



## SM840004-11

62.5/125MHz Gigabit Ethernet, 4 Output,  
Ultra-Low Jitter Clock Synthesizer

### General Description

The SM840004-11 clock synthesizer was designed for Gigabit Ethernet applications. The device design is optimized for 62.5MHz and 125MHz using a standard 25MHz fundamental parallel resonant crystal, with unparalleled stability and accuracy over the full operating range, and provides an easy fit for Jitter and Phase Noise standards for these high performance interfaces.

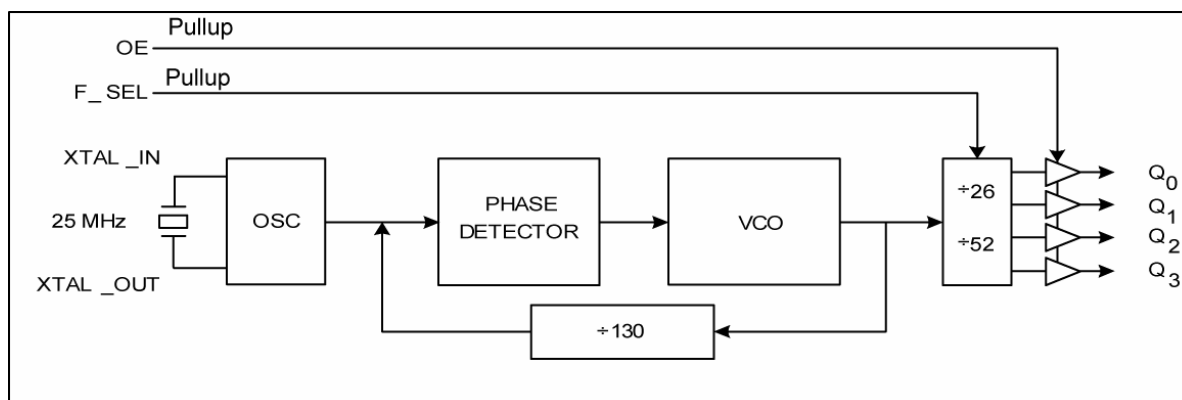
The SM840004-11 design includes a unique power reduction methodology, along with a patented RotaryWave™ architecture, that provides a stable clock with very low noise for optimized performance. This yields an overall improved Bit Error Rate (BER) and improved waveform integrity.

Datasheets and support documentation can be found on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

### Features

- Generates 4 optimized LVCMOS clock outputs
- RMS phase jitter @ 125MHz: ~55 fs (typ)
- Integrated loop filter components
- Operates with either a 3.3V or 2.5V supply
- Power consumption 65mA (typ @ 2.5V)
- Selectable output frequency: 125MHz or 62.5MHz
- Input frequency of 25MHz
- Fundamental parallel resonant crystal interface
- Pin compatible with the ICS/IDT840004-11
- Industrial temperature range: -40°C to +85°C
- Green, RoHS-compliant and PFOS-compliant

### Block Diagram



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July 2010

M9999-070110-A  
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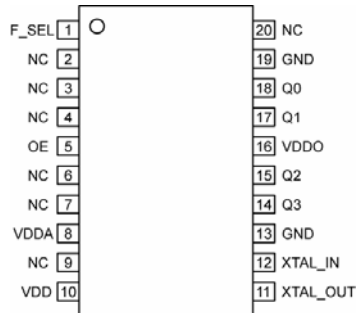
## Ordering Information<sup>(1)</sup>

Part Number	Package Type	Operating Range	Package Marking
SM840004-11KA	K-20	Industrial	840004-11
SM840004-11KA TR	K-20	Industrial	840004-11

**Note:**

1. Devices are Green, RoHS-compliant and PFOS-compliant.

## Pin Configuration



**20-Pin TSSOP (K-20)**

## Pin Description

Pin Number	Pin Name	Type	Level	Pin Function
1	F_SEL	I	Pull-up	Frequency Select Pin.
2,3,4,6,7,9,20	NC		NC	No Connect. Do Not Use.
5	OE	I	Pull-up	Output Enable: (1=Active, 0=High-Z)
8	V <sub>DDA</sub>	P		Analog Power.
10	V <sub>DD</sub>	P		Core Power.
11	XTAL_OUT	O		Crystal Out.
12	XTAL_IN	I		Crystal In.
13,19	GND	P		Ground.
14	Q3	O		Single Ended LVCMOS Clock Out-3.
15	Q2	O		Single Ended LVCMOS Clock Out-2.
16	V <sub>DDO</sub>	P		Output Power Supply.
17	Q1	O		Single Ended LVCMOS Clock Out-1.
18	Q0	O		Single Ended LVCMOS Clock Out-0.

## Configuration Table

F_SEL	M/N Ratio	M Divider	N Divider	Output Frequency (MHz)
0	2.5	130	52	62.5
1	5	130	26	125

**Absolute Maximum Ratings<sup>(1)</sup>**

Supply Voltage ( $V_{DD}$ )	+4.6V
Input Voltage ( $V_{IN}$ )	-0.50V to $V_{DD}+0.5V$
Output Voltage ( $V_{OUT}$ )	-0.50V to $V_{DD}+0.5V$
Lead Temperature (soldering, 20sec.)	260°C
Storage Temperature ( $T_s$ )	-65°C to +150°C

**Operating Ratings<sup>(2)</sup>**

Supply Voltage ( $V_{IN}$ )	+2.375V to +3.465V
Ambient Temperature ( $T_A$ )	-40°C to +85°C
Junction Thermal Resistance	
TSSOP ( $\theta_{JA}$ )	113°C/W

**DC Electrical Characteristics**

$V_{DD} = 2.5V \pm 5\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{DD}$	Core Supply Voltage		2.375	2.50	2.625	V
$V_{DDA}$	Analog Supply Voltage		2.375	2.50	2.625	V
$V_{DDO}$	Output Supply Voltage		2.375	2.50	2.625	V
$I_{DD}$	Power Supply Current			0.1	1	mA
$I_{DDA}$	Analog Supply Current			50	60	mA
$I_{DDO}$	Output Supply Current	No Load		15	23	mA

**DC Electrical Characteristics**

$V_{DD} = 3.3V \pm 5\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{DD}$	Core Supply Voltage		3.135	3.30	3.465	V
$V_{DDA}$	Analog Supply Voltage		3.135	3.30	3.465	V
$V_{DDO}$	Output Supply Voltage		3.135	3.30	3.465	V
$I_{DD}$	Power Supply Current			0.1	1	mA
$I_{DDA}$	Analog Supply Current			50	60	mA
$I_{DDO}$	Output Supply Current	No Load		25	32	mA

**LVCMOS DC Electrical Characteristics**

$T_A = -40^\circ C$  to  $+85^\circ C$ , unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{IH}$	Input HIGH Voltage	$V_{DD} = 3.3V \pm 5\%$	2		$V_{DD} + 0.3$	V
		$V_{DD} = 2.5V \pm 5\%$	1.7		$V_{DD} + 0.3$	V
$V_{IL}$	Input LOW Voltage	$V_{DD} = 3.3V \pm 5\%$	-0.30		0.80	V
		$V_{DD} = 2.5V \pm 5\%$	-0.30		0.70	V
$V_{OH}$	Output HIGH Voltage	$V_{DD} = 3.3V \pm 5\%$	2.6			V
		$V_{DD} = 2.5V \pm 5\%$	1.8			V
$V_{OL}$	Output LOW Voltage				0.5	V
$I_{IH}$	Input HIGH Current	Output Enable input			5	$\mu A$
$I_{IL}$	Input LOW Current	Output Enable input	-150			$\mu A$
$I_{IH}$	Input HIGH Current	FSEL input			150	$\mu A$
$I_{IL}$	Input LOW Current	FSEL input	-5			$\mu A$

**Notes:**

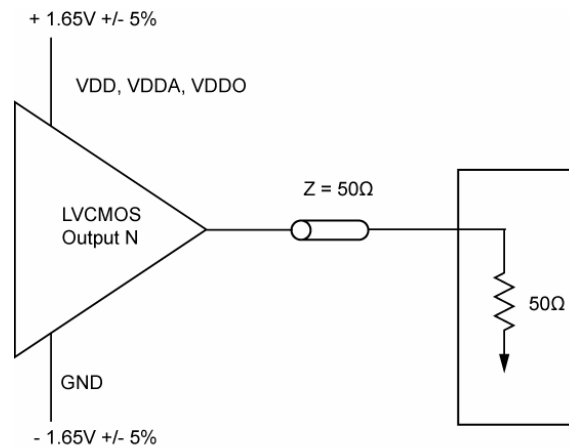
- Exceeding the absolute maximum rating may damage the device.
- The device is not guaranteed to function outside its operating rating.

## AC Electrical Characteristics

$V_{DD} = 2.5V$  and  $3.3V \pm 5\%$ ;  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
F <sub>OUT</sub>	Output Frequency	F_SEL = 1		125		MHz
		F_SEL = 0		62.5		
t <sub>SKEW</sub>	Output to Output Skew				12	ps
t <sub>JITTER</sub>	RMS Phase Jitter(random)	125MHz @ 1.875MHz-20MHz		55		fs
		62.5MHz @ 1.875MHz-20MHz		356		fs
t <sub>R</sub> / t <sub>F</sub>	Output Rise/Fall Time	20% to 80%		300		ps
ODC	Output Duty Cycle	62.5MHz & 125MHz	48	50	52	%

## Test Circuit



3.3V Output Load AC Test Circuit

### 3.3V Carrier Frequency, 62.5MHz

Offset from Carrier	Measured Phase Noise	Unit
100Hz	-103	dBc/Hz
1kHz	-124	dBc/Hz
10kHz	-137	dBc/Hz
100kHz	-135	dBc/Hz
1MHz	-145	dBc/Hz
1.825MHz	-151	dBc/Hz
10MHz	-169	dBc/Hz
20MHz	-169	dBc/Hz

### 3.3V Carrier Frequency, 125MHz

Offset from Carrier	Measured Phase Noise	Unit
100Hz	-103	dBc/Hz
1kHz	-125	dBc/Hz
10kHz	-134	dBc/Hz
100kHz	-132	dBc/Hz
1MHz	-143	dBc/Hz
1.825	-152	dBc/Hz
10MHz	-166	dBc/Hz
20MHz	-167	dBc/Hz

## Crystal Characteristics

Parameter	Min	Typ	Max	Units
Mode of Oscillation	Fundamental Parallel Resonant			
Frequency		25		MHz
Equivalent Series Resistance (ESR)			50	$\Omega$
Shunt Capacitor			7	pF
Drive Level			1	mW

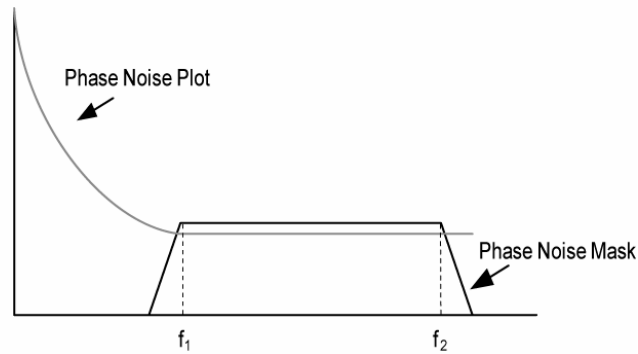
## Functional Description

The SM840004-11 provides a high performance and high accuracy solution for a precision clock source at either 62.5MHz or 125MHz derived from a low cost 25MHz Xtal. Four synchronous low skew 12mA capable LVCMOS outputs are provided with tri state controlled via an external pin (OE).

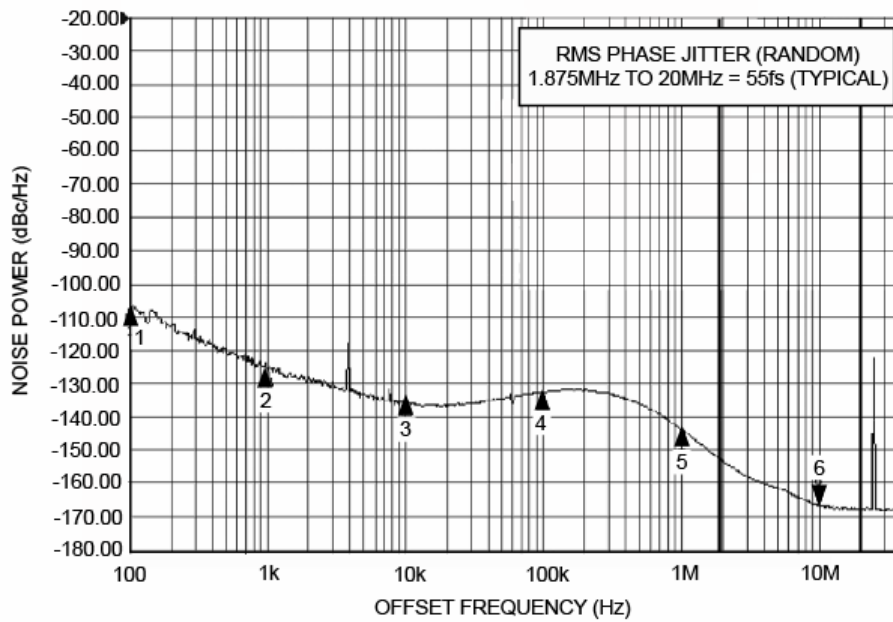
The design of the SM840004-11 consumes very low power in the PLL due to a patented technology in the VCO and the associated dividers. The VCO range is ~3.2GHz to 3.5GHz providing high resolution and easy

integer divide ratios. Output divider ratios are fixed at either  $\div 26$  or  $\div 52$  via the F\_SEL pin, and the feedback divider is fixed at  $\div 130$ . Duty Cycle is inherently improved and provides tight control and stability on this critical specification. This provides improved specifications for Duty Cycle, Jitter, Phase Noise, Power Consumption, and noise sensitivity. Additionally, the SM840004-11 will operate at either 3.3V or 2.5V supplies.

# RMS Phase Noise/Jitter

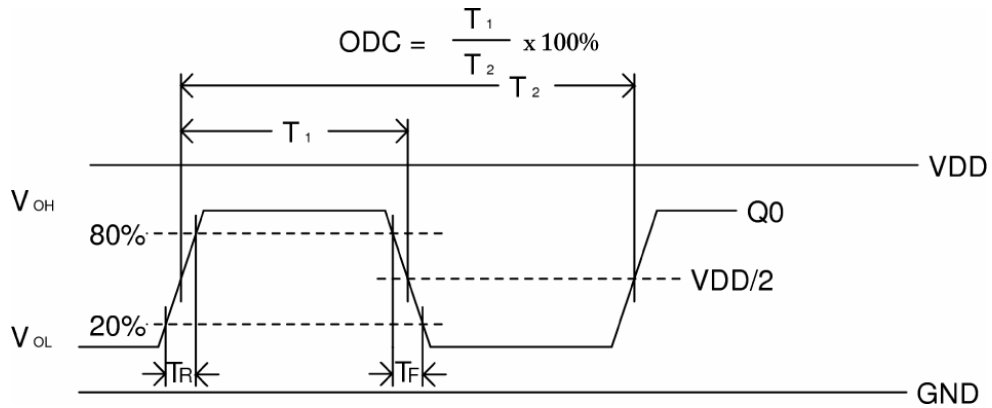


$$\text{RMS Jitter} = \sqrt{\text{Area Under the Phase Noise Plot}}$$

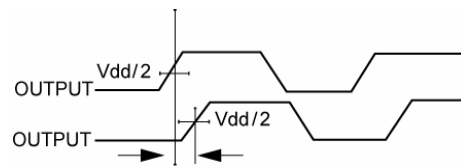


Phase Noise Plot 125MHz @ 3.3V

## Switching Waveforms



**Output Rise/Fall Time**



**Output-Output Skew**

**Power Supply Filtering**

The SM840004-11 provides separate power supply pins to isolate any high switching noise from outputs to internal core blocks. VDD and VDDA should be individually connected to the power plane through vias. Bypass capacitors should be used for each pin. Figure 2, illustrates how the power supply filter for 3.3V and 2.5V is configured.

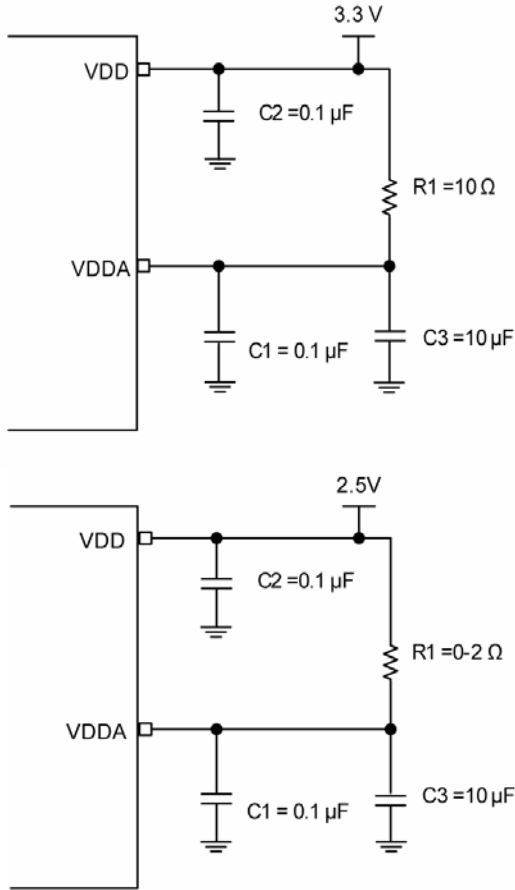
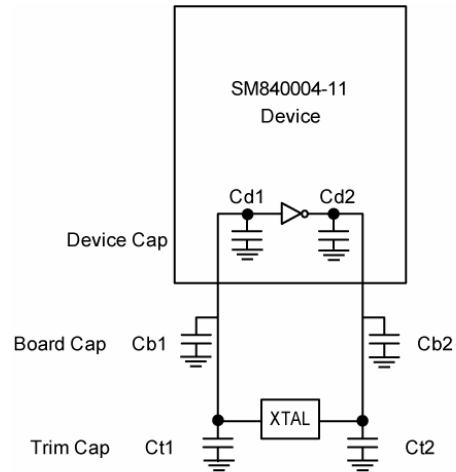


Figure 2. Power Supply Filter

**Crystal Loading**



**Crystal Recommendations**

This device requires a parallel resonance crystal. Substituting a series resonance crystal will cause this device to operate at the wrong frequency and violate the ppm specifications.

To achieve low ppm error, the total capacitance the crystal will see must be considered to calculate the appropriate capacitive loading (CL).

Load Capacitance at each side: Trim Capacitance =  $C_t = (2 \cdot CL - (C_b + C_d))$

CL: Crystal load capacitance. Defined by manufacturer

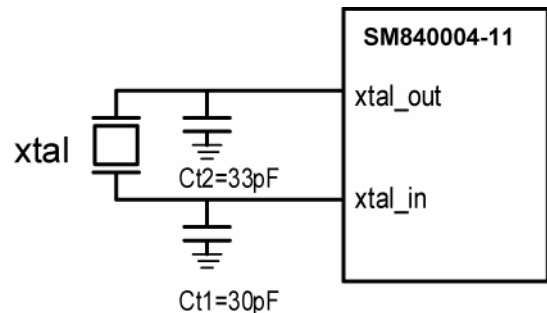
Ct: External trim capacitors. (Trimmed CL Load capacitance to get the right ppm)

Cb: Board capacitance (vias, traces, etc.)

Cd: Internal capacitance of the device (lead frame, bond wires, pin, etc.)

Equivalent Series Resistance (ESR) Max.	Cut	Load Cap.	Shunt Cap. Max.	Drive Max.
50Ω	AT	18pF	7pF	0.1mW

**Crystal Input Interface**





Total capacitance seen by crystal = CL =

$$\frac{1}{\frac{1}{(Ct1 + Cb1 + Cd1)} + \frac{1}{(Ct2 + Cb2 + Cd2)}}$$

**Example:**

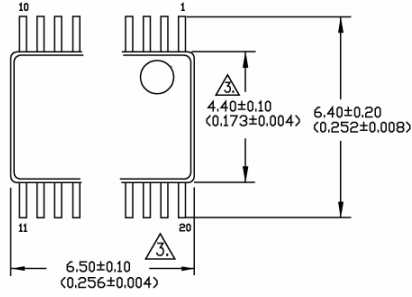
CL = 18pF, Cb = 2pF, Cd = 4pF

Trim Cap = Ct = 2 (18pF) - (2pF + 4pF) = 30pF

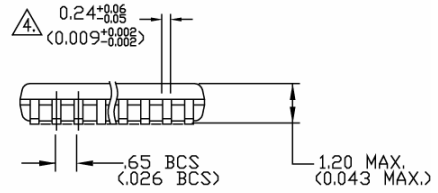
The SM840004-11 has been characterized with 19.44MHz, 18pF parallel resonant crystal. The trim capacitors Ct1 and Ct2 were optimized to minimize the ppm error.

To minimize the board capacitance, a short trace from pin to crystal footprint without vias is desirable. It is preferable to have ground shielding or distance between the crystal traces and noisy signals on the board.

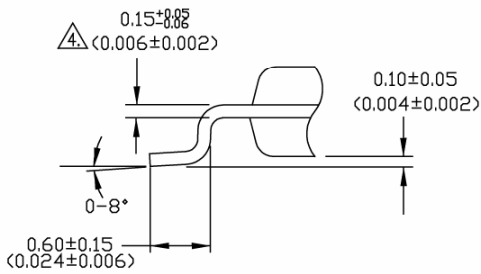
**Package Information**



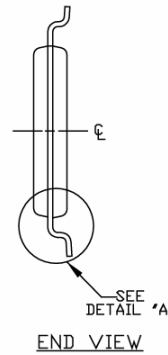
TOP VIEW



SIDE VIEW



DETAIL 'A'  
(VIEW ROTATED 90° C.W.)



END VIEW

**NOTES:**

1. DIMENSIONS ARE IN MM[INCHES].
2. CONTROLLING DIMENSION: MM.
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OF 0.254[0.010] MAX.
4. THIS DIMENSION INCLUDES LEAD FINISH.

**20-Pin TSSOP (K-20)**

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