



SM840021

125MHz Ultra-Low Jitter Clock Synthesizer

General Description

The SM840021 synthesizer was designed for Ethernet applications. This clock synthesizer is optimized for 125MHz using a standard 25MHz fundamental parallel resonant crystal, with unparalleled stability and accuracy over the full operating range. The SM840021 design includes a unique power reduction methodology, along with a patented RotaryWave™ architecture that provides a very stable clock with very low noise for optimized performance yielding 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.

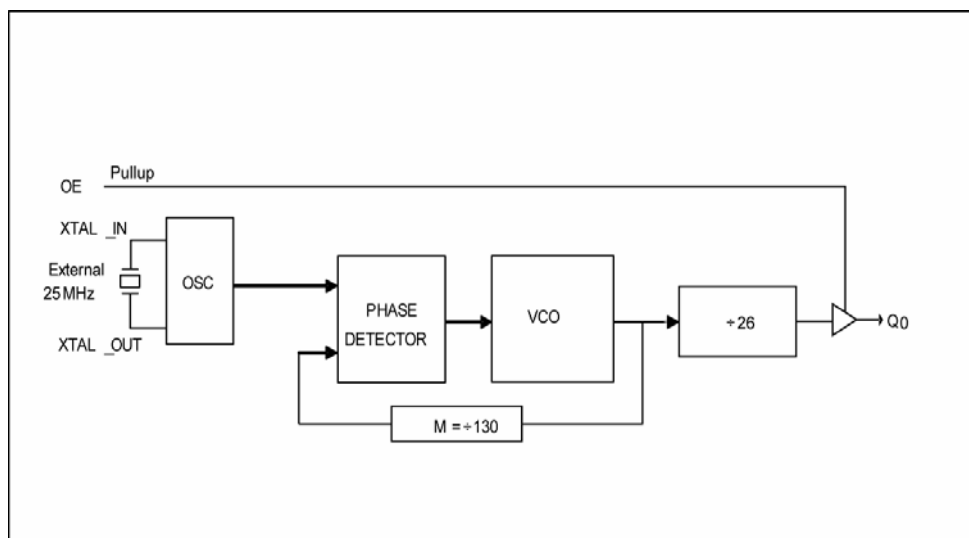
Features

- Generates an optimized 125MHz LVCMOS Output
- Integrated loop filter components
- RMS Phase Jitter: 250 fs (typ)
- Operates with either a 3.3V or 2.5V supply
- Power consumption is <77mA @ 3.3V
- Input frequency: 25MHz parallel resonant crystal
- Output frequency: 125MHz
- Temperature range: -40°C to +75°C
- Green, RoHS-compliant and PFOS-compliant
- Available in 8-pin TSSOP package

Applications

- Gigabit Ethernet
- Datacom/Telecom
- Ethernet Switch

Block Diagram



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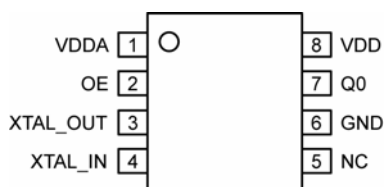
Ordering Information⁽¹⁾

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SM840021KA	K-8	-40°C to +75°C	840021	NiPdAu
SM840021KA TR ⁽²⁾	K-8	-40°C to +75°C	840021	NiPdAu

Note:

1. Devices are Green, RoHS-compliant and PFOS-compliant.
2. Tape and Reel

Pin Configuration



8-Pin TSSOP (K-8)

Pin Description

Pin Number	Pin Name	Type	Level	Pin Function
1	V _{DDA}	P		Analog Power.
2	OE	I	Pull-up	Output Enable: 1 = Enable, 0 = Disable.
3	XTAL OUT	O		Crystal Output.
4	XTAL IN	I		Crystal Input.
5	NC			No Connect.
6	GND	P		Ground.
7	Q0	O		Single Ended LVCMOS Clock Out.
8	V _{DD}	P		Core Power.

Output Enable

OE	Output
0	Disable
1	Enable

Absolute Maximum Ratings⁽¹⁾

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⁽²⁾

Supply Voltage (V_{IN}) +2.375V to +3.465V
 Ambient Temperature (T_A) -40°C to +75°C
 Junction Thermal Resistance
 TSSOP (θ_{JA}) 150°C/W

DC Electrical Characteristics

$V_{DD} = 2.5V \pm 5\%$; $T_A = -40^\circ C$ to $+75^\circ C$, 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
I_{DD}	Core Supply Current	No load		12	20	mA
I_{DDA}	Analog Supply Current			48	55	mA

DC Electrical Characteristics

$V_{DD} = 3.3V \pm 5\%$; $T_A = -40^\circ C$ to $+75^\circ C$, 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
I_{DD}	Core Supply Current	No load		15	22	mA
I_{DDA}	Analog Supply Current			49	55	mA

LVCMOS DC Characteristics

$V_{DD} = 2.5V \pm 5\%$ and $3.3V \pm 5\%$; $T_A = -40^\circ C$ to $+75^\circ C$, unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{IH}	Input HIGH Voltage	3.3V Operation	2		$V_{DD} + 0.3$	V
		2.5V Operation	1.7		$V_{DD} + 0.3$	V
V_{IL}	Input LOW Voltage	3.3V Operation	-0.3		0.8	V
		2.5V Operation	-0.3		0.7	V
I_{IH}	Input HIGH Current	$V_{DD} = V_{IN} = 3.465V$			5	μA
I_{IL}	Input LOW Current	$V_{DD} = 3.465V$; $V_{IN} = 0V$	-150			μA
V_{OH}	Output HIGH Voltage ⁽³⁾	$V_{DD} = 3.3V \pm 5\%$	2.6			V
		$V_{DD} = 2.5V \pm 5\%$	1.8			V
V_{OL}	Output LOW Voltage ⁽³⁾	$V_{DD} = 3.3V \pm 5\%$ or $V_{DD} = 2.5V \pm 5\%$			0.5	V

Notes:

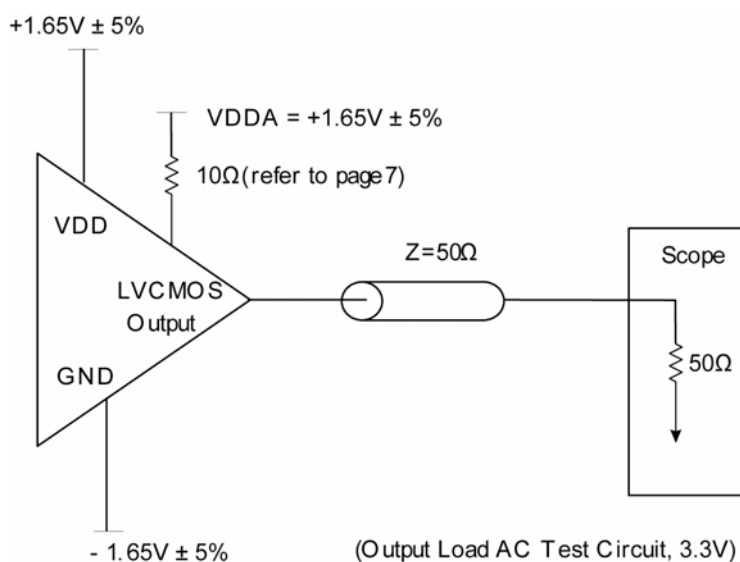
- Exceeding the absolute maximum rating may damage the device.
- The device is not guaranteed to function outside its operating rating.
- Outputs terminated with 50 Ω to $V_{DD}/2$. See Parameters measurements 3.3V load test circuit.

AC Electrical Characteristics

$V_{DD} = 2.5V \pm 5\%$ and $3.3V \pm 5\%$; $T_A = -40^{\circ}C$ to $+75^{\circ}C$, unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
F_{OUT}	Output Frequency	25MHz Crystal		125		MHz
t_{JITTER}	RMS phase jitter @ 125MHz	Integration Range: 1.875MHz to 20MHz		250		fs
t_R / t_F	Output Rise/Fall Time	20% to 80%	100		350	ps
ODC	Output Duty Cycle		48	50	52	%

Test Circuit



3.3V Carrier Frequency, 125MHz

Offset from Carrier	Measured Phase Noise	Unit
100Hz	-103	dBc/Hz
1kHz	-126	dBc/Hz
10kHz	-134	dBc/Hz
100kHz	-130	dBc/Hz
1MHz	-143	dBc/Hz
1.875MHz	-152	dBc/Hz
10MHz	-166	dBc/Hz
20MHz	-167	dBc/Hz

Functional Description

The SM840021 provides a high performance and high accuracy solution for a precision clock source at 125MHz derived, from a low cost 25MHz Xtal.

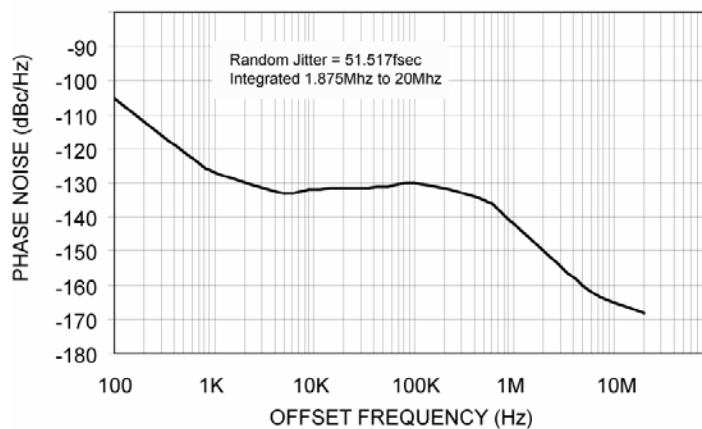
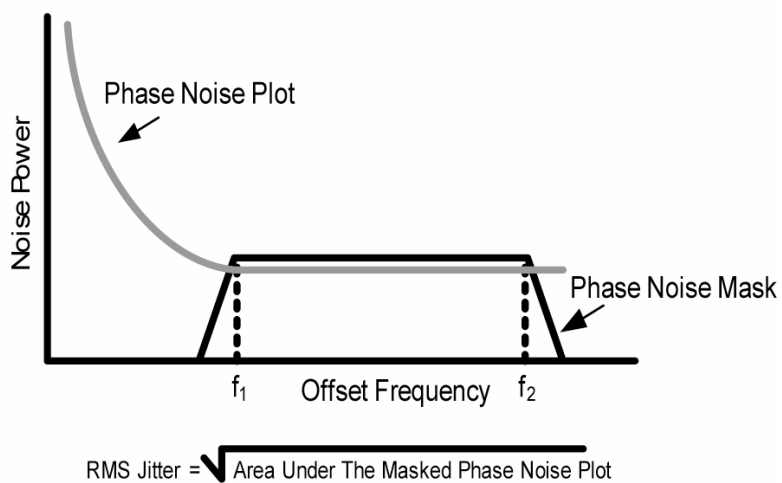
The design of the SM840021 consumes very low power in the PLL due to a proprietary technology in the VCO and the associated dividers. The output divider is fixed at $\div 26$, and the feedback divider is also fixed at $\div 130$

providing a precision clock at 125MHz. Duty Cycle is inherently improved to provide a tight control and stability on this critical specification.

The device provides improved specifications for Duty Cycle, Jitter, Phase Noise, Power Consumption, and noise sensitivity. Additionally, the SM840021 will operate at either 3.3V or 2.5V supplies.

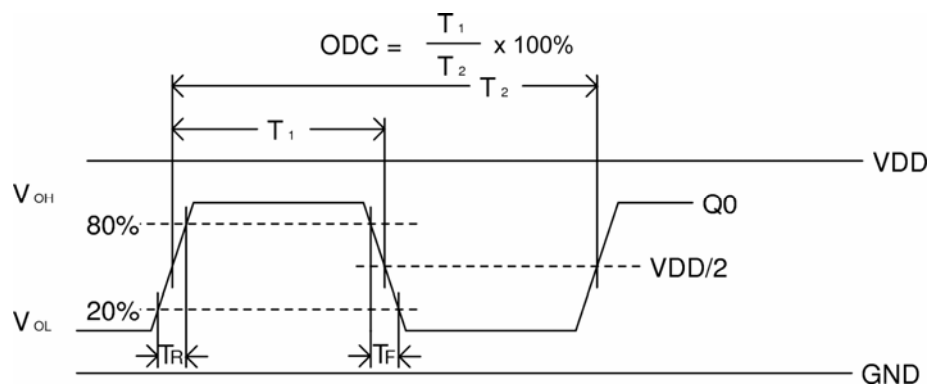
RMS Phase Noise/Jitter

RMS Phase Noise/Jitter



Phase Noise Plot: 125MHz @ 3.3V

Switching Waveforms



Power Supply Filtering

The SM840021 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 3.3 V and 2.5 V is configured.

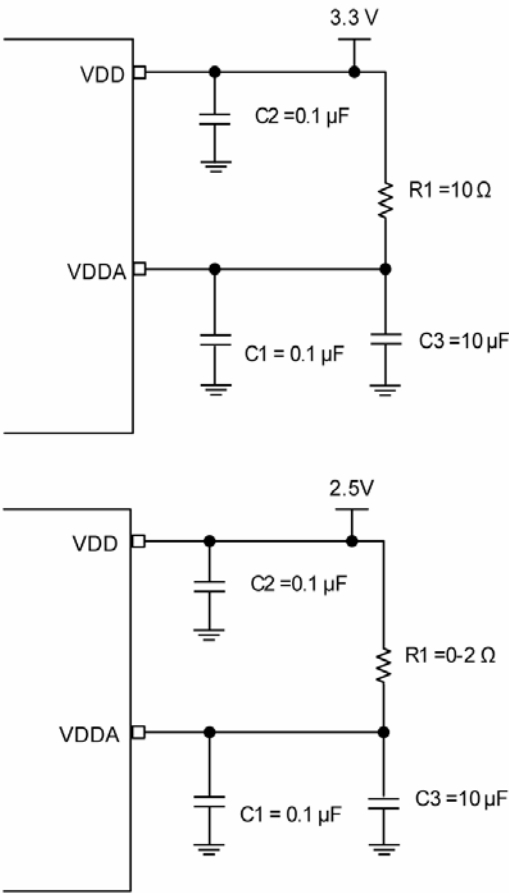
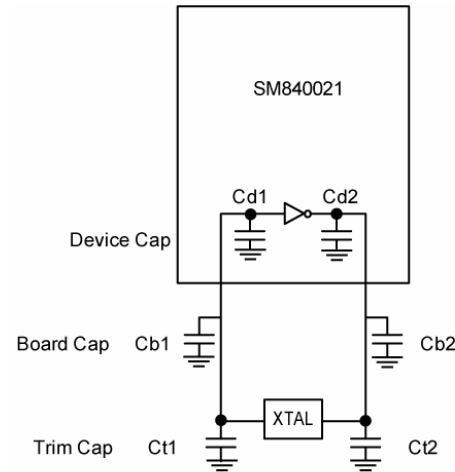


Figure 2.

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 of the crystal must be considered in order to calculate 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

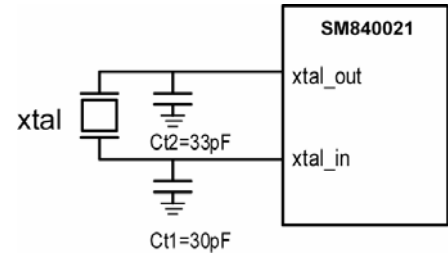
Ct: External trim capacitors. (Trimmed CL Load capacitance to get the right ppm)

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.
70Ω	AT		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:

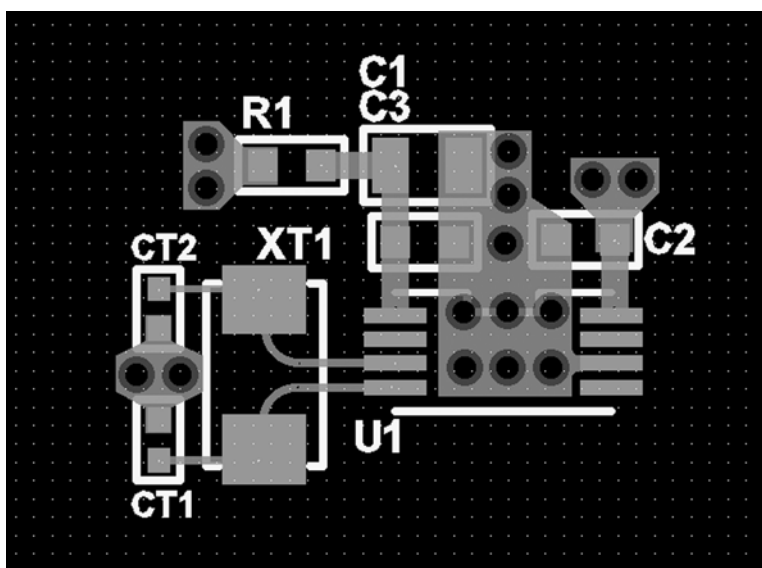
$CL = 18\text{pF}$, $Cb = 2\text{pF}$, $Cd = 4\text{pF}$

Trim Cap = $Ct = 2 (18\text{pF}) - (2\text{pF} + 4\text{pF}) = 30\text{pF}$

The SM840021 has been characterized with 25MHz, 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.

Board Layout



TOP VIEW

Dimensions and features shown in the top view:

- Overall width: 6.40 ± 0.13
- Pin pitch (between pins 1 and 4): 0.65 ± 0.13
- Pin width (pin 1): 0.25 ± 0.03
- Pin spacing (between pins 5 and 8): 0.25 ± 0.03
- Reference dimension for pin spacing: 1.95 REF
- INDEX MARK
- Surface finish symbol: $\sqrt{2} \Delta 44.40 \pm 0.07$

BOTTOM VIEW

Dimensions and features shown in the bottom view:

- Pin 1 and Pin 8 locations are indicated.

DETAIL A

Dimensions and features shown in Detail A:

- Lead thickness: $0.10 \pm 0.03 \times 45^\circ \pm 5^\circ$
- Lead width: 0.20 MIN
- Lead angle: 12.00° REF
- Lead radius: $R0.09 \text{ MIN}$
- Lead thickness at bend: 0.60
- Reference dimension for lead length: 1.00 REF
- Surface finish symbol: $\sqrt{2} \Delta 44.40 \pm 0.07$
- SEATING PLANE

8-Pin TSSOP (K-8)

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Электрон
Связь**

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