V_{CC}, V_{DD} = 4.5 to 5.5V
Rated supply voltage ····· V_{CC}, V_{DD} = 5V

SYSTEM CONFIGURATION



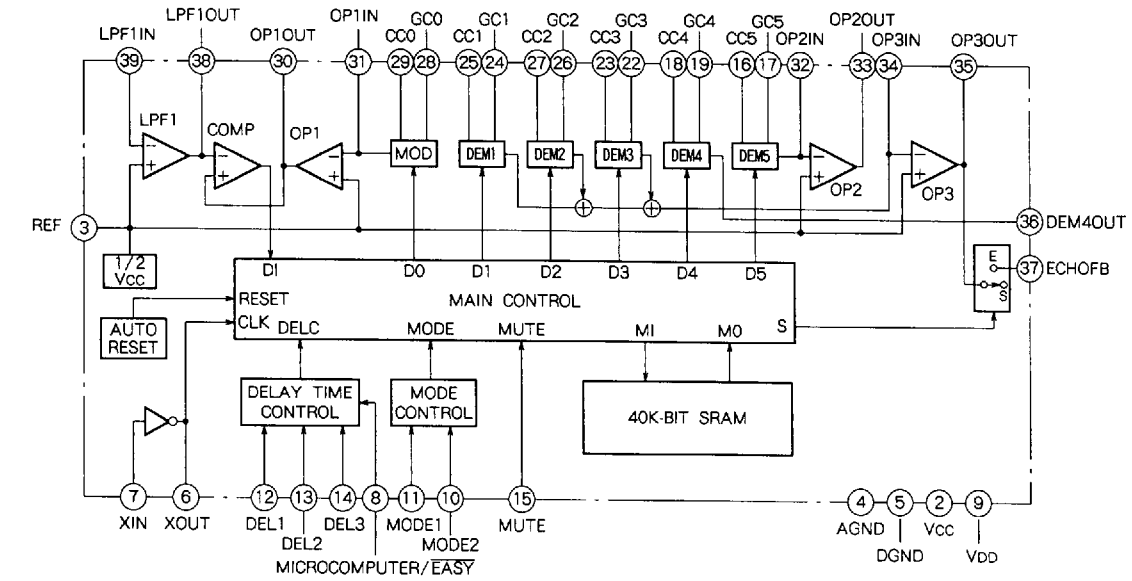
PIN CONFIGURATION (TOP VIEW)



Outline 40P4B

NC : NO CONNECTION

IC INTERNAL BLOCK DIAGRAM



PIN DESCRIPTION

Pin No.	Symbol	Name	I/O	Function	Standard output voltage
①	NC		–		–
②	V_{CC}	Analog power supply	–	To apply 4.5V to 5.5V (rating : 5V)	5V
③	REF	Reference	–	Analog regerence voltage ≒ 1/2V_{CC}	2.5V
④	A GND	Analog GND	–		–
⑤	D GND	Digital GND	–		–
⑥	X_{OUT}	Clock generator output	O		–
⑦	X_{IN}	Clock generator input	I		–
⑧	MICROCOMPUTER/ $\overline{EASY}$	Microcomputer/ $\overline{EASY}$	I	H = Microcomputer mode : control by serial data L = Easy mode : control by parallel data	–
⑨	V_{DD}	Digital power supply	–	To apply 4.5V to 5.5V (rating 5V)	5V
⑩	MODE2	Mode 2	I	Reverbe/echo/surround mode selection input Refer to the paragraph of FUNCTIONAL DESCRIPTION, item (1). In the microcomputer mode, fix the pin at L(Mode 2) H(Mode 1).	–
⑪	MODE1	Mode 1	I		–
⑫	REQ/DEL1	Request/delay 1	I↓	H=Microcomputer mode:data request signal input L=Easy mode:control time setting data 1 input	–
⑬	SECK/DEL2	Serial clock/delay 2	I↓	H=Microcomputer mode:serial data shift clock input L=Easy mode:delay time setting data 2 input	–
⑭	SEDATA/DEL3	Serial clock/delay 3	I↓	H=Microcomputer mode:serial data input L=Easy mode:delay time setting data 3 input	–
⑮	MUTE	Mute	I↓	Mute control, H = mute	–
⑯	CC5	Current control 5	–	ADM control of demodulator 5	0.4V when no signal
⑰	GC5	Gain control 5	–	Gain control of demodulator 5	
⑱	CC4	Current control 5	–	ADM control of demodulator 4	
⑲	GC4	Gain conrol 4	–	Gain control of demodulator 4	
⑳	NC		–		–
㉑	NC		–		–
㉒	GC3	Gain control 3	–	Gain conrol of demodulator 3	0.4V when no signal
㉓	CC3	Current control 3	–	ADM control of demodulator 3	
㉔	GC1	Gain control 1	–	Gain control of demodulator 1	
㉕	CC1	Current control 1	–	ADM control of demodulator 1	
㉖	GC2	Gain control 2	–	Gain control of demodulator 2	
㉗	CC2	Current control 2	–	ADM control of demodulator 2	
㉘	GC0	Gain control 0	–	Gain control of modulator 0	
㉙	CC0	Current control 0	–	ADM control of modulator 0	
㉚	OP1 OUT	Operational amplifier 1 output	O	To form modulating integrator by connecting external capacitor and resistor	2.5V
㉛	OP1 IN	Operational amplifier 1 input	I		2.5V
㉜	OP2 IN	Operational amplifier 2 input	I	To form demodulating integrator by connecting external capacitor and resistor	2.5V
㉝	OP2 OUT	Operational amplifier 2 output	O		2.5V
㉞	OP3 IN	Operational amplifier 3 input	I	To form demodulating integrator by connecting external capacitor and resistor	2.5V
㉟	OP3 OUT	Operational amplifier 3 output	O		2.5V
㊱	DEM4 OUT	DEM4 output	O	Demodulator 4 output	–
㊲	ECHOFB	Echo feedback	O	Feedback control for echo mode	2.5V
㊳	LPF1 OUT	Low-pass filter 1 output	O	To form input low-pass filter by connecting external capacitor and resistor	2.5V
㊴	LPF1 IN	Low-pass filter 1 input	I		2.5V
㊵	NC		–		–

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

Symbol	Parameter	Ratings	Unit
V_{CC}	Supply voltage	6.5	V
I_{CC}	Circuit current	150	mA
P_d	Power dissipation	1.7	W
T_{opr}	Operating temperature	−20 to 75	℃
T_{stg}	Storage temperature	−40 to 125	℃

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{DD}	Supply voltage		4.5	5	5.5	V
$V_{CC}-V_{DD}$	V_{CC}-V_{DD} potential difference		−0.3	0	0.3	V
f_{ck}	Clock frequency		3	4	6	MHz
V_{IH}	Input voltage (H level)		0.7V_{DD}	−	V_{DD}	V
V_{IL}	Input voltage (L level)		0	−	0.3V_{DD}	V
f_{SECK}	Microcomputer mode serial clock		−	−	4	MHz

ELECTRICAL CHARACTERISTICS (V_{CC} = 5V, f = 1kHz, V_i = 100mVrms, f_{ck} = 4MHz, Ta = 25℃, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
I_{CC}	Circuit current	No signal input			−	30	60	mA
V_{REF}	Reference voltage				2.0	2.5	3.0	V
Gv	I-O voltage gain	R_L = 47k Ω			−2.5	−0.5	1.5	dB
Gr	Low level I-O voltage gain	V_i = 2mVrms			−3.5	−0.5	2.5	dB
V_{Omax}	Maximum output voltage	THD = 10%			0.7	1.0	−	Vrms
THD	Output distortion	30kHz LPF	Reverbe mode	fs = 500kHz	−	0.3	1.0	%
			Echo mode	fs = 250kHz	−	0.7	1.5	%
			Surround mode	fs = 1MHz	−	0.3	1.0	%
No	Output noise voltage	Low sample rate side DIN-AUDIO	Reverbe mode	Average	−	−88	−75	dBv
				± peak	−	200	800	μV
			Echo mode	Average	−	−92	−80	dBv
				± peak	−	100	400	μV
			Surround mode	Average	−	−92	−85	dBv
				± peak	−	100	230	μV
SVRR	Supply voltage reduction ratio	△ V_{CC} = −20dBv, f = 100Hz			−	−40	−25	dB
tMUTE	Mute time	Reverbe/echo mode			515	520	525	msec
		Surround mode			122	127	132	msec
tM1	Mute operation time (Internal delay time change)	Reverbe/echo mode At time of (a) changing delay time, and (b) turning on power			257	260	263	msec
tM2	Mute operation time (Mute OFF)				257	260	263	msec
tM1	Mute operation time (Internal delay time change)	Surround mode At time of (a) changing delay time, and (b) turning on power			61	64	67	msec
tM2	Mute operation time (Mute OFF)				61	64	67	msec
I_{IHA}	Input leak current (H level)	V_I = 5V, pins 8, 10, 11			−	−	1	μA
I_{ILA}	Input leak current (L level)	V_I = 0V, pin 8, 10, 11			−	−	−1	μA
R_{PD}	Pulldown resistance	Pins 12, 13, 14, 15			25	50	75	kΩ

FUNCTION DESCRIPTION

(1) Operation mode

MODE1 (Pin ⑪)	MODE2 (Pin ⑩)	Mode	ECHOFB Output
L	H	Surround mode	OFF
H	H	Echo mode	ON
H	L	Reverbe mode	OFF
L	L	Test mode	–

(2) Delay time

DEL1	DEL2	DEL3	Surround mode		Echo mode		Reverbe mode	
			f_s	T_d	f_s	T_d	f_s	T_d
L	L	L	1M	4.1	500k	20.5	500k	81.9
H	H	L		10.2		41.0		49.2
H	L	L		14.3		61.4		61.4
L	H	L		20.5		81.9		69.6
H	L	H	1M	24.6	250k	98.3	250k	41.0
L	L	H		30.7		122.9		163.8
L	H	H		34.8		139.3		98.3
H	H	H		41.0		163.8		122.9
								139.3
								81.9

f_s = Sampling frequency (Hz)
T_d = Delay time (msec)

Note 1. In the reverbe mode, delay time changes according to the polarity at DEL3 (and independent of the polarity at DEL 1 or DEL2).

(3) Easy mode

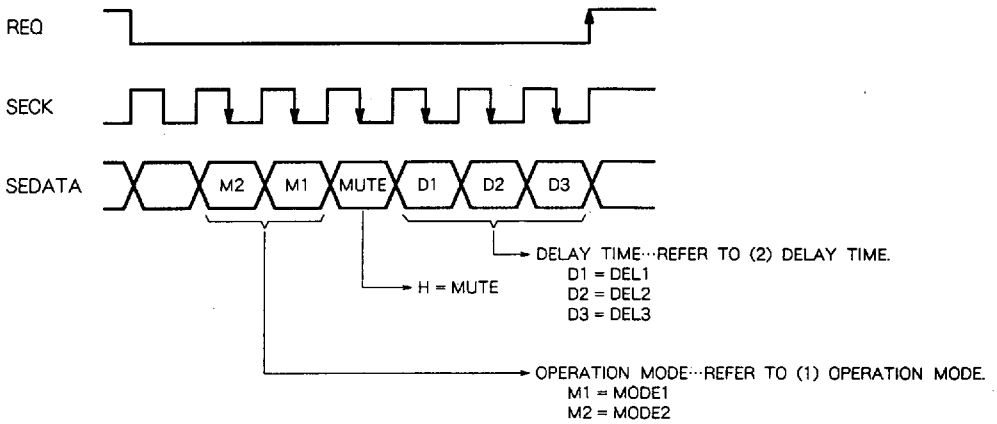
When microcomputer/$\overline{EASY}$ = L, operation mode and delay time can be controlled by parallel data input to each terminal

pin MODE1, MODE2) Operation mode···Refer to (1) Operation mode.

DEL1, DEL2, DEL3) Delay time···Refer to (2) Delay time.

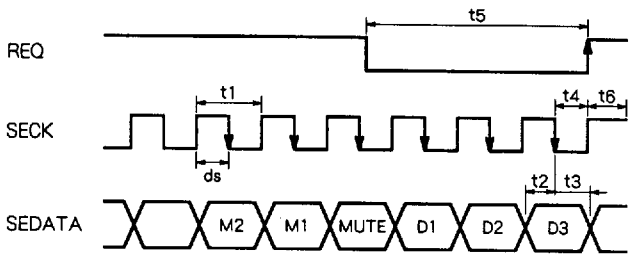
(4) Microcomputer mode

When microcomputer/$\overline{EASY}$ = H, operation mode and delay time can be controlled by serial data input at the following timing.



SEDATA is read at each fall of SECK, with the last six bits loaded at rise of REQ.

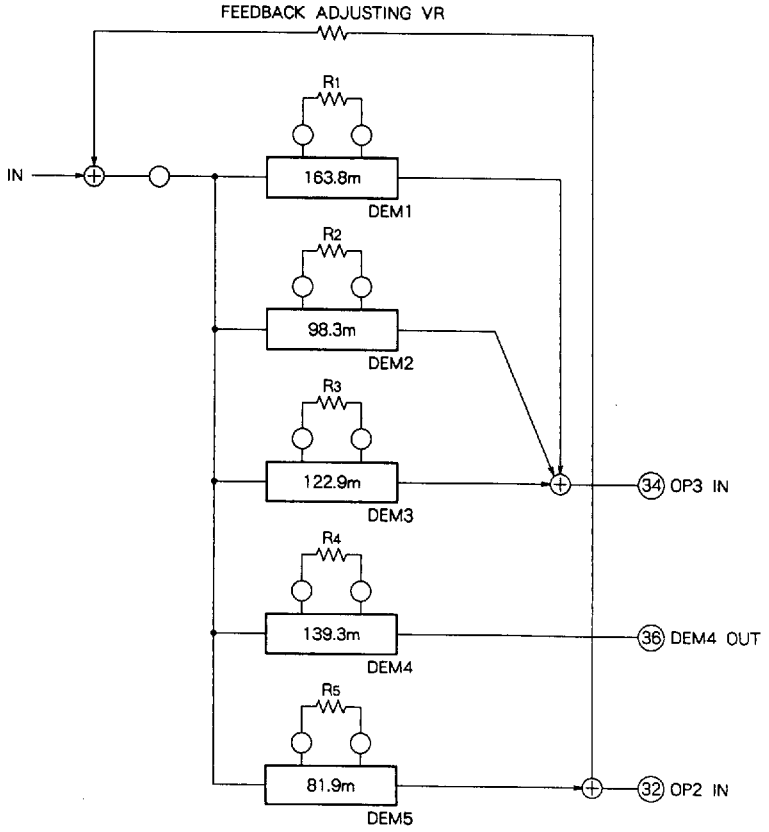
Input timing of REQ, SECK and SEDATA in the microcomputer mode is shown below :



Symbol	Name	min	typ	max	Unit
t1	SECK clock duration	250	–	–	nsec
ds	SECK pulse duty	–	50	–	%
t2	SEDATA setup time	100	t1/2	–	nsec
t3	SEDATA hold time	100	t1/2	–	nsec
t4	REQ hold time	100	–	–	nsec
t5	REQ pulse duration	100	–	–	nsec

Note. No specification for t6

(5) Reverbe construction



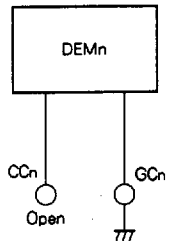
R1~R5 : Delay gain adjusting resistors
(Each delay time value is at fs = 250kHz)

(6) Selection of demodulator

Allocation of demodulator and delay time (msec)

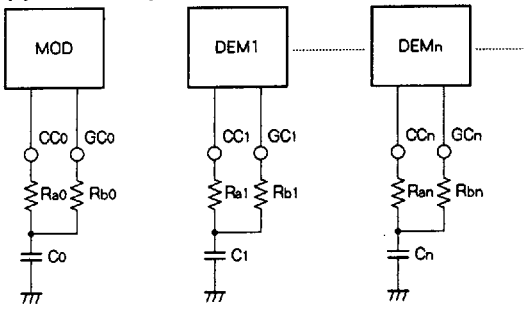
Demodulator	Surround mode	Echo mode	Reverbe mode	
			fs=500kHz	fs=250kHz
DEM1	–	–	81.9	163.8
DEM2	4.1~41.0	20.5~163.8	49.2	98.3
DEM3	–	–	61.4	122.9
DEM4	–	–	69.6	139.3
DEM5	–	–	41.0	81.9

Each modulator is turned OFF when connected as follows in the reverbe mode, so that unnecessary delay time can be eliminated.



However, demodulator 2 is used in the surround/echo mode. Therefore, demodulator 2 cannot be turned OFF if operation mode is switched over from the surround/echo mode to reverbe mode.

(7) Gain setting



The gain of DEMn (demodulator n) is determined by the ratio to R_{b0} connected to the modulator.

$$A_n = \frac{R_{b0}}{R_{bn}}$$

$$R_{an} = \frac{R_{bn}}{10}$$

$$C_n = A_n \cdot C_0$$

Typical constants on the modulator side :

$R_{a0} = 7.5k\,\Omega$

$R_{b0} = 75k\,\Omega$

$C_0 = 0.33\,\mu F$

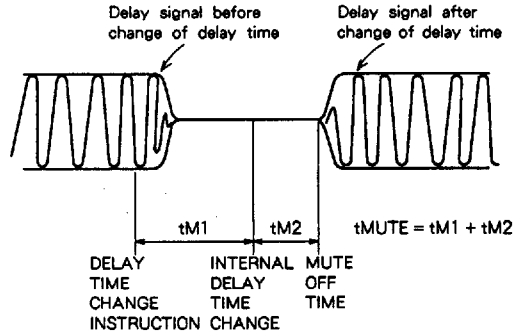
However, the gain in the surround/echo mode is determined by R_{b2} because demodulator 2 is used.

(8) Feedback output

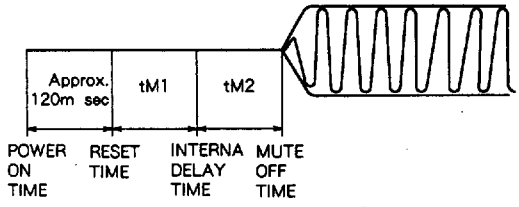
In the echo mode, signal is output from ECHOFB. Therefore, optimum multiple delay can automatically be obtained by feeding back the signal through appropriate feedback resistance from ECHOFB to the input side.

There is no feedback output in the surround or reverbe mode.

(9) Muting



(a) When delay time is changed



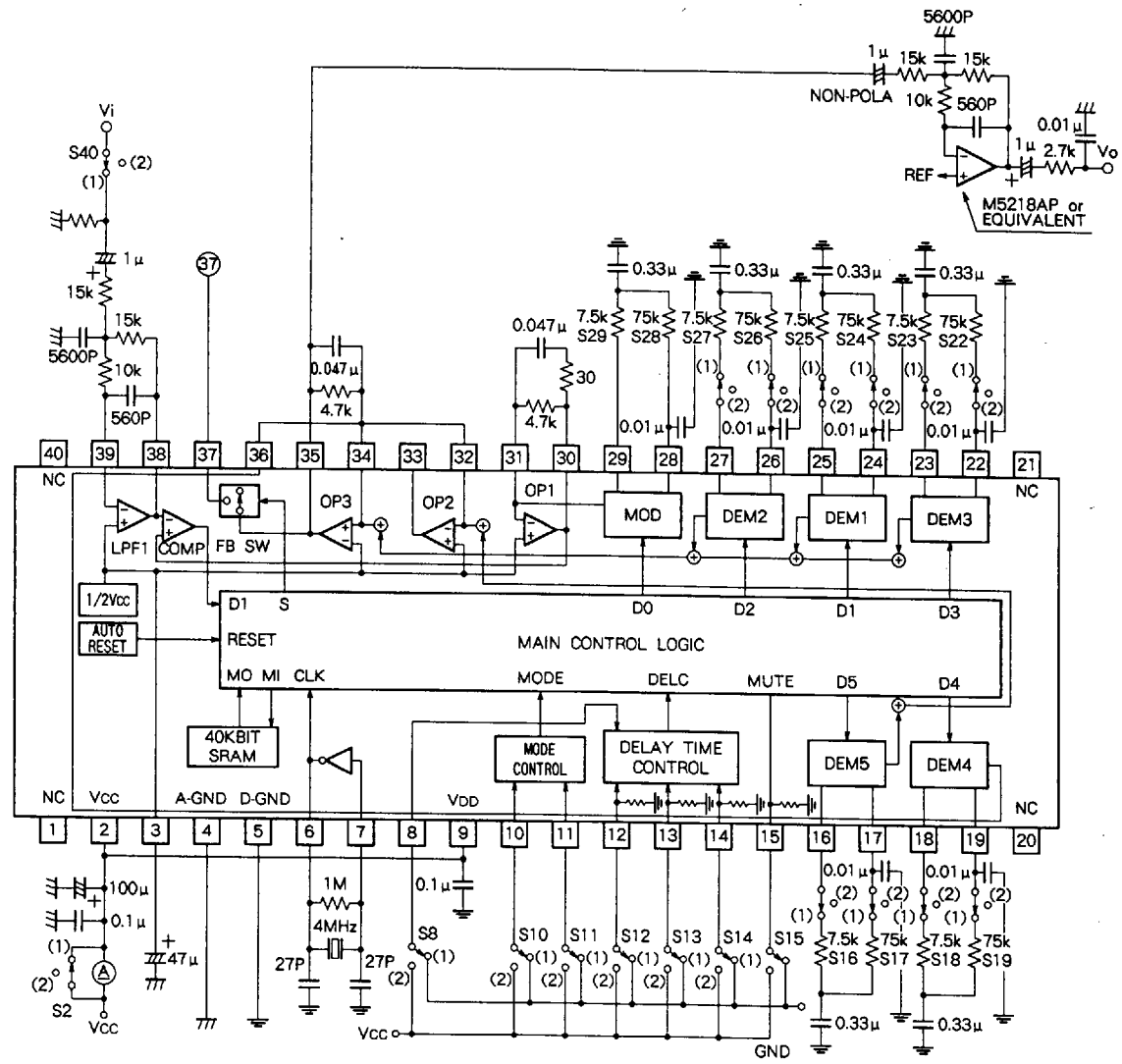
(b) When power is turned ON

(10) Reset

When reset circuit is activated, operation mode is switched to the echo mode, and Td is set to 163.8msec.

$$\begin{cases} \text{MODE1} = \text{H} \\ \text{MODE2} = \text{H} \end{cases} \qquad \begin{cases} \text{DEL1} = \text{H} \\ \text{DEL2} = \text{H} \\ \text{DEL3} = \text{H} \\ \text{MUTE} = \text{L} \end{cases}$$

TEST CIRCUIT



DIGITAL GND

ANALOG GND

Units Resistance : Ω
Capacitance : F

TEST CONDITIONS

Switch setting

※···See the note under the table. *···1 or 2

Symbol	Parameter	Mode	Sampling frequency	S02	S08	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S22	S23	S24	S25	S26	S27	S40	Remark
Icco	Circuit current	Surround/echo/reverbe		2	1	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	No signal
Gvs	Voltage gain	Surround	1MHz	1	↓	2	1	*	*	*	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	Gv = 20log (Vo/Vi) In the reverbe mode, measurement is made for individual demodulators.
Gve1		Echo	500kHz	↓	↓	2	2	*	*	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Gve2		Echo	250kHz	↓	↓	2	2	*	*	2	↓	↓	↓	↓	↓	1	1	1	1	1	1	↓	
Gvr1		Reverbe	500kHz	↓	↓	1	2	1	1	1	↓	↓	↓	↓	↓	※	※	※	※	※	※	↓	
Gvr2		Reverbe	250kHz	↓	↓	1	2	1	1	2	↓	↓	↓	↓	↓	※	※	※	※	※	※	↓	
Tdsa	Delay time	Surround	1MHz	↓	↓	2	1	1	1	1	↓	↓	↓	↓	↓	1	1	1	1	1	1	↓	Refer to FUNCTIONAL DESCIPTION. In the reverbe mode, measurement is made for individual demodulators.
Tdsb				↓	↓	↓	↓	2	2	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdsc				↓	↓	↓	↓	2	1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdsd				↓	↓	↓	↓	1	2	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdse				↓	↓	↓	↓	2	1	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdsf				↓	↓	↓	↓	1	1	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdsg				↓	↓	↓	↓	1	2	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdsh				↓	↓	↓	1	2	2	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdea		Echo	500kHz	↓	↓	↓	2	1	1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdeb				↓	↓	↓	↓	2	2	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdec				↓	↓	↓	↓	2	1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tded				1	1	2	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	
Tdee			250kHz	1	1	2	2	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	
Tdef				↓	↓	2	↓	1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdeg				↓	↓	2	↓	1	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Tdeh				↓	↓	2	↓	2	2	2	↓	1	1	1	1	1	1	1	1	1	1	↓	
Tdra		Reverbe	500kHz	↓	↓	1	↓	1	1	1	↓	2	2	2	2	2	2	1	1	2	2	↓	
Tdrb				↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	2	2	2	1	1	↓	
Tdrc				↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	2	1	1	↓	↓	2	2	↓	
Tdrd				↓	↓	↓	↓	↓	↓	↓	↓	2	2	1	1	2	2	↓	↓	↓	↓	↓	
Tdre				↓	↓	↓	↓	↓	↓	1	↓	1	1	2	2	↓	↓	2	2	↓	↓	↓	
Tdrf			250kHz	↓	↓	↓	↓	↓	↓	2	↓	2	2	↓	↓	↓	↓	1	1	2	2	↓	
Tdrg				↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	2	2	2	1	1	↓	
Tdrh				↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	2	1	1	↓	↓	2	2	↓	
Tdri				↓	↓	↓	↓	↓	↓	↓	↓	2	2	1	1	2	2	↓	↓	↓	↓	↓	
Tdrj				↓	↓	1	2	1	1	2	↓	1	1	2	2	2	2	2	2	2	2	↓	

Switching setting (Cont.)

※···See the under the table. *···1 or 2

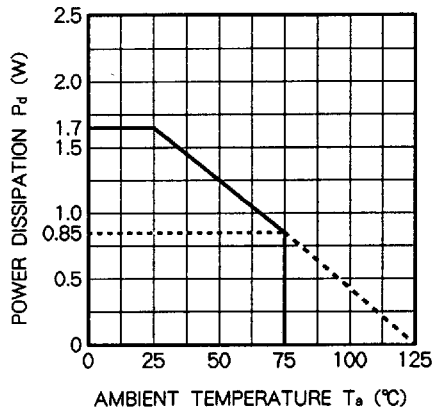
Symbol	Parameter	Mode	Sampling frequency	S02	S08	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S22	S23	S24	S25	S26	S27	S40	Remark
V_{Omaxs}	Maximum output voltage	Surround	1MHz	↓	↓	2	1	*	*	*	↓	↓	↓	1	1	1	1	1	1	1	1	↓	30kHz L.P.F THD = 10% In the reverbe mode, measurement is made for individual demodulators.
V_{Omaxe1}		Echo	500kHz	↓	↓	2	2	*	*	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
V_{Omaxe2}			250kHz	↓	↓	2	2	*	*	2	1	1	1	1	1	1	1	1	1	1	1	↓	
V_{Omaxr1}		Reverbe	500kHz	↓	↓	1	2	1	1	1	↓	※	※	※	※	※	※	※	※	※	※	↓	
V_{Omaxr2}			250kHz	1	1	1	2	1	1	2	1	※	※	※	※	※	※	※	※	※	※	1	
THDs	Higher harmonic distortion	Surround	1MHz	1	1	2	1	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	30kHz L.P.F In the reverbe mode, measurement is made for individual demodulators.
THDe1		Echo	500kHz	↓	↓	2	2	*	*	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
THDe2			250kHz	↓	↓	2	2	*	*	2	↓	↓	↓	1	1	1	1	1	1	1	1	↓	
THDr1		Reverbe	500kHz	↓	↓	1	2	1	1	1	↓	↓	↓	※	※	※	※	※	※	※	※	↓	
THDr2			250kHz	↓	↓	1	2	1	1	2	↓	↓	↓	※	※	※	※	※	※	※	※	1	
Nos	Output noise voltage	Surround	1MHz	↓	↓	2	1	*	*	*	↓	↓	↓	1	1	1	1	1	1	1	1	2	DIN AUDIO V_i = 0mVrms
Noe1		Echo	500kHz	↓	↓	2	2	*	*	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Noe2			250kHz	↓	↓	2	2	*	*	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Nor1		Reverbe	500kHz	↓	↓	1	2	1	1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Nor2			250kHz	↓	↓	1	2	1	1	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	
SVRR	Supply voltage reduction ratio	Suround/echo/ reverbe		↓	↓	*	*	*	*	*	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	△Vcc=-20dBV, f=100Hz
MUTEs	Muting time	Surround	1MHz	↓	↓	2	1	2→1	2→1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MUTEe		Echo	500kHz 250kHz	↓	↓	2	2	2→1	2→1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MUTEr		Reverbe	500kHz 250kHz	1	1	1	2	1	1	2→1	1	1	1	1	1	1	1	1	1	1	1	1	

Note. ※ indicates that measurement is made for individual demodulators in the reverbe mode.
For demodulator 2 (DEM2), measurement is made with the following switch setting. Use equivalent switch setting for measuring each of other demodulators 1 through 5.

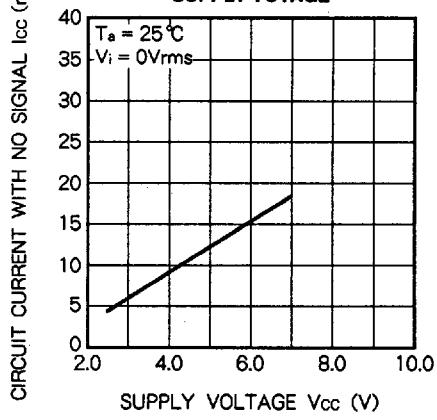
S16	S17	S18	S19	S22	S23	S24	S25	S26	S27
2	2	2	2	2	2	2	2	1	1

TYPICAL CHARACTERISTICS

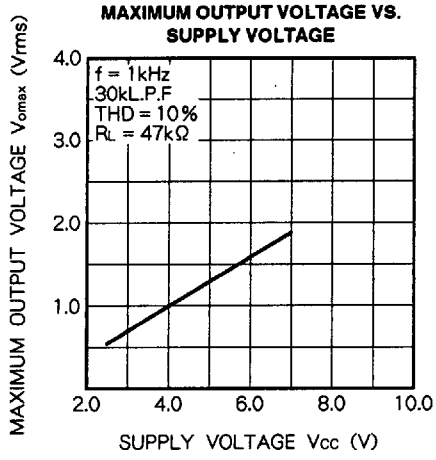
THERMAL DERATING



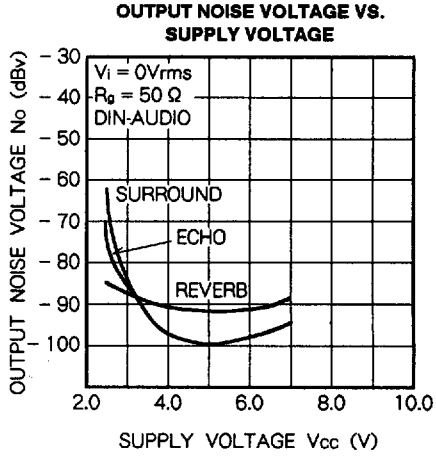
CIRCUIT CURRENT WITH NO SIGNAL VS. SUPPLY VOTAGE



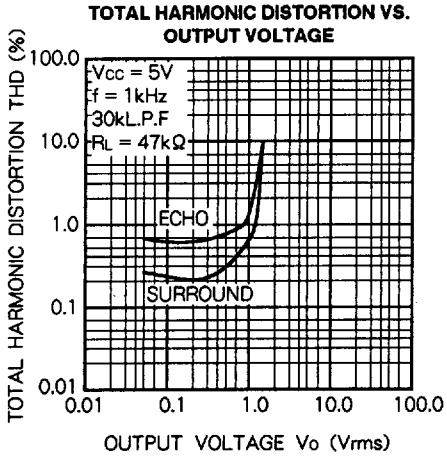
MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



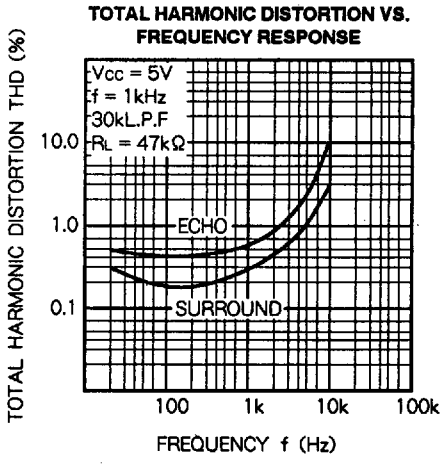
OUTPUT NOISE VOLTAGE VS. SUPPLY VOLTAGE



TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE

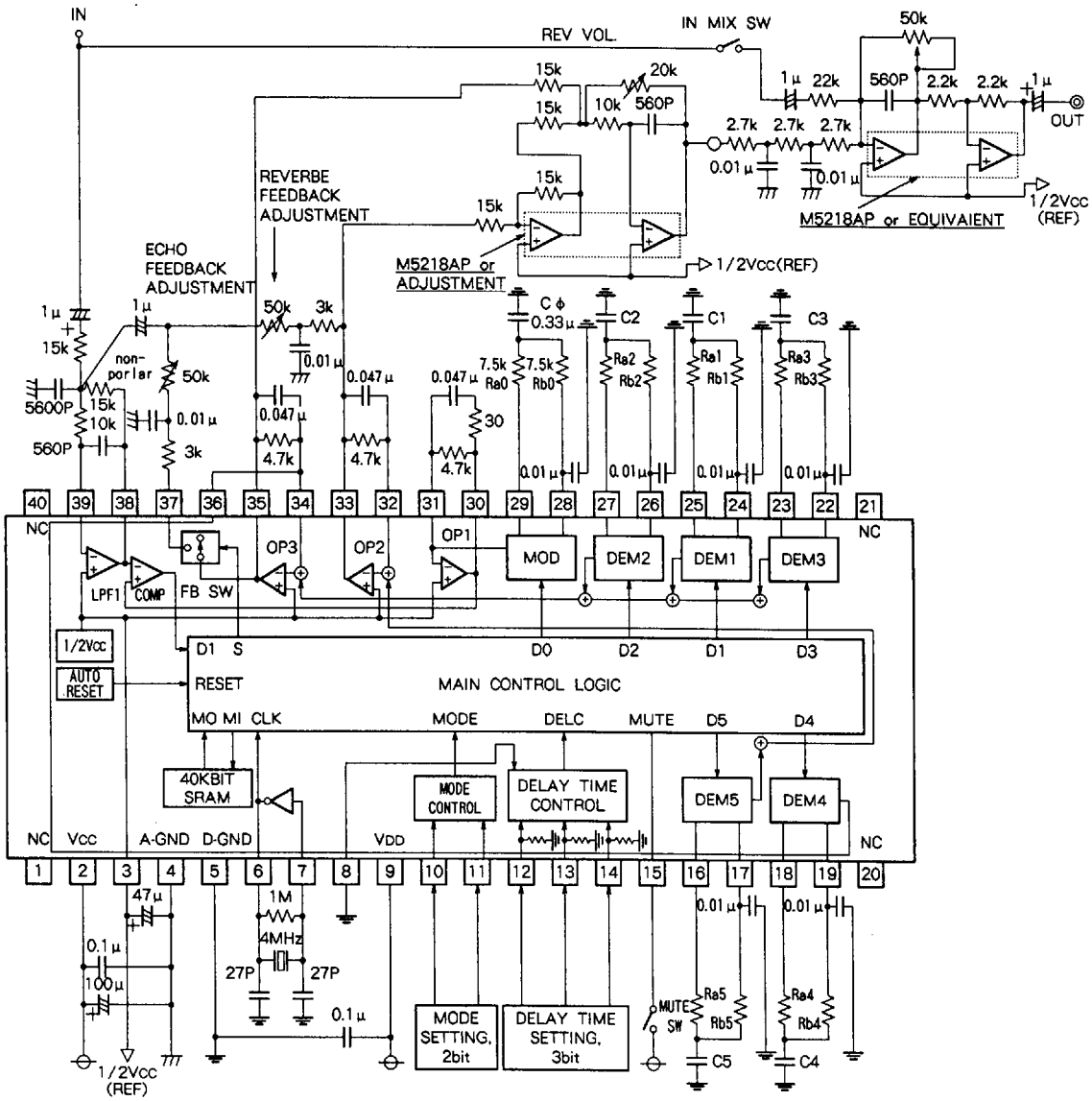


TOTAL HARMONIC DISTORTION VS. FREQUENCY RESPONSE



APPLICATION EXAMPLE

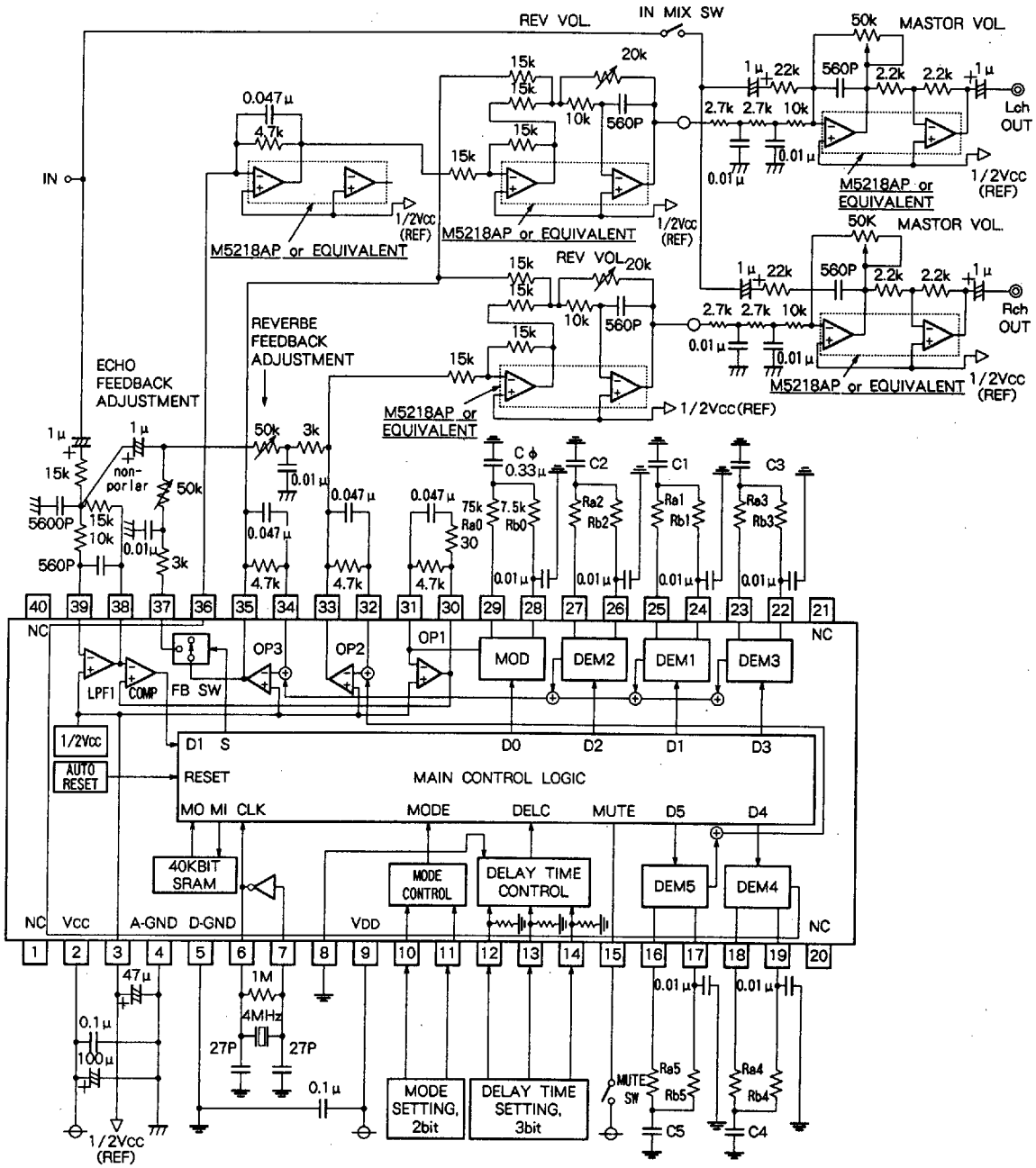
Easy mode 1ch. OUT



Units Resistance : Ω
Capacitance : F

APPLICATION EXAMPLE

Easy mode 2ch. OUT



Units Resistance : Ω
Capacitance : F