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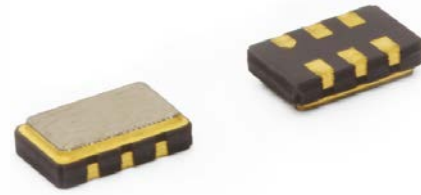


# Model 654P/L

## Advanced PLL LVPECL or LVDS Clock

### Features

- Ceramic Surface Mount Package
- Low Phase Jitter Performance, 500fs Typical
- Advanced PLL Design w/ Low Fundamental Crystal
- Frequency Range 10MHz – 800MHz \*
- +2.5V or +3.3V Operation
- Output Enable Standard, Pin 2 Option Available
- Tape and Reel Packaging, EIA-418



Part Dimensions:  
5.0 × 3.2 × 1.2mm • 62.00mg

### Applications

- Broadcast Video Systems
- Storage Area Networking
- Broadband Access
- PCI Express
- Networking Equipment
- Ethernet/GbE/SyncE
- Fiber Channel
- Test and Measurement

#### Standard Frequencies

- 25.00MHz	- 125.00MHz	- 250.00MHz
- 27.00MHz	- 148.50MHz	- 312.50MHz
- 50.00MHz	- 153.60MHz	- 322.265625MHz
- 74.25MHz	- 155.52MHz	- 400.00MHz
- 100.00MHz	- 156.25MHz	
- 106.25MHz	- 200.00MHz	

\* See Page 8 for additional developed frequencies.  
Check with factory for availability of frequencies not listed.

### Description

CTS Model 654P/L is a low cost, high performance PLL clock oscillator supporting differential LVPECL or LVDS outputs. Employing the latest IC technology, M654P/L has excellent stability and low phase jitter performance.

### Ordering Information

Model	Output Type	Frequency Code [MHz]	Frequency Stability	Temperature Range	Supply Voltage	Packaging
654	P	XXX or XXXX	3	I	3	T

Code	Output
P	LVPECL - Pin 1 Enable
L	LVDS - Pin 1 Enable
E	LVPECL - Pin 2 Enable
V	LVDS - Pin 2 Enable

Code	Stability
6	±20ppm <sup>2</sup>
5	±25ppm <sup>3</sup>
4	±30ppm
3	±50ppm

Code	Voltage
2	+2.5Vdc
3	+3.3Vdc

Code	Temp. Range
C	-20°C to +70°C
I	-40°C to +85°C

Code	Frequency
Product Frequency Code <sup>1</sup>	

Code	Packing
T	1k pcs./reel

Notes:

- 1] Refer to document 016-1454-0, Frequency Code Tables.  
3-digits for frequencies <100MHz, 4-digits for frequencies 100MHz or greater.
- 2] 6I Stability/Temperature combination not available.
- 3] Check factory availability when paired with 'I' temperature code.

**Not all performance combinations and frequencies may be available.  
Contact your local CTS Representative or CTS Customer Service for availability.**

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## Electrical Specifications

### Operating Conditions

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Maximum Supply Voltage	$V_{CC}$	-	-0.5	-	4.0	V
Supply Voltage	$V_{CC}$	±5%	2.375 3.135	2.5 3.3	2.625 3.465	V
<b>Supply Current</b>						
LVPECL	$I_{CC}$	Maximum Load Maximum Current Value @ +3.3V	-	54	88	mA
LVDS			-	23	65	
Operating Temperature	$T_A$	-	-20 -40	+25	+70 +85	°C
Storage Temperature	$T_{STG}$	-	-55	-	+125	°C

### Frequency Stability

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Frequency Range	$f_O$	-		10 - 800		MHz
Frequency Stability [Note 1]	$\Delta f/f_O$	-		20, 25 or 50		±ppm
Aging	$\Delta f/f_{25}$	First Year @ +25°C, nominal $V_{CC}$	-3	-	3	ppm

1.] Inclusive of initial tolerance at time of shipment, changes in supply voltage, load, temperature and 1st year aging.

### Output Parameters

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Output Type	-	-		LVPECL		-
Output Load	$R_L$	Terminated to $V_{CC} - 2.0V$	-	50	-	Ohms
Output Voltage Levels	$V_{OH}$	PECL Load	$V_{CC} - 1.03$	-	$V_{CC} - 0.60$	V
	$V_{OL}$		$V_{CC} - 1.85$	-	$V_{CC} - 1.60$	
Output Duty Cycle	SYM	@ $V_{CC} - 1.3V$	45	-	55	%
Rise and Fall Time	$T_{R}, T_F$	@ 20%/80% Levels, $R_L = 50$ Ohms	-	0.25	0.60	ns
Output Type	-	-		LVDS		-
Output Load	$R_L$	Between Outputs	-	100	-	Ohms
Output Voltage Levels	$V_{OH}$	LVDS Load	-	1.43	1.60	V
	$V_{OL}$		0.90	1.10	-	
Output Duty Cycle	SYM	@ 1.25V	45	-	55	%
Differential Output Voltage	$V_{OD}$	$R_L = 100$ Ohms	175	330	454	mV
Offset Voltage	$V_{OS}$	LVDS Load	1.20	1.25	1.30	V
Rise and Fall Time	$T_{R}, T_F$	@ 20%/80% Levels, $R_L = 100$ Ohms	-	-	0.5	ns

## Electrical Specifications

### Output Parameters

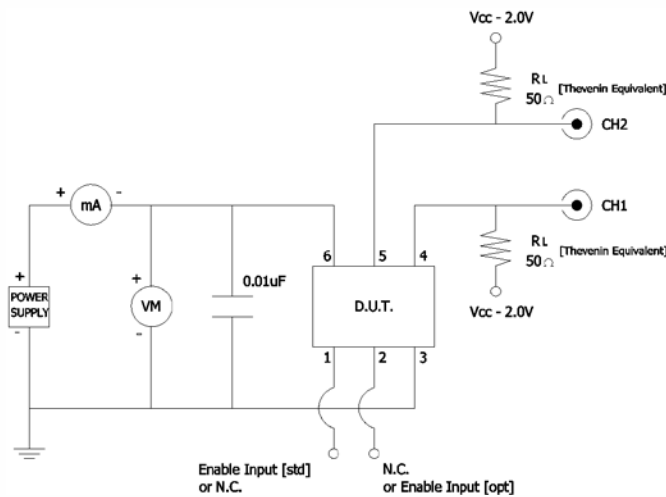
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Start Up Time	$T_S$	Application of $V_{CC}$	-	3	5	ms
<b>Enable Function [Tri-State]</b>						
Enable Input Voltage	$V_{IH}$	Pin 1 or 2 Logic '1', Output Enabled	$0.7V_{CC}$	-	-	V
Disable Input Voltage	$V_{IL}$	Pin 1 or 2 Logic '0', Output Disabled	-	-	$0.3V_{CC}$	V
Disable Current	$I_{IL}$	Pin 1 or 2 Logic '0', Output Disabled	-	16	22	mA
Enable Time	$T_{PLZ}$	Pin 1 or 2 Logic '1', Output Enabled	-	-	200	ns
Phase Jitter, RMS	$t_{jrms}$	Bandwidth 12 kHz - 20 MHz	-	500	<1000	fs
Period Jitter, RMS	$p_{jrms}$	-	-	2.5	-	ps
Period Jitter, pk-pk	$p_{jpk-pk}$	-	-	25	-	ps

### Enable Truth Table

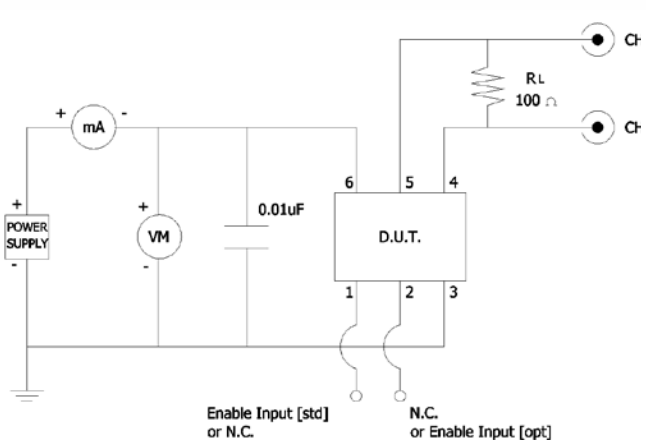
Pin 1 or Pin 2	Pin 4 & Pin 5
Logic '1'	Output
Open	Output
Logic '0'	High Imp.

### Test Circuit

LVPECL

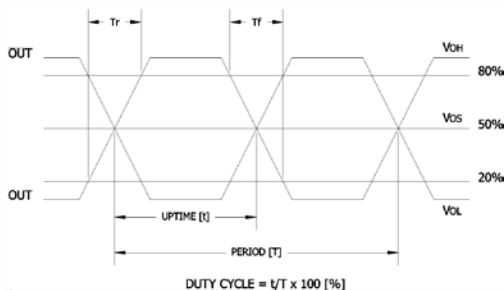


LVDS



### Output Waveform

LVPECL or LVDS

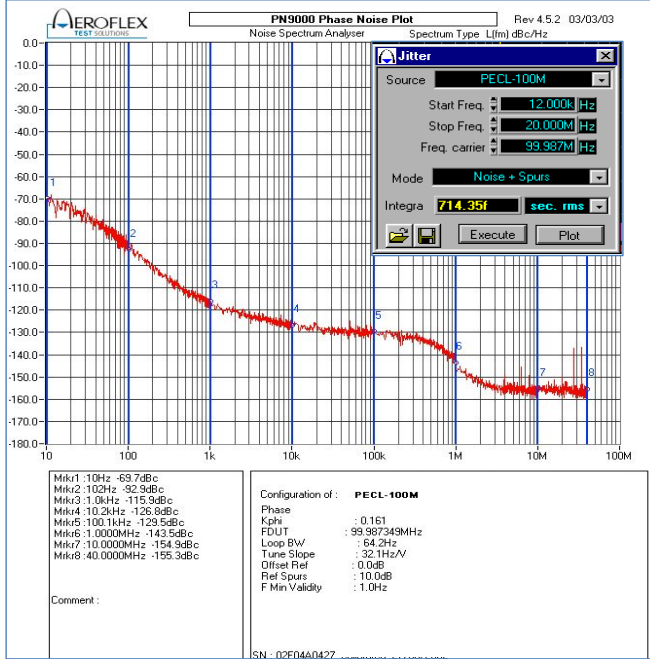


## Electrical Specifications

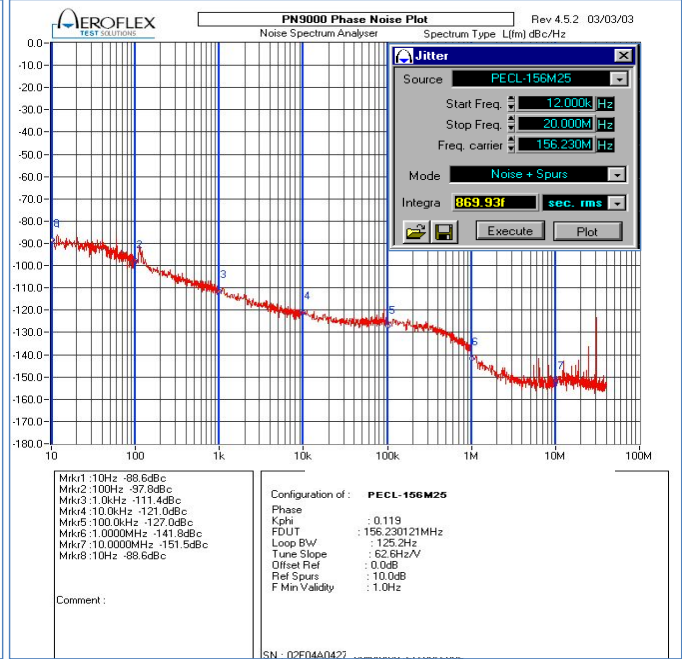
### Performance Data

#### Phase Noise [typical]

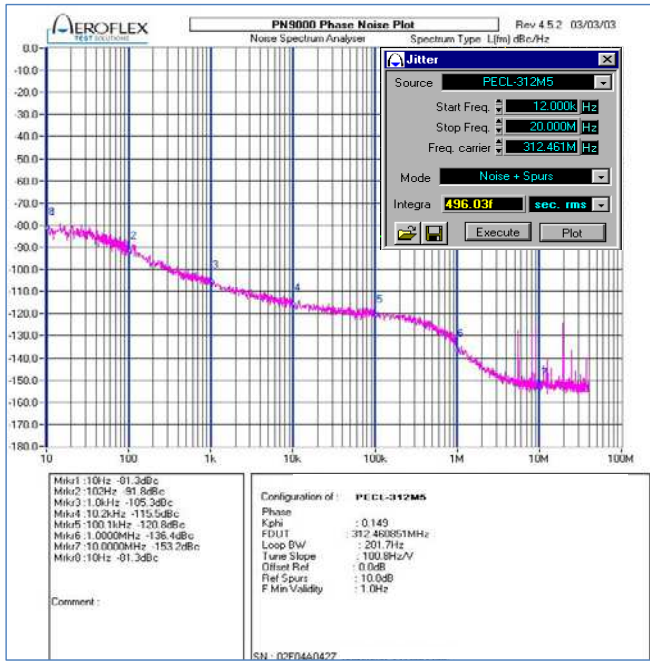
100.00MHz, LVPECL,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$



156.25MHz, LVPECL,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$



312.50MHz, LVPECL,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$





Performance Data

Phase Noise Tabulated

Typical, HCMOS,  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$

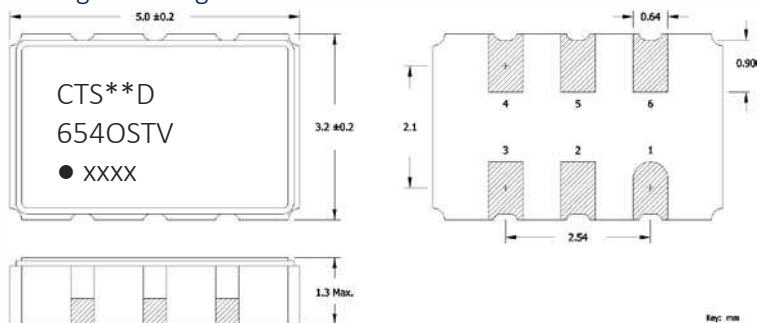
PARAMETER	SYMBOL	CONDITIONS	TYP	UNIT
<b>LVPECL @ 100.00MHz</b>				
<b>Phase Noise</b>		Single Side Band		
		@ 10Hz	-69.70	
		@ 100Hz	-92.90	
		@ 1kHz	-115.90	
	-	@ 10kHz	-126.80	dBc/Hz
		@ 100kHz	-129.50	
		@ 1MHz	-143.50	
		@ 10MHz	-154.90	
		@ 40MHz	-155.30	
<b>Phase Jitter, RMS</b>	tjrms	Integration Bandwidth 12kHz - 20MHz	714.35	fs

PARAMETER	SYMBOL	CONDITIONS	TYP	UNIT
<b>LVPECL @ 156.25MHz</b>				
<b>Phase Noise</b>		Single Side Band		
		@ 10Hz	-88.60	
		@ 100Hz	-97.80	
		@ 1kHz	-111.40	
	-	@ 10kHz	-121.00	dBc/Hz
		@ 100kHz	-127.00	
		@ 1MHz	-141.80	
		@ 10MHz	-151.50	
		@ 40MHz	-153.30	
<b>Phase Jitter, RMS</b>	tjrms	Integration Bandwidth 12kHz - 20MHz	869.93	fs

PARAMETER	SYMBOL	CONDITIONS	TYP	UNIT
<b>LVPECL @ 312.50MHz</b>				
<b>Phase Noise</b>		Single Side Band		
		@ 10Hz	-81.30	
		@ 100Hz	-91.80	
		@ 1kHz	-105.30	
	-	@ 10kHz	-115.50	dBc/Hz
		@ 100kHz	-120.80	
		@ 1MHz	-136.40	
		@ 10MHz	-153.20	
		@ 40MHz	-153.20	
<b>Phase Jitter, RMS</b>	tjrms	Integration Bandwidth 12kHz - 20MHz	496.03	fs

## Mechanical Specifications

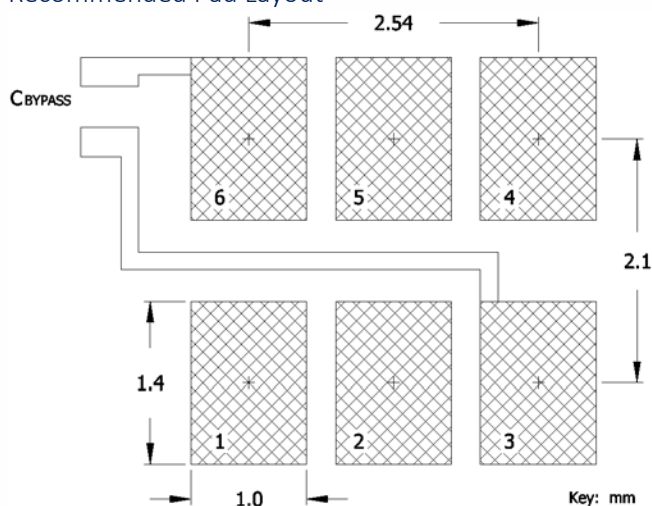
### Package Drawing



### Marking Information

- \*\* - Manufacturing Site Code.
  - D - Date Code. See Table I for codes.
  - O - Output Type; P = LVPECL, L = LVDS.
  - ST - Frequency Stability/Temperature Code. [Refer to Ordering Information]
  - V - Voltage Code; 3 = 3.3V, 2 = 2.5V.
  - xxxx - Frequency Code.  
3-digits, frequencies below 100MHz  
4-digits, frequencies 100MHz or greater
- [See document 016-1454-0, Frequency Code Tables.]

### Recommended Pad Layout



### Notes

- JEDEC termination code (e4). Barrier-plating is nickel [Ni] with gold [Au] flash plate.
- Reflow conditions per JEDEC J-STD-020; +260°C maximum, 20 seconds.
- MSL = 1.

### Pin Assignments

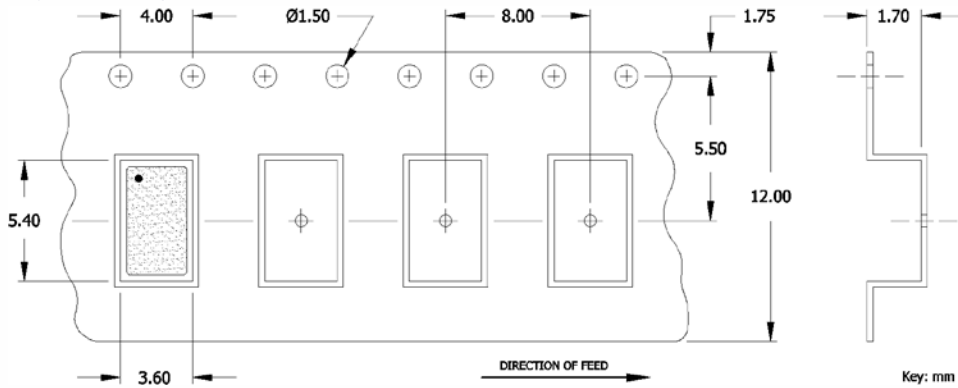
Pin	Symbol	Function
1	EOH or N.C.	Enable [std] or No Connect
2	N.C. or EOH	No Connect or Enable [opt]
3	GND	Circuit & Package Ground
4	Output	RF Output
5	Output	Complimentary RF Output
6	V <sub>CC</sub>	Supply Voltage

Table I - Date Code

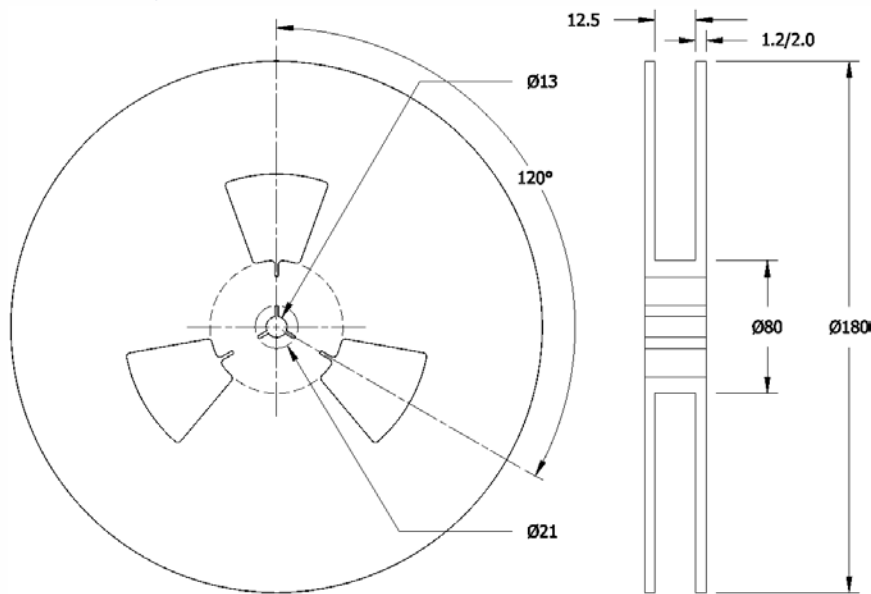
YEAR		MONTH															
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC				
2001	2005	2009	2013	2017	A	B	C	D	E	F	G	H	J	K	L	M	
2002	2006	2010	2014	2018	N	P	Q	R	S	T	U	V	W	X	Y	Z	
2003	2007	2011	2015	2019	a	b	c	d	e	f	g	h	j	k	l	m	
2004	2008	2012	2016	2020	n	p	q	r	s	t	u	v	w	x	y	z	

### Packaging - Tape and Reel

#### Tape Drawing



#### Reel Drawing



#### Notes

1. Device quantity is 1k pieces per 180mm reel.
2. Complete CTS part number, frequency value and date code information must appear on reel and carton labels.





## Addendum

### Additional Developed Frequencies – MHz

FREQUENCY	FREQUENCY CODE	FREQUENCY	FREQUENCY CODE	FREQUENCY	FREQUENCY CODE	FREQUENCY	FREQUENCY CODE
38.840000	38D	77.760000	777	135.000000	1350	184.320000	1843
38.880000	388	86.700000	867	144.500000	1445	204.800000	2048
43.350000	433	87.351542	873	148.351600	148A	233.000000	2330
45.000000	450	92.160000	921	148.351648	148B	245.760000	2457
54.000000	540	96.000000	960	150.000000	1500	300.000000	3000
62.500000	625	104.000000	1040	156.253906	156A	349.400000	3494
74.175800	74A	122.880000	1228	160.000000	1600		
76.800000	768	132.000000	1320	161.132800	1611		

### Frequency Codes for Cover Page Table – MHz

FREQUENCY	FREQUENCY CODE	FREQUENCY	FREQUENCY CODE	FREQUENCY	FREQUENCY CODE	FREQUENCY	FREQUENCY CODE
25.000000	250	106.250000	1062	156.250000	1562	400.000000	4000
27.000000	270	125.000000	1250	200.000000	2000		
50.000000	500	148.500000	1485	250.000000	2500		
74.250000	742	153.600000	1536	312.500000	3125		
100.000000	1000	155.520000	1555	322.265625	322A		