PEREGRINE SEMICONDUCTOR

PRODUCT SPECIFICATION

PE3240

2.2 GHz Integer-N PLL for Low Phase Noise Applications

Features

- 2.2 GHz operation
- 10/11 prescaler
- Internal phase detector
- Serial programmable
- Low power — 15 mA at 3 V
- Ultra-low phase noise
- Available in 20-lead TSSOP

Product Description

Peregrine's PE3240 is a high performance integer-N PLL capable of frequency synthesis up to 2.2 GHz. The superior phase noise performance of the PE3240 is ideal for applications such as wireless local loop basestations, LMDS systems and other demanding terrestrial systems.

The PE3240 features a 10/11 dual modulus prescaler, counters and a phase comparator as shown in Figure 1. Counter values are programmable through a three wire serial interface.

Fabricated in Peregrine's patented UTSi® (Ultra Thin Silicon) CMOS technology, the PE3240 offers excellent RF performance with the economy and integration of conventional CMOS.

Figure 1. Block Diagram

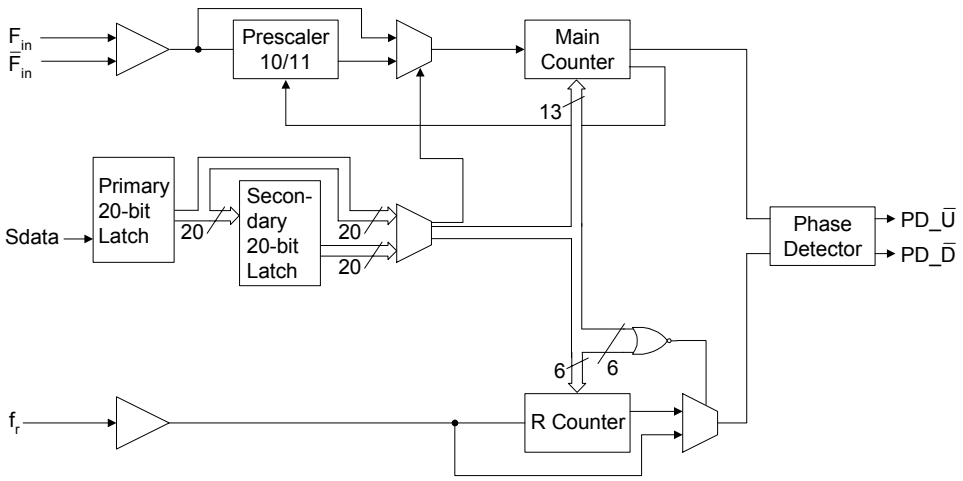


Figure 2. Pin Configuration

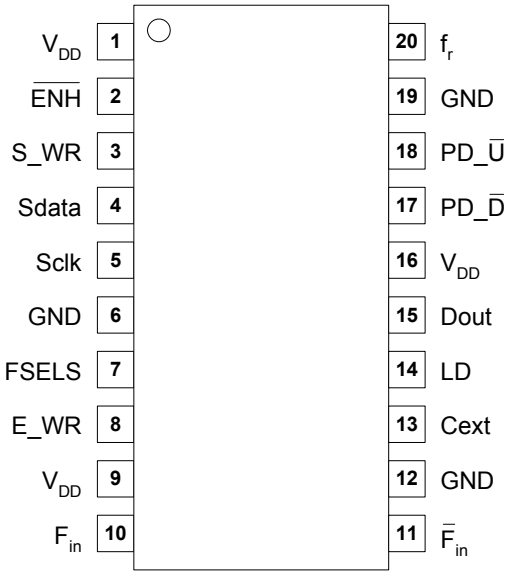


Table 1. Pin Descriptions

Pin No.	Pin Name	Type	Description
1	V_{DD}	(Note 1)	Power supply input. Input may range from 2.85 V to 3.15 V. Bypassing required.
2	$\overline{Enh}$	Input	Enhancement mode. When asserted low (“0”), enhancement register bits are functional. Internal 70 kΩ pull-up resistor.
3	S_WR	Input	Serial load enable input. While S_WR is “low”, Sdata can be serially clocked. Primary register data are transferred to the secondary register on S_WR rising edge.
4	Sdata	Input	Binary serial data input. Input data entered MSB first.
5	Sclk	Input	Serial clock input. Sdata is clocked serially into the 20-bit primary register (E_WR “low”) or the 8-bit enhancement register (E_WR “high”) on the rising edge of Sclk.
6	GND		Ground.
7	FSELS	Input	Selects contents of primary register (FSELS=1) or secondary register (FSELS=0) for programming of internal counters. Internal 70 kΩ pull-down resistor.
8	E_WR	Input	Enhancement register write enable. While E_WR is “high”, Sdata can be serially clocked into the enhancement register on the rising edge of Sclk. Internal 70 kΩ pull-down resistor.
9	V_{DD}	(Note 1)	Same as pin 1.
10	Fin	Input	Prescaler input from the VCO. Max frequency input is 2.2 GHz.
11	$\overline{F}_{in}$	Input	Prescaler complementary input. A bypass capacitor should be placed as close as possible to this pin and be connected in series with a 50 Ω resistor to the ground plane.
12	GND		Ground.
13	Cext	Output	Logical “NAND” of PD_$\overline{U}$ and PD_$\overline{D}$ terminated through an on chip, 2 kΩ series resistor. Connecting Cext to an external capacitor will low pass filter the input to the inverting amplifier used for driving LD.
14	LD	Output	Lock detect is an open drain logical inversion of CEXT. When the loop is in lock, LD is high impedance, otherwise LD is a logic low (“0”).
15	Dout	Output	Data out function, Dout, enabled in enhancement mode.
16	V_{DD}	(Note 1)	Same as pin 1.

Pin No.	Pin Name	Type	Description
17	PD_$\overline{D}$	Output	PD_$\overline{D}$ pulses down when f_p leads f_c.
18	PD_$\overline{U}$	Output	PD_$\overline{U}$ pulses down when f_c leads f_p.
19	GND		Ground.
20	f_r	Input	Reference frequency input.

Note 1: V_{DD} pins 1, 9, and 16 are connected by diodes and must be supplied with the same positive voltage level.

Table 2. Absolute Maximum Ratings

Symbol	Parameter/Conditions	Min	Max	Units
V_{DD}	Supply voltage	-0.3	4.0	V
V_I	Voltage on any input	-0.3	V_{DD} + 0.3	V
I_I	DC into any input	-10	+10	mA
I_O	DC into any output	-10	+10	mA
T_{stg}	Storage temperature range	-65	150	°C

Table 3. Operating Ratings

Symbol	Parameter/Conditions	Min	Max	Units
V_{DD}	Supply voltage	2.85	3.15	V
T_A	Operating ambient temperature range	-40	85	°C

Table 4. ESD Ratings

Symbol	Parameter/Conditions	Level	Units
V_{ESD}	ESD voltage human body model (Note 1)	1000	V

Note 1: Periodically sampled, not 100% tested. Tested per MIL-STD-883, M3015 C2

Electrostatic Discharge (ESD) Precautions

When handling this UTSi device, observe the same precautions that you would use with other ESD-sensitive devices. Although this device contains circuitry to protect it from damage due to ESD, precautions should be taken to avoid exceeding the rating specified in Table 4.

Latch-Up Avoidance

Unlike conventional CMOS devices, UTSi CMOS devices are immune to latch-up.

Table 5. DC Characteristics

V_{DD} = 3.0 V, -40° C < T_A < 85° C, unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{DD}	Operational supply current; Prescaler enabled	V_{DD} = 2.85 to 3.15 V		15	20	mA
Digital Inputs: S_WR, Sdata, Sclk						
V_{IH}	High level input voltage	V_{DD} = 2.85 to 3.15 V	0.7 x V_{DD}			V
V_{IL}	Low level input voltage	V_{DD} = 2.85 to 3.15 V			0.3 x V_{DD}	V
I_{IH}	High level input current	V_{IH} = V_{DD} = 3.15 V			+1	µA
I_{IL}	Low level input current	V_{IL} = 0, V_{DD} = 3.15 V	-1			µA
Digital inputs: $\overline{Enh}$ (contains a 70 kΩ pull-up resistor)						
V_{IH}	High level input voltage	V_{DD} = 2.85 to 3.15 V	0.7 x V_{DD}			V
V_{IL}	Low level input voltage	V_{DD} = 2.85 to 3.15 V			0.3 x V_{DD}	V
I_{IH}	High level input current	V_{IH} = V_{DD} = 3.15 V			+1	µA
I_{IL}	Low level input current	V_{IL} = 0, V_{DD} = 3.15 V	-100			µA
Digital inputs: FSELS, E_WR (contains a 70 kΩ pull-down resistor)						
V_{IH}	High level input voltage	V_{DD} = 2.85 to 3.15 V	0.7 x V_{DD}			V
V_{IL}	Low level input voltage	V_{DD} = 2.85 to 3.15 V			0.3 x V_{DD}	V
I_{IH}	High level input current	V_{IH} = V_{DD} = 3.15 V			+100	µA
I_{IL}	Low level input current	V_{IL} = 0, V_{DD} = 3.15 V	-1			µA
Reference Divider input: f_r						
I_{IHR}	High level input current	V_{IH} = V_{DD} = 3.15 V			+100	µA
I_{ILR}	Low level input current	V_{IL} = 0, V_{DD} = 3.15 V	-100			µA
Counter and phase detector outputs: Dout, PD_$\overline{D}$, PD_$\overline{U}$						
V_{OLD}	Output voltage LOW	I_{out} = 6 mA			0.4	V
V_{OHD}	Output voltage HIGH	I_{out} = -3 mA	V_{DD} - 0.4			V
Lock detect outputs: (Cext, LD)						
V_{OLC}	Output voltage LOW, Cext	I_{out} = 0.1 mA			0.4	V
V_{OHC}	Output voltage HIGH, Cext	I_{out} = -0.1 mA	V_{DD} - 0.4			V
V_{OLLD}	Output voltage LOW, LD	I_{out} = 1 mA			0.4	V

Table 6. AC Characteristics

V_{DD} = 3.0 V, -40° C < T_A < 85° C, unless otherwise specified

Symbol	Parameter	Conditions	Min	Max	Units
Control Interface and Latches (see Figures 5, 6)					
f_{Clk}	Serial data clock frequency	(Note 1)		10	MHz
t_{ClkH}	Serial clock HIGH time		30		ns
t_{ClkL}	Serial clock LOW time		30		ns
t_{DSU}	Sdata set-up time to Sclk rising edge		10		ns
t_{DHLD}	Sdata hold time after Sclk rising edge		10		ns
t_{PW}	S_WR pulse width		30		ns
t_{CWR}	Sclk rising edge to S_WR rising edge		30		ns
t_{CE}	Sclk falling edge to E_WR transition		30		ns
t_{WRC}	S_WR falling edge to Sclk rising edge		30		ns
t_{EC}	E_WR transition to Sclk rising edge		30		ns
Main Divider (Including Prescaler)					
F_{in}	Operating frequency		200	2200	MHz
P_{Fin}	Input level range	External AC coupling	-5	5	dBm
Main Divider (Prescaler Bypassed)					
F_{in}	Operating frequency		20	220	MHz
P_{Fin}	Input level range	External AC coupling	-5	5	dBm
Reference Divider					
f_r	Operating frequency	(Note 3)		100	MHz
P_{fr}	Reference input power (Note 2)	Single ended input	-2		dBm
Phase Detector					
f_c	Comparison frequency	(Note 3)		20	MHz

Note 1: fclk is verified during the functional pattern test. Serial programming sections of the functional pattern are clocked at 10 MHz to verify fclk specification.

Note 2: CMOS logic levels can be used to drive reference input if DC coupled. Voltage input needs to be a minimum of 0.5 Vp-p. For optimum phase noise performance, the reference input falling edge rate should be faster than 80mV/ns.

Note 3: Parameter is guaranteed through characterization only and is not tested.

Typical Performance Data (V_{DD} = 3.00V, T_A = 25°C)

Figure 3. Typical RF Input Sensitivity

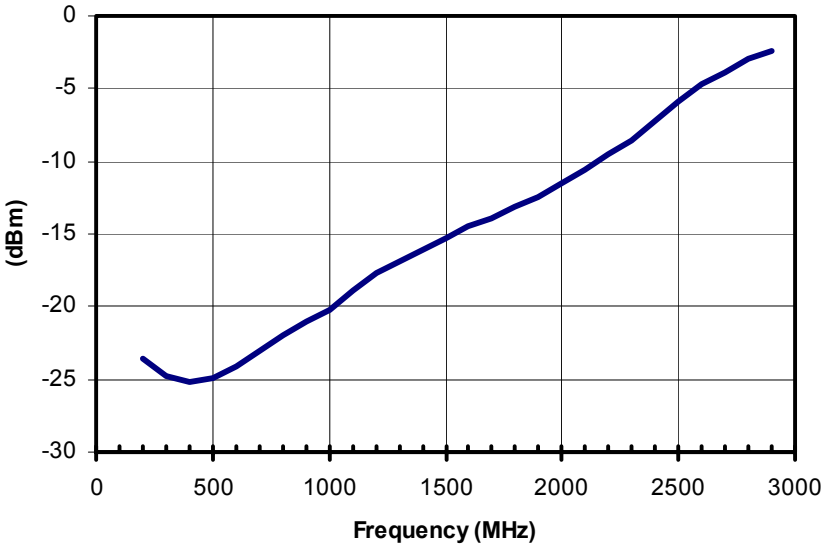
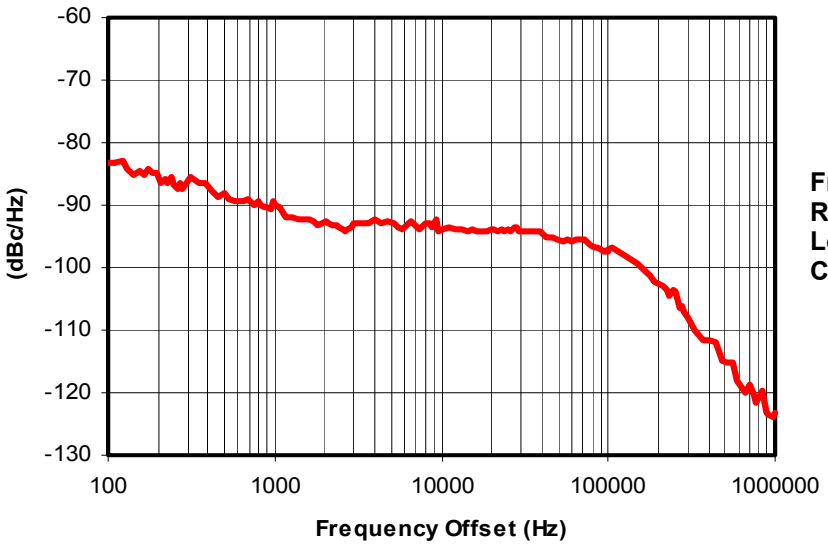


Figure 4. Typical Phase Noise Performance



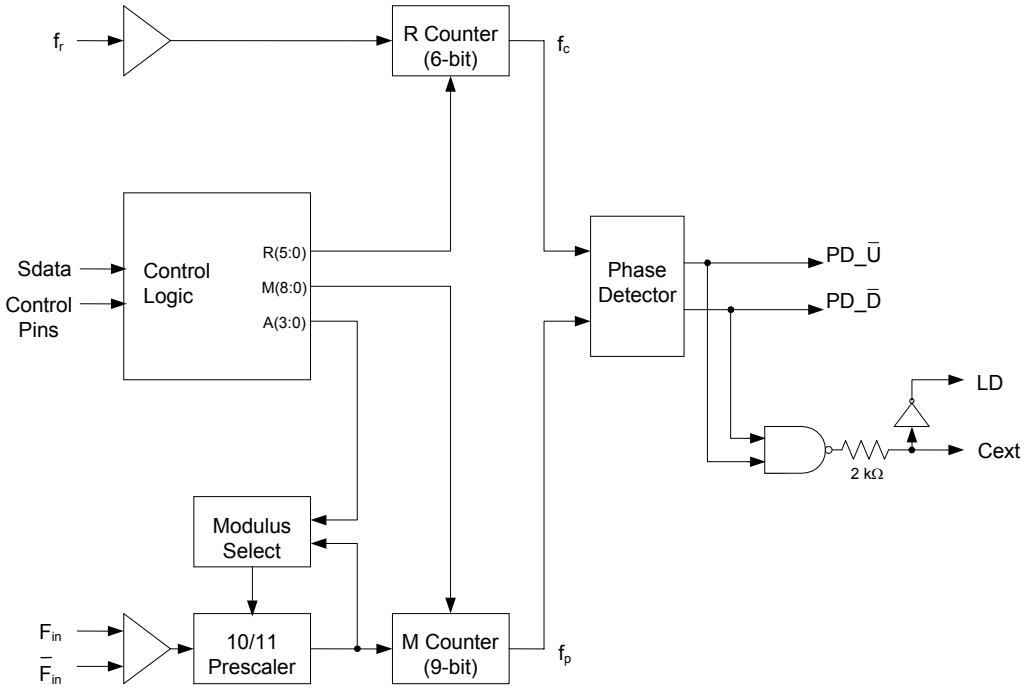
Frequency = 1300 MHz
Reference = 10 MHz
Loop Band Width = 100 kHz
Comparison Frequency = 1.25MHz

Functional Description

The PE3240 consists of a prescaler, counters, a phase detector and control logic. The dual modulus prescaler divides the VCO frequency by either 10 or 11, depending on the value of the modulus select. Counters “R” and “M” divide the reference and prescaler output, respectively, by integer values stored in a 20-bit register. An additional counter (“A”) is used in the modulus select logic.

The phase-frequency detector generates up and down frequency control signals. Data is written into the internal registers via the three wire serial bus. There are also various operational and test modes and a lock detect output.

Figure 5. Functional Block Diagram



Main Counter Chain

The main counter chain divides the RF input frequency, F_{in}, by an integer derived from the user defined values in the "M" and "A" counters. It is composed of the 10/11 dual modulus prescaler, modulus select logic, and 9 bit M counter. Setting Pre_en "low" enables the 10/11 prescaler. Setting Pre_en "high" allows F_{in} to bypass the prescaler and powers down the prescaler.

The output from the main counter chain, f_p, is related to the VCO frequency, F_{in}, by the following equation:

$$f_p = F_{in} / [10 \times (M + 1) + A] \quad (1)$$
$$\text{where } A \leq M + 1, M \neq 0$$

When the loop is locked, F_{in} is related to the reference frequency, f_r, by the following equation:

$$F_{in} = [10 \times (M + 1) + A] \times (f_r / (R+1)) \quad (2)$$
$$\text{where } A \leq M + 1, M \neq 0$$

A consequence of the upper limit on A is that F_{in} must be greater than or equal to 90 x (f_r / (R+1)) to obtain contiguous channels. Programming the M Counter with the minimum value of "1" will result in a minimum M Counter divide ratio of "2".

Reference Counter

The reference counter chain divides the reference frequency, f_r, down to the phase detector comparison frequency, f_c.

The output frequency of the 6 bit R Counter is related to the reference frequency by the following equation:

$$f_c = f_r / (R + 1) \quad (3)$$
$$\text{where } R \geq 0$$

Note that programming R equal to "0" will pass the reference frequency, f_r, directly to the phase detector.

Register Programming

Serial Interface Mode

While the E_WR input is "low" and the S_WR input is "low", serial input data (Sdata input), B_0 to B_{19}, are clocked serially into the primary register on the rising edge of Sclk, MSB (B_0) first. The contents from the primary register are transferred into the secondary register on the rising edge of either S_WR according to the timing diagrams shown in Figure 6. Data are transferred to the counters as shown in Table 7 on page 9.

The double buffering provided by the primary and secondary registers allows for "ping-pong" counter control using the FSELS input. When FSELS is "high", the primary register contents set the counter inputs. When FSELS is "low", the secondary register contents are utilized.

While the E_WR input is "high" and the S_WR input is "low", serial input data (Sdata input), B_0 to B_7, are clocked serially into the enhancement register on the rising edge of Sclk, MSB (B_0) first. The enhancement register is double buffered to prevent inadvertent control changes during serial loading, with buffer capture of the serially entered data performed on the falling edge of E_WR according to the timing diagram shown in Figure 6. After the falling edge of E_WR, the data provide control bits as shown in Table 8 on page 9 will have their bit functionality enabled by asserting the Enh input "low".

Table 7. Primary Register Programming

Interface Mode	$\overline{Enh}$	R_5	R_4	M_8	M_7	$\overline{Pre\_en}$	M_6	M_5	M_4	M_3	M_2	M_1	M_0	R_3	R_2	R_1	R_0	A_3	A_2	A_1	A_0
Serial*	1	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}	B_{16}	B_{17}	B_{18}	B_{19}

*Serial data clocked serially on Sclk rising edge while E_WR "low" and captured in secondary register on S_WR rising edge.

MSB (first in) ↑ ↑ (last in) LSB

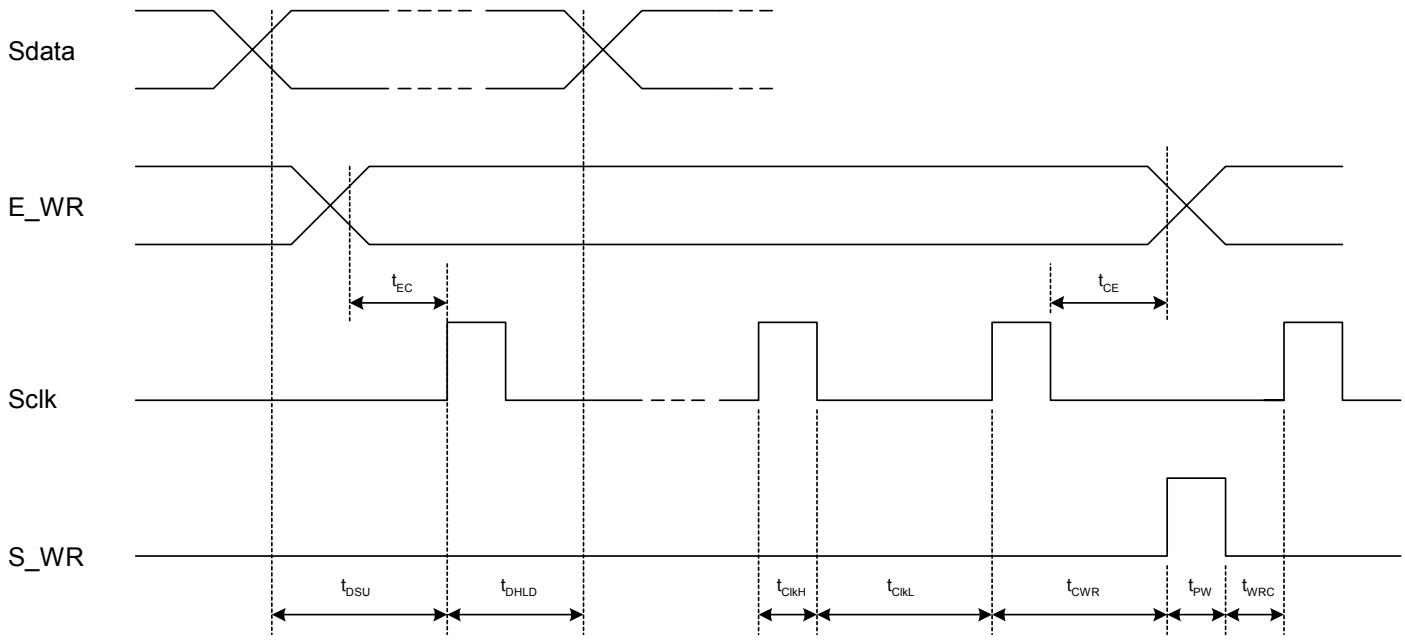
Table 8. Enhancement Register Programming

Interface Mode	$\overline{Enh}$	Reserved	Reserved	f_p Output	Power down	Counter load	MSEL output	f_c output	Reserved
Serial*	0	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7

*Serial data clocked serially on Sclk rising edge while E_WR "high" and captured in the double buffer on E_WR falling edge.

MSB (first in) ↑ ↑ (last in) LSB

Figure 6. Serial Interface Mode Timing Diagram



Enhancement Register

The functions of the enhancement register bits are shown below with all bits active “high”.

Table 9. Enhancement Register Bit Functionality

Bit Function		Description
Bit 0	Reserved**	
Bit 1	Reserved**	
Bit 2	f_p output	Drives the M counter output onto the Dout output.
Bit 3	Power down	Power down of all functions except programming interface.
Bit 4	Counter load	Immediate and continuous load of counter programming.
Bit 5	MSEL output	Drives the internal dual modulus prescaler modulus select (MSEL) onto the Dout output.
Bit 6	f_c output	Drives the reference counter output onto the Dout output
Bit 7	Reserved**	

** Program to 0

Phase Detector

The phase detector is triggered by rising edges from the main Counter (f_p) and the reference counter (f_c). It has two outputs, namely PD_$\overline{U}$, and PD_$\overline{D}$. If the divided VCO leads the divided reference in phase or frequency (f_p leads f_c), PD_$\overline{D}$ pulses “low”. If the divided reference leads the divided VCO in phase or frequency (f_c leads f_p), PD_$\overline{U}$ pulses “low”. The width of either pulse is directly proportional to phase offset between the two input signals, f_p and f_c.

The phase detector gain is equal to 2.70 V / 2 π, which numerically yields 0.43 V / Radian.

PD_$\overline{U}$ and PD_$\overline{D}$ drive an active loop filter which controls the VCO tune voltage. PD_$\overline{U}$ pulses result in an increase in VCO frequency and PD_$\overline{D}$ results in a decrease in VCO frequency, for a positive Kv VCO.

A lock detect output, LD is also provided, via the pin Cext. Cext is the logical “NAND” of PD_$\overline{U}$ and PD_$\overline{D}$ waveforms, which is driven through a series 2 kohm resistor. Connecting Cext to an external shunt capacitor provides low pass filtering of this signal. Cext also drives the input of an internal inverting comparator with an open drain output. Thus LD is an “AND” function of PD_$\overline{U}$ and PD_$\overline{D}$.

Figure 7. Package Drawing

20-lead TSSOP (JEDEC MO-153-AC)

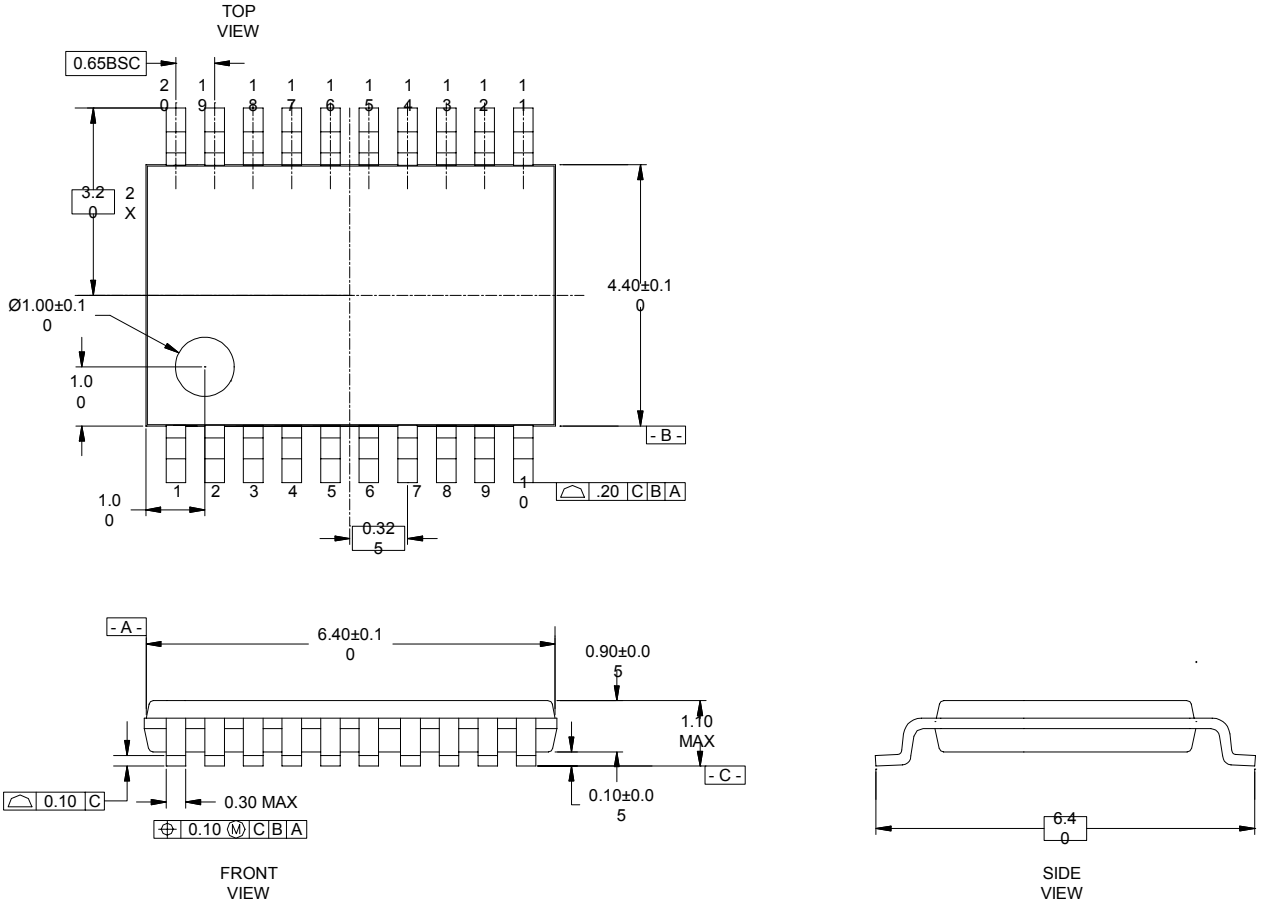


Table 10. Ordering Information

Order Code	Part Marking	Description	Package	Shipping Method
3240-11	PE3240	PE3240-20TSSOP-74A	20-lead TSSOP	74 units / Tube
3240-12	PE3240	PE3240-20TSSOP-200C	20-lead TSSOP	2000 units / T&R
3240-00	PE3240EK	PE3240-20TSSOP-EVAL KIT	Evaluation board	1 / Box

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Data Sheet Identification

Advance Information

The product is in a formative or design stage. The data sheet contains design target specifications for product development. Specifications and features may change in any manner without notice.

Preliminary Specification

The data sheet contains preliminary data. Additional data may be added at a later date. Peregrine reserves the right to change specifications at any time without notice in order to supply the best possible product.

Product Specification

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