Q-TECH
CORPORATION

CLASS B+ PRODUCTS
CRYSTAL CLOCK OSCILLATORS
3.3 to 5.0Vdc - 450kHz to 85MHz

Introduction

The commercial satellite industry has requested that smaller, lighter, less expensive oscillator products with shorter lead times be made available for minisatellites, microsatellites, nanosatellites and picosatellites. In addition some newer satellite programs are being created for short term space lives and do not need oscillators with the assurance of a 15-20 year life span.

Q-Tech Corporation, the industry leader in both Class B and Space Rated hybrid crystal oscillators is pleased to advise that we have created a special category of product designated as Class B+ for these applications.

We have created these Class B+ products for the discriminate user's applications and needs using our small form MIL QPL Class B oscillators. You, the customer, can now pick and choose the style of clock oscillator you wish, whether you want a 100kRad (Si) High Dose Tolerant NSC 54ACT3301 (FACT) or a standard Class B qualified die, a swept quartz space qualified crystal or a Class B cultured quartz crystal and/or a combination thereof in an oscillator product that otherwise utilizes Class B qualified passive devices. Q-Tech offers several different screening options to allow you to choose the screening plan that best suits your needs.

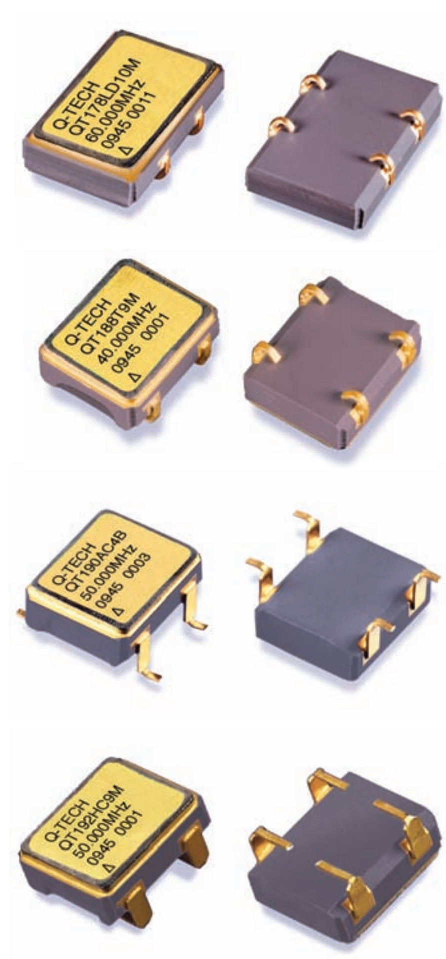
Q-Tech Corporation does not guarantee the specific radiation hardness of its Class B+ products but will provide the necessary active device component traceability to allow you to make your own decision and do your own testing and evaluation based upon your specific needs and requirements.

Initially we will begin this product offering in our leading miniature clock oscillator product lines: QT78 (M55310/27, /28 & /30) , QT88 (M55310/33 & /34), QT90, and QT92 (M55310/37 & /38). Product will be available in 5.0 and 3.3 Vdc from 450kHz to 85MHZ. Please consult the factory if you would like to know if this option is available in other standard Q-Tech Class B product lines or if you have any other specific oscillator needs that we can help you with.

Features

- Made in the USA
- ECCN: EAR99
- DFARS 252-225-7014 Compliant: Electronic Component Exemption
- USML Registration # M17677
- Broad frequency range from 450kHz to 85MHz
- Rugged 4 point mount design for high shock and vibration
- ACMOS, HCMOS, TTL or LVHCMOS logic
- Tri-State Output Option (D)
- Hermetically sealed ceramic SMD package
- Fundamental and 3rd Overtone designs
- Low phase noise
- Custom designs available
- Q-Tech does not use pure lead or pure tin in its products
- RoHS compliant

See website for link to RAD test data.



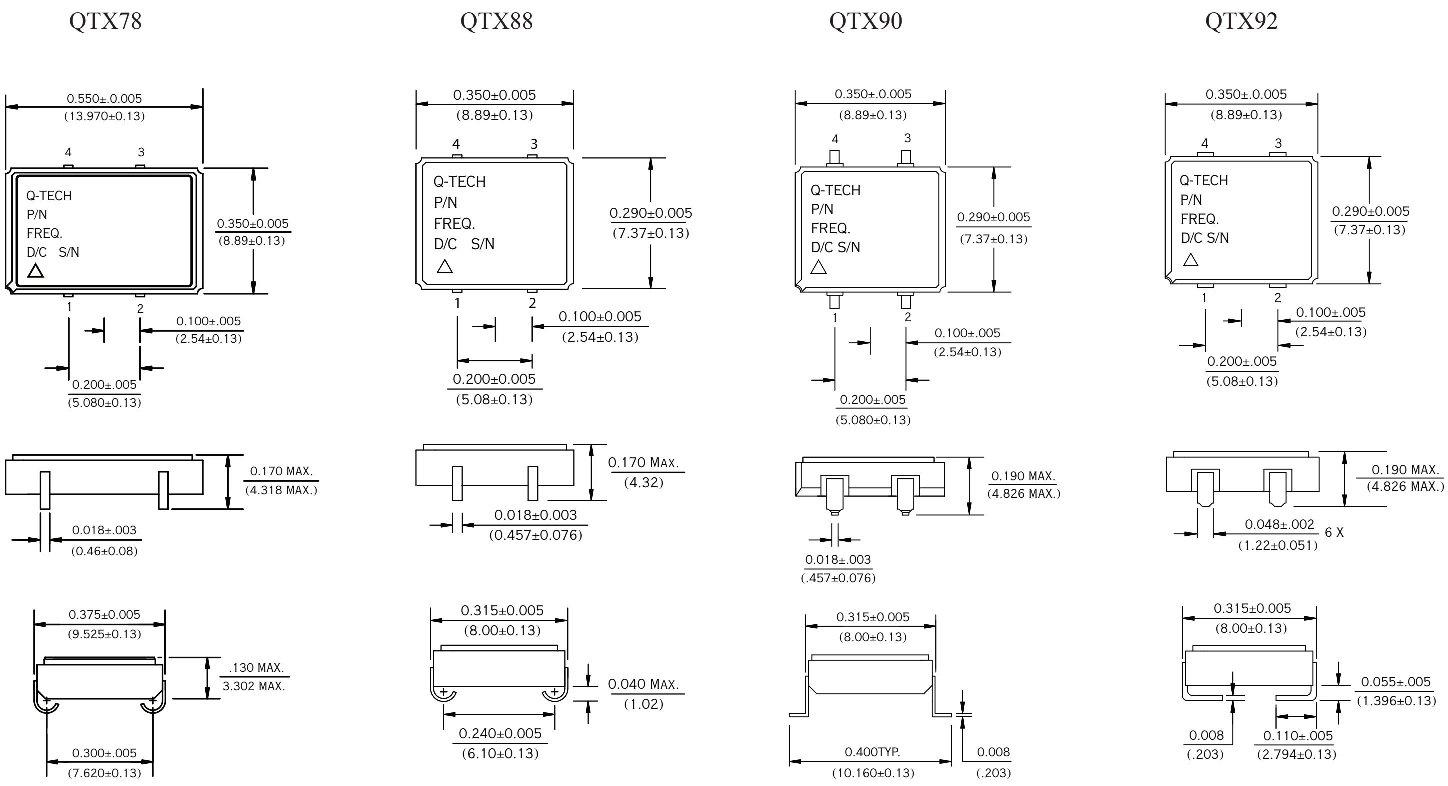
Electrical Characteristics

Parameters		QTX78AC QTX88AC QTX90AC QTX92AC	QTX78HC QTX88HC QTX90HC QTX92HC	QTX78T QTX88T QTX90T QTX92T	QTX78L QTX88L QTX90L QTX92L
Output frequency range (Fo)	QTX78	**450kHz — 85.000MHz**			**450kHz — 70.000MHz**
	QTX88, QTX90, & QTX92	**500kHz — 85.000MHz**			**500kHz — 70.000MHz**
Supply voltage (Vdd)		5.0Vdc ± 10%			3.3Vdc ± 10%
Maximum Applied Voltage (Vdd max.)		-0.5 to +7.0Vdc			
Frequency stability (ΔF/ΔT)		See Option codes			
Operating temperature (Topr)		See Option codes			
Storage temperature (Tsto)		-62ºC to + 125ºC			
Operating supply current (Idd) (No Load)		20 mA max. - 450kHz ~ < 16MHz 25 mA max. - 16MHz ~ < 32MHz 35 mA max. - 32MHz ~ < 60MHz 45 mA max. - 60MHz ~ ≤ 85MHz			3 mA max. - 450kHz ~ < 500kHz 6 mA max. - 500kHz ~ < 16MHz 10 mA max. - 16MHz ~ < 32MHz 20 mA max. - 32MHz ~ < 60MHz 30 mA max. - 60MHz ~ < 70MHz
Symmetry (50% of ouput waveform or 1.4Vdc for TTL)		45/55% max. - 450kHz ~ < 15MHz 40/60% max. - 15 ~ ≤ 85MHz (Tighter symmetry available)			45/55% max. - 450kHz ~ < 15MHz 40/60% max. - 15 ~ ≤ 70MHz (Tighter symmetry available)
Rise and Fall times (with typical load)		6ns max. - Fo < 30MHz 3ns max. - Fo ≥ 30 - 85MHz (between 10% to 90%)	7ns max. - Fo < 30MHz 3ns max. - Fo ≥ 30 - 85MHz (between 10% to 90%)	5ns max. - Fo < 30MHz 3ns max. - Fo ≥ 30 - 85MHz (between 0.8V to 2.0V)	6ns max. - 450kHz ~ < 40MHz 3ns max. - 40 ~ ≤ 70MHz (between 10% to 90%)

Output Load		**15pF // 10kohms**
		50pF max. or 10TTL
		for (Fo < 60MHz)
		30pF max. or 6TTL
		for (Fo ≥ 60MHz)
			15pF // 10kohms
			(2LSTTL)
				10TTL (Fo < 60MHz)
				6TTL (Fo ≥ 60MHz)
					15pF // 10kohms
					(30pF max. for F ≤ 50MHz)

Start-up time (Tstup)		5ms max.			
Output voltage (Voh/Vol)		0.9 x Vdd min.; 0.1 x Vdd max.		2.4V min.; 0.4V max.	0.9 x Vdd min.; 0.1 x Vdd max.
Output Current (Ioh/Iol)		± 24mA max.	± 8mA max.	-1.6 mA/TTL +40 µA/TTL	± 4mA max.
Enable/Disable Tristate function Pin 1		VIH ≥ 2.2V Oscillation; VIL ≤ 0.8V High Impedance			
Jitter RMS 1σ (at 25ºC)		8ps typ. - < 40MHz 5ps typ. - ≥ 40MHz			15ps typ. - < 40MHz 8ps typ. - ≥ 40MHz
Aging (at 70ºC)		± 5ppm max. first year / ± 2ppm max. per year thereafter			

Package Specifications and Outline



Dimensions are in inches (mm)

Pin No.	Function
1	TRISTATE or NC
2	GND/CASE
3	OUTPUT
4	VDD

Package Information

- Package material: 90% AL_2O_3
- Lead material: Kovar
- Lead finish:
  - Gold Plated: 50µ ~ 80µ inches
  - Nickel Underplate: 100µ ~ 250µ inches
- Weight: 1.1g typ., 3.0g max.

Ordering Information

Sample part number

QT178ACD9S-85.000MHz

Q	T	1	78	AC	D	9	S	-	85.000MHz

T = Standard
S = Solder Dip **(*)**

Blank = Class B Die, Cultured Quartz Crystal
1 = 100 kRad (Si) High Dose 54ACT3301, Swept Quartz Crystal
2 = 100 kRad (Si) High Dose 54ACT3301, Cultured Quartz Crystal
3 = Class B Die, Swept Quartz Crystal

78 = QT78
88 = QT88
90 = QT90
92 = QT92

L = CMOS 3.3V
AC = ACMOS 5V
HC = HCMOS 5V
T = TTL 5V

Tristate Option D
(Left blank if no Tristate)

1	±100ppm	at 0ºC to +70ºC
4	± 50ppm	at 0ºC to +70ºC
5	± 25ppm	at -20ºC to +70ºC
6	± 50ppm	at -55ºC to +105ºC
9	± 50ppm	at -55ºC to +125ºC
10	±100ppm	at -55ºC to +125ºC
11	± 50ppm	at -40ºC to +85ºC
12	±100ppm	at -40ºC to +85ºC
14	± 20ppm	at -20ºC to +70ºC
15	± 25ppm	at -40ºC to +85ºC

Blank / M / B / S — See screening level tables on page 4

Output frequency

(*) Hot Solder Dip Sn60 per MIL-PRF 55310 is optional for an additional cost

Frequency stability vs. temperature codes may not be available in all frequencies.

For Non-Standard requirements, contact Q-Tech Corporation at Sales@Q-Tech.com

Packaging Options

- Standard packaging in anti-static plastic tube (60pcs/tube)
- Tape and Reel is available for an additional charge.

Specifications subject to change without prior notice.

Screening Test Table

SCREENING				TEST DESCRIPTION	STANDARD	METHOD	CONDITION	QUANTITY	COMMENTS
Blank	M	B	S						
✓	✓	✓	✓	Internal visual	883	2017	Class H	100%	
✓	✓	✓	✓	Stabilization bake	883	1008	C	100%	48 hours at 150'C
	✓	✓	✓	Temperature cycling	883	1010	B (for M) C (for B & S)	100%	10 cycles
	✓	✓	✓	Constant acceleration	883	2001	A	100%	Y1 direction only
		✓	✓	Particle impact noise detection (PIND)	883	2020	B	100%	5 passes minimum (see note 1)
	✓	✓	✓	Pre burn-in electrical	Refer to Table I and detail specification			100%	
	✓	✓	✓	Burn-in #1	883	1015	125°C for 160 hours	100%	(see note 2)
			✓	Interim electrical	Refer toTable I, II and detail specification			100%	
			✓	Burn-in #2	883	1015	125 °C for 160 hours	100%	(see note 2)
✓	✓	✓	✓	Final electrical	Refer to detail specification .... (for Blank) Refer to Table I and detail specification .... (for M) Refer to Table I and detail specification .... (for B) Refer to Table I, II and detail specification ... (for S)			100%	
✓	✓	✓	✓	Seal: Fine leak	883	1014	A1	100%	
✓	✓	✓	✓	Seal: Gross leak	883	1014	C	100%	
			✓	Radiographic inspection	883	2012	Class S	100%	
			✓	Frequency aging 30days	MIL-PRF-55310	-	+70°C±3°C	100%	±1.5ppm max. (see note 3)
	✓	✓	✓	Frequency/Temperature stability	MIL-PRF-55310		Measure the output frequency at ten equispaced points minimum of the specified operating temperature range		
✓	✓	✓	✓	External visual	883	2009		100%	

1. PIND testing shall be performed using five (5) independent passes and all failures found at the end of each pass are rejected. The survivors of the last pass are acceptable.
2. Burn-in shall be under the specified load and nominal voltage conditions.
3. Normally, frequency aging tests are for 30 days. However, the frequency aging test may be ceased if after 15 days the measured aging rate is less than half of the specified aging rate.

Table I Electrical Test - Measurement Requirements (Applicable to screening level M, B, & S only)

Parameters	Pre BI at 25°C			Pre BI Low T			Pre BI High T			Interim BI at 25°C			Post BI at 25°C			Post BI Low T			Post BI High T		
	M	B	S	M	B	S	M	B	S	M	B	S	M	B	S	M	B	S	M	B	S
Output frequency	✓	✓	✓		✓	✓		✓	✓			✓	✓	✓	✓		✓	✓		✓	✓
Frequency/temperature stability	✓	✓	✓		✓	✓		✓	✓			✓	✓	✓	✓		✓	✓		✓	✓
Frequency/voltage stability	✓	✓	✓										✓	✓	✓						
Input current	✓	✓	✓									✓	✓	✓	✓		✓	✓		✓	✓
Output voltage	✓	✓	✓		✓	✓		✓	✓			✓	✓	✓	✓		✓	✓		✓	✓
Waveform	✓	✓	✓		✓	✓		✓	✓			✓	✓	✓	✓		✓	✓		✓	✓
Duty cycle (symmetry)	✓	✓	✓		✓	✓		✓	✓			✓	✓	✓	✓		✓	✓		✓	✓
Rise and fall times	✓	✓	✓									✓	✓	✓	✓		✓	✓		✓	✓
Start up time	✓	✓	✓									✓	✓	✓	✓						

Table II Delta Limits (Applicable to screening level S only)

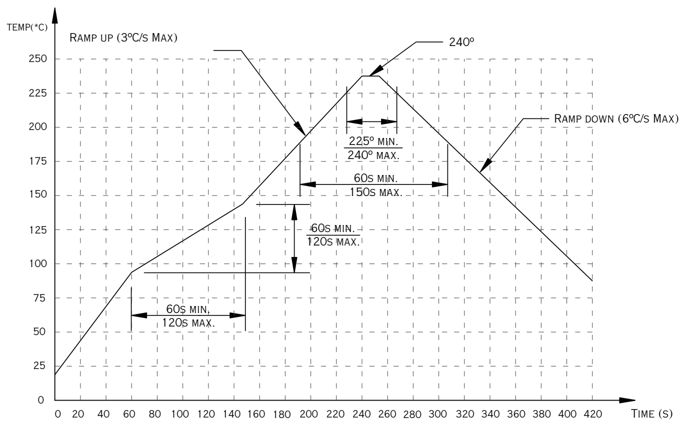
Test	Parameter	Symbol	Delta Limits
Burn-In (second 160 hours Burn-In period)	Supply current	Icc	±10% of initial reading
Frequency aging after 30 days at +70°C	Output Frequency	Fo	Refer to detail spec.

Reflow Profile

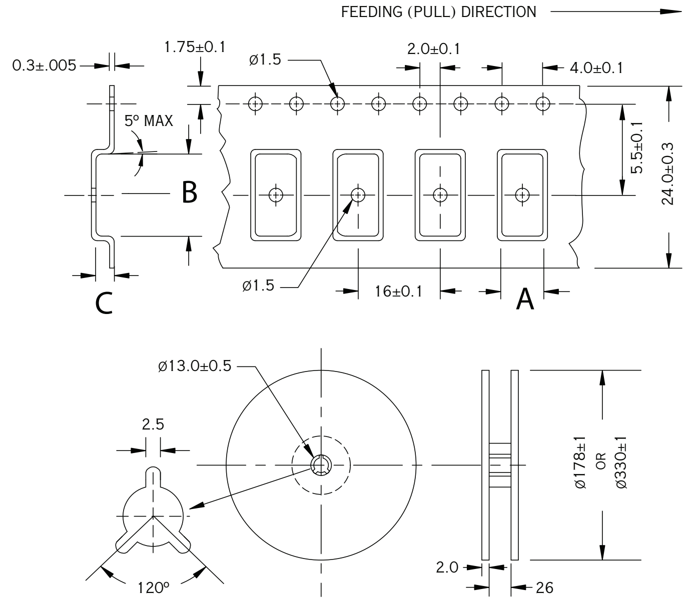
The five transition periods for the typical reflow process are:

- Preheat
- Flux activation
- Thermal equalization
- Reflow
- Cool down

TYPICAL REFLOW PROFILE FOR SN-PB ASSEMBLY



Embossed Tape and Reel Information



QT	A	B	C
QTX78	10.01 ±0.1	14.53 ±0.1	4.80 ±0.1
QTX88 & QTX92	7.747 ±0.1	9.271 ±0.1	4.699 ±0.1

Dimensions are in mm. Tape is compliant to EIA-481-A.

Reel size vs. quantity:

Reel size (Diameter in mm)	Qty per reel (pcs)	
	QTX78	QTX88,QTX90,QTX92
178	250	150
330	1000	800

Environmental Specifications

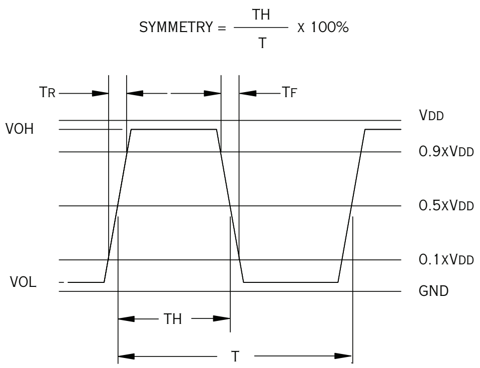
Q-Tech Standard Screening/QCI (MIL-PRF55310) is available for all of our B+ Products. Q-Tech can also customize screening and test procedures to meet your specific requirements. The B+ product is designed and processed to exceed the following test conditions:

Environmental Test	Test Conditions
Temperature cycling	MIL-STD-883, Method 1010, Cond. B or Cond. C
Constant acceleration	MIL-STD-883, Method 2001, Cond. A, Y1
Seal: Fine and Gross Leak	MIL-STD-883, Method 1014, Cond. A and C
Burn-in	160 hours, 125°C with load
Aging	30 days, 70°C, ±1.5ppm max
Vibration sinusoidal	MIL-STD-202, Method 204, Cond. D
Shock, non operating	MIL-STD-202, Method 213, Cond. I (See Note 1)
Thermal shock, non operating	MIL-STD-202, Method 107, Cond. B
Ambient pressure, non operating	MIL-STD-202, 105, Cond. C, 5 minutes dwell time minimum
Resistance to solder heat	MIL-STD-202, Method 210, Cond. B
Moisture resistance	MIL-STD-202, Method 106
Terminal strength	MIL-STD-202, Method 211, Cond. C
Resistance to solvents	MIL-STD-202, Method 215
Solderability	MIL-STD-202, Method 208
ESD Classification	MIL-STD-883, Method 3015, Class 1HBM 0 to 1,999V
Moisture Sensitivity Level	J-STD-020, MSL=1

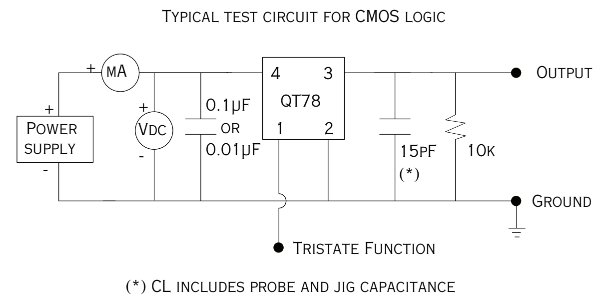
Note 1: Additional shock results successfully passed on 16MHz, 40MHz, and 80MHz
- Shock 850g peak, half-sine, 1 ms duration (MIL-STD-202, Method 213, Cond. D modified)
- Shock 1,500g peak, half-sine, 0.5ms duration (MIL-STD-883, Method 2002, Cond. B)
- Shock 36,000g peak, half-sine, 0.12 ms duration (QTX88, QTX90 & QTX92)

Please contact Q-Tech for higher shock requirements

Output Waveform (Typical)

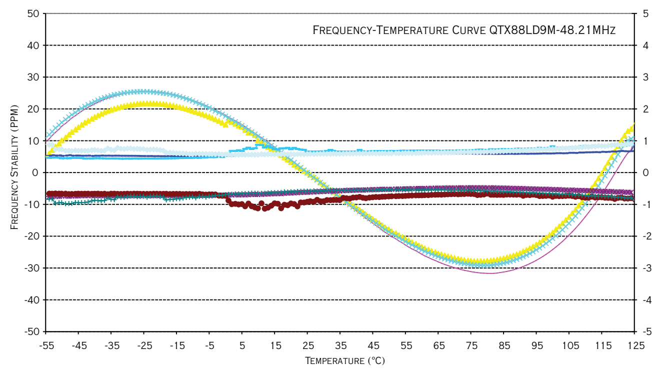


Test Circuit



The Tristate function on pin 1 has a built-in pull-up resistor typical 50kΩ, so it can be left floating or tied to Vdd without deteriorating the electrical performance.

Frequency vs. Temperature Curve



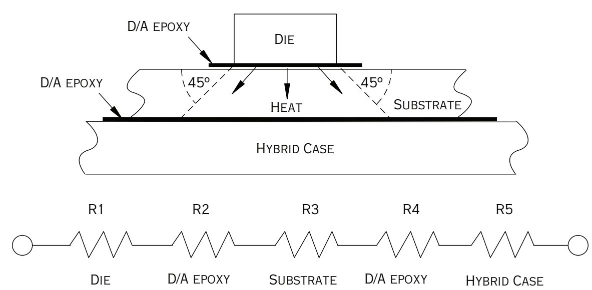
Thermal Characteristics

The heat transfer model in a hybrid package is described in figure 1.

Heat spreading occurs when heat flows into a material layer of increased cross-sectional area. It is adequate to assume that spreading occurs at a 45° angle.

The total thermal resistance is calculated by summing the thermal resistances of each material in the thermal path between the device and hybrid case.

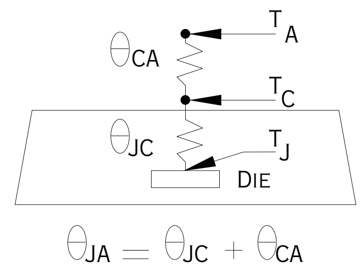
$$RT = R1 + R2 + R3 + R4 + R5$$



(Figure 1)

The total thermal resistance RT (see figure 2) between the heat source (die) to the hybrid case is the Theta Junction to Case (Theta JC) in°C/W.

- Theta junction to case (Theta JC) for this product is 30°C/W.
- Theta case to ambient (Theta CA) for this part is 100°C/W.
- Theta Junction to ambient (Theta JA) is 130°C/W.



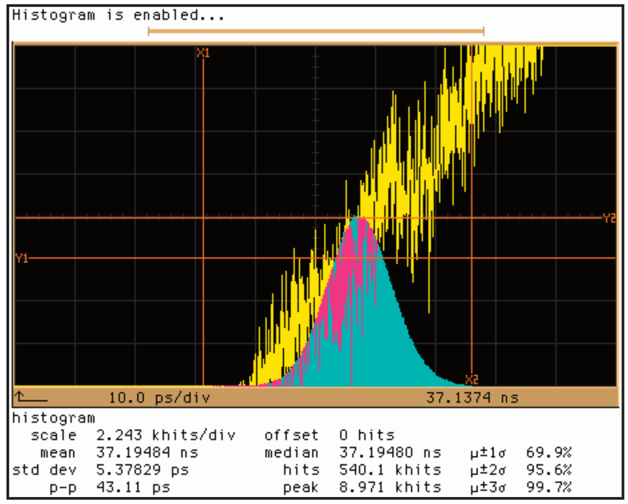
(Figure 2)

Maximum power dissipation PD for this package at 25°C is:

- PD(max) = (TJ (max) – TA)/Theta JA
- With TJ = 175°C (Maximum junction temperature of die)
- PD(max) = (175 – 25)/130 = 1.15W

Period Jitter

As data rates increase, effects of jitter become critical with its budgets tighter. Jitter is the deviation of a timing event of a signal from its ideal position. Jitter is complex and is composed of both random and deterministic jitter components. Random jitter (RJ) is theoretically unbounded and Gaussian in distribution. Deterministic jitter (DJ) is bounded and does not follow any predictable distribution. DJ is also referred to as systematic jitter. A technique to measure period jitter (RMS) one standard deviation (1σ) and peak-to-peak jitter in time domain is to use a high sampling rate (>8G samples/s) digitizing oscilloscope. Figure shows an example of peak-to-peak jitter and RMS jitter (1σ) of a QTX78AC-24MHz, at 5.0Vdc.



RMS jitter (1σ): 5.37ps Peak-to-peak jitter: 43ps

Phase Noise and Phase Jitter Integration

Phase noise is measured in the frequency domain, and is expressed as a ratio of signal power to noise power measured in a 1Hz bandwidth at an offset frequency from the carrier, e.g. 10Hz, 100Hz, 1kHz, 10kHz, 100kHz, etc. Phase noise measurement is made with an Agilent E5052A Signal Source Analyzer (SSA) with built-in outstanding low-noise DC power supply source. The DC source is floated from the ground and isolated from external noise to ensure accuracy and repeatability.

In order to determine the total noise power over a certain frequency range (bandwidth), the time domain must be analyzed in the frequency domain, and then reconstructed in the time domain into an rms value with the unwanted frequencies excluded. This may be done by converting L(f) back to Sφ(f) over the bandwidth of interest, integrating and performing some calculations.

Symbol	Definition
$\int \mathcal{L}(f)$	Integrated single side band phase noise (dBc)
$S\varphi(f)=(180/\Pi) \times \sqrt{2 \int \mathcal{L}(f)df}$	Spectral density of phase modulation, also known as RMS phase error (in degrees)
RMS jitter = $S\varphi(f)/(\text{fosc}.360°)$	Jitter(in seconds) due to phase noise. Note Sφ (f) in degrees.

The value of RMS jitter over the bandwidth of interest, e.g. 10kHz to 20MHz, 10Hz to 20MHz, represents 1 standard deviation of phase jitter contributed by the noise in that defined bandwidth.

Figure below shows a typical Phase Noise/Phase jitter of a QTX78AC6, 5.0Vdc, 80MHz clock at offset frequencies 10Hz to 5MHz, and phase jitter integrated over the bandwidth of 12kHz to 1MHz.