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## Features

- Wide range of operating supply voltage: 1.5V to 3.6V
- Optimized low crystal drive current oscillation for miniature crystal units
- PT7C5028BxDE series: for Wire Bonding (type I)
- PT7C5028CxDE series: for Wire Bonding (type II)
- Recommended oscillation frequency range
  - Low frequency version: 20MHz to 60MHz
- Multi-stage frequency divider for low-frequency output support: 0.75MHz(min)
- Frequency divider built-in:
  - Selectable by version: f0, f0/2, f0/4, f0/8, f0/16, f0/32, f0/64
- -40 to 85°C operating temperature range
- Standby function
  - High impedance in standby mode, oscillator stops
  - CMOS output duty level(1/2VDD)
- 50± 5% output duty
- 15pF output drive capability
- Die form and Wafer form

## Description

The PT7C5028B/C series are miniature crystal oscillator module ICs. The pad layouts are selective from 2 types depending on package structures, mounting methods, which are suitable for miniature crystal oscillators. The PT7C5028B/C series can be used to realize ultra miniature, ultra low voltage crystal oscillators.

## Ordering Information

Part no.	Package type
PT7C5028Bx-5GDE	Die form
PT7C5028Bx-5GWF	Wafer form
PT7C5028Bx-6GDE	Die form
PT7C5028Bx-6GWF	Wafer form
PT7C5028Cx-5GDE	Die form
PT7C5028Cx-5GWF	Wafer form
PT7C5028Cx-6GDE	Die form
PT7C5028Cx-6GWF	Wafer form

**Note:** 1. "x" shows the different function. See below description.

2. "-5G" show the die thickness is 130±15µm without coating ; "-6G" show the die thickness is 100±10µm without coating.

## Applications

- Used for crystal oscillator

## Series Configuration

**Table 1 Part No suffix description**

Part No	Pad Layout Type
PT7C5028Bx	Wire Bonding (type I)
PT7C5028Cx	Wire Bonding (type II)

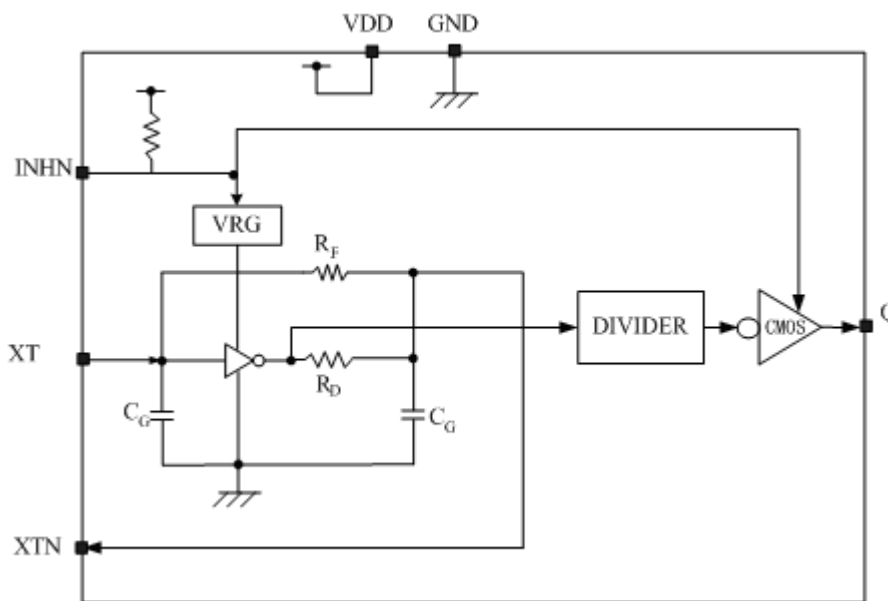
**Table 2 Part No suffix description**

Part No	Operating supply voltage range(V)	Oscillation mode	Recommended oscillation frequency range*1(MHz)	Output frequency	Output drive capability (mA)	Standby mode	
						Oscillator stop function	Output state
PT7C5028B1/C1	1.5 to 3.6	Fundamental	20 to 60	$f_0^{*2}$	4	Yes	Hi-Z
PT7C5028B2/C2				$f_0/2$			
PT7C5028B3/C3				$f_0/4$			
PT7C5028B4/C4				$f_0/8$			
PT7C5028B5/C5				$f_0/16$			
PT7C5028B6/C6				$f_0/32$			
PT7C5028B7/C7				$f_0/64$			

**Note:** \* 1. The recommended operating frequency is a yardstick value derived from the crystal used for PTI characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.

\* 2.  $f_0$  is oscillation frequency (input frequency).

**Block Diagram**



**Function Description**

**Standby Function**

When INHN goes LOW, the oscillator stops and the oscillator output on Q becomes high impedance.

INHN	Q	Oscillator
HIGH (or open)	$f_0$ output frequency	Normal operation
Low	High impedance	Stopped



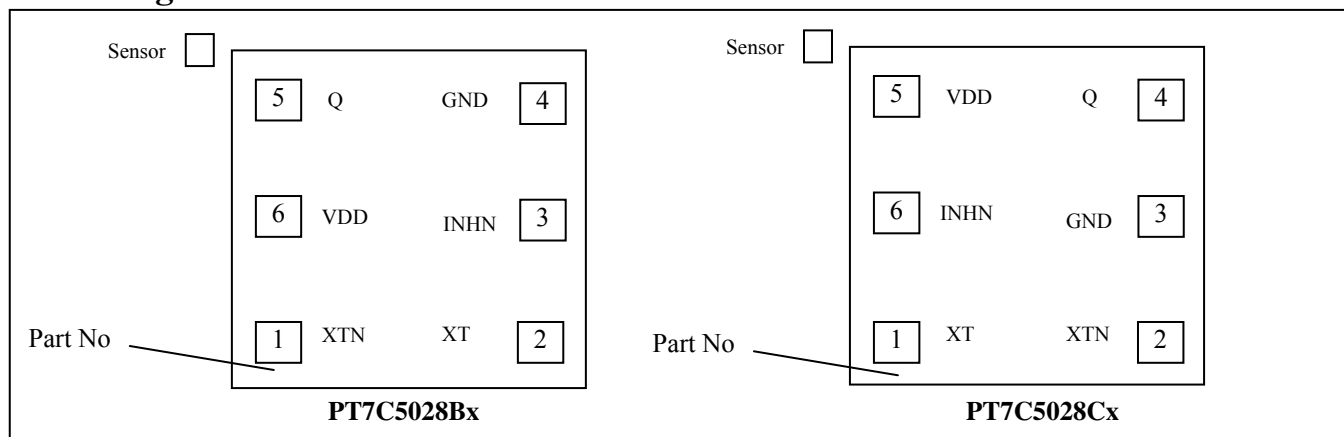
**Power-saving Pull-up Resistor**

The INHN pin pull-up resistance  $R_{UP1}$  or  $R_{UP2}$  changes in response to the input level (HIGH or LOW). When INHN is tied LOW level, the pull-up resistance is large ( $R_{UP1}$ ), reducing the current consumed by the resistance. When INHN is left open circuit, the pull-up resistance is small ( $R_{UP2}$ ), which increases the input susceptibility to external noise. However, the pull-up resistance ties the INHN pin HIGH level to prevent external noise from unexpectedly stopping the output.

**Oscillation Detector Function**

The PT7C5028B/C series also feature an oscillation detector circuit. This circuit functions disable the outputs until the oscillator circuit starts and oscillation becomes stable. This alleviates the danger of abnormal oscillator output at oscillator start-up when power is applied or when INHN is switched.

**Pad Configuration**



Pad Coordinate File					
Pad Name	X Coordinate	Y Coordinate	Pad Name	X Coordinate	Y Coordinate
sensor	-40	650.00			
1	79.00	79.00	4	531.00	530.99
2	531.00	79.00	5	79.00	530.99
3	531.00	282.31	6	79.00	282.31

**Note:** Substrate is connected to GND.  
**Die Size:** 690 $\mu$ m\*690 $\mu$ m (Including scribe line size 80 $\mu$ m\*80 $\mu$ m.)  
**Die Thickness:** 130 $\mu$ m $\pm$ 15 $\mu$ m and 100 $\mu$ m $\pm$ 10 $\mu$ m without coating.  
**Pad Size:** 90 $\mu$ m\*90 $\mu$ m

**Pad Description**

Sym.	Type	Description
XTN	O	Amplifier output.
XT	I	Amplifier input.
Crystal oscillator connected between XT and XTN		
INHN	I	Output state control input. High impedance when LOW. Power-saving pull-up resistor built in.
VDD	P	Supply voltage
GND	P	Ground
Q	O	Output. Output frequency determined by internal circuit to one of $f_0, f_0/2, f_0/4, f_0/8, f_0/16, f_0/32, f_0/64$

**Maximum Ratings**

Storage Temperature .....	-65°C to +150°C
Supply Voltage range.....	-0.5V to +4.0V
Input voltage range.....	-0.5V to V <sub>DD</sub> +0.5V
Output voltage range .....	-0.5V to V <sub>DD</sub> +0.5V

**Note:**  
 Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

**Recommended Operating Conditions**

Sym.	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>DD</sub>	Supply voltage	C <sub>L</sub> ≤ 15pF	1.5	-	3.6	V
V <sub>IN</sub>	Input voltage	Input pins	GND	-	V <sub>DD</sub>	V
T <sub>A</sub>	Operating temperature	-	-40	+25	+85	°C
f <sub>0</sub>	Oscillation frequency* <sup>1</sup>	-	20	-	60	MHz
f <sub>OUT</sub>	Output frequency	C <sub>L</sub> ≤ 15pF	0.75	-	60	MHz

**Note:**\* 1. The recommended oscillation frequency is a yardstick value derived from the crystal used for PTI characteristics authentication. However, the oscillation frequency range is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.

### DC Electrical Characteristics

$V_{DD}=1.5$  to  $3.6V$ ,  $T_A=-40$  to  $85^{\circ}C$  unless otherwise noted

Parameter	Sym	Conditions	Rating			Unit	
			Min	Typ	Max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct3, $I_{OH}=4mA$	$V_{DD}-0.4$	-	-	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct3, $I_{OL}=4mA$	-	-	0.4	V	
HIGH-level input voltage	$V_{IH}$	INH, Measurement cct4	$0.7V_{DD}$	-	-	V	
LOW-level input voltage	$V_{IL}$	INH, Measurement cct4	-	-	$0.3V_{DD}$	V	
Output leakage current	$I_Z$	Q: Measurement cct5, INHN=LOW	$V_{OH}=V_{DD}$	-	-	20	$\mu A$
			$V_{OL}=GND$	20	-	-	$\mu A$
Current consumption	$I_{DD}$	5028 $\times$ 1( $f_0$ ),no load INH=open, $f_0=48MHz$ $f_{OUT}=48MHz$	$V_{DD}=3.3V$	-	1.6	2.4	mA
			$V_{DD}=2.5V$	-	1.3	2.0	mA
			$V_{DD}=1.8V$	-	1.0	1.5	mA
		Measurement cct 1, 5028 $\times$ 2( $f_0/64$ ),no load INH=open, $f_0=48MHz$ $f_{OUT}=24MHz$	$V_{DD}=3.3V$	-	1.5	2.3	mA
			$V_{DD}=2.5V$	-	1.2	1.8	mA
			$V_{DD}=1.8V$	-	0.9	1.4	mA
		Measurement cct 1, 5028 $\times$ 3( $f_0/64$ ),no load INH=open, $f_0=48MHz$ $f_{OUT}=12MHz$	$V_{DD}=3.3V$	-	1.3	2.0	mA
			$V_{DD}=2.5V$	-	1.0	1.5	mA
			$V_{DD}=1.8V$	-	0.8	1.2	mA
		Measurement cct 1, 5028 $\times$ 4( $f_0/64$ ),no load INH=open, $f_0=48MHz$ $f_{OUT}=6MHz$	$V_{DD}=3.3V$	-	1.1	1.7	mA
			$V_{DD}=2.5V$	-	0.9	1.4	mA
			$V_{DD}=1.8V$	-	0.75	1.15	mA
		Measurement cct 1, 5028 $\times$ 5( $f_0/64$ ),no load INH=open, $f_0=48MHz$ $f_{OUT}=3MHz$	$V_{DD}=3.3V$	-	1.05	1.6	mA
			$V_{DD}=2.5V$	-	0.85	1.3	mA
			$V_{DD}=1.8V$	-	0.7	1.1	mA
		Measurement cct 1, 5028 $\times$ 6( $f_0/64$ ),no load INH=open, $f_0=48MHz$ $f_{OUT}=1.5MHz$	$V_{DD}=3.3V$	-	1.0	1.5	mA
			$V_{DD}=2.5V$	-	0.85	1.3	mA
			$V_{DD}=1.8V$	-	0.7	1.1	mA
		Measurement cct 1, 5028 $\times$ 7( $f_0/64$ ),no load INH=open, $f_0=48MHz$ $f_{OUT}=0.94MHz$	$V_{DD}=3.3V$	-	1.0	1.5	mA
			$V_{DD}=2.5V$	-	0.85	1.3	mA
			$V_{DD}=1.8V$	-	0.7	1.1	mA
Standby current	$I_{ST}$	Measurement cct1, INHN=LOW	-	-	10	$\mu A$	
INH pull-up resistance	$R_{UP1}$	Measurement cct6	0.4	1.5	8	$M\Omega$	
	$R_{UP2}$		30	70	150	$K\Omega$	
Oscillator feedback resistance	$R_f$	-	50	100	200	$K\Omega$	
Oscillator capacitance	$C_G$	Design value(a monitor pattern on a wafer is tested), Excluding parasitic capacitance	4.8	6	7.2	pF	
	$C_D$		8	10	12	pF	

**AC Electrical Characteristics**

$V_{DD}=1.5$  to  $3.6V$ ,  $T_A=-40$  to  $85^\circ C$  unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit	
			Min	Type	Max		
Output rise time	$t_{r1}$	Measurement cct1, $C_L=15pF$ , $0.1V_{DD}$ to $0.9V_{DD}$	$V_{DD}=2.0$ to $3.6 V$	-	1.3	3.0	ns
	$t_{r2}$	Measurement cct1, $C_L=15pF$ , $0.2V_{DD}$ to $0.8V_{DD}$	$V_{DD}=1.5$ to $2.0 V$	-	1.3	3.0	ns
Output fall time	$t_{f1}$	Measurement cct1, $C_L=15pF$ , $0.9V_{DD}$ to $0.1V_{DD}$	$V_{DD}=2.0$ to $3.6 V$	-	1.3	3.0	ns
	$t_{f2}$	Measurement cct1, $C_L=15pF$ , $0.8V_{DD}$ to $0.2V_{DD}$	$V_{DD}=1.5$ to $2.0 V$	-	1.3	3.0	ns
Output duty cycle	Duty	Measurement cct 1, $T_A=25^\circ C, C_L=15pF$	45	50	55	%	
Output disable delay time	$t_{OD}$	Measurement cct 1, $T_A=25^\circ C, C_L \leq 15pF$	-	-	50	$\mu S$	

**Timing chart**

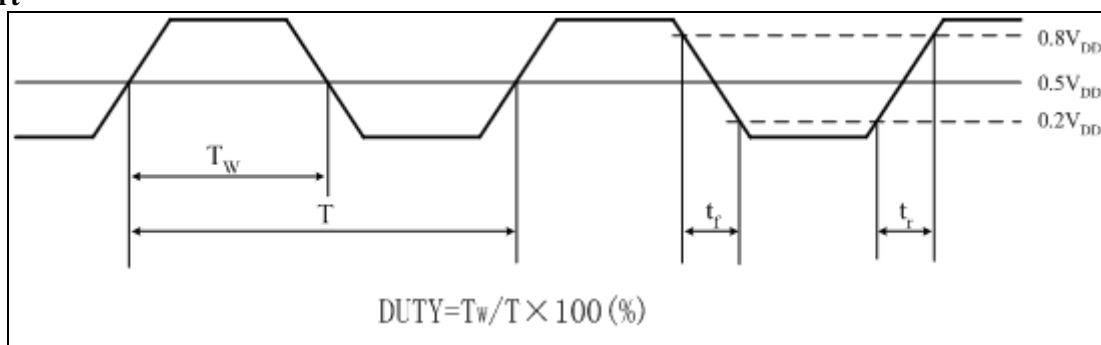


Figure 1: Output switching waveform

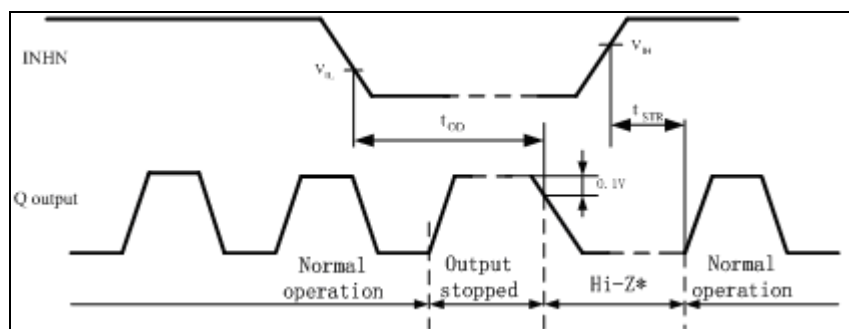


Figure 2: Output disable and oscillation start timing chart

When INHN goes HIGH to LOW, the Q output goes HIGH once and then becomes high impedance.

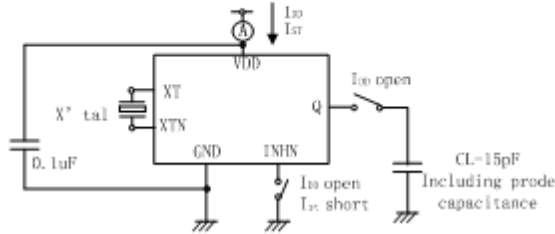
When INHN goes LOW to HIGH, the Q output from high impedance to normal output operation when the oscillation starts(oscillation is detected)

\*) the high –impedance interval in the figure is shown as a LOW level due to the  $1K\Omega$  pull-down resistor connected to the Q pin(see “Measurement circuit 2” in the “Measurement circuits” section)

**Measurement Circuit**

**Measurement cct1**

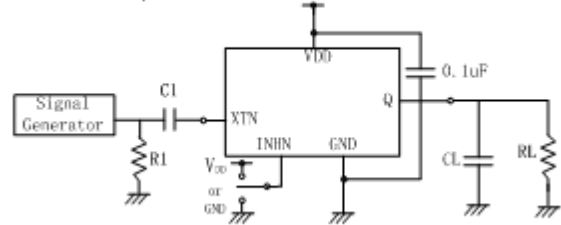
Measurement parameter:  $I_{DD}$ ,  $I_{ST}$ , Duty,  $t_{on}$ ,  $t_r$



Note: The AC characteristics are observed using an oscilloscope on pin Q

**Measurement cct2**

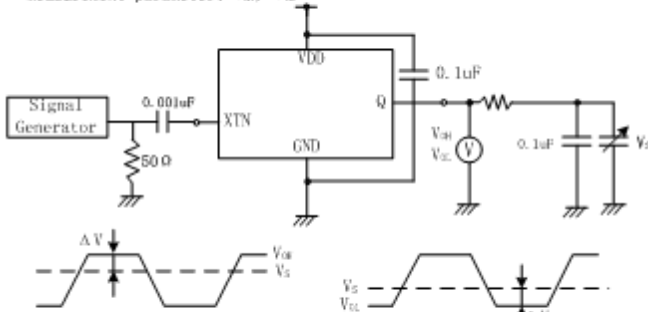
Measurement parameter:  $I_{DD}$



XTN input signal: 1Vp-p, sine wave  
 C1: 0.001uF CL: 15pF  
 R1: 50 Ω RL: 1K Ω

**Measurement cct3**

Measurement parameter:  $V_{OH}$ ,  $V_{OL}$

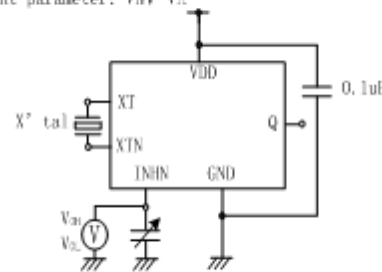


$V_S$  adjusted such that  $\Delta V=50 \times I_{DD}$      $V_S$  adjusted such that  $\Delta V=50 \times I_{DD}$

XTN input signal: 1Vp-p, sine wave

**Measurement cct4**

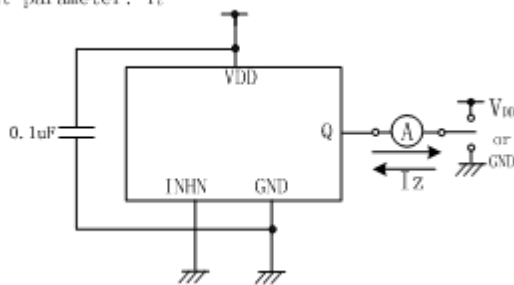
Measurement parameter:  $V_{IH}$ ,  $V_{IL}$



$V_{IH}$ : Voltage is 0V to  $V_{DD}$  transition that changes the output state.  
 $V_{IL}$ : Voltage is  $V_{DD}$  to 0V transition that changes the output state.  
 INHN has an oscillation stop function

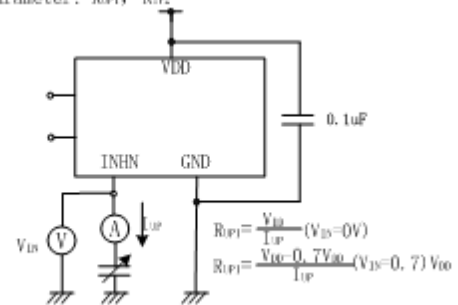
**Measurement cct5**

Measurement parameter:  $I_Z$



**Measurement cct6**

Measurement parameter:  $R_{IP1}$ ,  $R_{IP2}$



$$R_{IP1} = \frac{V_{IH}}{I_{IP}} \quad (V_{IS}=0V)$$

$$R_{IP2} = \frac{V_{IH}-0.7V_{DD}}{I_{IP}} \quad (V_{IS}=0.7)V_{DD}$$



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**Notes**

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