**YAMAHAuoi**

YM2413

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.
* Si-Gate NMOS LSI.
* A single 5V power source.

YAMAHA CORPORATION

YM2413 CATALOG  
CATALOG No.: LSI-212413A2  
1996. 6

**HIM**

**YM2413**

**■ PIN ASSIGNMENT**

• YM2413

• YM2413-F

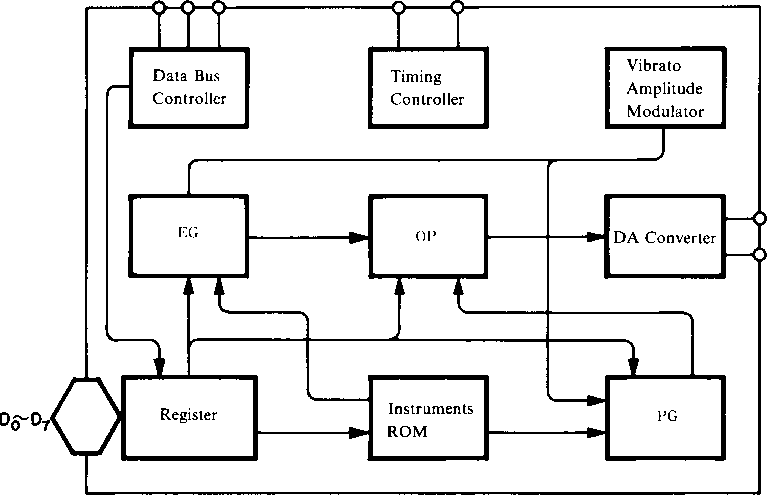
|  |  |  |  |
| --- | --- | --- | --- |
| GND E |  | *y* is | □ D1 |
| D2 E | 2 | 17 | □ do |
| D3E | 3 | 16 | □ vcc |
| D4 E | 4 | 15 | □ ro |
| D5 E | 5 | 14 | □ mo |
| D6 E | 6 | 13 | □ ic |
| D7 E |  | 12 | □ cs |
| XIN E | 8 | 11 | □ we |
| xoutE | 9 | 10 | □ ao |

|  |  |  |  |
| --- | --- | --- | --- |
| GND E |  | *J* 24 | □ D1 |
| D2 E | 2 | 23 | □ DO |
| D3 E | 3 | 22 | □ NC |
| D4 E | 4 | 21 | □ vcc |
| D5 E | 5 | 20 | □ RO |
| NC E | 6 | 19 | □ MO |
| D6 E |  | 18 | □ NC |
| NC E | 8 | 17 | □ ic |
| D7 E | 9 | 16 | □ NC |
| XIN E | 10 | 15 | □ CS |
| XOUT E | 11 | 14 | □ WE |
| NC E | 12 | 13 | □ AO |

18 pin DIP Top View

24 pin SOP Top View

**■ BLOCK DIAGRAM**



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**YM2413**

warn

■ PIN FUNCTIONS

|  |  |  |  |
| --- | --- | --- | --- |
| **SYMBOL** | **I/O** | **FUNCTION** | |
| XIN XOUT | I o | A quartz oscillator (3.579545 MHz) is connected between these two pins. | |
| Do ?  D? | I/O | 8-Bit Data Bus for OPLL control. | |
| Ao  CS  WE | I | For controlling the Do~D? Data Bus. | |
| CS WE Ao |  |
| 0 0 0  0 0 1  0 1 0 | Writes register address into OPLL.  Writes register contents into OPLL.  Outputs OPLL test data to Do/Di Pins. Normally not used. |
| 0 1 1  0 X X | OPLL Data Bus high impedance |
| 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. | |
| Vcc | 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, wl, I and w2 in the equation below), all kinds of harmonic can be created on the basis of the sample wave wl.

FM = E sin (wit + 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.

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**YM2413**

**■ REGISTER MAP**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Address | d  - □ Q Q O 6 d d | | | | | | | |  |
| **00**  **01**  **02**  **03**  **04**  **05**  **06**  **07** | A  M | V I  B | **E G**  **P** | K  S  R | MULTI. | | | | User Tone Register |
| KSL | | T L <M> | | | | | |
|  | DC | DM | F B | | |
| A R | | | | D R | | | |
| S L | | | | R R | | | |
| **0 E** |  | | R | BD | SD | TOM | T-CT | HH | Rhythm Control |
| **0 F** | TEST | | | | | | | | OPLL Test Data |
| **10**  **7**  **18** | F-Num. 0~7 | | | | | | | | F-Number LSB 8 bits |
| **20**  **?**  **28** |  | | S u s ON  OFF | K E Y ON  OFF | BLOCK 0-2 | | | F N u m 8 | F-Number MSB, Octave set  Key ON/OFF Register Sustain ON/OFF Register |
| **30**  **7**  **38** | INST. | | | | VOL | | | | Instruments Selection and Volume Register |

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Register Contents

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Address** | **Bit** |  |
| 1 | 00, 01 | D7 | Amplitude modulation ON/OFF switch |
| D6 | Vibrato ON/OFF switch |
| D5 | Sustained sound/decaying sound switch. 0: decaying sound 1: sustained sound |
| D4 | RATE key scale |
| Do — Ds | Controls MULTI sample wave - harmonics relationship |
| 2 | 02, 03 | D6 D? | LEVEL key scale |
| 3 | 02 | Do —Ds | Modulated wave total level. Modulation index control |
| 4 | 03 | D3 D4 | Carrier and modulated wave distortion waveform (flat wave rectification) ON/OFF switch |
| Do —D2 | FM feedback constant |
| 5 | 04, 05 | D4 — D7 | Attack envelope change rate control |
| Do — D3 | Decay envelope change rate control |
| 6 | 06, 07 | D4 —D? | Indication of decay - sustain level |
| Do —D3 | Release envelope change rate control |
| 7 | 0E | Ds | Rhythm sound mode selection. 1: Rhythm sound mode 0: Melody sound mode |
| Do —D4 | Rhythm instruments ON/OFF switch |
| 8 | 10-18 | Do —D7 | F-Number LSB 8 bits |
| 9 | 20-28 | Ds | Sustain ON/OFF switch |
| D4 | Key ON/OFF |
| D1-D3 | Octave setting |
| Do | F-Number MSB |
| 10 | 30-38 | D4 —D7 | Instruments selection |
| Do —D3 | Volume data |

Tone Data

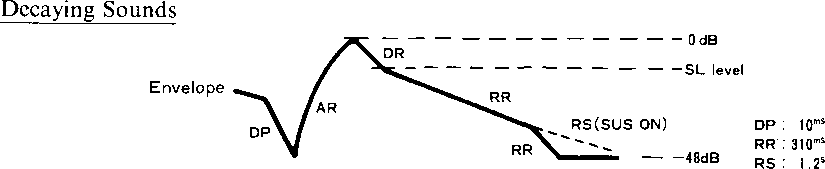
|  |  |  |  |
| --- | --- | --- | --- |
|  | **Instrument** |  | **Instrument** |
| 0 | Original | 8 | Organ |
| 1 | Violin | 9 | Horn |
| 2 | Guitar | 10 | Synthesizer |
| 3 | Piano | 11 | Harpsichord |
| 4 | Flute | 12 | Vibraphone |
| 5 | Clarinet | 13 | Synthesizer Bass |
| 6 | Oboe | 14 | Acoustic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

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**YM2413**

Envelope Waveforms



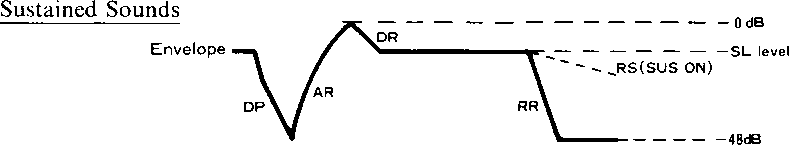
( 0-48dB)

( 0 —»48dB)

( 0 ~\*48dB)





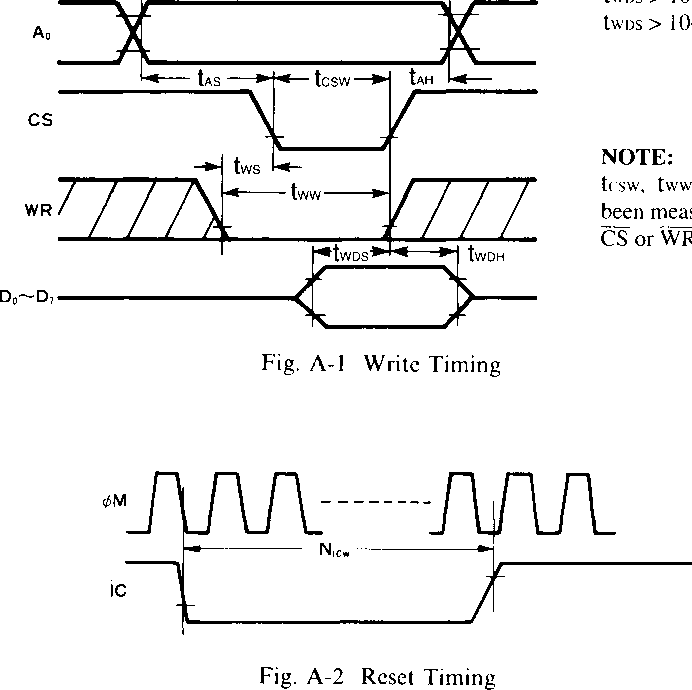


**Key-ON/OFF**





**■ TIMING DIAGRAMS (Standard timing settings are** Vih **= 2.0V,** Vil **= 0.8V)**



s : tcsw < t0MX7 tcsw-t0MX7ns

: tcsw > t0MX7

and twDH have □red with either high.

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**YM2413**

**■ 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 | Vcc | 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 | VlH |  | 2.0 |  |  | V |
| Low level input voltage | All input | VlL |  |  |  | 0.8 | V |
| Leak input current | AO, WE | II | Vin = 0~5 V | -10 |  | 10 | jllA |
| Three-state (off) Input current | D0-D7 | I TSL | Vin = 0~5 V | -10 |  | 10 | pA |
| Analog output voltage | **MO** | Vmoa | Rload = 2.2Q peak to peak |  | 1.6 |  | V |
| RO | Vroa | Rload = 2.2Q peak to peak |  | 1.6 |  | V |
| Pullup resistance | ices’ | Ru |  | 100 |  |  | kQ |
| Input capacity | All input | Ci |  |  |  | 10 | pF |
| Output capacity | All input | Co |  |  |  | 10 | pF |
| Power current |  | I cc |  |  | 40 | 80 | mA |

4. AC Characteristics

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ITEM** | | **SYMBOL** | **CONDITION** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| Address setup time | Ao | tAS | Fig. A-l | 10 |  |  | ns |
| Address hold time | Ao | tAH | Fig. A-l | 10 |  |  | ns |
| Chip select write width | CS | tesw | Fig. A-l | 80 |  |  | ns |
| Write pulse write width | WE | tww | Fig. A-l | 110 |  |  | ns |
| Write pulse set up | WE | tws | Fig. A-l | 30 |  |  | ns |
| Write data setup time | Do — D? | tWDS\* | Fig. A-l | 10 |  |  | ns |
| Write data hold time | Do — D? | tWDH | Fig. A-l | 25 |  |  | ns |
| Reset pulse width | IC | Nicw | Fig. A-2 |  | 80 |  | cycle |

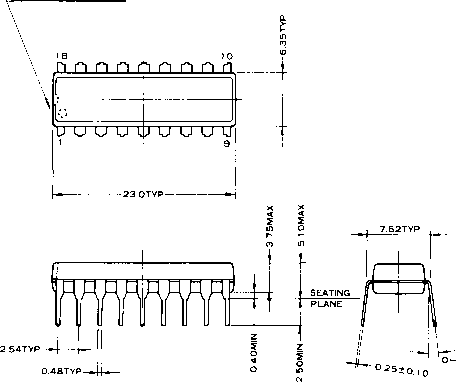
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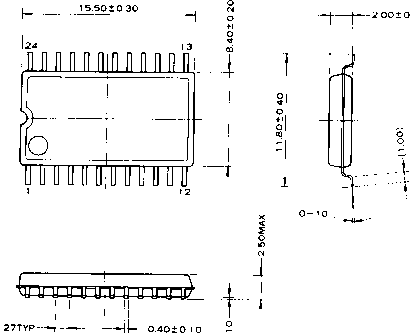
■ OUTLINE DIMENSIONS

YM2413

**Notch or 1 -pm index mark**



YM2413-F



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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**WHMfi**

**■ MEMO**

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**WWfflB**

**YM2413**

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YAMAHA CORPORATION

AGENCY

Address inquiries to :

Semiconductor Sales & Marketing Department

■ Head Office

203, Matsunokijima, Toyooka-mura, Iwata-gun, Shizuoka-ken, 438-0192

Tel. +81-539-62-4918 Fax. +81-539-62-5054

■ Tokyo Office

2-17-11, Takanawa, Minato-ku,

Tokyo, 108-8568

Tel. +81-3-5488-5431 Fax. +81-3-5488-5088

■ Osaka Office

Namba Tsujimoto Nissei Bldg, 4F 1-13-17, Namba Naka, Naniwa-ku, Osaka City, Osaka, 556-0011

Tel. +81-6-6633-3690 Fax. +81-6-6633-3691

■U.S.A Office

YAMAHA Systems Technology.

100 Century Center Court, San Jose, CA 95112 Tel. +1-408-467-2300 Fax. +1-408-437-8791

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