

## 1.8V-3.3V PicoPLL, World's Smallest Programmable Clock

### Features

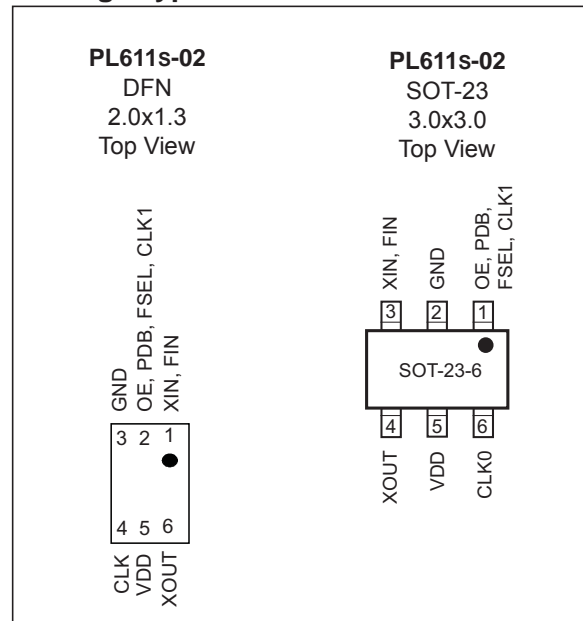
- Lowest-Power, Smallest Programmable PLL
- Very Low Jitter and Phase Noise
- Output Frequency up to:
  - 110 MHz @ 1.8V Operation
  - 166 MHz @ 2.5V Operation
  - 200 MHz @ 3.3V Operation
- Input Frequency:
  - Fundamental Crystal: 10 MHz to 50 MHz
  - Reference Clock: 1 MHz to 200 MHz
- Accepts >0.1V Reference Signal Input Voltage
- One I/O Pin can be Configured as Output Enable (OE), Frequency Switching (FSEL), Power Down (PDB) Input, or CLK1 Output.
- <10  $\mu$ A Current Consumption with PDB Active.
- Single 1.8V to 3.3V,  $\pm$ 10% Power Supply
- Operating Temperature Range from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- Available in 6-pin DFN and SOT-23 GREEN/RoHS Compliant Packages

### General Description

The PL611s-02 is a low-power, small form factor, high performance OTP-base programmable frequency synthesizer and a part in the PicoPLL Factory Programmable Quick Turn Clocks family.

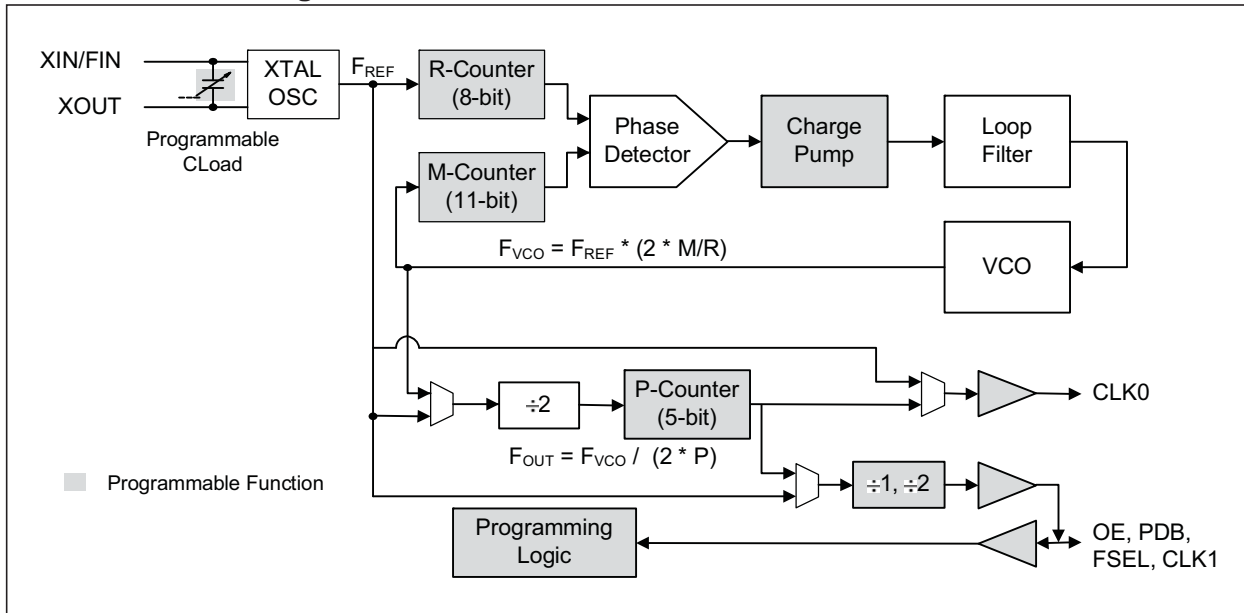
Designed to fit in a small DFN or SOT-23 package for a broad range of applications, the PL611s-02 offers the best phase noise and jitter performance, and power consumption of its rivals. In addition, one programmable I/O pin can be configured as Output Enable (OE), Frequency Switching (FSEL), Power Down (PDB) input, or CLK1 (F<sub>OUT</sub>, F<sub>REF</sub>, F<sub>REF</sub>/2) output. The power down feature of PL611s-02, when activated, allows the IC to consume less than 10  $\mu$ A of power, while its programming flexibility allows generating any output, up to 200 MHz using a low-cost crystal or reference input.

### Package Types



# PL611S-02

## Functional Block Diagram



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

Supply Voltage Range, $V_{DD}$ .....	-0.5V to +7.0V
Input Voltage Range, $V_{IN}$ .....	-0.5V to $V_{DD}$ +0.5V
Output Voltage, $V_{OUT}$ .....	-0.5V to $V_{DD}$ +0.5V
Data Retention @ 85°C .....	10 Years

† **Notice:** Exposure of the device under conditions beyond the limits specified by Maximum Ratings for extended periods may cause permanent damage to the device and affect product reliability. These conditions represent a stress rating only, and functional operations of the device at these or any other conditions above the operational limits noted in this specification is not implied. \*Operating temperature is guaranteed by design. Parts are tested to commercial grade only.

# PL611S-02

**TABLE 1-1: DC SPECIFICATIONS**

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Supply Current, Dynamic	$I_{DD}$	—	6.0	—	mA	$V_{DD} = 3.3V, 30\text{ MHz},$ Load = 15 pF
		—	3.9	—		$V_{DD} = 2.5V, 30\text{ MHz},$ Load = 15 pF
		—	2.1	—		$V_{DD} = 1.8V, 30\text{ MHz},$ load = 15 pF
PLL Off: Supply Current, Dynamic	$I_{DD}$	—	2.0	—	mA	$V_{DD} = 3.3V, 30\text{ MHz},$ Load = 15 pF
		—	1.6	—		$V_{DD} = 2.5V, 30\text{ MHz},$ Load = 15 pF
		—	0.8	—		$V_{DD} = 1.8V, 30\text{ MHz},$ Load = 15 pF
Supply Current, Disabled State	$I_{DD}$	—	—	<10	$\mu A$	When PDB=0
Operating Voltage	$V_{DD}$	1.62	—	3.63	V	—
Power Supply Ramp	$t_{PU}$	0.05	—	100	ms	Time for $V_{DD}$ to reach 90% $V_{DD}$ . Power ramp must be monotonic.
Output Low Voltage	$V_{OL}$	—	—	0.4	V	$I_{OL} = +4\text{ mA}$ Standard Drive
Output High Voltage	$V_{OH}$	$V_{DD} - 0.4$	—	—	V	$I_{OH} = -4\text{ mA}$ Standard Drive
Output Current, Low Drive	$I_{OSD}$	4	—	—	mA	$V_{OL} = 0.4V, V_{OH} = 2.4V$
Output Current, Standard Drive	$I_{OSD}$	8	—	—	mA	$V_{OL} = 0.4V, V_{OH} = 2.4V$
Output Current, High Drive	$I_{OHD}$	16	—	—	mA	$V_{OL} = 0.4V, V_{OH} = 2.4V$

**TABLE 1-2: AC SPECIFICATIONS**

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Crystal Input Frequency ( $X_{IN}$ )		10	—	50	MHz	Fundamental Crystal
Input ( $F_{IN}$ ) Frequency		1	—	200	MHz	@ $V_{DD} = 3.3V$
		1	—	166		@ $V_{DD} = 2.5V$
		1	—	110		@ $V_{DD} = 1.8V$
Input ( $F_{IN}$ ) Signal Amplitude		0.9	—	$V_{DD}$	$V_{PP}$	Internally AC coupled (High Frequency)
Input ( $F_{IN}$ ) Signal Amplitude		0.1	—	$V_{DD}$	$V_{PP}$	Internally AC coupled (Low Frequency) 3.3V<50 MHz, 2.5V<40 MHz, 1.8V<15 MHz
Output Frequency		—	—	200	MHz	@ $V_{DD} = 3.3V$
		—	—	166		@ $V_{DD} = 2.5V$
		—	—	110		@ $V_{DD} = 1.8V$
Settling Time		—	—	2	ms	At power-up (after $V_{DD}$ increases over 1.62V)

**TABLE 1-2: AC SPECIFICATIONS (CONTINUED)**

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Enable Time		—	—	10	ns	OE Function; $T_A = 25^\circ\text{C}$ , 15 pF Load. Add one clock period to this measurement for a usable clock output.
		—	—	2	ms	PDB Function; $T_A = 25^\circ\text{C}$ , 15 pF Load
$V_{DD}$ Sensitivity		-2	—	2	ppm	Frequency vs. $V_{DD} \pm 10\%$
Output Rise Time		—	1.2	1.7	ns	15 pF Load, 10/90% $V_{DD}$ , High Drive, 3.3V
Output Fall Time		—	1.2	1.7	ns	15 pF Load, 90/10% $V_{DD}$ , High Drive, 3.3V
Duty Cycle		45	50	55	%	@2.5V and 3.3V over entire frequency range, $V_{DD}/2$
		45	50	55		@1.8V, $\leq 75\text{ MHz } F_{OUT}$ , $V_{DD}/2$
		40	—	60		@1.8V, $75\text{ MHz} < F_{OUT} \leq 110\text{ MHz}$
Period Jitter, Pk-to-Pk (Note 1) (10,000 samples measured)		—	70	—	ps	With capacitive decoupling between $V_{DD}$ and GND

**Note 1:** Jitter performance depends on the programming parameters.

**TABLE 1-3: CRYSTAL SPECIFICATIONS**

Parameters		Symbol	Min	Typ	Max	Units
Fundamental Crystal Resonator Frequency		$F_{XIN}$	10	—	50	MHz
Crystal Loading Rating (The IC can be programmed for any value in this range)		$C_{L(xtal)}$	8	—	12	pF
Maximum Sustainable Drive Level		—	—	—	100	$\mu\text{W}$
Operating Drive Level		—	—	30	—	$\mu\text{W}$
Metal Can Crystal	Shunt Capacitance	$C_0$	—	—	5.5	pF
	ESR Max	ESR	—	—	50	$\Omega$
Small SMD Crystal	Shunt Capacitance	$C_0$	—	—	2.5	pF
	ESR Max	ESR	—	—	80	$\Omega$

# PL611S-02

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## TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
<b>Temperature Ranges</b>						
Storage Temperature Range	$T_S$	-65	—	150	°C	—
Soldering Temperature	$T_S$	—	—	260	°C	Green Package
Ambient Operating Temperature Range	$T_A$	-40	—	85	°C	—

**Note 1:** Exposure of the device under conditions beyond the limits specified by Maximum Ratings for extended periods may cause permanent damage to the device and affect product reliability. These conditions represent a stress rating only, and functional operations of the device at these or any other conditions above the operational limits noted in this specification is not implied. \*Operating temperature is guaranteed by design. Parts are tested to commercial grade only.

## 2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 2-1](#).

**TABLE 2-1: PIN FUNCTION TABLE**

Name	Pin Assignment		Type	Description			
	SOT-23	DFN					
OE, PDB, FSEL, CLK1	1	2	I/O	This programmable I/O pin can be configured as an Output Enable (OE) input, Power Down input (PDB), On-the-Fly Frequency Switching Selector (FSEL), or CLK1 clock output. This pin has an internal 60 kΩ pull up resistor for OE, PDB, and FSEL.			
				State	OE	PDB	FSEL
				0	Tri-State CLK	Power Down Mode	Bank 1
				1 (default)	Normal Mode	Normal Mode	Bank 2
GND	2	3	P	GND connection			
XIN, FIN	3	1	I	Crystal or Reference Clock input pin			
XOUT	4	6	O	Crystal Output pin. Do Not Connect (DNC) when F <sub>IN</sub> is present.			
VDD	5	5	P	V <sub>DD</sub> connection			
CLK0	6	4	O	Programmable Clock Output			

**TABLE 2-2: KEY PROGRAMMING PARAMETERS**

CLK[0:1] Output Frequency	Output Drive Strength	Programmable Input/Output
$F_{OUT} = F_{REF} \times M / (R \times P)$ Where: M = 11 bit R = 8 bit P = 5 bit  $CLK0 = F_{OUT}, F_{REF} \text{ or } F_{REF}/(2 \times P)$  $CLK1 = F_{REF}, F_{REF}/2, CLK0 \text{ or } CLK0/2$	Three optional drive strengths to choose from: <ul style="list-style-type: none"> <li>• Low: 4 mA</li> <li>• Std: 8 mA (default)</li> <li>• High: 16 mA</li> </ul>	One output pin can be configured as: <ul style="list-style-type: none"> <li>• OE - input</li> <li>• PDB - input</li> <li>• FSEL - input</li> <li>• CLK1 - output</li> </ul>

# PL611S-02

## 3.0 FUNCTIONAL DESCRIPTION

PL611s-02 is a highly featured, very flexible, advanced programmable PLL design for high performance, low-power, small form-factor applications. The PL611s-02 accepts a fundamental input crystal of 10 MHz to 50 MHz or reference clock input of 1 MHz to 200 MHz and is capable of producing two outputs up to 200 MHz. This flexible design allows the PL611s-02 to deliver any PLL generated frequency,  $F_{REF}$  (Crystal or REF\_CLK) frequency or  $F_{REF}/(2 \times P)$  to CLK0 and/or CLK1. The following content explains some of the design features of the PL611s-02.

### 3.1 PLL Programming

The PLL in the PL611s-02 is fully programmable. The PLL is equipped with an 8-bit input frequency divider (R-Counter), and an 11-bit VCO frequency feedback loop divider (M-Counter). The output of the PLL is transferred to a 5-bit post VCO divider (P-Counter). The output frequency is determined by the following formula:

EQUATION 3-1:

$$F_{OUT} = \frac{F_{REF} \times M}{R \times P}$$

### 3.2 Clock Output (CLK0)

CLK0 is the main clock output. The output of CLK0 can be configured as the PLL output ( $F_{VCO}/(2 \times P)$ ),  $F_{REF}$  (Crystal or REF\_CLK) output, or  $F_{REF}/(2 \times P)$  output. The output drive level can be programmed to Low Drive (4 mA), Standard Drive (8 mA) or High Drive (16 mA). The maximum output frequency is determined by the Power Supply Voltage; 200 MHz at 3.3V, 166 MHz at 2.5V and 110 MHz at 1.8V.

### 3.3 Clock Output (CLK1)

The CLK1 feature allows the PL611s-02 to have an additional clock output programmed to one of the following:

- $F_{REF}$  - Reference (Crystal or REF\_CLK) Frequency
- $F_{REF} / 2$
- CLK0
- CLK0 / 2

### 3.4 Maximum VCO Frequency

For the best performance, we recommend to use the highest VCO frequency allowed at the power supply voltage where the PL611s-02 will be used. It is actually the maximum VCO frequency that determines the maximum output frequency. When a PL611s-02 is programmed for use at a certain power supply voltage,

it is safe to use that part at higher voltages also because at higher voltages the maximum VCO frequency is also higher. The other way around, using the part at a lower voltage than what it was originally configured for, is not safe.

### 3.5 Output Enable (OE)

The Output Enable feature allows the user to enable and disable the clock output(s) by toggling the OE pin. The OE pin incorporates a 60 k $\Omega$  pull up resistor giving a default condition of logic "1".

### 3.6 Power-Down Control (PDB)

The Power Down (PDB) feature allows the user to put the PL611s-02 into "Sleep Mode". When activated (logic '0'), PDB disables the PLL, the oscillator circuitry, counters, and all other active circuitry. In Power Down mode the IC consumes <10  $\mu$ A of power. The PDB pin incorporates a 60 k $\Omega$  pull up resistor giving a default condition of logic "1".

### 3.7 Frequency Select (FSEL)

The Frequency Select (FSEL) feature allows the PL611s-02 to switch between two pre-programmed outputs allowing the device "On the Fly" frequency switching. The FSEL pin incorporates a 60 k $\Omega$  pull up resistor giving a default condition of logic "1".



## 4.0 LAYOUT RECOMMENDATIONS

The following guidelines are to assist you with a performance optimized PCB design.

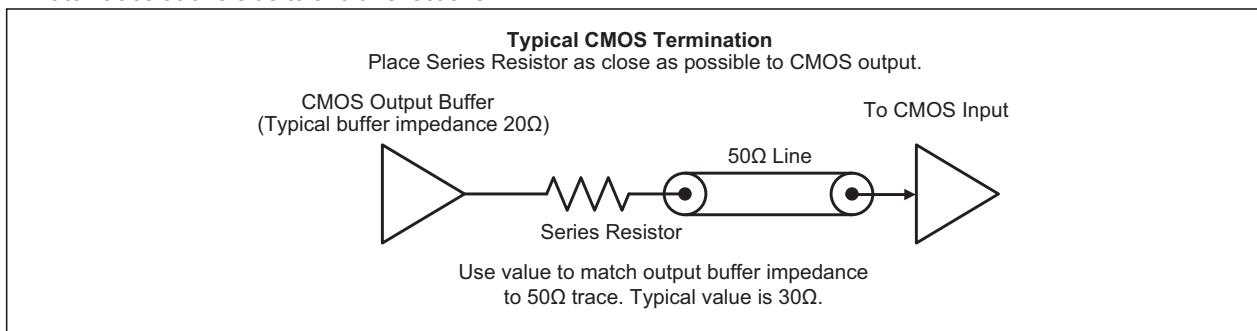
### 4.1 Signal Integrity and Termination Considerations

- Keep traces short!
- Trace = Inductor. With a capacitive load this equals ringing
- Long trace = Transmission Line. Without proper termination this will cause reflections (looks like ringing).
- Design long traces (greater than one inch) as striplines or microstrips with defined impedance.
- Match trace at one side to avoid reflections

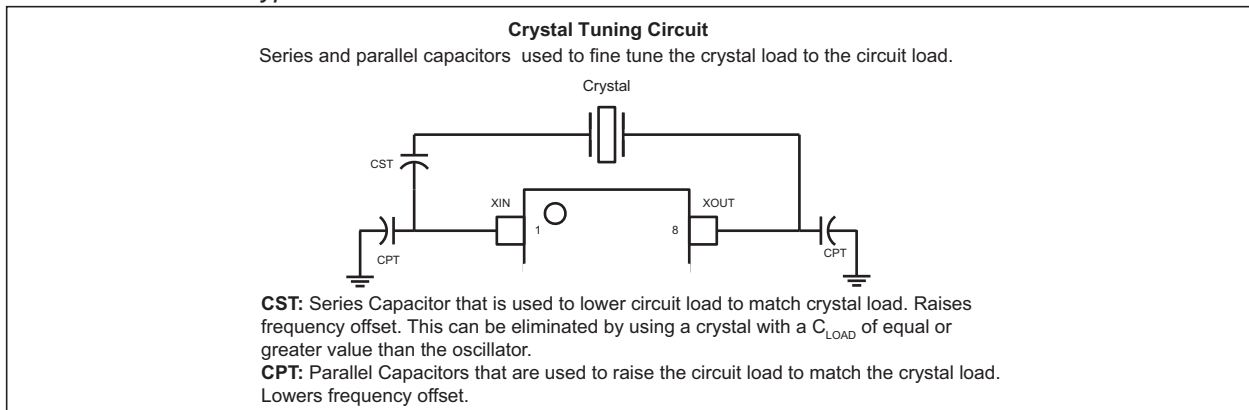
bouncing back and forth.

### 4.2 Decoupling and Power Supply Considerations

- Place decoupling capacitors as close as possible to the  $V_{DD}$  pin(s) to limit noise from the power supply
- Multiple  $V_{DD}$  pins should be decoupled separately for best performance.
- Addition of a ferrite bead in series with  $V_{DD}$  can help prevent noise from other board sources
- Value of decoupling capacitor is frequency dependent. Typical values to use are 0.1  $\mu\text{F}$  for designs using frequencies < 50 MHz and 0.01  $\mu\text{F}$  for designs using frequencies > 50 MHz.



**FIGURE 4-1:** Typical CMOS Termination.

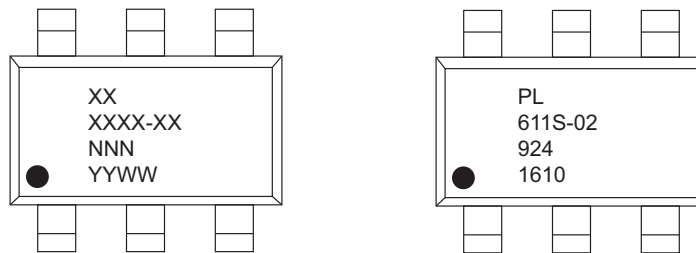


**FIGURE 4-2:** Crystal Tuning Circuit.

# PL611S-02

## 5.0 PACKAGING INFORMATION

### 5.1 Package Marking Information



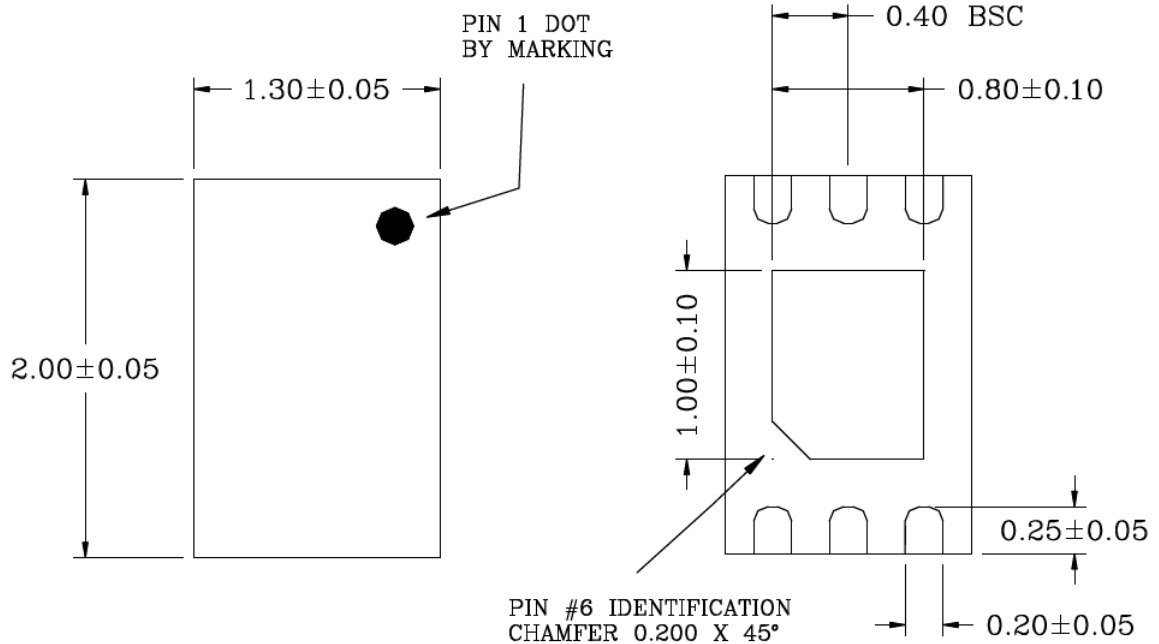
<b>Legend:</b>	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC <sup>®</sup> designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	•, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).
<b>Note:</b>	In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.	
	Underbar (¯) and/or Overbar (˘) symbol may not be to scale.	

## 6-LEAD TDFN 2.0 MM × 1.3 MM PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

**TITLE**

6 LEAD TDFN 2.0x1.3 mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

<b>DRAWING #</b>	TDFN2013-6LD-PL-1	<b>UNIT</b>	MM
<b>Lead Frame</b>	NiPdAu	<b>Lead Finish</b>	NiPdAu



TOP VIEW

NOTE: 1, 2

BOTTOM VIEW

NOTE: 1, 2

SIDE VIEW

NOTE: 1, 2

**NOTES**

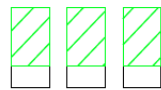
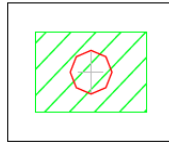
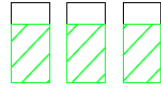
1. MAX PACKAGE WARPAGE IS 0.05mm.
2. MAX ALLOWABLE BURR IS 0.076mm IN ALL DIRECTIONS.
3. PIN #1 IS ON TOP WILL BE LASER MARKED.
4. UNIT IN mm.
5. SHADED AREA IS SOLDER STENCIL OPENING.
6. RECOMMENDED VIA SIZE IS 0.30-0.35mm.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

# PL611S-02

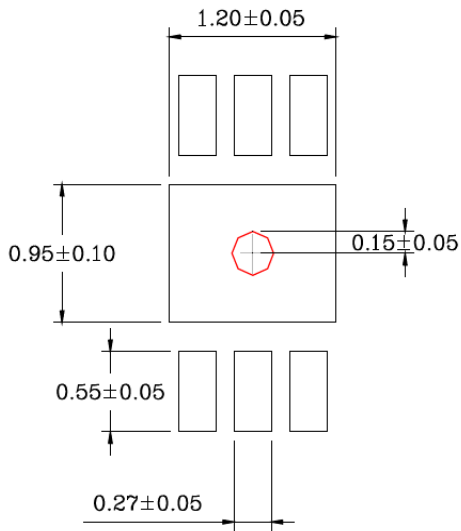
POD-Land Pattern TDFN2013-6LD-PL-1

## RECOMMENDED LAND PATTERN



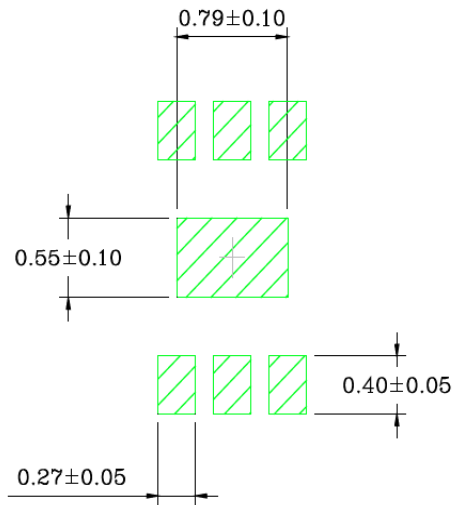
### STACKED-UP

NOTE: 4, 5, 6



### EXPOSED METAL TRACE

NOTE: 4, 6



### SOLDER STENCIL OPENING

NOTE: 4, 5

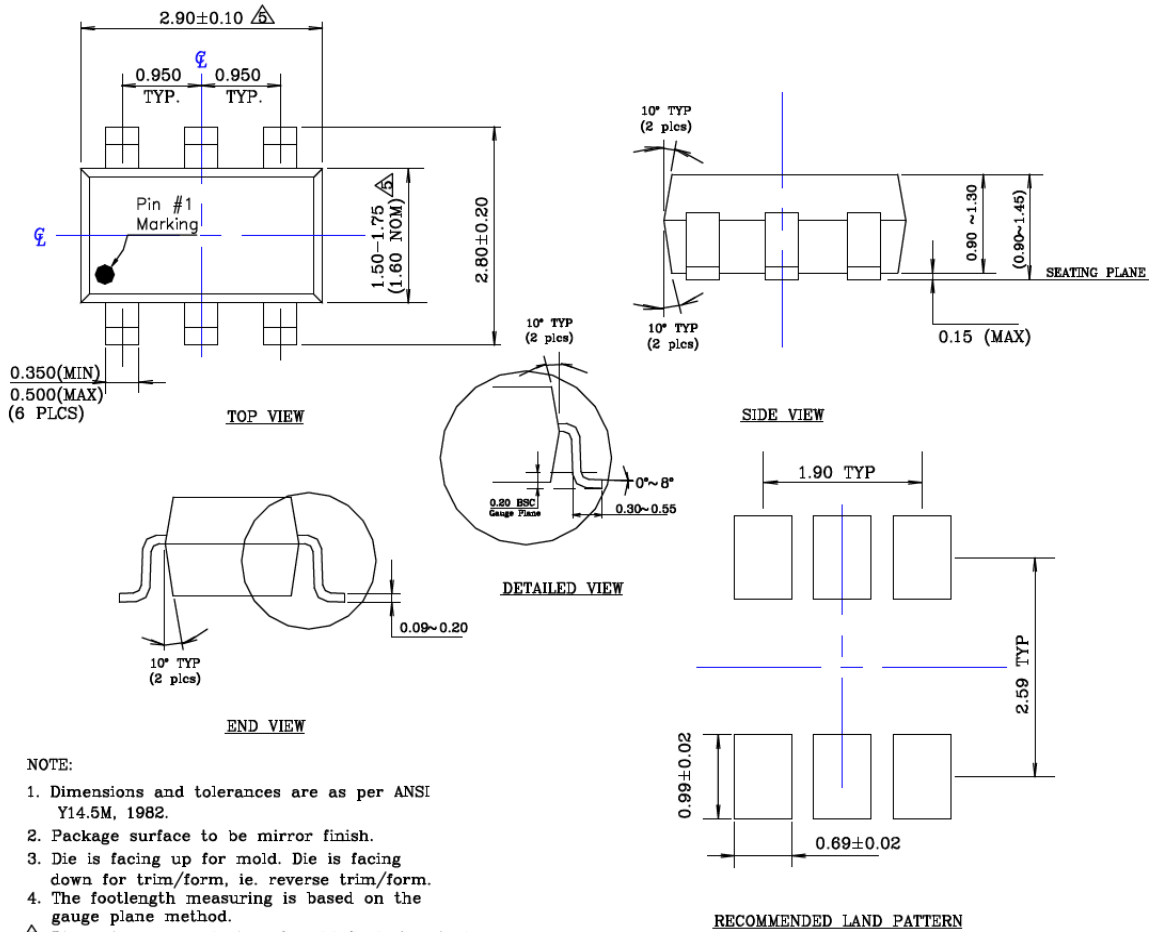
Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

## 6-LEAD SOT-23 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

**TITLE**

6 LEAD SOT23 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

<b>DRAWING #</b>	SOT23-6LD-PL-1	<b>UNIT</b>	MM
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Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.



## APPENDIX A: REVISION HISTORY

### Revision A (November 2016)

- Converted Micrel document PL611s-02 to Microchip data sheet DS20005670A
- Minor grammatical and text changes throughout document.
- Remove TM trademark from “PicoPLL” in title and throughout document.

# PL611S-02

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NOTES:



## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

<u>PART NO.</u>	-	<u>XXX</u>	X	X	-	<u>XX</u>
Device		ID Code	Package Type	Temperature		Media Type
<b>Device:</b>		PL611s-02:	1.8V-3.3V PicoPLL, World's Smallest Programmable Clock			
<b>ID Code</b>		XXX =	Unique 3-digit code assigned at programming time			
<b>Package Type:</b>		G =	DFN-6 Lead			
		T =	SOT23-6 Lead			
<b>Temperature:</b>		C =	Commercial (0°C to +70°C)			
		I =	Industrial (-40°C to +85°C)			
<b>Media Type:</b>		Blank =	Tube			
		TR =	Tape & Reel			
<b>Examples:</b>						
a) PL611s-02-XXXGC-TR: 1.8V-3.3V PicoPLL™ Clock, Unique 3-digit programming code, DFN-6 Lead, Commercial Temperature, Tape & Reel						
b) PL611s-02-XXXTC-TR: 1.8V-3.3V PicoPLL™ Clock, Unique 3-digit programming code, SOT23-6 Lead, Commercial Temperature, Tape and Reel						
c) PL611s-02-XXXGI: 1.8V-3.3V PicoPLL™ Clock, Unique 3-digit programming code, DFN-6 Lead, Industrial Temperature, Tube						
d) PL611s-02-XXXGI-TR: 1.8V-3.3V PicoPLL™ Clock, Unique 3-digit programming code, DFN-6 Lead, Industrial Temperature, Tape & Reel						
<b>Note 1:</b> Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.						

# PL611S-02

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NOTES:

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- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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