

# YMZ294 YAMAHA 音源LSI

## ■概要

◎ YMZ294は、YM2149相当の音源LSIです。

◎ 3系列の矩形波発生器と1系列のノイズ発生器、エンベロープ発生器を内蔵しておりメロディ音効果音の発音が可能です。

## ■特徴

☆ YM2149とワイヤラッシュの矩形波3音+ノイズ1音の音源

☆ 5ビットDACを3個内蔵し、3音ミキシング出力

☆ CS、WR制御信号と8ビットデータバスによる汎用CPU

インターフェイス

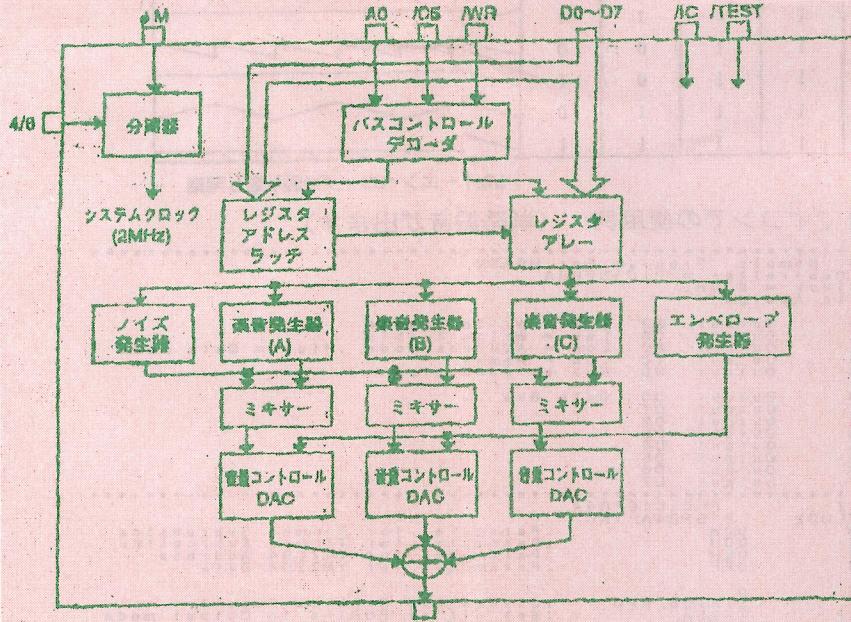
☆ 8オクターブの広い発音域

☆ エンベロープ発生器による滑らかな減衰感

☆ マスタークロックは4MHzまたは、8MHzから選択

☆ 5V単一電源

## ■ブロック図



## ■端子機能

(注) I+: プルアップ抵抗付入力端子

No.	名 称	I/O	端 子
1	AVR	I	CPUインターフェイス ライトイネーブル
2	ICS	I	CPUインターフェイス チップセレクト
3	AD	I	CPUインターフェイス アドレス/データセレクト
4	VDD	-	+5V電源
5	SO	O	SSGLP音源DAC出力
6	GND	-	グランド
7	M	I	マスタークロック入力
8	4/8	I+	マスタークロック周波数選択(「I」=4MHz, 「L」=6MHz)
9	I/C	I+	リセット入力
10	/TEST	I+	テスト用端子(通常無接続で使用)
11	D7	I	CPUインターフェイス データ(MSB)
12	D6	I	CPUインターフェイス データ
13	D5	I	CPUインターフェイス データ
14	D4	I	CPUインターフェイス データ
15	D3	I	CPUインターフェイス データ
16	D2	I	CPUインターフェイス データ
17	DI	I	CPUインターフェイス データ
18	DO	I	CPUインターフェイス データ LSB)

## ■端子機能説明

**1. M**  
マスタークロック入力です。入力周波数は4MHzまたは6MHzです。

**2. I/C**  
マスタークロックの周波数を選択します。Iの時は4MHz、Lの時は6MHzです。

**3. DO~D7**  
8ビットのデータバスです。

**4. ICS, WR, AD**  
8ビットのデータバスからのアドレスとデータの書き込みをコントロールします。

I/C	AVR	AD	動作
0	0	0	SSGLPにアドレスを書き込みます。
0	0	1	SSGLPにデータを書き込みます。

**5. AC**  
「L」の時システムリセットになります。レジスタアレーの内容が全てリセットになります。

**6. SO**  
音声信号のアナログ出力です。

**7. /TEST**  
テスト用端子です。通常無接続で使用します。

**8. VDD**  
+5Vの電源端子です。

**9. GND**  
接地端子です。

## ■機能説明

SSGLPの全機能は15個の内蔵レジスタによって制御されます。

以下は各ブロックの機能についての説明です。

- ・楽音発生器 各チャンネル(A,B,C)毎に、周波数の異なった矩形波を発生させます。
- ・ノイズ発生器 調整ランダム波を発生します(周波数可変)。
- ・ミキサー 各チャンネル(A,B,C)の楽音とノイズの出力をミキシングします。
- ・音量コントロール 各チャンネル(A,B,C)毎に、一定音量または可変音量を与えます。一定音量はCPUによって制御され、可変音量はエンベロープ発生器によって制御されます。
- ・エンベロープ発生器 各種のエンベロープを発生させます。
- ・D/Aコンバータ ミキシングされた音声信号をアナログ出力します。

## ■電気的特性

### 1. 最大定格

項目	記号	定格値	単位
電源電圧	VDD	-0.3~7.0	V
入力電圧	VI	VSS~0.3~VDD+0.3	V
動作温度	Top	0~85	°C
保存温度	Tstg	-50~125	°C

### 2. 推奨動作条件

項目	記号	最小	標準	最大	単位
電源電圧	VDD	4.75	5	5.25	V
動作温度	Vop	0	25	70	V

### 3. 直流特性 (VDD = 5V)

項目	記号	条件	最小	標準	最大	単位
入力電圧Hレベル	ViH	*1	2.2	3	5	V
入力電圧Lレベル	ViL	*1			0.8	V
入力電圧Hレベル	ViH	*2	3.5			V
入力電圧Lレベル	ViL	*2			1.0	V
入力リード電圧	IL	Vi=0~5V, *1	-10		10	μA
ブルアップ抵抗	RUP	*2	60	250	600	kΩ
入力容量	CI	*3			10	pF
電源電流	Ind				10	mA
オーディオ最大出力振幅	VOA	*4	1.50	1.70	1.90	V

\*1: 4.6, I/C, /TEST以外の全ての入力端子に適用。

\*2: 4.6, I/C, /TESTに適用。

\*3: 全ての入力端子に適用。

\*4: SO端子に適用。最大音量、RL=1kΩ, peak to peak.

### 4. 交流特性 (VDD = 5V)

項目	記号	最小	標準	最大	単位
マスタークロック周波数	fc		4 or 6		MHz
マスタークロックデューティ	D	40		60	%
リセットパルス幅	tCW	5			μs
アドレスセットアップ時間	tAS	0			ns
アドレスホールド時間	tAH	5			ns
チップセレクトパルス幅	tCSV	30			ns
ライトパルスセットアップ時間	tWS	20			ns
ライトパルスホールド時間	tWH	0			ns
ライトデータセットアップ時間(アドレス)	tWDSA	10			ns
ライトデータセットアップ時間(データ)	tWDSD	10			ns
ライトデータホールド時間(アドレス)	tWDHA	10			ns
ライトデータホールド時間(データ)	tWDHO	10			ns
ライトパルスオフ時間	tWOFF	40			ns

### 5. タイミング図

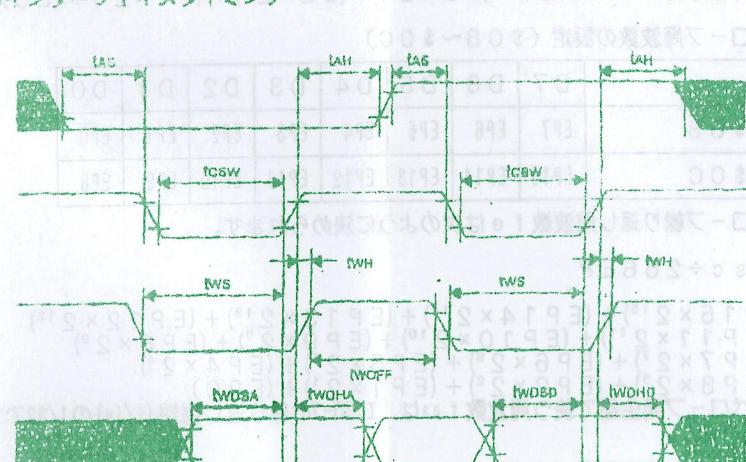
#### (1) マスタークロックタイミング



#### (2) リセットタイミング



#### (3) CPUインターフェイスタイミング



## ■レジスタ機能説明

以下の説明の fsc は 2MHz です。

### 1、楽音周波数の設定 (\$00～\$05)

	D7	D6	D5	D4	D3	D2	D1	DO
\$00 (チャンネルA)	TP7	TP6	TP5	TP4	TP3	TP2	TP1	TP0
\$01 (チャンネルA)	--	--	--	--	TP11	TP10	TP9	TP8
\$02 (チャンネルB)	TP7	TP6	TP5	TP4	TP3	TP2	TP1	TP0
\$03 (チャンネルB)	--	--	--	--	TP11	TP10	TP9	TP8
\$04 (チャンネルC)	TP7	TP6	TP5	TP4	TP3	TP2	TP1	TP0
\$05 (チャンネルC)	--	--	--	--	TP11	TP10	TP9	TP8

各チャンネル(A, B, C)の楽音発生器で作られる矩形波の周波数 ft は次のように決められます

$$f_t = f_{sc} \div 16 \text{TP}$$

$$\text{TP} = (TP11 \times 2^{11}) + (TP10 \times 2^{10}) + (TP9 \times 2^9) + (TP8 \times 2^8) + \\ (TP7 \times 2^7) + (TP6 \times 2^6) + (TP5 \times 2^5) + (TP4 \times 2^4) + \\ (TP3 \times 2^3) + (TP2 \times 2^2) + (TP1 \times 2^1) + (TP0)$$

例 TP = 000100011100 = 284 の時 ft = 440.14Hz

### 2、ノイズ音周波数の設定 (\$06)

	D7	D6	D5	D4	D3	D2	D1	DO
\$06	--	--	--	NP4	NP3	NP2	NP1	NP0

ノイズ発生器で作られるノイズ音の周波数 fn は次のように決められます

$$f_n = f_{sc} \div 16 \text{NP}$$

$$NP = (NP4 \times 2^4) + (NP3 \times 2^3) + (NP2 \times 2^2) + (NP1 \times 2^1) + (NP0)$$

### 3、ミキサーの設定 (\$07)

	D7	D6	D5	D4	D3	D2	D1	DO
\$07	--	--	C	B	A	C	B	A
	--	--	ノイズ		トーン			

各チャンネル(A, B, C)毎に楽音(トーン)及びノイズ音を出力するか設定します。  
レジスタに'0'を書き込むと音を出力します。ノイズとトーンが共に'0'の時はミキシングされて出力します。

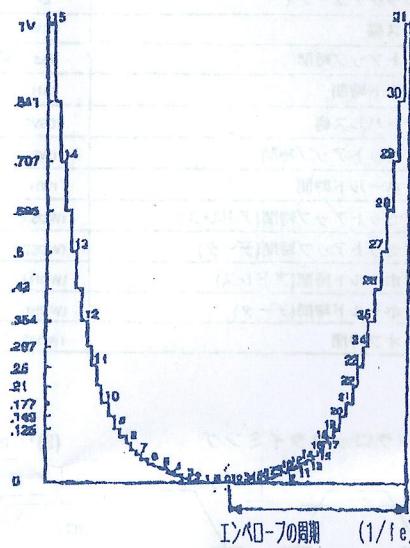
### 4、音量コントロールとDAC (\$08～\$0A)

	D7	D6	D5	D4	D3	D2	D1	DO
\$08 (チャンネルA)	--	--	--	M	L3	L2	L1	L0
\$09 (チャンネルB)	--	--	--	M	L3	L2	L1	L0
\$0A (チャンネルC)	--	--	--	M	L3	L2	L1	L0

各チャンネル(A, B, C)の音量を設定します。  
M=0の時は、L3, L2, L1, L0の4ビットのデータによって16通りのレベルから1つを選択します  
M=1の時は、内蔵のI/PD発生器で作られるE4, E3, E2, E1, EOの5ビットのデータにより音量を制御します。E4, E3, E2, E1, EOは時間と共に変化しますので、可変音量になります。

5ビットDACは最大振幅を1Vに正規化した時に以下に示すような周波数に変換します  
これは直線対数変換になっていて、広い付加モードを持ち、自然な減衰音が得られます

図1 DACコンバータの出力レベル



図中左半分の添字は、(L3 × 2^3) + (L2 × 2^2) + (L1 × 2^1) + (L0)  
図中右半分の添字は、(E4 × 2^4) + (E3 × 2^3) + (E2 × 2^2) + (E1 × 2^1) + (EO)

### 5、エンベローブ周波数の設定 (\$0B～\$0C)

	D7	D6	D5	D4	D3	D2	D1	DO
\$0B	EP7	EP6	EP5	EP4	EP3	EP2	EP1	EP0
\$0C	EP16	EP14	EP13	EP12	EP11	EP10	EP9	EP8

エンベローブ繰り返し周波数 fe は次のように決められます。

$$f_e = f_{sc} \div 256 EP$$

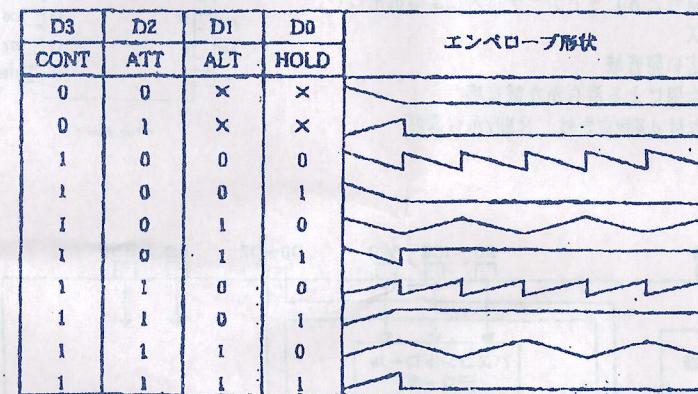
$$EP = (EP15 \times 2^{15}) + (EP14 \times 2^{14}) + (EP13 \times 2^{13}) + (EP12 \times 2^{12}) + \\ (EP11 \times 2^{11}) + (EP10 \times 2^{10}) + (EP9 \times 2^9) + (EP8 \times 2^8) + \\ (EP7 \times 2^7) + (EP6 \times 2^6) + (EP5 \times 2^5) + (EP4 \times 2^4) + \\ (EP3 \times 2^3) + (EP2 \times 2^2) + (EP1 \times 2^1) + (EP0)$$

実際にエンベローブ発生器で使う周波数 f\_ea は、I/PD-7の繰り返し周期 (1/f\_e) の 1/32 です

### 6、エンベローブの形状コントロール (\$0D)

\$0D	D7	D6	D5	D4	D3	D2	D1	DO
	--	--	--	--	CONT	ATT	ALT	HOLD

エンベローブ発生器は、E4, E3, E2, E1, EOを出力する5ビットのカウンターを持ち、エンベローブ繰り返し周波数 fe の32倍の周波数でカウントします。  
CONT, ATT, ALT, HOLDの設定によりこのカウンターをアップカウントしたり、ダウンカウントしたり、1サイクルで止めたり、繰り返しをさせたりしてエンベローブの形状をつくります。  
このカウンタは \$0D のレジスタにデータが書き込まれた時にカウントを開始します。  
CONT, ATT, ALT, HOLDにより、エンベローブは次の様な各種形状をとります



### PICマイコンでの使用例 (単発振音ができます)

```
***** Sample Program for MPASM *****

Micro Controller: PIC16F84A
Clock: 4 MHz
Pin Assignment:
RA0 Output WR Low = Write Enable
RA1 Output AO Low = Address mode, High = Data mode
RA2 Output IC Low = Reset
RA3 Output NC Not be Connected
RA4 Output D0 Data Bus

RB0 Output D0
RB1 Output D1
RB2 Output D3
RB3 Output D4
RB4 Output D5
RB5 Output D6
RB6 Output D7
RB7 Output D8

LIST P=PIC16F84A.INC
INCLUDE P=16F84A.INC

X EQU OCH : Parameter for Timer Subroutine
Y EQU ODH : Parameter for YMZ294 Subroutine
ADR EQU OEH : Parameter for YMZ294 Data
DAT EQU OFH : Parameter for YMZ294 Address

ORG 0
STATUS, RPO : Change the Bank to Page 1
BCLR, FTRISA : Set all of PORTAs to Output mode
BCLRF, TRISB : Set all of PORTBs to Output mode
BCLRF, STATUS, RPO : Return the Bank to Page 0
CALL TIMTIM : Wait for YMZ294 gets ready

MAIN CALL MIXVOL : Set the Receipt Pipe to High
MAIN CALL E_1A : Set the Receipt Pipe to High
MAIN CALL SUBROUTINE1 : Subroutine1 calls Subroutine2
MAIN CALL SUBROUTINE2 : Subroutine2 sends Address & Data to YMZ294
MAIN CALL MIXVOL : Set the Receipt Pipe to High
MAIN CALL E_1A : Set the Receipt Pipe to High
MAIN CALL SUBROUTINE1 : Subroutine1 for Setting Each of Sounds
MAIN CALL SUBROUTINE2 : Subroutine2 for Setting Each of Sounds
MAIN CALL SUBROUTINE3 : Subroutine3 for Setting Each of Sounds
MAIN CALL SUBROUTINE4 : Subroutine4 for Setting Each of Sounds
MAIN CALL SUBROUTINE5 : Subroutine5 for Setting Each of Sounds
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MAIN CALL SUBROUTINE150 : Subroutine150 for Setting Each of Sounds
MAIN CALL SUBROUTINE151 : Subroutine151 for Setting Each of Sounds
MAIN CALL SUBROUTINE152 : Subroutine152 for Setting Each of Sounds
MAIN CALL SUBROUTINE153 : Subroutine153 for Setting Each of Sounds
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MAIN CALL SUBROUTINE161 : Subroutine161 for Setting Each of Sounds
MAIN CALL SUBROUTINE162 : Subroutine162 for Setting Each of Sounds
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MAIN CALL SUBROUTINE167 : Subroutine167 for Setting Each of Sounds
MAIN CALL SUBROUTINE168 : Subroutine168 for Setting Each of Sounds
MAIN CALL SUBROUTINE169 : Subroutine169 for Setting Each of Sounds

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