YAMAHA LSI

YMF289B

OPL3-L

OPL3 Low Voltage version

■ OVERVIEW

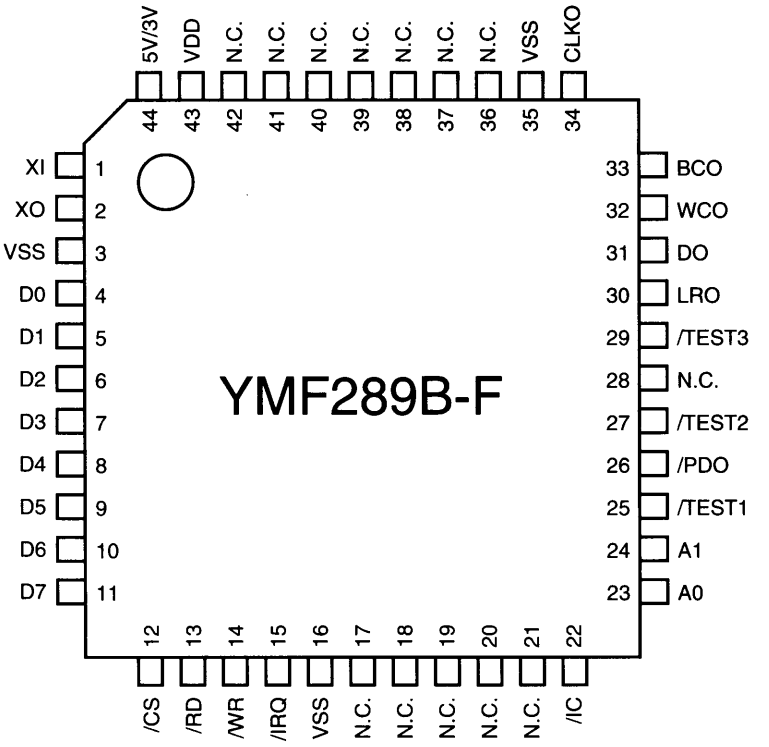
YMF289B (OPL3-L) is a synthesizer chip developed specially for note PC, PCMCIA (type II) card. YMF289B is compatible with YMF262 which is de facto standard in sound card market. Special functions (power down mode, 3.3V power supply and etc.) are newly featured.

■ FEATURES

- Register-compatible with YMF262
  1. Sound generation modes
     - Two-operator mode
       Generates eighteen voices or fifteen voices plus five rhythm sounds simultaneously.
     - Four-operator mode
       Generates six voices in four-operator mode plus six voices in two-operator mode, or generates six voices in four-operator mode plus three voices in two-operator mode plus five rhythm sounds simultaneously.
  2. Eight selectable waveforms
  3. Stereo output
- Sampling frequency is 44.1kHz.
- All registers are readable.
- Supports low power consumption mode (power down mode).
- 5V or 3.3V power supply.
- DAC interface compatible with YAC516 and YAC513.
- 44-pin QFP (YMF289B-F) or 48-pin SQFP (YMF289B-S) package.

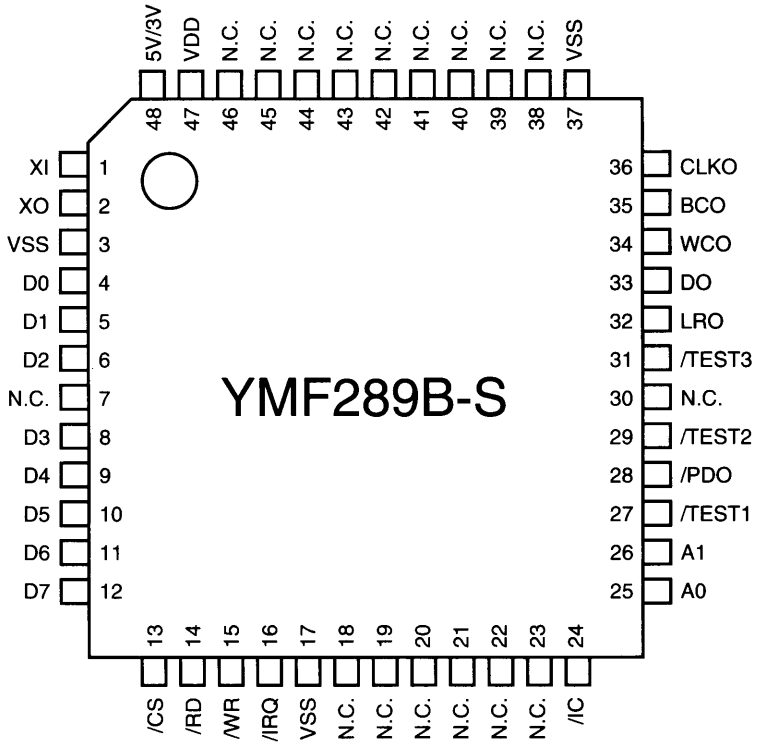
■ PIN OUT DIAGRAM

• YMF289B-F



44 pin Top View

• YMF289B-S



48 pin Top View

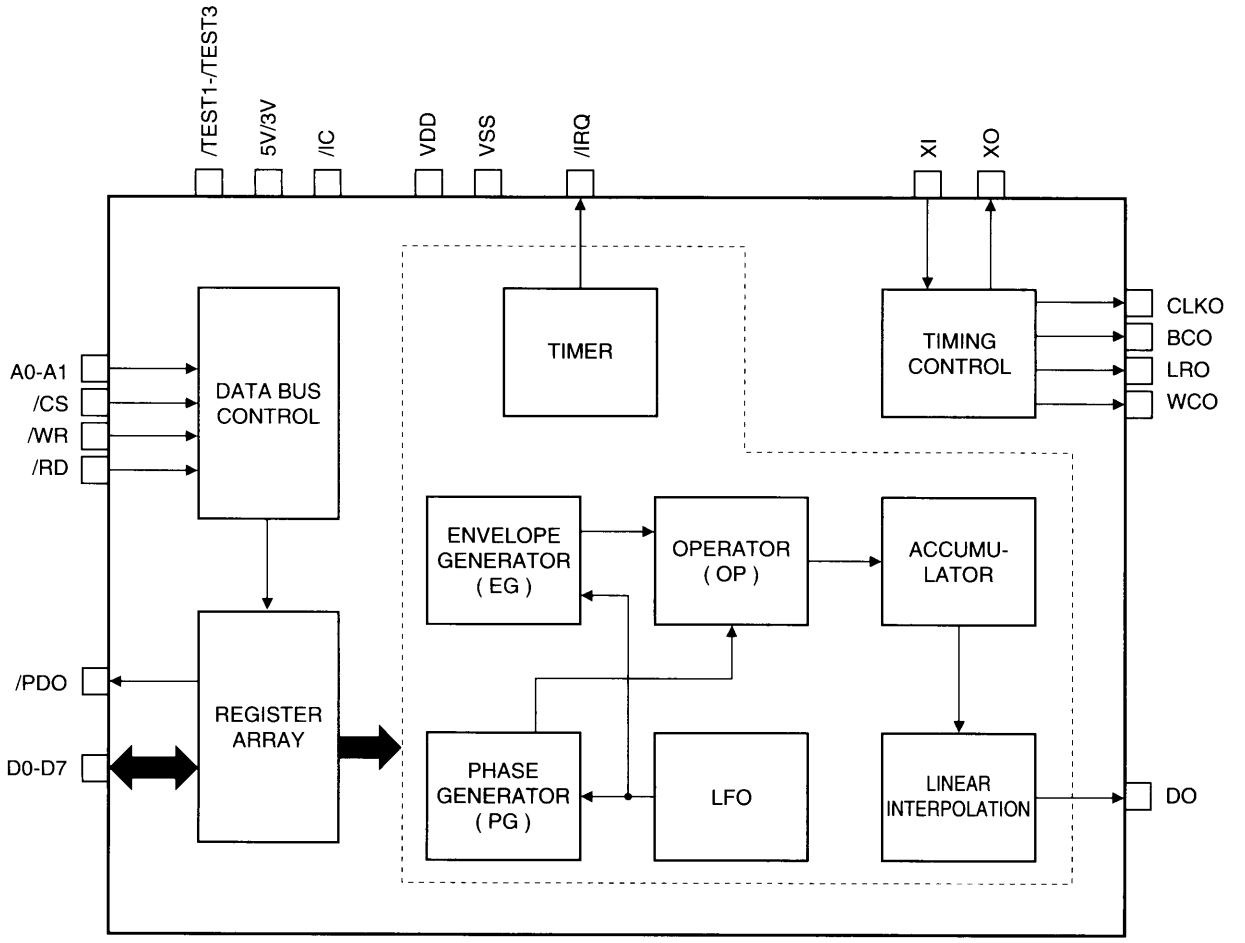
■ PIN DESCRIPTION

No.		I/O	Name	Function
44QFP	48SQFP			
1	1	I	XI	Crystal oscillator connection pin or master clock input (33.8688MHz)
2	2	O	XO	Crystal oscillator connection pin
3	3	-	VSS	Ground
4	4	I/O	D0	CPU interface: data 0
5	5	I/O	D1	CPU interface: data 1
6	6	I/O	D2	CPU interface: data 2
7	8	I/O	D3	CPU interface: data 3
8	9	I/O	D4	CPU interface: data 4
9	10	I/O	D5	CPU interface: data 5
10	11	I/O	D6	CPU interface: data 6
11	12	I/O	D7	CPU interface: data 7
12	13	I	/CS	CPU interface: chip select
13	14	I	/RD	CPU interface: read enable
14	15	I	/WR	CPU interface: write enable
15	16	OD	/IRQ	CPU interface: interrupt signal
16	17	-	VSS	Ground
22	24	I+	/IC	Initial clear input
23	25	I	A0	CPU interface: address 0
24	26	I	A1	CPU interface: address 1
25	27	I+	/TEST1	LSI test pin (Normally NC)
26	28	O	/PDO	Power down mode output
27	29	I+	/TEST2	LSI test pin (Normally NC)
29	31	I+	/TEST3	LSI test pin (Normally NC)
30	32	O	LRO	DAC interface: L/R clock output
31	33	O	DO	DAC interface: voice data output
32	34	O	WCO	DAC interface: word clock output
33	35	O	BCO	DAC interface: bit clock output
34	36	O	CLKO	Clock output pin (16.9344MHz)
35	37	-	VSS	Ground
43	47	-	VDD	+5V (or +3.3V) power supply
44	48	I	5V/3V	5V, 3.3V operation select (H: 5V, L:3.3V)

All pins other than the above are N.C. Normally do not connect them.

Note) I+: Input pin with pull up resistor
OD: Open drain output pin

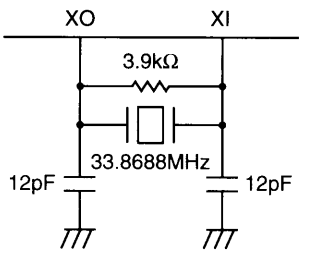
■ BLOCK DIAGRAM



■ FUNCTION OVERVIEW

1. Master clock

The YMF289B synthesized frequency and envelope rate depend on the clock supplied from the XI pin. The YMF289B has a built-in self-oscillation circuit. Therefore, connect a 33.8688MHz (third overtone oscillation) crystal oscillator to the XI and XO pins as shown below.



2. CPU interface

The FM performance, sound generation, and other functions of the YMF289B are controlled by writing data to the data registers described in "3. Register map". Data is written to and read from the registers over the data bus (D0 to D7). The data bus is controlled by address signals A0 and A1 and control signals /CS, /WR, and /RD. These signals set the data bus mode as shown below.

/CS	/RD	/WR	A1	A0	Mode
H	X	X	X	X	Interactive mode
L	L	H	L	L	Status read mode
L	H	L	L/H	L	Address write mode
L	H	L	X	H	Data write mode
L	L	H	X	H	Data read mode

X: Don't care

2-1 Inactive Mode

When /CS is 'H', data bus (D0-D7) becomes high-impedance.

2-2 Status Read Mode

The Status Register can be read from D0-D7 in this mode.

2-3 Address Write Mode

In this mode data presented at D0-D7 will be latched as the register to be accessed. The A1 signal determines which register array is accessed: when A1 is 'L', register array 0 is selected: when A1 is 'H', register array 1 is selected.

<Caution>

Do not attempt to use the latched address until 56 (master clock) cycles have elapsed.

2-4 Data Write Mode

Data written to D0-D7 will go to the previously specified register. Successive writes to the same register can be made without refreshing the address.

<Caution>

Do not attempt to change the latched address or write new data until 56 (master clock) cycles have elapsed.

2-5 Data Read Mode

The previously specified register can be read from D0-D7 in this mode.

3. Register map

The YMF289B registers are made up of data registers, which control the LSI itself, and status registers, which show the status of the LSI.
Most of the data registers are compatible with the YMF262(OPL3). The YMF289B can read all the registers, even those not supported by the YMF262. However, the registers cannot be read in the power down mode. Initialization (/IC="L") clears all the registers.

3-1 Data registers

ADDRESS	REGISTER ARRAY 0 (A1='L')								REGISTER ARRAY 1 (A1='H')							
(HEX)	D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
00H~01H	LSI TEST								LSI TEST							
02H	TIMER 1															
03H	TIMER 2															
04H	RST	MT1	MT2				ST2	ST1		CONNECTION SEL						
05H														NEW3	★	NEW
08H		NTS												CLR	PD1	PD0
20H~35H	AM	VIB	EGT	KSR	MULT				AM	VIB	EGT	KSR	MULT			
					3	2	1	0					3	2	1	0
40H~55H	KSL		TL						KSL		TL					
	1	0	5	4	3	2	1	0	1	0	5	4	3	2	1	0
60H~75H	AR				DR				AR				DR			
	3	2	1	0	3	2	1	0	3	2	1	0	3	2	1	0
80H~95H	SL				RR				SL				RR			
	3	2	1	0	3	2	1	0	3	2	1	0	3	2	1	0
A0H~A8H	F-NUMBER (L)								F-NUMBER (L)							
	F7	F6	F5	F4	F3	F2	F1	F0	F7	F6	F5	F4	F3	F2	F1	F0
B0H~B8H			KON	BLOCK			F-NUM (H)				KON	BLOCK			F-NUM (H)	
				B2	B1	B0	F9	F8				B2	B1	B0	F9	F8
BDH	DAM	DVB	RHY	BD	SD	TOM	TC	HH								
C0H~C8H	★	★	CHR	CHL	FB			CNT	★	★	CHR	CHL	FB			CNT
					FB2	FB1	FB0						FB2	FB1	FB0	
E0H~F5H						WS								WS		
						W2	W1	W0						W2	W1	W0

Notes)

1. The register map is basically the same as that of the YMF262 except for the following:
   a) The NEW3, PD0, PD1, and CLR bits of registers 05H and 08H of REGISTER ARRAY 1 are newly defined.
   b) Bits D6 and D7 of registers C0 to C8H of register arrays 0 and 1 are not supported .
2. The LSI TEST registers are used for factory testing. Always set them to "0" during normal operation.
3. ☐ not used by the YMF289B may be used to expand the functions. Always set them to "0".
4. Bits indicated by ★ can be read, but are not supported functionally.

3.2 Status register

ADDRESS (HEX)	STATUS REGISTER							
	D7	D6	D5	D4	D3	D2	D1	D0
xx	IRQ	FT1	FT2			BUSY		BUSY

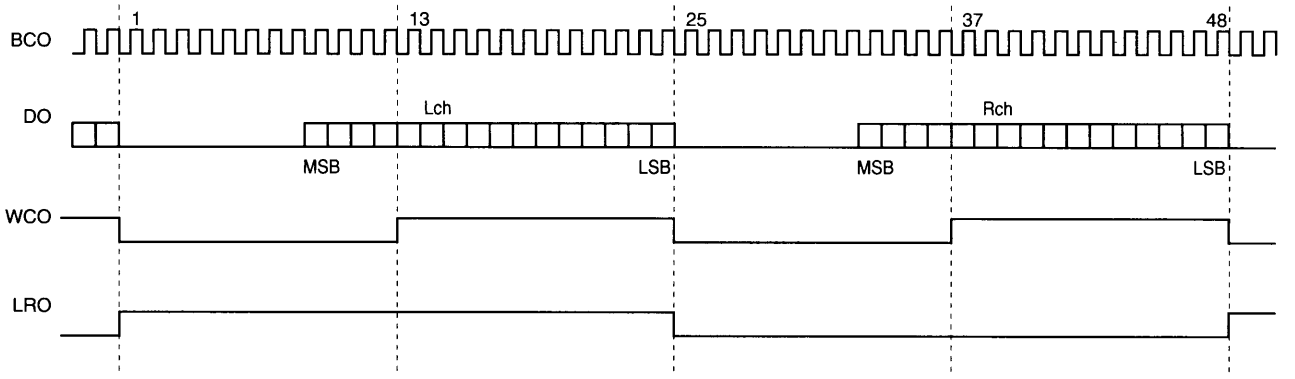
YMF289B identification

When the status is read after initialization, the YM3812(OPL2) outputs 06H and the YMF262 outputs 00H.

The YMF289B outputs the same value as the YMF262, but since it can read all the data registers, it can be discriminated from the YMF262 by whether or not all the data registers can be read.

4. DAC interface

The YMF289B outputs the voice data as digital data. Therefore, an external D/A converter is necessary. The digital data is output MSB-first from the DO pin as 2's complement data. The sampling frequency is 44.1kHz. The relationship between the DO pin digital data and the control signals (BCO, WCO, LRO) is shown below.



BCO: 48fs duty 50%
WCO: 2fs duty 50%
LRO: fs duty 50%

5. Additional functions

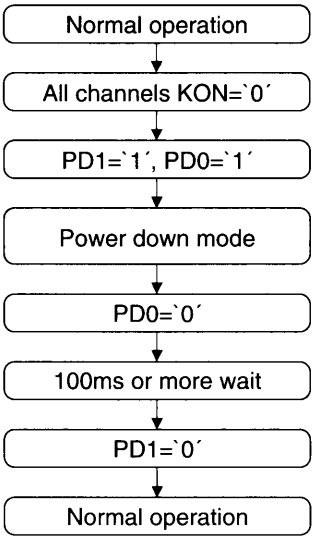
The YMF289B has the following additional functions, as compared to the YMF262.

5-1 NEW3 bit

This bit enables the newly defined bits (PD0 bit, PD1 bit, CLR bit, BUSY flag). When this bit is "1", the bits above are enabled.

5-2 PD0, PD1 bits

These bits set the power down mode. Always set and reset the power down mode in the following order:



Power down mode

In the power down mode, clock oscillation is completely stopped and there is much lower power consumption than during normal operation. At this time, synthesizing stops, but the registers retain their contents before the YMF289B enters the power down mode.

In the power down mode, all the DAC interface pins (CLKO, LRO, WCO, BCO, DO) are fixed at the "L" level and the /IRQ pin retains its state before the YMF289B enters the power down mode. Be sure to fix the input pins (including D0 to D7) at the "H" or "L" level.

<Caution>

If KON="1" when the machine returns from the power down mode, unexpected sound may be generated. Therefore, before switching to the power down mode, set all channels to KON="0". As for the timer, when the machine returns from the power down mode, RST becomes "1" and the counter is reset.

5-3 CLR bit

This bit clears all the data register bits except NEW and NEW3. CLR="1" clears the data registers and CLR="0" resets the data registers. The time required to clear the data registers is 90μs (3000 cycles @ 33.8688NHz).

5-4 BUSY flag

This flag inhibits register access. It remains "1" until the data bus data is latched as an address, or is verified as register data.

5-5 /PDO pin

This bit becomes "L" when the YMF289B shifted to the power down mode. When the YMF289B returns to normal operation, this bit becomes "H". Use this bit to control a YAC516 or other YMF289B peripheral LSI.

■ ELECTRICAL CHARACTERISTICS

1. Absolute maximum ratings

Item	Symbol	Rated value	Unit
Power supply voltage	V_{DD}	–0.3~7.0	V
Input voltage	V_{IN}	–0.3~V_{DD}+0.5	V
Operation temperature	T_{OP}	0~70	°C
Storage temperature	T_{STG}	–50~125	°C

2. Recommended operating conditions

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Power supply voltage	V_{DD}	5V/3V="H"	4.75	5.00	5.25	V
	V_{DD}	5V/3V="L"	3.00	3.30	3.60	V
Operating temperature	T_{OP}		0	25	70	°C

3. DC characteristics

*At recommended operating conditions.

Item	Symbol	Condition	Min.	Max.	Unit
Power consumption	P_D	V_{DD}=5.0V, *1	-	150	mW
		V_{DD}=3.3V, *1	-	60	mW
		V_{DD}=5.0V, *2	-	300	µW
		V_{DD}=3.3V, *2	-	200	µW
Input high level voltage (1)	V_{IH1}	*3	2.0	-	V
Input low level voltage (1)	V_{IL1}	*3	-	0.8	V
Input high level voltage (2)	V_{IH2}	*4	0.7V_{DD}	-	V
Input low level voltage (2)	V_{IL2}	*4	-	0.2V_{DD}	V
Input leakage current	I_{LI}	*5	–10	10	µA
Input capacitance	C_I		-	10	pF
Output high level voltage (1)	V_{OH1}	I_{OH}=–80 [µA], *6	V_{DD}–1.0	-	V
Output low level voltage (1)	V_{OL1}	I_{OL}=2 [mA], *6	-	V_{SS}+0.4	V
Output high level voltage (2)	V_{OH2}	I_{OH}=–80 [µA], *7	2.4	-	V
Output low level voltage (2)	V_{OL2}	I_{OL}=2 [mA], *7	-	0.4	V
Output low level voltage (3)	V_{OL3}	I_{OL}=2 [mA], *8	-	0.4	V
Output capacitance	C_O		-	10	pF
Pull-up resistance	R_U	*9	50	400	kΩ

Notes) *1: f_{M1}=33.8688MHz, normal operation

*2: Power down mode

*3: Applies to /TEST1 to TEST3, /IC, /WR/, /RD, /CS, A0 to A1, and D0 to D7.

*4: Applies to XI and 5V/3V.

*5: V_{IN}=0-5V. Applies to /WR, /RD, /CS, A0 to A1, D0 to D7, XI, and 5V/3V.

*6: 5V/3V="H". Applies to D0 to D7 (at output), /PDO, CLKO, BCO, LRO, WCO, and DO.

*7: 5V/3V="L". Applies to D0 to D7 (at output), /PDO, CLKO, BCO, LRO, WCO, and DO.

*8: Applies to /IRQ pin.

*9: Applies to /IC, and /TEST1 to /TEST3.

4. AC characteristics

*At recommended operating conditions.

Item	Symbol	Fig.	Min.	Typ.	Max.	Unit
Master clock frequency	f_{MI}	Fig. 1	-	33.8688	-	MHz
Duty 1	D1		40	50	60	%
Output master clock frequency	f_{M2}	Fig. 2	-	16.9344	-	MHz
Duty 2	D2		-	50	-	%
Reset pulse width	t_{ICW}	Fig. 3	$3000/f_{M1}$	-	-	s
Address setup time	t_{AS}	Figs. 4, 5	30	-	-	ns
Address hold time	t_{AH}	Figs. 4, 5	10	-	-	ns
Chip select setup time	t_{CSS}	Figs. 4, 5	5	-	-	ns
Chip select hold time	t_{CSH}	Figs. 4, 5	10	-	-	ns
Write pulse width	t_{WW}	Fig. 4	50	-	-	ns
Write data setup time	t_{WDS}	Fig. 4	10	-	-	ns
Write data hold time	t_{WDH}	Fig. 4	10	-	-	ns
Read pulse width	t_{RW}	Fig. 5	80	-	-	ns
Read data access time	t_{ACC}	Fig. 5	-	-	60	ns
Read data hold time	t_{RDH}	Fig. 5	10	-	-	ns
Bit clock frequency	f_{BC}	Fig. 6	-	48fs	-	MHz
Bit clock high level time	t_{CH}	Fig. 6	110	-	-	ns
Data out setup time	t_{DOS}	Fig. 6	100	-	-	ns
Data out hold time	t_{DOH}	Fig. 6	280	-	-	ns
LR clock setup time	t_{LRS}	Fig. 6	100	-	-	ns
LR clock hold time	t_{LRH}	Fig. 6	280	-	-	ns
Word clock hold time	t_{WCH}	Fig. 6	280	-	-	ns

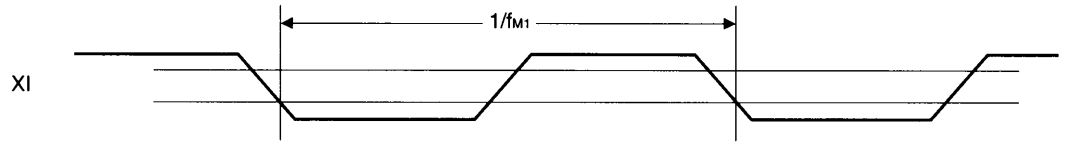


Fig. 1 Input Clock timing

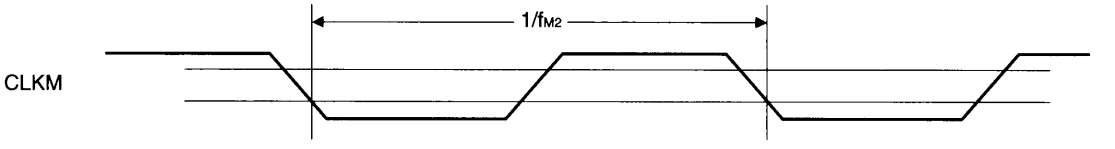


Fig. 2 Output Clock Timing

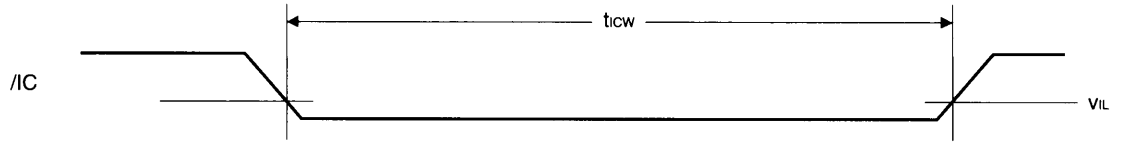


Fig. 3 Setup Pulse Width

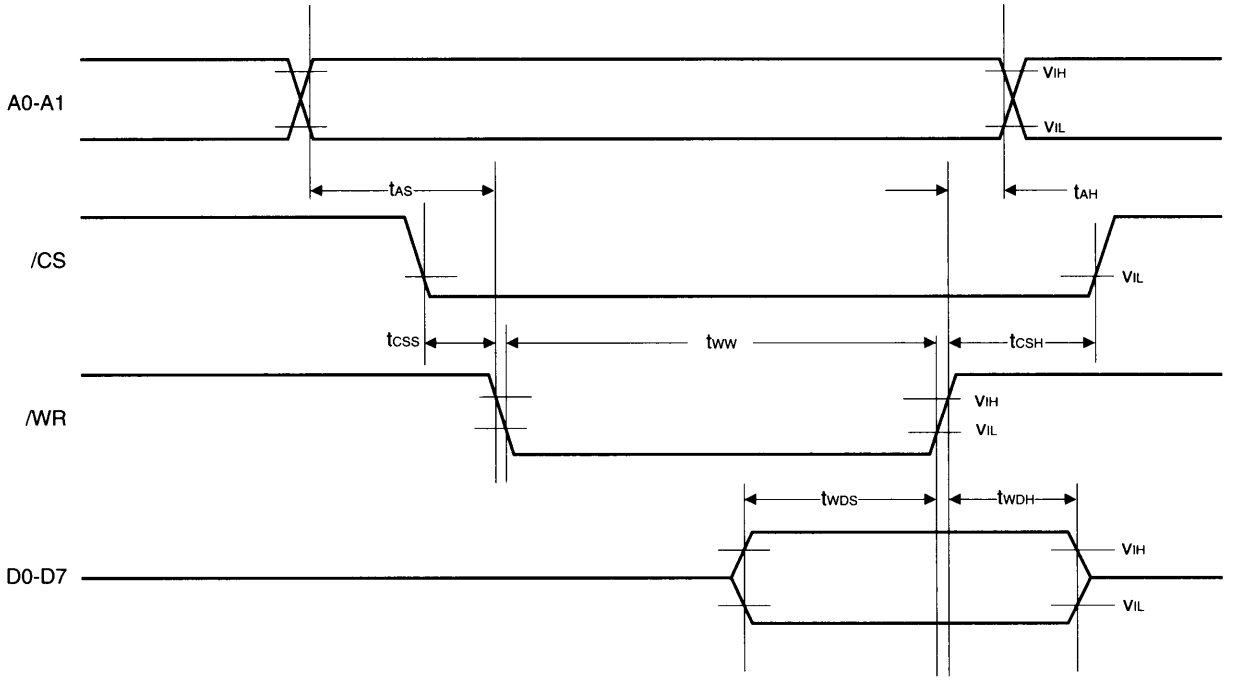


Fig. 4 CPU Write Timing

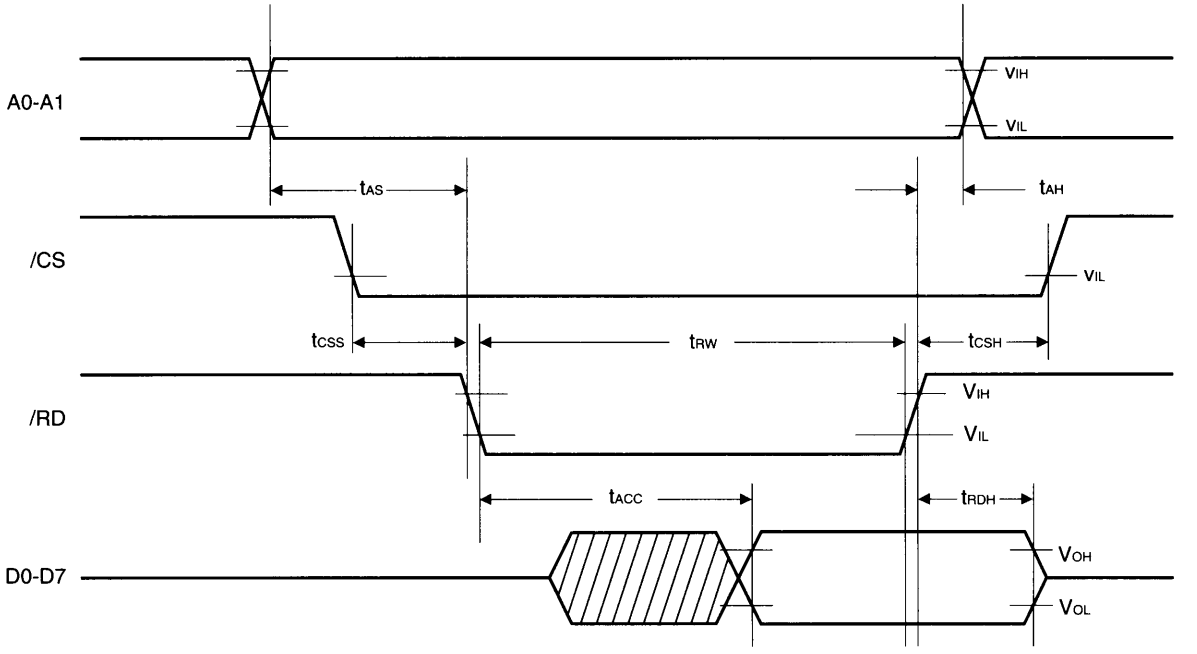


Fig. 5 CPU Read Timing

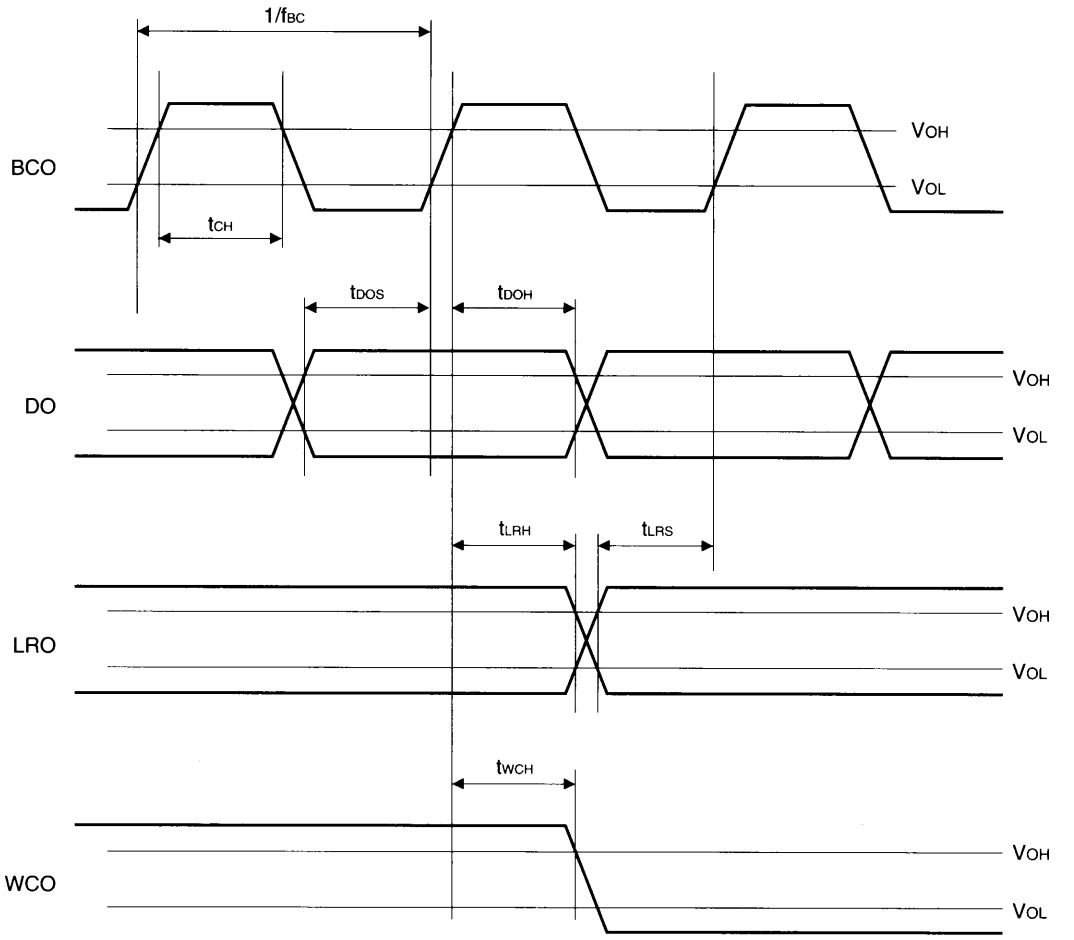
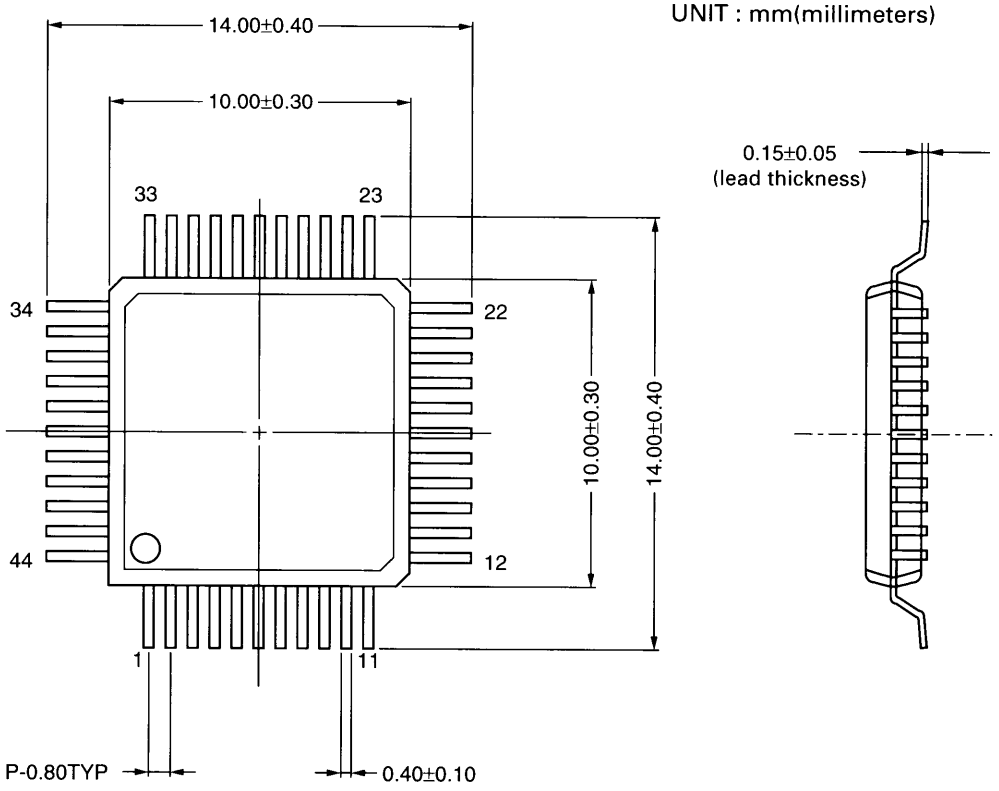


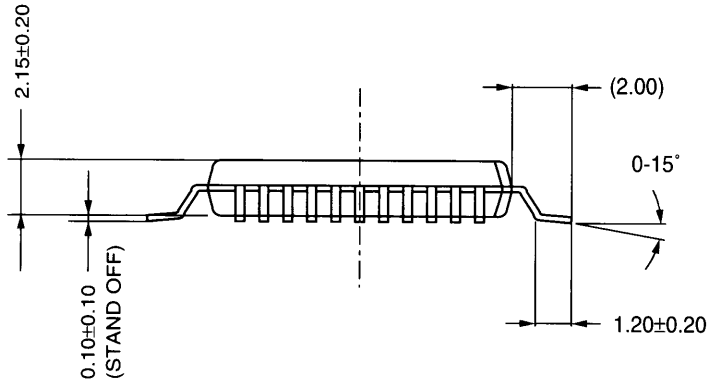
Fig. 6 DAC Interface Timing

■ EXTERNAL DIMENSIONS

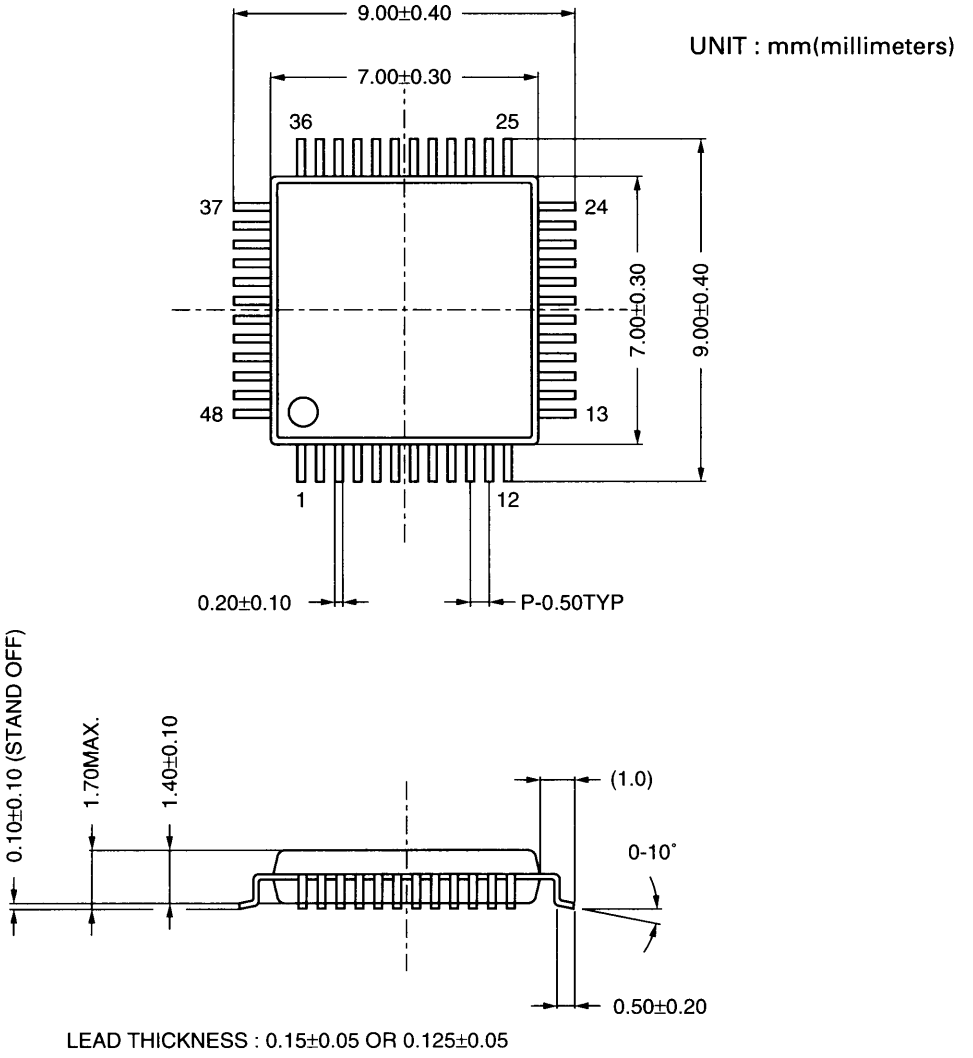
• YMF289B-F (44QFP)

UNIT : mm(millimeters)





- **YMF289B-S (48SQFP)**



LEAD THICKNESS : 0.15±0.05 OR 0.125±0.05

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