YAMAHA LSI

YM2413B

OPLL

FM OPERATOR TYPE-LL

■ OUTLINE

This LL-Type FM Operator incorporates a DA Converter and a Quartz Oscillator in addition to a YAMAHA original FM Sound Generator, allowing for a much easier and economical sound generating system assembly than conventional LSIs. Tone data are stored in ROM for software simplicity, making it possible to execute data alterations involved in tone changes with just one Instruments selection operation. Furthermore, a built-in Tone Data Register with capacity for one tone permits sound effects and original tones generation. Tones applicable to the "CAPTAIN" and TELETEXT are included among built-in tone data.

■ FEATURES

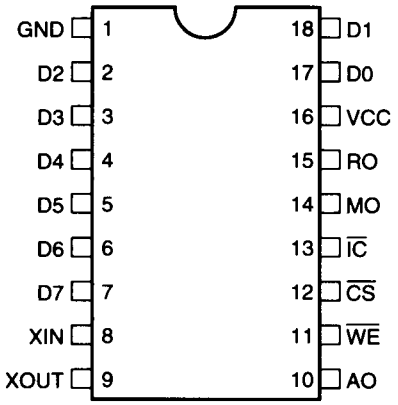
- FM Sound Generator for real sound creation.
- Two selectable modes: 9 simultaneous sounds or 6 melody sounds plus 5 rhythm sounds (different tones can be used together in either case).
- Built-in Instruments data (15 melody tones, 5 rhythm tones, "CAPTAIN" and TELETEXT applicable tones).
- Built-in DA Converter.
- Built-in Quartz Oscillator.
- Built-in Vibrato Oscillator/AM Oscillator.
- TTL Compatible Input.
- A single 5V power source.

YAMAHA CORPORATION

YM2413B CATALOG
CATALOG No.:LSI-212413B2
1999.5

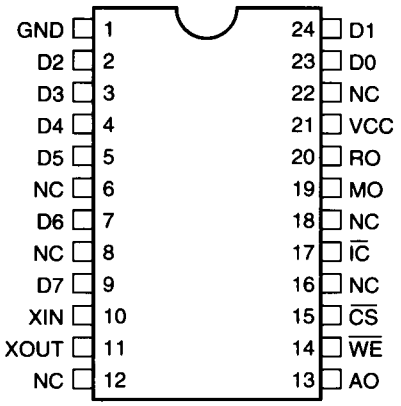
■ PIN ASSIGNMENT

● YM2413B



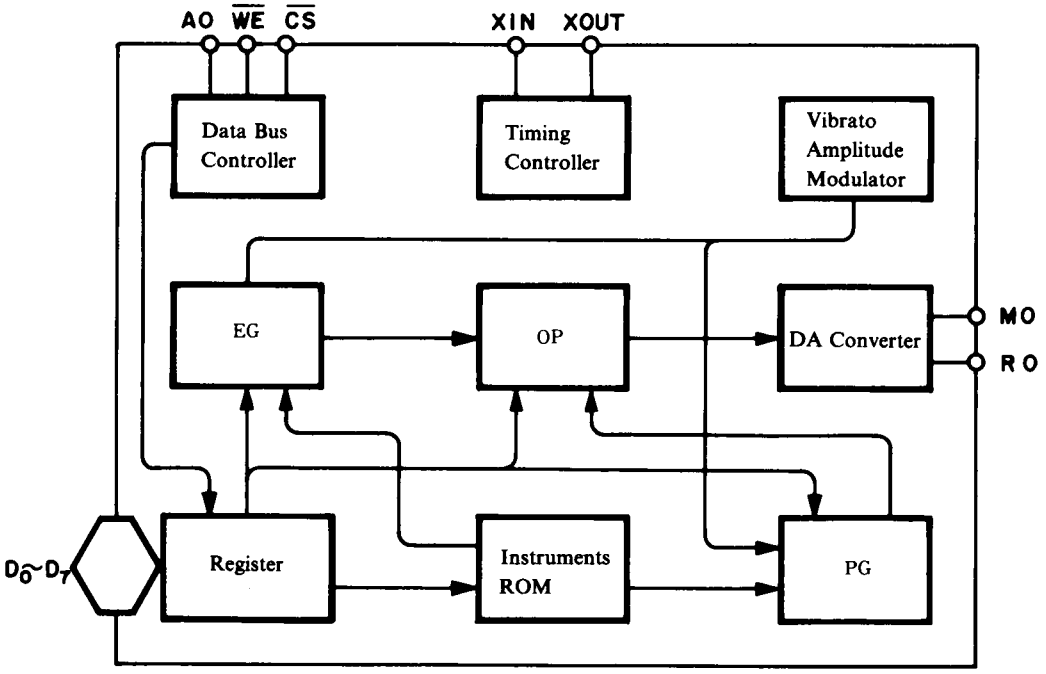
18 pin DIP Top View

● YM2413B-F



24 pin SOP Top View

■ BLOCK DIAGRAM



■ PIN FUNCTIONS

SYMBOL	I/O	FUNCTION	
XIN XOUT	I O	A quartz oscillator (3.579545 MHz) is connected between these two pins.	
D_0 ~ D_7	I/O	8-Bit Data Bus for OPLL control.	
A_0 $\overline{CS}$ $\overline{WE}$	I	For controlling the $D_0 \sim D_7$ Data Bus.	
		$\overline{CS}$ $\overline{WE}$ A_0	
		0 0 0	Writes register address into OPLL.
		0 0 1	Writes register contents into OPLL.
		0 1 0	Outputs OPLL test data to D_0/D_1 Pins. Normally not used.
		0 1 1 0 x x	OPLL Data Bus high impedance
$\overline{IC}$	I	Resets the system when level is low, clearing OPLL Registers.	
MO RO	O	Melody (MO) and Rhythm (RO) Outputs. Both sound types are output by a source follower. Integrated circuitry and an amplifier are necessary for subsequent processing.	
V_{CC}	I	+5V Power Pin.	
GND	—	Ground Pin.	

Note: Please do not connect NC.

■ EXPLANATION OF FUNCTIONS

This OPLL is a FM Sound Generator LSI with a built-in 9-Bit DA Converter. It has two sound generation modes: 9 melody sounds or 6 melody sounds plus 5 rhythm sounds, both allowing for simultaneous generation of different tones. Selection between these two modes can be performed from the software. One of the special features of this LSI is its built-in Instruments ROM. As shown in the table hereunder, this ROM incorporates 15 melody tones and 5 rhythm tones, as well as all tones used for "CAPTAIN" and TELETEXT for easy application to "CAPTAIN" Adaptors and Character Multiplex TVs. Furthermore, a built-in Tone Register with capacity for one tone allows for sound effects and original sounds creation. By controlling the parameters of this register (E, w1, I and w2 in the equation below), all kinds of harmonic can be created on the basis of the sample wave w1.

$$FM = E \sin (w1t + I \sin w2t)$$

Unlike conventional FM sound generators, this OPLL has a bulti-in Instruments ROM, permitting a substantial simplification of sound generation commands from the processor. First, the desired Instruments code is stored in the Instruments Selection Register. Then, after data has been input at the fixed intervals and timing, the unit starts generating sound. Processor automatic play can be easily performed by writing data appropriate to the music into the Sustain and Volume Registers. For using an original tone, the Instruments Selection Register must be cleared after writing data into the Tone Register as explained above. Rhythm sounds are generated by turning ON or OFF the corresponding bits in the Rhythm Control Register. In this case, the specified data must be input to the Key ON/OFF and F-Number Registers 8CH and 9CH.

■ REGISTER MAP

Address	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	
00	AM	VIB	EGTYP	KSR	MULTI				User Tone Register
01	AM	VIB	EGTYP	KSR	MULTI				
02	KSL		TL						
03	KSL		\	DC	DM	F	B		
04	AR				DR				
05	AR				DR				
06	SL				RR				
07	SL				RR				
0E	\		R	BD	SD	TOM	T-CT	HH	Rhythm Control
0F	TEST								OPLL Test Data
10 ~ 18	F-Num. 0 ~ 7								F-Number LSB 8 bits
20	\		SUSON/OFF	KEYON/OFF	BLOCK 0 ~ 2			F-Num 8	F-Number MSB, Octave set
~	\		SUSON/OFF	KEYON/OFF	BLOCK 0 ~ 2			F-Num 8	Key ON/OFF Register
28	\		SUSON/OFF	KEYON/OFF	BLOCK 0 ~ 2			F-Num 8	Sustain ON/OFF Register
30 ~ 38	INST.				VOL				Instruments Selection and Volume Register

Register Contents

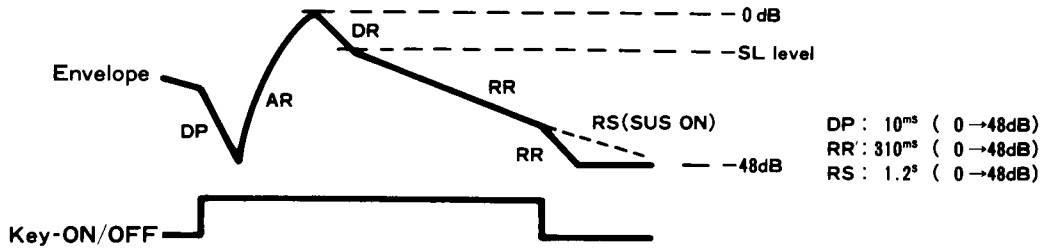
	Address	Bit	
1	00, 01	D_7	Amplitude modulation ON/OFF switch
		D_6	Vibrato ON/OFF switch
		D_5	Sustained sound/decaying sound switch. 0: decaying sound 1: sustained sound
		D_4	RATE key scale
		$D_0 \sim D_3$	Controls MULTI sample wave - harmonics relationship
2	02, 03	D_6 D_7	LEVEL key scale
3	02	$D_0 \sim D_5$	Modulated wave total level. Modulation index control
4	03	D_3 D_4	Carrier and modulated wave distortion waveform (flat wave rectification) ON/OFF switch
		$D_0 \sim D_2$	FM feedback constant
5	04, 05	$D_4 \sim D_7$	Attack envelope change rate control
		$D_0 \sim D_3$	Decay envelope change rate control
6	06, 07	$D_4 \sim D_7$	Indication of decay - sustain level
		$D_0 \sim D_3$	Release envelope change rate control
7	0E	D_5	Rhythm sound mode selection. 1: Rhythm sound mode 0: Melody sound mode
		$D_0 \sim D_4$	Rhythm instruments ON/OFF switch
8	10 ~ 18	$D_0 \sim D_7$	F-Number LSB 8 bits
9	20 ~ 28	D_5	Sustain ON/OFF switch
		D_4	Key ON/OFF
		$D_1 \sim D_3$	Octave setting
		D_0	F-Number MSB
10	30 ~ 38	$D_4 \sim D_7$	Instruments selection
		$D_0 \sim D_3$	Volume data

Tone Data

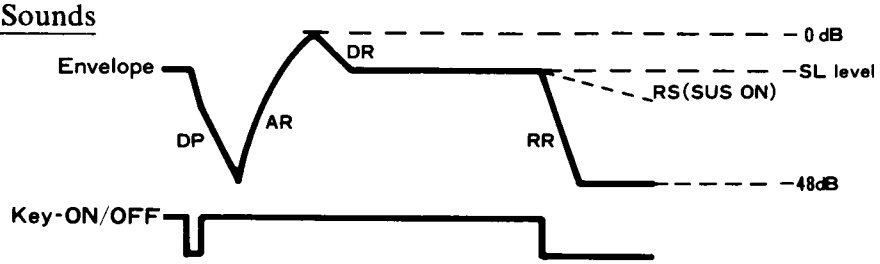
	Instrument		Instrument
0	Original	8	Organ
1	Violin	9	Horn
2	Guitar	10	Synthesizer
3	Piano	11	Harpsichord
4	Flute	12	Vibraphone
5	Clarinet	13	Synthesizer Bass
6	Oboe	14	Acoustic Bass
7	Trumpet	15	Electric Guitar

Envelope Waveforms

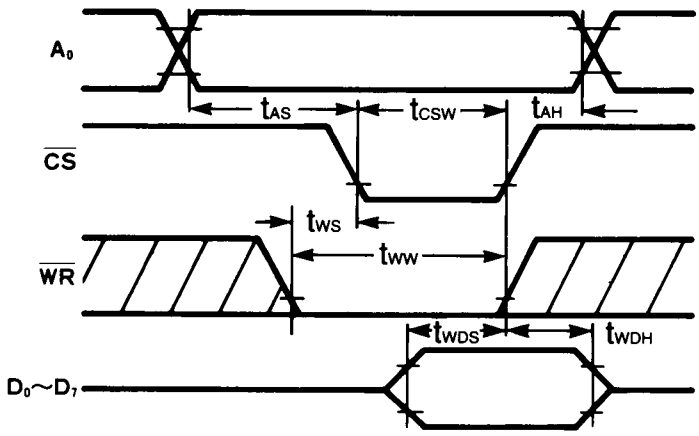
Decaying Sounds



Sustained Sounds



■ TIMING DIAGRAMS (Standard timing settings are V_{IH} = 2.0V, V_{IL} = 0.8V)



*t_{WDS} > 10ns : $t_{CSW} < t_{\phi M}$X7
$t_{WDS} > 10+t_{CSW}-t_{\phi M}$X7ns
: $t_{CSW} > t_{\phi M}$X7

NOTE:
t_{CSW}, t_{WW} and t_{WDH} have been measured with either $\overline{CS}$ or $\overline{WR}$ high.

Fig. A-1 Write Timing

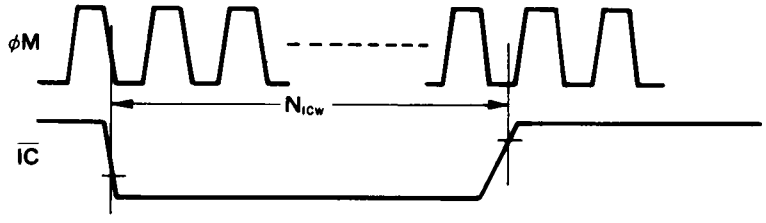


Fig. A-2 Reset Timing

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

ITEM	RATING	UNIT
Pin voltage	0.3 ~ 7.0	V
Ambient operating temperature	0 ~ 70	°C
Storage temperature	− 50 ~ 125	°C

2. Recommended Operating Conditions

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage	V_{CC}	4.75	5	5.25	V
	GND	0	0	0	V

3. DC Characteristics

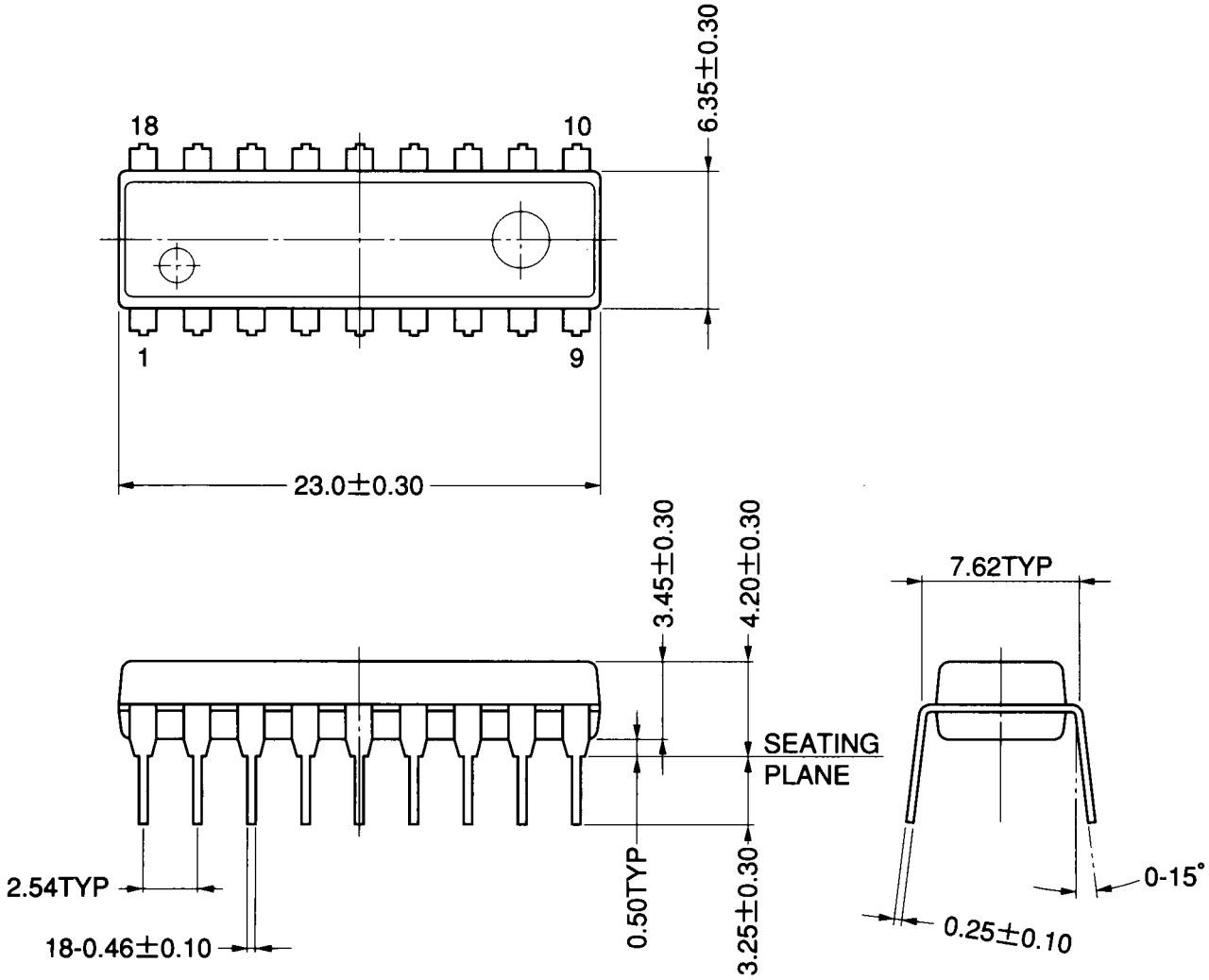
ITEM		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
High level input voltage	All input	V_{IH}		2.0			V
Low level input voltage	All input	V_{IL}				0.8	V
Leak input current	A0, $\overline{WE}$	I_L	Vin = 0~5 V	−10		10	μA
Three-state (off) Input current	D_0~D_7	I_{TSL}	Vin = 0~5 V	−10		10	μA
Analog output voltage	MO	V_{MOA}	R_{LOAD} = 2.2Ω peak to peak		1.6		V
	RO	V_{ROA}	R_{LOAD} = 2.2Ω peak to peak		1.6		V
Pullup resistance	$\overline{IC}$, $\overline{CS}$	R_U		100			kΩ
Input capacity	All input	C_I				10	pF
Output capacity	All input	C_O				10	pF
Power current		I_{CC}			5	10	mA

4. AC Characteristics

ITEM		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Address setup time	Ao	t_{AS}	Fig. A-1	10			ns
Address hold time	Ao	t_{AH}	Fig. A-1	10			ns
Chip select write width	$\overline{CS}$	t_{CSW}	Fig. A-1	80			ns
Write pulse write width	$\overline{WE}$	t_{WW}	Fig. A-1	110			ns
Write pulse set up	$\overline{WE}$	t_{WS}	Fig. A-1	30			ns
Write data setup time	D_0~D_7	t_{WDS}*	Fig. A-1	10			ns
Write data hold time	D_0~D_7	t_{WDH}	Fig. A-1	25			ns
Reset pulse width	$\overline{IC}$	N_{ICW}	Fig. A-2		80		cycle

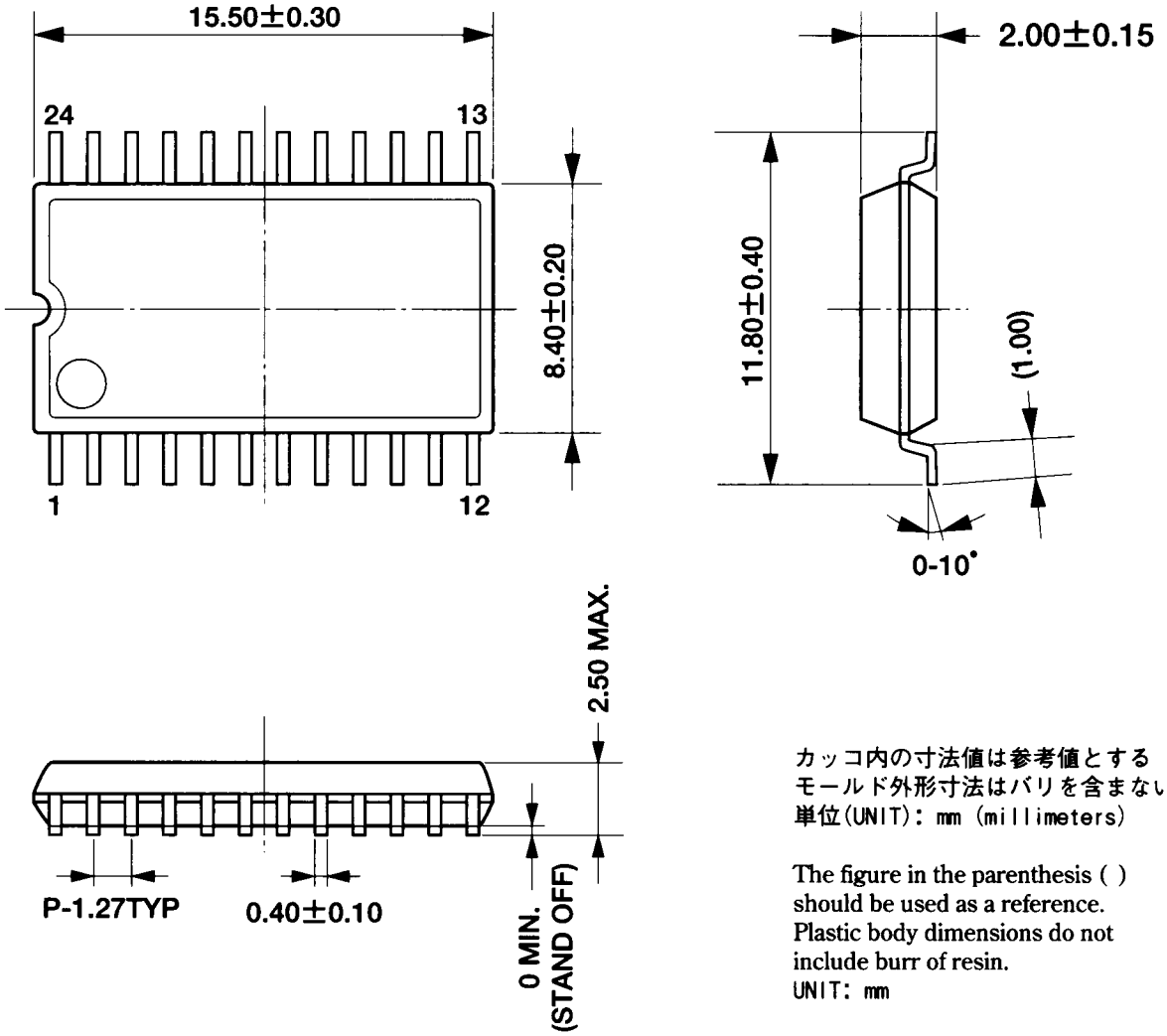
■ OUTLINE DIMENSIONS

YM2413B



モールド外形寸法はバリを含まない
単位 (UNIT) : mm (millimeters)

YM2413B-F



カッコ内の寸法値は参考値とする
モールド外形寸法はバリを含まない
単位(UNIT)：mm (millimeters)

The figure in the parenthesis ( ) should be used as a reference.
Plastic body dimensions do not include burr of resin.
UNIT: mm

端子厚さ：0.15±0.10
(LEAD THICKNESS)

Note : The LSIs for surface mount need especial consideration on storage and soldering conditions. For detailed information, please contact your nearest agent of yamaha.

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