

# M66238FP

# Standard Clock Generator with PLL Frequency Synthesizer

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### Description

The M66238 is a LSI that incorporates a PLL synthesizer and a sync clock generator in it. The PLL synthesizer covers the range of 25 MHz to 50 MHz at the minimum steps of 3 kHz.

The sync circuit outputs a clock and a one-shot pulse which are synchronized with an external trigger signal. Setting a dividing ratio allows acquisition of sync clock outputs within the range of 0.78 MHz to 25 MHz.

### Features

- Sync clock output frequency range: 1/1, 1/2, 1/4, 1/8, 1/16, 1/32 of 25 to 50 MHz
- Sync accuracy (jitter): ±3 ns
- Trigger input: Polarity selectable
- One-shot pulse output: Polarity and width selectable
- 5 V power supply

# Application

Pixel clock generator

# **Block Diagram**



### **Pin Arrangement**



#### **Pin Description**

Pin Name	Name	I/O	Function
RESET	Reset input	Input	Initialize M66238 internal status.
CS	Chip select input	Input	Transfer serial data when $\overline{CS}$ = "L".
SIN	Serial data input	Input	Synchronize 32-bit serial data from MCU with SCK, and enter.
SCLK	Serial clock input	Input	Enter a sync clock for writing 32-bit serial data.
XIN	Clock input	Input	Used by connecting crystal oscillator between XIN and
XOUT	Clock output	Output	XOUT. When using an external clock signal, connect the clock oscillator to XIN pin and open XOUT pin.
TR	Trigger input	Input	Trigger input for clock sync.
СКОВ	Clock output	Output	Output an inverted CKO signal.
CKO/PLLO	PLL output	Output	CKO outputs a clock synchronized with a trigger signal
			and PLLO outputs a PLL oscillator clock as it is.
PULSE	One-shot pulse output	Output	Output a one-shot pulse synchronized with a CKO signal.
CPOUT	Filter connect pin	Output	Connect a low pass filter to charge pump output.
CPIN	Filter connect pin	Input	Low pass filter input pin.
RV	VCO load output	Output	Connect a load resistor for VCO circuit operation between RV and GND.
TCKI	Test pin	Input	Shipping test pin. Connect to GND when use.
ТСКО	Test pin	Output	Shipping test pin. Keep open when use.
UP	Test pin	Output	Shipping test pin. Keep open when use.
DOWN	Test pin	Output	Shipping test pin. Keep open when use.
DVCC	Digital power supply pin	—	Digital power supply pin.
DGND	Digital GND pin	—	Digital GND pin.
VCCO	Sync output power supply pin	—	Power supply pin for sync output.
GNDO	Sync output GND pin	_	GND pin for sync output.
AVCC	Analog power supply pin	—	Analog power supply pin.
AGND	Analog GND pin	—	Analog GND pin.

### **Absolute Maximum Ratings**

Item	Symbol	Ratings	Unit
Supply voltage	Vcc	–0.5 to +7.0	V
Input voltage	Vi	-0.5 to Vcc + 0.5	V
Output voltage	Vo	-0.5 to Vcc + 0.5	V
Power dissipation* <sup>1</sup>	Pd	650	mW
Storage temperature	Tstg	–65 to +150	°C

Note: 1. When board is mounted

All voltages adopt the GND pin of the circuit as the base (0 V) and absolute values are displayed for maximum and minimum values.

# **Recommended Operating Conditions**

				(	$Ta = 0 \text{ to } 70^{\circ}C)$
Item	Symbol	Min	Тур	Max	Unit
Supply voltage	Vcc	4.75	5	5.25	V
Supply voltage	GND	—	0	—	V
Input voltage	Vi	0	_	Vcc	V
Output voltage	Vo	0	_	Vcc	V
Operating ambient temperature	Topr	0	—	70	°C

Note: The direction of current flowing into a circuit is defined to be positive (no sign) and the direction of current flowing out is defined to be negative (–sign).

Absolute values are displayed for maximum and minimum values.

# **Electrical Characteristics**

 $(Ta = 0 \text{ to } 70^{\circ}C, Vcc = 5 V \pm 5\%, GND = 0 V)$ 

Item	Symbol	Min	Тур	Max	Unit	Test Conditions
High-level input voltage	VIH	2	—	—	V	TR
Low-level input voltage	VIL	—	—	0.8	V	
High-level input voltage	VIH	0.8  imes Vcc	—	—	V	XIN
Low-level input voltage	VIL	—	—	$0.2\times Vcc$	V	
High-level output voltage	VOH	Vcc - 0.8	—	—	V	GND = 0 V, IOH = -4 mA
Low-level output voltage	VOL	—	—	0.55	V	GND = 0 V, IOL = 4 mA
Supply current (at time of standstill)	lcc (s)	_	_	50	μΑ	GND = 0 V, VI = Vcc or GND
Supply current (at time of operation)	lcc (a)	_	_	120	mA	GND = 0 V, CKO = 50 MHz VI = Vcc or GND
High-level input current	ШΗ	—	_	10	μA	GND = 0 V, VI = Vcc
Low-level input current	IIL	—	_	-10	μA	GND = 0 V, VI = 0 V
Input capacitance	CI	_	_	10	pF	

Note: Measurement circuit; The direction of current flowing to the circuit is specified to be positive (no sign).

# **Timing Requirements**

#### $(Ta = 0 \text{ to } 70^{\circ}C, Vcc = 5 V \pm 5\%, GND = 0 V)$

Item	Symbol	Min	Тур	Max	Unit
CS width	tw ( <del>CS</del> )	1	_	_	μs
CS set up time	tsu (CS-SCK)	50			ns
CS hold time	th (SCK- <del>CS</del> )	50			ns
SCK width	tw (SCK)	25			ns
SIN set up time	tsu (SIN-SCK)	25			ns
SIN hold time	th (SCK-SIN)	25			ns
Clock input frequency	fin	7		12	MHz
Clock input duty	fiDUTY	40		60	%
Trigger input "H" pulse width	tw (TR)	200			ns
Clock input rising time	tr	—	_	5	ns
Clock input falling time	tf			5	ns

# **Switching Characteristics**

$(Ta = 0 \text{ to } 70^{\circ}C.$	$Vcc = 5 V \pm 5\%$	GND = 0 V.	CL = 15	pF)
(10 010 /0 0;		, one $\circ$ ,	CD 10	P* /

		,			1 /
Item	Symbol	Min	Тур	Max	Unit
VCO oscillation frequency	fvco	25	_	50	MHz
Synchronous output frequency	fout	—	_	50	MHz
Synchronous accuracy (jitter)	Δt	—	_	±3	ns
Synchronous clock output start	tss (CKO)	—	_	tlp + 200	ns
Synchronous clock reversible output start	tss (CKOB)	—	_	tlp + 200	ns
One-shot pulse output start	tss (PULSE)	—	_	tlp + 200	ns
Synchronous clock output stop	tsp (CKO)	—	_	40	ns
Synchronous clock reversible output stop	tsp (CKOB)	—	_	40	ns
One-shot pulse output width	tw (PULSE)	n ● tp – 10	_	n • tp + 10	ns
Synchronous clock output duty	fo <sub>DUTY</sub> (CKO)	40	—	60	%
Synchronous clock reversible output duty	fo <sub>DUT</sub> (CKOB)	40	_	60	%

Note: tp = 1 / fout,  $tlp = tp \times (100 - fvcoduty) / 100$ 

The n value of one-shot pulse output width is set in the register.

# **Measurement Circuit**



# List of Register Setting Commands

A1	A0	Setting
0	0	Setting of CKO/PLLO dividing ratio, PLL synthesizer 15-bit generation dividing ratio and reference clock generation 12-bit dividing ratio.
1	0	Setting of one-shot pulse polarity and width, setting of trigger edge, HALT of entire M66238, HALT of charge pump and VCO, phase comparator output UP/DOWN, CKO/PLLO switching.
1	1	Dummy trigger generation command

# Serial Data Write Timing



# **Register Configuration**

#### 1. Clock frequency setting command

Reference clock generation 12-bit division ratio, PLL synthesizer 15-bit division ratio and CKO/PLLO division ratio are set at address (A1, A0) = (0, 0).

Data Bit		Description	Default
D0	0	12-bit reference clock dividing ratio is set.	0
	1	D11 and D0 correspond to MSB and LSB, respectively.	
D1	0	$\overset{11}{K} = \Sigma \left( Dk \times 2^{k} \right)$	1
<b>D</b> 0	1	k = 0	0
D2	0	K: Reference clock dividing ratio	0
D3	0		1
23	1		1
D4	0		0
	1		
D5	0		0
	1		
D6	0		0
D7	0		0
	1		0
D8	0		1
	1		
D9	0		0
	1		
D10	0		0
D11	0		0
	1		U
D12	0	15-bit PLL synthesizer dividing ratio is set.	0
	1	D26 and D12 correspond to MSB and LSB, respectively.	
D13	0	$N = \sum_{n=1}^{26} (Dn \times 2^{n-12})$	0
D14	1	n = 12	
D14	0	N: PLL synthesizer dividing ratio	0
D15	0		1
210	1		
D16	0		0
	1		
D17	0		1
D19	1		1
010	1		1
D19	0		1
	1		
D20	0		1
<b>D</b> 04	1		4
D21	0		1
D22	0		0
<b>-</b>	1		-
D23	0		0
	1		
D24	0		0
D25			0
525	1		
D26	0		0
	1		

#### M66238FP

Data Bit		Description						
D27	0	Setting of CKO/PLLO dividing ratios						
	1	Dividing Ratio	D29	D28	D27	PLLO/CKO Oscillator Frequency	7	
		1/1	0	0	0	25 MHz to 50 MHz	┨┝	
D28	0	1/2	0	0	1	12.5 MHz to 25 MHz	1 1	
	4	1/4	0	1	0	6.25 MHz to 12.5 MHz	1	
	1	1/8	0	1	1	3.125 MHz to 6.25 MHz		
D29	0	1/16	1	0	0	1.563 MHz to 3.125 MHz	0	
		1/32	1	0	1	0.781 MHz to 1.563 MHz	1	

#### 2. Operating mode setting commands

Address (A1, A0) = (1, 0) allows setting of one-shot pulse polarity and width, trigger edge, M66238 entire halt, charge pump and VCO halt, phase comparator UP/DOWN output, LPF cutoff, CKO/PLLO switching, VCO switching and charge pump switching.

Data Bit		Description					
D0	0	Setting of trigger e	dge		0		
			•	Description			
	1						
		0 0 Syr	ichronizes with TR	$\bigvee$ CKO is stopped when TR = "H"			
D1	0	0 1 Syr	chronizes with TR	CKO is stopped when TR = "L"	0		
		1 0 Syr	hchronizes with TR	CKO is output when TR = "H"			
	1	1 1 Syr	hchronizes with TR	CKO is output when TR = "L"			
		· · · ·					
D2	0	When trigger occu	s: spike of sync cloc	k is not eliminated.	0		
2.0	1	When trigger occu	s: spike of sync cloc	k is eliminated (disabled when $D1 = 1$ ).			
D3	0	Polarity of one-sho	t pulse: Negative pul	se	0		
	1	Polarity of one-sho	t pulse: Positive puls	e	_		
D4	0 Setting of one-shot pulse width						
		D5	D4	Description			
	1	0	0	CKO 2-cycle width			
		0	1	CKO 4-cycle width			
D5	0	1	0	CKO 8 cycle width	0		
			0				
	1	1	1	CKO 16-cycle width			
De	0	CKO/PLLO pip: Ck			0		
DO	1	CKO/PLLO pin: PL			0		
D7	0	Entire M66238: Or	erating state		0		
21	1	Entire M66238: Ha	It state		Ŭ		
D8	0	VCO: Operating st	ate		0		
	1	VCO: Halt state					
D9	0	Charge pump: ON			0		
	1	Charge pump: OFI					
D10	0	Low pass filter: Op	erating state		0		
	1	Low pass filter: Se	parated				
D11	0	Normal use: Not or	utput to outside		0		
540	1	Phase comparator	UP/DOWN output er	nable	_		
D12	0	Normal use	4		0		
D10	1	VCO test circuit se	t		0		
D13	0	Normai use	circuit cot		0		
D14	0	Normal use			0		
	1	15-bit counter test	clock enable				
D15	0	Normal use			0		
-	1	Sync clock genera	or test clock enable				
D16	0	Normal use			0		
	1	Sync clock genera	or test input enable				
D17	0	Normal use			0		
	1	12-bit counter test	output enable				
D18	0	Normal use			0		
	1	15-bit counter test	output enable				
D19	0	Normal use			0		
	1	Sync clock genera	or trigger test output	enable			
D20	0	Normal use			0		
D21	1	Sync clock general	or test output enable	)			
		in normal use: "0"	set		0		
D29							
					Ŭ		

#### M66238FP

3. Dummy trigger generating command

The internal status of sync clock generator becomes unstable and a stable sync clock output (CKO) is not obtained after the power is turned on, after a reset is cleared or after an internal VCO oscillator frequency is set. To obtain a stable sync clock output, enter a trigger signal from the TR input after VCO oscillator becomes stable, or enter a dummy trigger generating command from the MCU. The PLL synthesizer oscillator frequency after the cancellation of a reset depends on a default (See the register configuration).

Set the command for address (A1, A0) = (1, 1).

Data Bit		Description	Default
D0	0	The command must be stored two times continuously when a dummy trigger is generated. For the first time, set the dummy trigger generating command with $D0 = 1$ .	0
	1	The second setting becomes a sync edge and a clock begins to be output from CKO. After the first setting, CKO is in the halt state.	
D1	0	In normal use: "0"	0
	1		
$\downarrow$			$\downarrow$
D29	0		0
	1		

# **Operating Timing**

#### 1. Sync Clock Spike Non-removal Mode upon Occurrence of Trigger

#### 1.1 Setting of Trigger Edge when D1 = 0

One-shot pulse start timing:	1st leading edge of CKO after TR fall
One-shot pulse polarity:	Negative pulse
One-shot pulse width:	16 cycles of CKO
CKO output dividing ratio:	1/2 division

An example set for the condition of address (A1, A0) = (1, 0), data (D6, D5, D4, D3, D2, D1, D0) = (0, 1, 1, 0, 0, 0, 0) is shown below. CKO is a clock output synchronized by TR and PULSE is a one-shot pulse synchronized with the rise of CKO.



#### 1.2 Setting of Trigger Edge when D1 = 1

One-shot pulse start timing:	1st leading edge of CKO after TR rise (except the rise of a spike which occurs when CKO is stopped).
One-shot pulse polarity:	Negative pulse
One-shot pulse width:	16 cycles of CKO
CKO output dividing ratio:	1/2 division

An example set for the condition of address (A1, A0) = (1, 0), data (D6, D5, D4, D3, D2, D1, D0) = (0, 1, 1, 0, 0, 1, 0) is shown below. CKO is a clock output synchronized by TR and PULSE is a one-shot pulse synchronized with the rise of CKO.



#### 2. Sync Clock Spike Removal Mode upon Occurrence of Trigger

When address (A1, A0) = (1, 0) and data (D6, D5, D4, D3, D2, D1, D0) = (0, 1, 1, 0, 1, 0, 0), CKO with the first rise after occurrence of a trigger is output and then CKO stops.

However, this mode is not available when D1 = 1 in trigger edge setting. Set a wide TR so that TR sync edge is entered 200 ns or more after CKO stops.



Notes: 1. 200 ns or more required

2. tss (CKO, CKOB, PULSE) is defined by input clock width "L" +  $\alpha$ . In addition, the value of  $\alpha$  denotes IC internal delay, and the values of  $\alpha$  and tss are definite unless temperature, Vcc, etc. are changed, and tss variations at that time is defined as  $\Delta t$  (sync accuracy: jitter).

# **CKO/PLLO Output Frequency Range**

The M66238 requires an internal VCO oscillator frequency of 25 MHz to 50 MHz.

Settings of dividing ratio K of 12-bit divider and dividing ratio N of 15-bit counter are required in order to determine the internal VCO oscillator frequency. The relation between the settings and the internal VCO oscillator frequency is shown below.

Oscillator frequency  $f_{VCO} = \frac{fin \times N}{K}$  (MHz)  $K = \sum_{k=0}^{11} (D_k \times 2^k)$  k = 0 $N = \sum_{n=12}^{26} (D_n \times 2^{n-12})$ 

Note: 3. Setting of fin /  $K \ge 100$  kHz is recommended in consideration of the frequency accuracy characteristics of PLL output.

Therefore, set the division ratio K of the 12-bit divider and the division ratio N of the 15-bit counter to meet the following conditions:

 $25 \text{ MHz} \leq fvco \leq 50 \text{ MHz}$ 

In addition, for PLLO and CKO, setting the division ratios of the sync/division circuit (synchronous clock generating area) to 1/1, 1/2, 1/4, 1/8, 1/16, 1/32 will allow the frequencies of 0.78 Hz to 50 MHz to be accommodated.

# Input Timing

### (1) Register Setting



#### (2) Clock from Trigger Input and One-shot Pulse Output



#### (3) Stop of Clock from Trigger Input



#### (4) Trigger Input Width



#### (5) One-shot Pulse Width



# **Application Circuit Example**



# **Package Dimensions**



# RenesasTechnology Corp. sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

- Benesas lechnology Corp. sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan
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### Renesas Technology Singapore Pte. Ltd.

1 Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632 Tel: <65> 6213-0200, Fax: <65> 6278-8001

Renesas Technology Korea Co., Ltd. Kukje Center Bldg. 18th Fl., 191, 2-ka, Hangang-ro, Yongsan-ku, Seoul 140-702, Korea Tel: <82> (2) 796-3115, Fax: <82> (2) 796-2145

Renesas Technology Malaysia Sdn. Bhd Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No.18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia Tel: <603> 7955-9390, Fax: <603> 7955-9510

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