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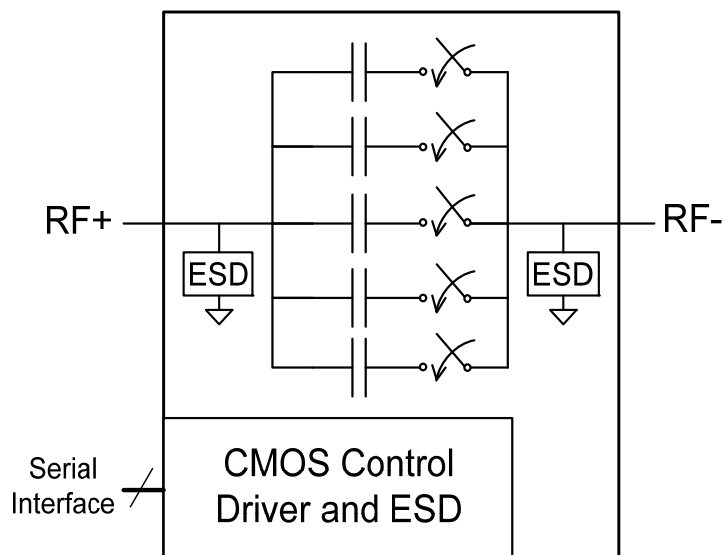
### Product Description

The PE64101 is a DuNE™-enhanced Digitally Tunable Capacitor (DTC) based on Peregrine's UltraCMOS® technology. DTC products provide a monolithically integrated impedance tuning solution for demanding RF applications. They also offer a cost-effective tunable capacitor with excellent linearity and ESD performance.

This highly versatile product can be mounted in series or shunt configuration and is controlled by a 3-wire (SPI compatible) serial interface. High ESD rating of 2 kV HBM on all ports making this the ultimate in integration and ruggedness. The DTC is offered in a standard 12-lead 2.0 x 2.0 x 0.55 mm QFN package.

Peregrine's DuNE™ technology enhancements deliver high linearity and exceptional harmonics performance. It is an innovative feature of the UltraCMOS® process, providing performance superior to GaAs with the economy and integration of conventional CMOS.

**Figure 1. Functional Block Diagram**



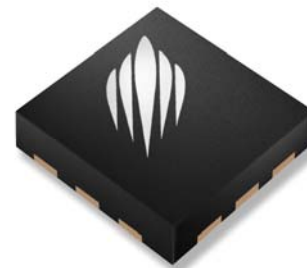
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### UltraCMOS® Digitally Tunable Capacitor (DTC) 100 - 3000 MHz

#### Features

- 3-wire (SPI compatible) 8-bit serial interface with built-in bias voltage generation and stand-by mode for reduced power consumption
- DuNE™-enhanced UltraCMOS® device
- 5-bit 32-state Digitally Tunable Capacitor
- $C = 1.38 - 5.90$  pF (4.3:1 tuning ratio) in discrete 146 fF steps
- RF power handling (up to 26 dBm, 6 V<sub>PK</sub> RF) and high linearity
- High quality factor
- Wide power supply range (2.3 to 3.6V) and low current consumption (typ. I<sub>DD</sub> = 30 µA @ 2.8V)
- Optimized for shunt configuration, but can also be used in series configuration
- Excellent 2 kV HBM ESD tolerance on all pins
- Applications include:
  - Antenna tuning
  - Tunable filters
  - Phase shifters
  - Impedance matching

**Figure 2. Package Type**  
12-lead 2 x 2 x 0.55 mm QFN



**Table 1. Electrical Specifications @ 25°C, V<sub>DD</sub> = 2.8V**

Parameter	Configuration	Condition	Min	Typ	Max	Units
Operating Frequency Range <sup>7</sup>	Both		100		3000	MHz
Minimum Capacitance	Shunt <sup>6</sup>	State = 00000, 100 MHz (RF+ to Grounded RF-)	-10%	1.38	+10%	pF
Maximum Capacitance	Shunt <sup>6</sup>	State = 11111, 100 MHz (RF+ to Grounded RF-)	-10%	5.90	+10%	pF
Tuning Ratio	Shunt <sup>6</sup>	C <sub>max</sub> /C <sub>min</sub> , 100 MHz		4.3:1		
Step Size	Shunt <sup>6</sup>	5 bits (32 states), constant step size (100 MHz)		0.146		pF
Quality Factor (C <sub>min</sub> ) <sup>1</sup>	Shunt <sup>6</sup>	470 - 582 MHz with L <sub>s</sub> removed 698 - 960 MHz, with L <sub>s</sub> removed 1710 - 2170 MHz, with L <sub>s</sub> removed		50 50 30		
Quality Factor (C <sub>max</sub> ) <sup>1</sup>	Shunt <sup>6</sup>	470 - 582 MHz with L <sub>s</sub> removed 698 - 960 MHz, with L <sub>s</sub> removed 1710 - 2170 MHz, with L <sub>s</sub> removed		50 25 10		
Self Resonant Frequency	Shunt <sup>7</sup>	State 00000 State 11111		5.5 2.5		GHz
Harmonics (2 <sub>fo</sub> and 3 <sub>fo</sub> ) <sup>4</sup>	Shunt <sup>6</sup>	470 to 582 MHz, Pin +26 dBm, 50Ω 698 to 915 MHz, Pin +26 dBm, 50Ω 1710 to 1910 MHz, Pin +26 dBm, 50Ω			-36 -36 -36	dBm dBm dBm
	Series <sup>5</sup>	470 to 582 MHz, Pin +20 dBm, 50Ω 698 to 915 MHz, Pin +20 dBm, 50Ω 1710 to 1910 MHz, Pin +20 dBm, 50Ω			-36 -36 -36	dBm dBm dBm
3rd Order Intercept Point	Shunt <sup>6</sup>	IIP3 = (Pblocker + 2*Ptx - [IMD3]) / 2, where IMD3 = -95 dBm, Ptx = +20 dBm and Pblocker = -15 dBm		60		dBm
Switching Time <sup>2,3</sup>	Shunt <sup>6</sup>	State change to 10/90% delta capacitance between any two states		2	10	μs
Start-up Time <sup>2</sup>	Shunt <sup>6</sup>	Time from V <sub>DD</sub> within specification to all performances within specification		5	20	μs
Wake-up Time <sup>2,3</sup>	Shunt <sup>6</sup>	State change from standby mode to RF state to all performances within specification		5	20	μs

Note: 1. Q for a Shunt DTC based on a Series RLC equivalent circuit  
 $Q = X_C / R = (X - X_L) / R$ , where  $X = X_L + X_C$ ,  $X_L = 2\pi f L$ ,  $X_C = -1 / (2\pi f C)$ , which is equal to removing the effect of parasitic inductance L<sub>s</sub>  
 2. DC path to ground at RF+ and RF- must be provided to achieve specified performance  
 3. State change activated on falling edge of SEN following data word  
 4. Between 50Ω ports in series or shunt configuration using a pulsed RF input with 4620 vs period, 50% duty cycle, measured per 3GPPTS45.005  
 5. In series configuration the greater RF power or higher RF voltage should be applied to RF+  
 6. RF- should be connected to ground  
 7. DTC operation above SRF is possible

Figure 3. Pin Configuration (Top View)

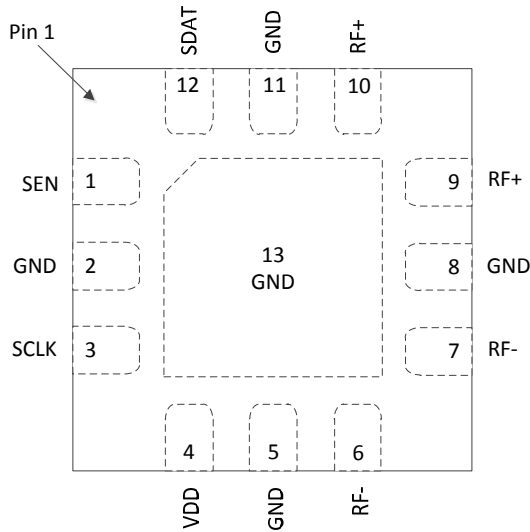


Table 2. Pin Descriptions

Pin #	Pin Name	Description
1	SEN	Serial Enable
2	GND	Digital and RF Ground
3	SCLK	Serial Interface Clock Input
4	VDD	Power Voltage
5	GND	Digital and RF Ground
6	RF-	Negative RF Port <sup>1</sup>
7	RF-	Negative RF Port <sup>1</sup>
8	GND	Digital and RF Ground <sup>3</sup>
9	RF+	Positive RF Port <sup>2</sup>
10	RF+	Positive RF Port <sup>2</sup>
11	GND	Digital and RF Ground
12	SDAT	Serial Interface Data Input
13	GND	Digital and RF Ground <sup>3</sup>

Notes: 1. Pins 6 and 7 must be tied together on PCB board to reduce inductance  
 2. Pins 9 and 10 must be tied together on PCB board to reduce inductance  
 3. Pin 2, 5, 8, 11 and 13 must be connected together on PCB

### Moisture Sensitivity Level

The Moisture Sensitivity Level rating for the PE64101 in the 12-lead 2 x 2 QFN package is MSL1.

### Latch-Up Avoidance

Unlike conventional CMOS devices, UltraCMOS<sup>®</sup> devices are immune to latch-up.

Table 3. Operating Ranges<sup>1</sup>

Parameter	Symbol	Min	Typ	Max	Units
V <sub>DD</sub> Supply Voltage	V <sub>DD</sub>	2.3	2.8	3.6	V
I <sub>DD</sub> Power Supply Current (Normal mode) <sup>6</sup>	I <sub>DD</sub>		30	75	μA
I <sub>DD</sub> Power Supply Current (Standby mode) <sup>6</sup>	I <sub>DD</sub>		20	45	μA
Control Voltage High	V <sub>IH</sub>	1.2		3.1	V
Control Voltage Low	V <sub>IL</sub>	0		0.2	V
Peak Operating RF Voltage <sup>5</sup>				6	V <sub>PK</sub>
V <sub>P</sub> to V <sub>M</sub>				6	V <sub>PK</sub>
V <sub>P</sub> to RFGND				6	V <sub>PK</sub>
V <sub>M</sub> to RFGND				6	V <sub>PK</sub>
RF Input Power (50Ω) <sup>3,4,5</sup>				+26	dBm
shunt				+20	dBm
series					
Input Control Current	I <sub>CTL</sub>		1	10	μA
Operating Temperature Range	T <sub>OP</sub>	-40		+85	°C
Storage Temperature Range	T <sub>ST</sub>	-65		+150	°C

Notes: 1. Operation should be restricted to the limits in the Operating Ranges table  
 2. The DTC is active when STBY is low (set to 0) and in low-current stand-by mode when high (set to 1)  
 3. Maximum CW power available from a 50Ω source in shunt configuration  
 4. Maximum CW power available from a 50Ω source in series configuration  
 5. RF+ to RF- and RF+ and/or RF- to ground. Cannot exceed 6 V<sub>PK</sub> or max RF input power (whichever occurs first)  
 6. I<sub>DD</sub> current typical value is based on V<sub>DD</sub> = 2.8V. Max I<sub>DD</sub> is based on V<sub>DD</sub> = 3.6V

Table 4. Absolute Maximum Ratings

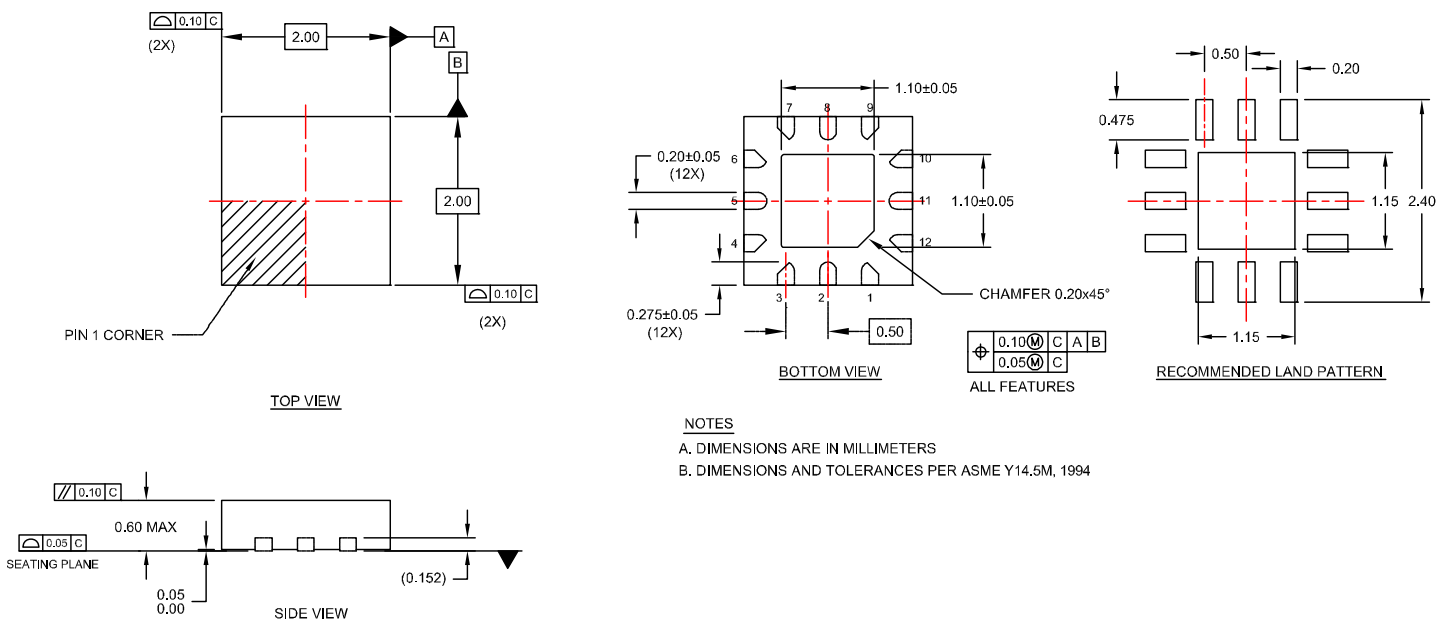
Symbol	Parameter/Conditions	Min	Max	Units
V <sub>DD</sub>	Power supply voltage	-0.3	4.0	V
V <sub>I</sub>	Voltage on any DC input	-0.3	4.0	V
V <sub>ESD</sub>	ESD Voltage (HBM, MIL_STD 883 Method 3015.7)		2000	V
V <sub>ESD</sub>	ESD Voltage (MM, JEDEC JESD22-A115-A)		100	V

Exceeding absolute maximum ratings may cause permanent damage. Operation between operating range maximum and absolute maximum for extended periods may reduce reliability.

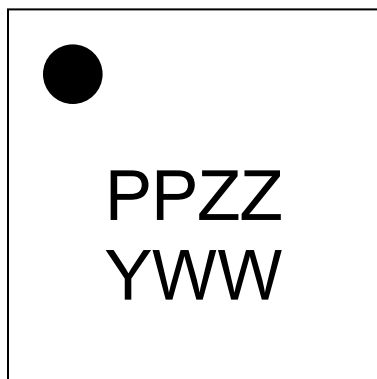
### Electrostatic Discharge (ESD) Precautions

When handling this UltraCMOS<sup>®</sup> 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 specified rating.

**Figure 4. Package Drawing**  
12-lead 2 x 2 x 0.55 mm QFN



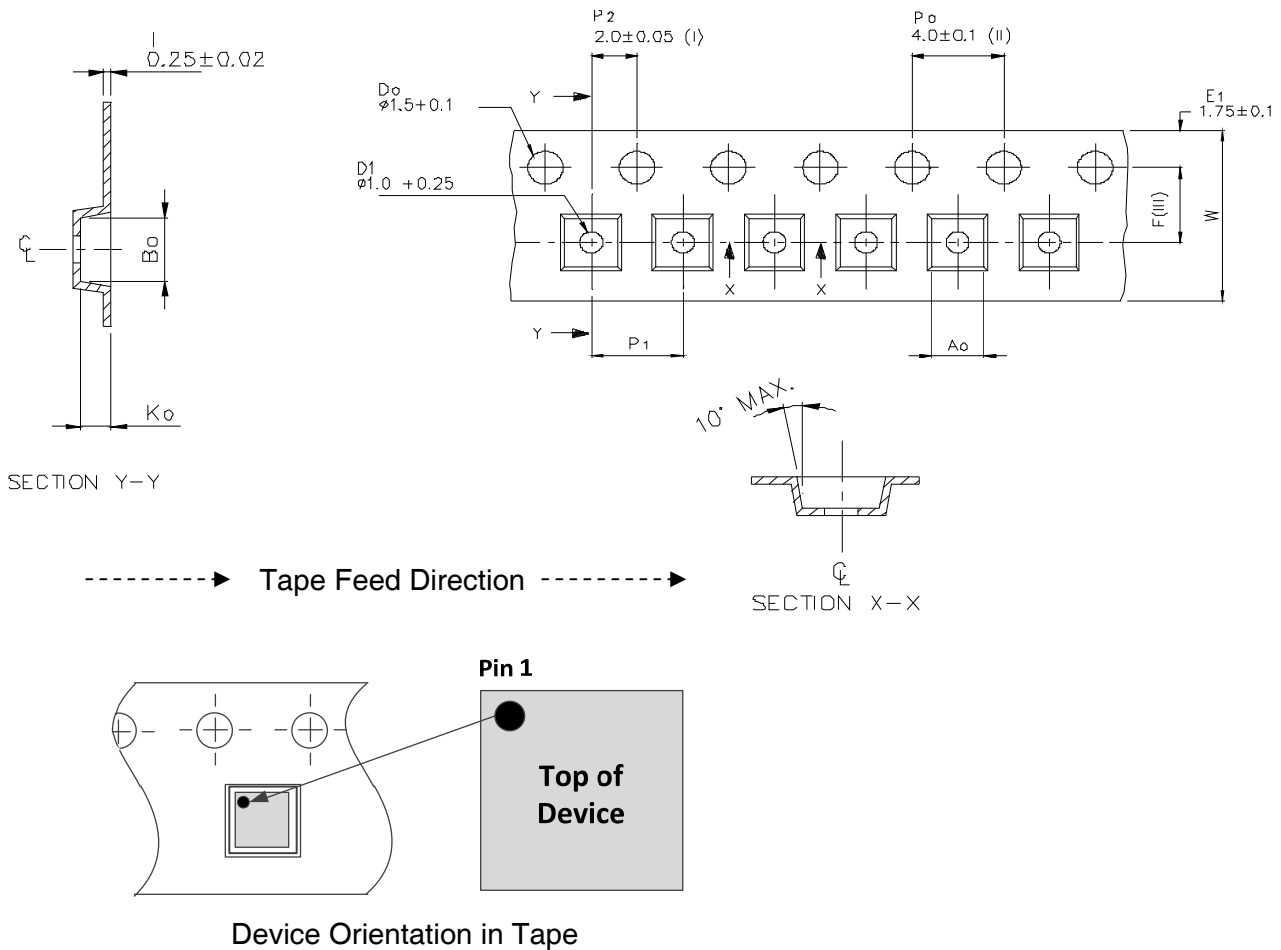
**Figure 5. Top Marking Specifications**



17-0112

Marking Spec Symbol	Package Marking	Definition
PP	CR	Part number marking for PE64101
ZZ	00-99	Last two digits of lot code
Y	0-9	Last digit of year, starting from 2009 (0 for 2010, 1 for 2011, etc)
WW	01-53	Work week

**Figure 6. Tape and Reel Specifications**  
12-lead 2 x 2 x 0.55 mm QFN



**Table 5. Ordering Information**

Order Code	Package	Description	Shipping Method
PE64101MLAA-Z	12-lead 2 x 2 x 0.55 mm QFN	Package Part in Tape and Reel	3000 units/T&R
EK64101-11	Evaluation Kit	Evaluation Kit	1 Set/Box

### Sales Contact and Information

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