

# PE3293

## Product Description

The PE3293 is a dual fractional-N phase-lock loop (PLL) IC designed for frequency synthesis and fabricated on Peregrine's patented UTSi® CMOS process. Each PLL includes a prescaler, phase detector, charge pump and on-board fractional spur compensation.

The patented spur compensation circuitry designed into the device ensures superior spur performance over the full temperature and VCO tuning range.

The PE3293 provides fractional-N division with power-of-two denominator values up to 32. This allows comparison frequencies up to 32 times the channel spacing, providing a lower phase noise floor than integer PLLs. The 32/33 RF prescaler (PLL1) operates up to 1.8 GHz and the 16/17 IF prescaler (PLL2) operates up to 550 MHz.

## Applications

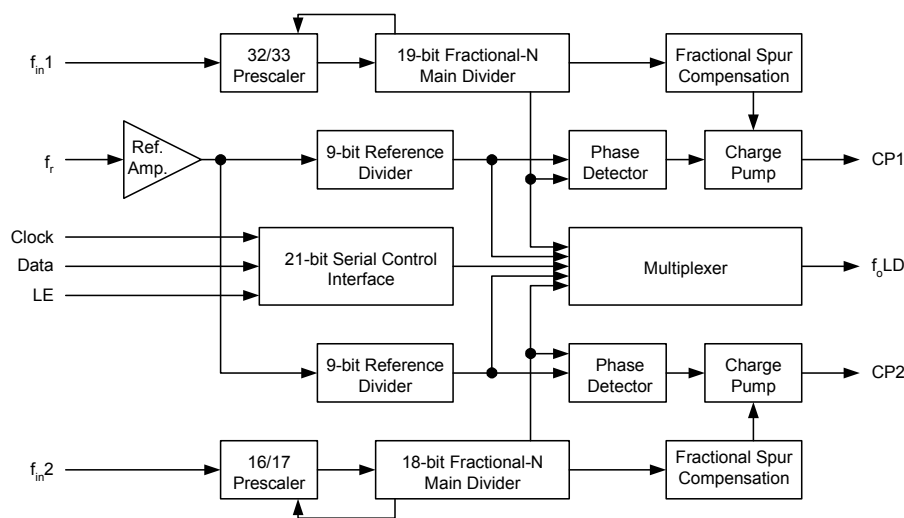
- Triple mode, dual-band PCS / Cellular handset
- PCS/CDMA/Cellular handsets
- PCS/CDMA/Cellular base stations

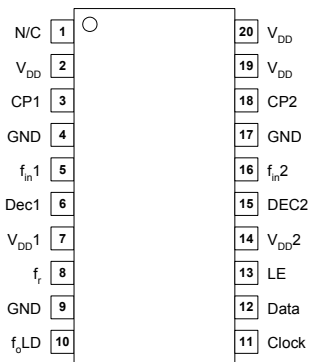
## 1.8 GHz / 550 MHz Dual Fractional-N Ultra-Low Spurious PLL for Frequency Synthesis

### Features

- Industry leading fractional spur compensation: no adjusting required, stable over temp.
- Ultra-Low Power consumption: 4.0 mA typical, both loops operating
- Modulo-32 fractional-N main counters
- Supply voltage range 2.7 to 3.3 VDC

Figure 1. Block Diagram

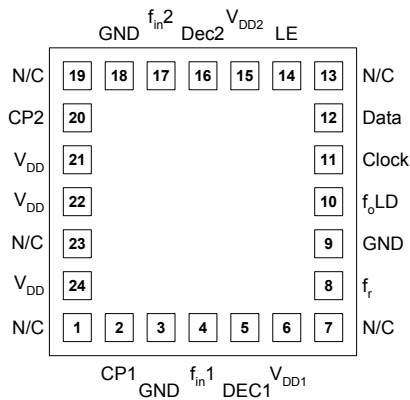


**Figure 2. Pin Configuration: TSSOP (JEDEC MO-153-AC)**

**Table 1. Pin Descriptions**

Pin No.	Pin Name	Type	Description
1	N / C		No connect.
2	V <sub>DD</sub>	(Note 1)	Power supply voltage input. Input may range from 2.7 V to 3.3 V. A bypass capacitor should be placed as close as possible to this pin and be connected directly to the ground plane.
3	CP1	Output	Internal charge-pump output from PLL1 for connection to a loop filter for driving the input of an external VCO.
4	GND		Ground.
5	f <sub>in1</sub>	Input	Prescaler input from the PLL1 (RF) VCO. Maximum frequency is 1.8 GHz.
6	Dec1		Power supply decoupling pin for PLL1. A capacitor should be placed as close as possible to this pin and be connected directly to the ground plane.
7	V <sub>DD1</sub>		PLL1 prescaler power supply. 3.3 kohm resistor to V <sub>DD</sub> .
8	f <sub>r</sub>	Input	Reference frequency input.
9	GND		Ground.
10	f <sub>oLD</sub>	Output	Multiplexed output of the PLL1 and PLL2 main counters or reference counters, Lock Detect signals, and data out of the shift register. CMOS output (see Table 11, f <sub>oLD</sub> Programming Truth Table).
11	Clock	Input	CMOS clock input. Serial data for the various counters is clocked in on the rising edge into the 21-bit shift register.
12	Data	Input	Binary serial data input. CMOS input data entered MSB first. The two LSBs are the control bits.
13	LE	Input	Load Enable CMOS input. When LE is high, data word stored in the 21-bit serial shift register is loaded into one of the four appropriate latches (as assigned by the control bits).
14	V <sub>DD2</sub>	Output	PLL2 prescaler power supply. 3.3 kohm resistor to V <sub>DD</sub> .
15	Dec2	Output	Power supply decoupling pin for PLL2. A capacitor should be placed as close as possible to this pin and be connected directly to the ground plane.
16	f <sub>in2</sub>	Input	Prescaler input from the PLL2 (IF) VCO. Maximum frequency is 550 MHz.
17	GND		Ground.
18	CP2	Output	Internal charge-pump output for PLL2. For connection to a loop filter for driving the input of an external VCO.
19	V <sub>DD</sub>	(Note 1)	Same as pin 2.
20	V <sub>DD</sub>	(Note 1)	Same as pin 2.

**Note 1:** V<sub>DD</sub> pins 2, 19, and 20 are connected by diodes and must be supplied with the same voltage level.

**Figure 3. Pin Configuration: 24-Pin BCC (Top View)**



**Table 2. Pin Descriptions**

Pin No.	Pin Name	Type	Description
1	N / C		No connect.
2	CP1	Output	Internal charge-pump output from PLL1 for connection to a loop filter for driving the input of an external VCO.
3	GND		Ground
4	f <sub>in1</sub>	Input	Prescaler input from the PLL1 (RF) VCO. Maximum frequency is 1.8 GHz.
5	Dec1		Power supply decoupling pin for PLL1. A capacitor should be placed as close as possible to this pin and be connected directly to the ground plane.
6	V <sub>DD1</sub>		PLL1 prescaler power supply (FlexiPower 1).
7	N / C		No connect.
8	f <sub>r</sub>	Input	Reference frequency input.
9	GND		Ground.
10	f <sub>oLD</sub>	Output	Multiplexed output of the PLL1 and PLL2 main counters or reference counters, Lock Detect signals, and data out of the shift register. CMOS output (see Table 11, f <sub>oLD</sub> Programming Truth Table).
11	Clock	Input	CMOS clock input. Serial data for the various counters is clocked in on the rising edge into the 21-bit shift register.
12	Data	Input	Binary serial data input. CMOS input data entered MSB first. The two LSBs are the control bits.
13	N / C		No connect.
14	LE	Input	Load Enable CMOS input. When LE is high, data word stored in the 21-bit serial shift register is loaded into one of the four appropriate latches (as assigned by the control bits).
15	V <sub>DD2</sub>		PLL2 prescaler power supply. 3.3 kohm resistor to V <sub>DD</sub> .
16	Dec2		Power supply decoupling pin for PLL2. A capacitor should be placed as close as possible to this pin and be connected directly to the ground plane.
17	f <sub>in2</sub>	Input	Prescaler input from the PLL2 (IF) VCO. Maximum frequency is 550MHz.
18	GND		Ground.
19	N / C		No connect.
20	CP2	Output	Internal charge-pump output for PLL2. For connection to a loop filter for driving the input of an external VCO.
21	V <sub>DD</sub>	(Note 1)	Power supply voltage input. Input may range from 2.7 V to 3.3 V. A bypass capacitor should be placed as close as possible to this pin and be connected directly to the ground plane.

Pin No.	Pin Name	Type	Description
22	V <sub>DD</sub>	(Note 1)	Same as pin 21.
23	N / C		No connect.
24	V <sub>DD</sub>	(Note 1)	Same as pin 21.

**Note 1:** V<sub>DD</sub> pins 21, 22, and 24 are connected by diodes and must be supplied with the same voltage level.

## PE3293 Description

The PE3293 is intended for such applications as the local oscillator for the RF and first IF of dual-conversion transceivers. The RF PLL (PLL1) includes a 32/33 prescaler with a 1.8 GHz maximum frequency of operation, where the IF PLL (PLL2) incorporates a 16/17 prescaler with a 550 MHz maximum frequency of operation. Using an advanced fractional-N phase-locked loop technique, the PE3293 can generate a stable, very low phase-noise signal. The dual fractional architecture allows fine resolution in both PLLs, with no degradation in phase noise performance.

Data is transferred into the PE3293 via a three-wire interface (Data, Clock, LE). Supply voltage can range from 2.7 to 3.3 volts for V<sub>DD</sub>. PE3293 features very low power consumption and is available in a JEDEC MO-153-AC (TSSOP), 20-pin package and 24-lead BCC package.

## Spurious Response

A critical parameter for synthesizer designs is spurious output. Spurs occur at the integer multiples of the step size away from center tone. An important feature of fractional synthesizers is their ability to reduce these spurious sidebands. The PE3293 has a built-in method for reducing these spurs, with no external components or tuning required. In addition, this circuitry works over the full commercial temperature and VCO tuning range.

**Table 3. Absolute Maximum Ratings**

Symbol	Parameter/Conditions	Min	Max	Units
$V_{DD}$	Supply voltage	-0.3	4.0	V
$V_{DD1}, V_{DD2}$	Prescaler supply voltage	-0.3	$V_{DD}$	V
$V_i$	Voltage on any input	-0.3	$V_{DD} + 0.3$	V
$I_i$	DC into any input	-10	+10	mA
$T_{stg}$	Storage temperature range	-65	150	°C

**Table 4. Operating Ratings**

Symbol	Parameter/Conditions	Min	Max	Units
$V_{DD}$	Supply voltage	2.7	3.3	V
$V_{DD1}, V_{DD2}$	Prescaler supply voltage	0.8	$V_{DD}$	°C
$T_A$	Operating ambient temperature range	-40	85	°C

**Table 5. ESD Ratings**

Symbol	Parameter/Conditions	Level	Units
$V_{ESD}$	ESD voltage human body model (Note 1)	2000	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 5.

### Latch-Up Avoidance

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

**Table 6. DC Characteristics**
 $V_{DD} = 3.0\text{ V}$ ,  $-40^\circ\text{ C} < T_A < 85^\circ\text{ C}$ , unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$I_{DD}$	3 V supply current	$C_{10}, C_{20} = 00$ (both PLLs on)		4.0		mA
$I_{stby}$	Total standby current			5.0	50	$\mu\text{A}$
Digital inputs: Clock, Data, LE						
$V_{IH}$	High level input voltage	$V_{DD} = 2.7$ to $3.3$ volts	$0.7 \times V_{DD}$			V
$V_{IL}$	Low level input voltage	$V_{DD} = 2.7$ to $3.3$ volts			$0.3 \times V_{DD}$	V
$I_{IH}$	High level input current	$V_{IH} = V_{DD} = 3.3$ volts	-1		+1	$\mu\text{A}$
$I_{IL}$	Low level input current	$V_{IL} = 0, V_{DD} = 3.3$ volts	-1		+1	$\mu\text{A}$
Reference Divider input: $f_r$						
$I_{IHR}$	Input current	$V_{IH} = V_{DD} = 3.3$ volts			+25	$\mu\text{A}$
$I_{ILR}$	Input current	$V_{IL} = 0, V_{DD} = 3.3$ volts	-25			$\mu\text{A}$
Digital output: $f_oLD$						
$V_{OLD}$	Output voltage LOW	$I_{out} = 1\text{ mA}$			0.4	V
$V_{OHD}$	Output voltage HIGH	$I_{out} = -1\text{ mA}$	$V_{DD} - 0.4$			V
Charge Pump outputs: CP1, CP2						
$I_{CP - Source}$	Drive current	$V_{CP} = V_{DD} / 2$		-70		$\mu\text{A}$
$I_{CP - Sink}$				-70		$\mu\text{A}$
$I_{CPL}$	Leakage current	$0.5\text{ V} < V_{CP} < V_{DD} - 0.5\text{ volt}$	-5		5	nA
$I_{CP - Source}$ vs. $I_{CP - Sink}$	Sink vs. source mismatch	$V_{CP} = V_{DD} / 2, T_A = 25^\circ\text{ C}$			10	%
$I_{CP}$ vs $T_A$	Output current vs. temperature	$V_{CP} = V_{DD} / 2$		10		%
$I_{CP}$ vs. $V_{CP}$	Output current magnitude variation vs. voltage	$0.5\text{ V} < V_{CP} < V_{DD} - 0.5\text{ volt}, T_A = 25^\circ\text{ C}$		10		%

## Table 7. AC Characteristics

$V_{DD} = 3.0\text{ V}$ ,  $-40^{\circ}\text{ C} < T_A < 85^{\circ}\text{ C}$ , unless otherwise specified

Symbol	Parameter	Conditions	Min	Max	Units
Control Interface and Latches (see figure 6)					
$f_{\text{Clock}}$	Serial data clock frequency			10	MHz
$t_{\text{ClockH}}$	Serial clock HIGH time		50		ns
$t_{\text{ClockL}}$	Serial clock LOW time		50		ns
$t_{\text{DSU}}$	Data set-up time to Clock rising edge		50		ns
$t_{\text{DHLd}}$	Data hold time after Clock rising edge		10		ns
$t_{\text{LEW}}$	LE pulse width		50		ns
$t_{\text{CLE}}$	Clock falling edge to LE rising edge		50		ns
$t_{\text{LEC}}$	LE falling edge to Clock rising edge		50		ns
$t_{\text{Data Out}}$	Data Out delay after Clock falling edge ( $f_{\text{oLD}}$ pin)	$C_L = 50\text{ pf}$		90	ns
Main Divider (Including Prescaler)					
$f_{\text{in}1}$	Operating frequency		300	1800	MHz
$f_{\text{in}2}$	Operating frequency		45	550	MHz
$P_{f_{\text{in}1}}$	Input level range	External AC coupling	-7	5	dBm
$P_{f_{\text{in}2}}$	Input level range	External AC coupling	-10	5	dBm
$f_{\text{c}}$	Comparison frequency			10	MHz
Reference Divider					
$f_{\text{r}}$	Operating frequency			50	MHz
$V_{\text{fr}}$	Input sensitivity	External AC coupling (note 1)	0.5		$V_{\text{P-P}}$

**Note 1:** CMOS logic levels may be used if DC coupled.

## Functional Description

The Functional Block Diagram in Figure 5 shows a 21-bit serial control register, a multiplexed output, and PLL sections PLL1 and PLL2. Each PLL contains a fractional-N main counter chain, a reference counter, a phase detector, and an internal charge pump with on-chip fractional spur compensation. Each fractional-N main counter chain includes an internal dual modulus prescaler, supporting counters, and a fractional accumulator.

Serial input data is clocked on the rising edge of Clock, MSB first. The last two bits are the address bits that determine the register address. Data is transferred into the counters as shown in Table 8, PE3293 Register Set. If the  $f_{0LD}$  pin is configured as data out, then the contents of shift register bit  $S_{20}$  are clocked on the falling edge of Clock onto the  $f_{0LD}$  pin. This feature allows the PE3293 and compatible devices to be connected in a daisy-chain configuration.

The PLL1 (RF) VCO frequency  $f_{in1}$  is related to the reference frequency  $f_r$  by the following equation:

$$f_{in1} = [(32 \times M_1) + A_1 + (F_1/32)] \times (f_r/R_1)$$

(1) Note that  $A_1$  must be less than or equal to  $M_1$ . Also,  $f_{in1}$  must be greater than or equal to  $1024 \times (f_r/R_1)$  to obtain contiguous channels.

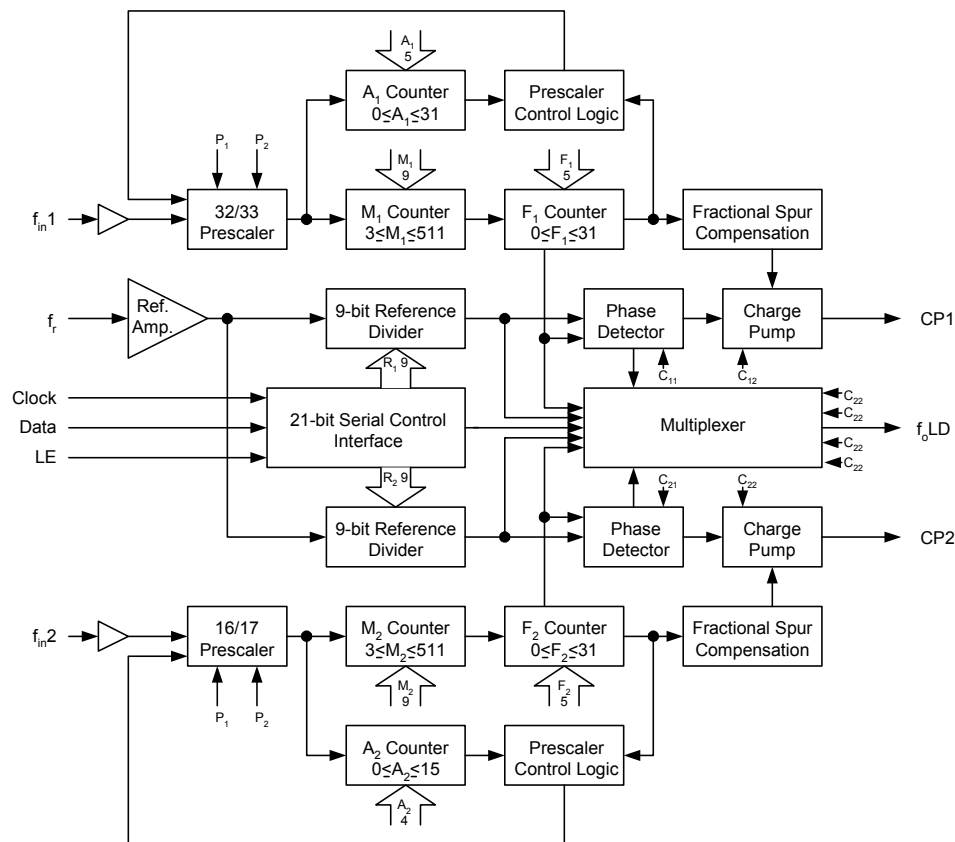
The PLL2 (IF) VCO frequency  $f_{in2}$  is related to the reference frequency  $f_r$  by the following equation:

$$f_{in2} = [(16 \times M_2) + A_2 + (F_2/32)] \times (f_r/R_2)$$

(2) Note that  $A_2$  must be less than or equal to  $M_2$ . Also,  $f_{in2}$  must be greater than or equal to  $256 \times (f_r/R_2)$  to obtain contiguous channels.

$F_1$  sets PLL1 fractionality. If  $F_1$  is an even number, the PE3293 automatically reduces the fraction. For example, if  $F_1 = 12$ , then the fraction  $12/32$  is automatically reduced to  $3/8$ . In this way, fractional denominators of 2, 4, 8, 16 and 32 are available.  $F_2$  sets the fractionality for PLL2 in the same manner.

**Figure 4. Functional Block Diagram**





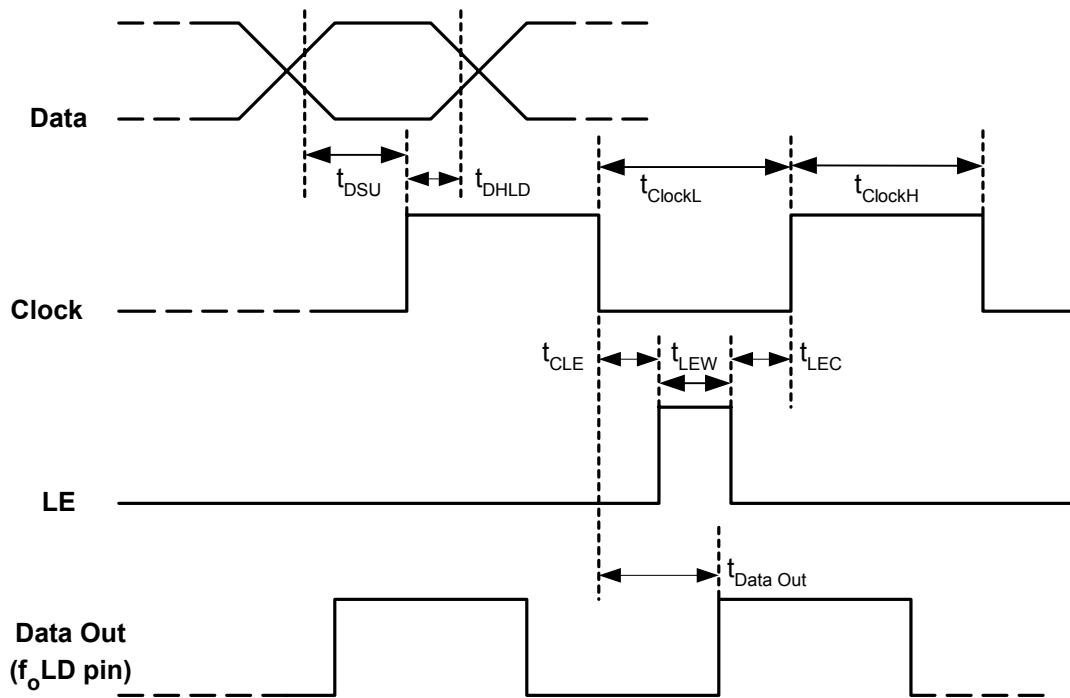
**Table 8. Register Set**

S <sub>20</sub>	S <sub>19</sub>	S <sub>18</sub>	S <sub>17</sub>	S <sub>16</sub>	S <sub>15</sub>	S <sub>14</sub>	S <sub>13</sub>	S <sub>12</sub>	S <sub>11</sub>	S <sub>10</sub>	S <sub>9</sub>	S <sub>8</sub>	S <sub>7</sub>	S <sub>6</sub>	S <sub>5</sub>	S <sub>4</sub>	S <sub>3</sub>	S <sub>2</sub>	S <sub>1</sub>	S <sub>0</sub>
<b>Reserved</b>				Test	PLL2 Synthesizer control					PLL2 Reference counter R <sub>2</sub> divide ratio							Address			
				0	C <sub>24</sub>	C <sub>23</sub>	C <sub>22</sub>	C <sub>21</sub>	C <sub>20</sub>	R <sub>28</sub>	R <sub>27</sub>	R <sub>26</sub>	R <sub>25</sub>	R <sub>24</sub>	R <sub>23</sub>	R <sub>22</sub>	R <sub>21</sub>	R <sub>20</sub>	0	0
<b>Res.</b>	PLL2 Main counter M <sub>2</sub> divide ratio									PLL2 Swallow counter A <sub>2</sub> divide ratio				PLL2 Fractional counter F <sub>2</sub> numerator value					Address	
	M <sub>28</sub>	M <sub>27</sub>	M <sub>26</sub>	M <sub>25</sub>	M <sub>24</sub>	M <sub>23</sub>	M <sub>22</sub>	M <sub>21</sub>	M <sub>20</sub>	A <sub>23</sub>	A <sub>22</sub>	A <sub>21</sub>	A <sub>20</sub>	F <sub>24</sub>	F <sub>23</sub>	F <sub>22</sub>	F <sub>21</sub>	F <sub>20</sub>	0	1
<b>Res.</b>	FlexiPower voltage regulation			PLL1 Synthesizer control					PLL1 Reference counter R <sub>1</sub> divide ratio							Address				
	P <sub>2</sub>	<b>Res.</b>	P <sub>1</sub>	C <sub>14</sub>	C <sub>13</sub>	C <sub>12</sub>	C <sub>11</sub>	C <sub>10</sub>	R <sub>18</sub>	R <sub>17</sub>	R <sub>16</sub>	R <sub>15</sub>	R <sub>14</sub>	R <sub>13</sub>	R <sub>12</sub>	R <sub>11</sub>	R <sub>10</sub>	1	0	
PLL1 Main counter M <sub>1</sub> divide ratio									PLL1 Swallow counter A <sub>1</sub> divide ratio					PLL1 Fractional counter F <sub>1</sub> numerator value					Address	
M <sub>18</sub>	M <sub>17</sub>	M <sub>16</sub>	M <sub>15</sub>	M <sub>14</sub>	M <sub>13</sub>	M <sub>12</sub>	M <sub>11</sub>	M <sub>10</sub>	A <sub>14</sub>	A <sub>13</sub>	A <sub>12</sub>	A <sub>11</sub>	A <sub>10</sub>	F <sub>14</sub>	F <sub>13</sub>	F <sub>12</sub>	F <sub>11</sub>	F <sub>10</sub>	1	1

↑  
MSB (first in)

↑  
(last in) LSB

**Figure 5. Serial Interface Mode Timing Diagram**



## Programmable Divide Values (R1, R2, F1, F2, A1, A2, M1, M2)

Data is clocked into the 21-bit shift register, MSB first. When LE is asserted HIGH, data is latched into the registers addressed by the last two bits shifted into the 21-bit register, according to Table 8. For example, to program the PLL1 (RF) swallow counter, A<sub>1</sub>, the last two bits shifted into the register (S<sub>0</sub>, S<sub>1</sub>) would be (1,1). The 5-bit A<sub>1</sub> counter would then be programmed according to Table 9. For normal operation, S<sub>16</sub> of address (0,0) (the Test bit) must be programmed to 0 even if PLL2 (IF) is not used.

**Table 9. PE3293 Counter Programming Example**

Divide Value	MSB				LSB	Address	
	S <sub>11</sub>	S <sub>10</sub>	S <sub>9</sub>	S <sub>8</sub>	S <sub>7</sub>	S <sub>1</sub>	S <sub>0</sub>
	A <sub>14</sub>	A <sub>13</sub>	A <sub>12</sub>	A <sub>11</sub>	A <sub>10</sub>	1	1
0	0	0	0	0	0	1	1
1	0	0	0	0	1	1	1
2	0	0	0	1	0	1	1
-	-	-	-	-	-	1	1
31	1	1	1	1	1	1	1

## Program Modes

Several modes of operation can be programmed with bits C<sub>10</sub> - C<sub>14</sub> and C<sub>20</sub> - C<sub>24</sub>, including the phase detector polarity, charge pump high impedance, output of the f<sub>o</sub>LD pin and power-down modes. The PE3293 modes of operation are shown on Table 10. The truth table for the f<sub>o</sub>LD output is shown in Table 11.

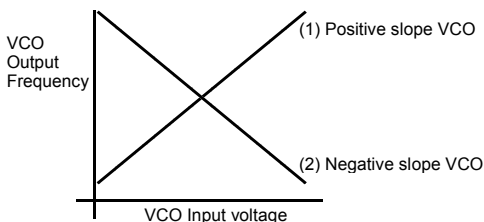
**Table 10. PE3293 Program Modes**

S <sub>15</sub>	S <sub>14</sub>	S <sub>13</sub>	S <sub>12</sub>	S <sub>11</sub>	S <sub>1</sub>	S <sub>0</sub>
C <sub>24</sub> See Table 11	C <sub>23</sub> See Table 11	C <sub>22</sub> 0 = PLL1 CP normal 1 = PLL1 CP High Z	C <sub>21</sub> (Note 2) 0 = PLL2 Phase Detector inverted 1 = PLL2 Phase Detector normal	C <sub>20</sub> (Note 1) 0 = PLL2 on 1 = PLL2 off	0	0
C <sub>14</sub> See Table 11	C <sub>13</sub> See Table 11	C <sub>12</sub> 0 = PLL1 CP normal 1 = PLL1 CP High Z	C <sub>11</sub> (Note 2) 0 = PLL1 Phase Detector inverted 1 = PLL1 Phase Detector normal	C <sub>10</sub> (Note 1) 0 = PLL1 on 1 = PLL1 off	1	0

**Note 1:** The PLL1 power-down mode disables all of PLL1's components except the R<sub>1</sub> counter and the reference frequency input buffer, with CP1 (pin 3) and f<sub>in</sub>1 (pin 5) becoming high impedance. The power down of PLL2 has similar results with CP2 (pin 18) and f<sub>in</sub>2 (pin 16) becoming high impedance. Power down of both PLL1 and PLL2 further disables counters R<sub>1</sub> and R<sub>2</sub>, the reference frequency input, and the f<sub>o</sub>LD output, causing f<sub>r</sub> (pin 8) and f<sub>o</sub>LD (pin 10) to become high impedance. The Serial Control Interface remains active at all times.

**Note 2:** The C<sub>11</sub> and C<sub>21</sub> bits should be set according to the voltage versus frequency slope of the VCO as shown in Figure 7. This relationship presumes the use of a passive loop filter. If an inverting active loop filter is used the relationship is also inverted.

## Figure 6. VCO Characteristics



- When VCO1 (RF) slope is positive like (1), C<sub>11</sub> should be set HIGH.
- When VCO1 (RF) slope is negative like (2), C<sub>11</sub> should be set LOW.
- When VCO2 (IF) slope is positive like (1), C<sub>21</sub> should be set HIGH.
- When VCO2 (IF) slope is negative like (2), C<sub>21</sub> should be set LOW.

**Table 11. f<sub>o</sub>LD Programming Truth Table**

X = don't care condition

f <sub>o</sub> LD Output State	C <sub>14</sub> (PLL1F <sub>0</sub> )	C <sub>13</sub> (PLL1LD)	C <sub>24</sub> (PLL2F <sub>0</sub> )	C <sub>23</sub> (PLL2LD)
Disabled (Note 1)	0	0	0	0
PLL 1 Lock detect (Note 2) (LD1)	0	1	0	0
PLL2 Lock detect (Note 2) (LD2)	0	0	0	1
PLL1 / PLL2 Lock detect (Note 2)	0	1	0	1
PLL1 Reference divider output (f <sub>c1</sub> )	1	X	0	0
PLL2 Reference divider output (f <sub>c2</sub> )	0	X	1	0
PLL1 Programmable divider output (f <sub>p1</sub> )	1	X	0	1
PLL2 Programmable divider output (f <sub>p2</sub> )	0	X	1	1
Serial data out	1	0	1	0
Reserved	1	0	1	1
Reserved	1	1	1	0
Counter reset (Note 3)	1	1	1	1

**Note 1:** When the f<sub>o</sub>LD is disabled the output is a CMOS LOW.

**Note 2:** Lock detect indicates when the VCO frequency is in "lock". When PLL1 is in lock and PLL1 lock detect is selected, the f<sub>o</sub>LD pin will be HIGH with narrow pulses LOW. When PLL2 is in lock and PLL2 lock detect is selected, the f<sub>o</sub>LD pin will be HIGH with narrow pulses LOW. When PLL1 / PLL2 lock detect is selected the f<sub>o</sub>LD pin will be HIGH with narrow pulses LOW only when both PLL1 and PLL2 are in lock.

**Note 3:** The counter reset state when activated resets all counters. Upon removal of the reset, counters M, A, and F resume counting in close alignment with the R counter (the maximum error is one prescaler cycle). The reset bits can be activated to allow smooth acquisition upon powering up.

### Programming the Pre-scaler

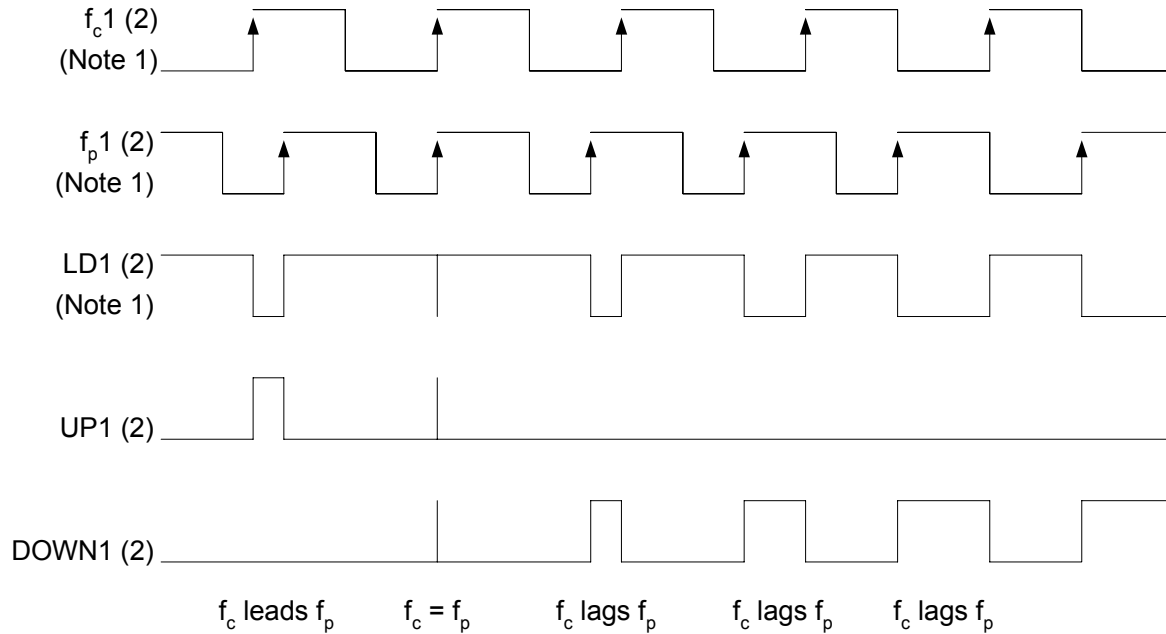
P<sub>2</sub> and P<sub>1</sub> are used for internal testing of the prescaler and must be programmed with 0,0 for normal PLL operation.

### Phase Comparator Characteristics

PLL1 has the timing relationships shown below for  $f_c1$ ,  $f_p1$ , LD1, UP1, and DOWN1. When  $C_{11} = \text{HIGH}$ , UP1 directs the internal PLL1 charge pump to source current and DOWN1 directs the PLL1 internal charge pump to sink current. If  $C_{11} = \text{LOW}$ , UP1 and DOWN1 are interchanged.

PLL2 has the timing relationships shown below for  $f_c2$ ,  $f_p2$ , LD2, UP2, and DOWN2. When  $C_{21} = \text{HIGH}$ , UP2 directs the internal PLL2 charge pump to source current and DOWN2 directs the PLL2 internal charge pump to sink current. If  $C_{21} = \text{LOW}$ , UP2 and DOWN2 are interchanged.

**Figure 7. Phase Comparator Timing Diagram**



**Note 1:**  $f_c1(2)$ ,  $f_p1(2)$ , and LD1(2) are accessible via the  $f_oLD$  pin per programming in Table 11.

## Loop Filter

### Second/Third Order Loops

Choosing the optimum loop filter for a design encompasses many trade offs. The rule of thumb for choosing the loop filter bandwidth is 10 percent of the step size. A second order loop ( $C_1$   $C_2$   $R_2$  and  $C_4$   $C_5$   $R_5$  in Figure 9 omitting  $C_3$   $R_3$   $C_6$  and  $R_6$ ) will provide the least amount of components and the fastest lock times. If lock time is an issue, one might try opening up the loop filter, although if it is too wide, instability will dominate and worsen lock time. If lock time is not an issue, a narrower second order filter will minimize residual FM without requiring additional components.

Third Order loop filters ( $C_1$   $C_2$   $R_2$   $C_3$   $R_3$  and  $C_4$   $C_5$   $R_5$   $C_6$   $R_6$  in Figure 9) provide a good compromise between lock time and residual FM. We have found using a third order loop with 20 dB of rejection at the step size will halve the Residual FM as measured with a similar second order loop, with minimum effect on lock time.

### Loop Filter Bandwidth Design Considerations

As part of the spur compensation circuitry, the PE329x series PLLs contain capacitors to ground internal to the charge pump. PLL1 contains a 50 pF capacitor and PLL2 contains a 100 pF capacitor. To ensure accurate loop filter calculations, it is critical that the calculated value of the first shunt capacitor ( $C_1$  &  $C_4$  in Figure 11) be at least 100 pF for PLL1 and 200 pF for PLL2. With this requirement satisfied, the remaining loop components can be calculated.

For a stable loop, it is also important that the loop bandwidth be less than or equal to one tenth of the step size.

## Digital Control Lines

### Control Line Noise

We have noticed frequency jitter during programming when a low impedance, such as a capacitor to ground, is placed next to any control line pin (clock, data, and load enable). The use of a 51 k ohm resistor in series with the control line will eliminate the problem with no effect to programming time.

### Enable Line Voltage

The PE329x series PLLs use a level sensitive load enable. Therefore the digital controller must provide an active low to the part at all times except when the data is to be loaded into the shift register. If the PLL controller does not hold the voltage low, a high impedance resistor to ground should be added to the enable line to ensure stable operation.

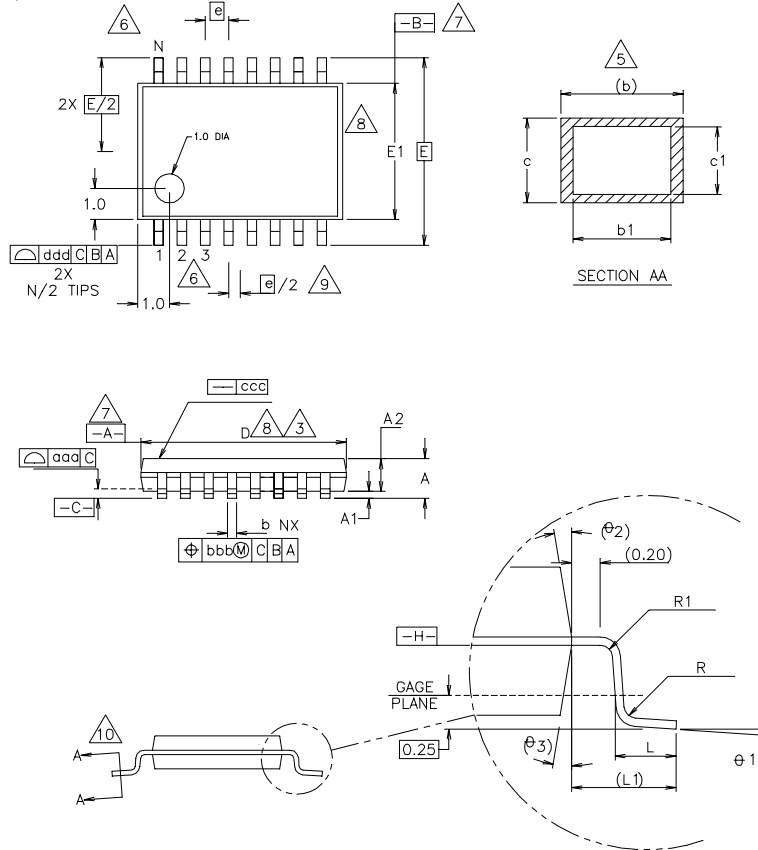
### 5 Volt Operation:

The PE329x series PLLs are not capable of accepting control voltages greater than 3.3 volts. Interface to 5 volt controllers requires the addition of resistor dividers to comply with the 3.3 volt maximum operation voltage.



### Figure 9. Package Drawing

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

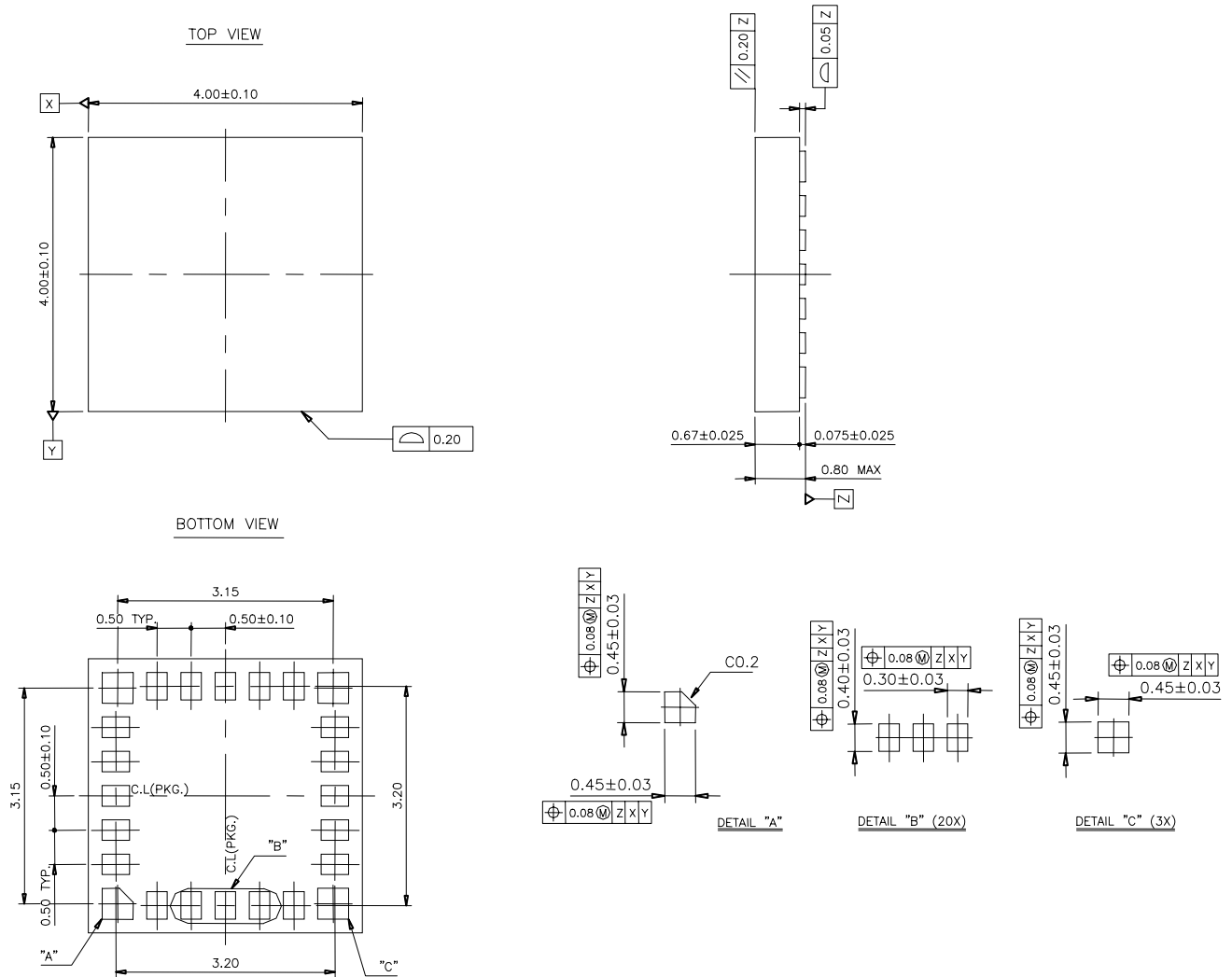


SYMBOL	COMMON DIMENSION (MILLIMETERS)		
	0.65mm LEAD PITCH		
	MIN	NOM	MAX
A	---	---	1.10
A1	0.05	---	0.15
A2	0.85	0.90	0.95
L	0.50	0.60	0.75
R	0.09	---	---
R1	0.09	---	---
b	0.19	---	0.30
b1	0.19	0.22	0.25
c	0.09	---	0.20
c1	0.09	---	0.16
theta1	0°	---	8°
L1	1.0 REF		
aaa	0.10		
bbb	0.10		
ccc	0.05		
ddd	0.20		
e	0.65 BSC		
theta2	12° REF		
theta3	12° REF		

SYMBOL	AC			NOTE
	MIN	NOM	MAX	
D	6.40	6.50	6.60	3,8
E1	4.30	4.40	4.50	4,8
E	6.4 BSC			
e	0.65 BSC			
N	20			6
NOTE	1,2			
ISSUE	A			

**Figure 10. Package Drawing**

24-lead BCC





**Table 12. Ordering Information**

Order Code	Part Marking	Description	Package	Shipping Method
3293-11	PE3293	Screened to datasheet specs., fully qualified	20-lead TSSOP	74 units / Tube
3293-12	PE3293	Screened to datasheet specs., fully qualified	20-lead TSSOP	2000 unit / T&R
3293-14	3293	Screened to datasheet specs., fully qualified	24-lead BCC	640 Unit Trays
3293-15	3293	Screened to datasheet specs., fully qualified	24-lead BCC	2000 Unit T&R
3293-00	PE3293EK	Evaluation Board	20-lead TSSOP	1 / Box
3293-04	PE3293EK	Evaluation Board	24-lead BCC	1 / Box

## Sales Offices

### **United States**

#### **Peregrine Semiconductor Corp.**

6175 Nancy Ridge Drive  
San Diego, CA 92121  
Tel 1-858-455-0660  
Fax 1-858-455-0770

### **Europe**

#### **Peregrine Semiconductor Europe**

Bâtiment Maine  
13-15 rue des Quatre Vents  
F- 92380 Garches  
Tel 33-1-47-41-91-73  
Fax 33-1-47-41-91-73

### **Japan**

#### **Peregrine Semiconductor K.K.**

5A-5, 5F Imperial Tower  
1-1-1 Uchisaiwaicho, Chiyoda-ku  
Tokyo 100-0011 Japan  
Tel: 03-3507-5755  
Fax: 03-3507-5601

### **Australia**

#### **Peregrine Semiconductor Australia**

8 Herb Elliot Ave.  
Homebush, NSW 2140  
Australia  
Tel: 011-61-2-9763-4111  
Fax: 011-61-2-9746-1501

For a list of representatives in your area, please refer to our Web site at: <http://www.peregrine-semi.com>

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