Q-TECH
CORPORATION

SINE WAVE SOURCES

DUAL-IN-LINE CRYSTAL CLOCK OSCILLATORS

5.0 to 15Vdc - 10Hz to 450MHz

Description

The Q-Tech Sine Wave Sources encompasses state-of-the-art sinewave source with low harmonic distortion and a precise sinewave output.

A flexible design allows Q-Tech Corporation to offer a variety of choices of output power and load. Based on this flexibility, Q-Tech welcomes specifications with parameters other than standard. An external trimming capacitor option is available for applications that require a tight frequency stability.

The AT-Cut crystal utilized in the design allows for high stability for a particular temperature range extending from -55ºC to +125ºC. For more information, please refer to the stability vs. temperature on the following page.

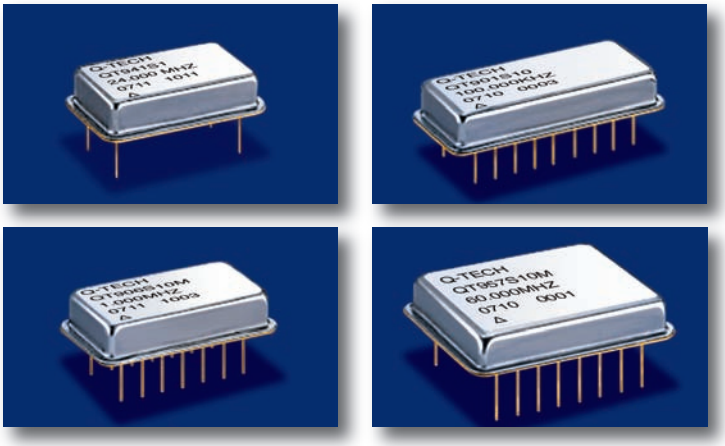
The reliable construction of these sinewave oscillators qualifies them for more stringent environmental applications. Military screening per MIL-PRF-55310, Level B is available as an option.

Features

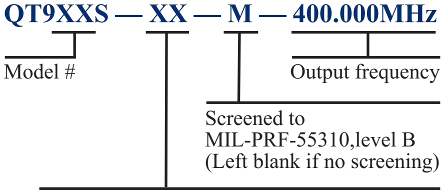
- Made in the USA
- ECCN: EAR99
- DFARS 252-225-7014 Compliant: Electronic Component exception
- USML Registration # M17677
- Available in both DIP and Double DIP packages
- Supply voltages 5Vdc and 15Vdc
- Broad frequency range from 10Hz to 450MHz
- AT-Cut crystal
- Low Total Harmonic Distortion
- Choice of output power and load
- All metal and hermetically sealed packages
- Low phase noise
- External tuning capacitor option
- Fundamental and third overtone designs
- Analog multiplier for frequency ≥ 200MHz
- Tristate option
- Custom design available tailors to meet customer's needs
- Q-Tech does not use pure lead or pure tin in its products
- RoHS compliant

Applications

- Designed to meet today's requirements for communication systems.
- Wide military clock applications
- Control and measurement
- Signal processing



Ordering Information



1	=	± 100ppm	at	0ºC	to	+70ºC
3**	=	± 5ppm	at	0ºC	to	+50ºC
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

(**) Require an external capacitor

For custom load, supply voltage, output power, harmonic distortion, frequency stability vs. temperature, and others not listed herein, please request a custom part number.

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

Package Information

Lead material: Kovar
Lead finish:
- Gold Plated: 50µ ~ 80µ inches
- Nickel Underplate: 100µ ~ 250µ inches

Package to Lid Attachment

- Standard packaging in black foam

Packaging Options

- Standard packaging in black foam
- Optional anti-static plastic tube

Other Options Available For An Additional Charge

- Lead forming available on all packages. Please contact for details.
- Solder Dip Sn/Pb 60/40%
- P. I. N. D. test
- Lead trimming
- Phase Noise test (Static and under vibration)
- Jitter test

All DIP packages are available in surface mount form.

Specifications subject to change without prior notice.

Electrical Characteristics

Parameters	QT901S	QT906S	QT941S	QT957S
Output freq. range (Fo)	**10Hz — 1MHz (*)**	**1MHz — 85MHz (**)**		**10Hz — 450MHz (*)**
Supply voltage (Vdd)	+15Vdc ± 5%	+5Vdc ± 10%		
Frequency stability (ΔF/ΔT)	See Option codes			
Operating temp. (Topr)	See Option codes			
Storage temp. (Tsto)	-62ºC to + 125ºC			
Operating supply current (Idd)	**20mA max.**	**40mA max.** 20mA typ. at 25MHz 30mA typ. at 50MHz		**60mA max.** 40mA typ. at 175MHz
Output amplitude or power	**1V RMS min.** 2V RMS typ.	**0dBm min.** +5dBm typ.		**1V p-p min. for Fo < 1MHz** **0dBm min. for F ≥1MHz**
Output Load	**1kΩ**	**50Ω** Internally AC coupled		**1kΩ for Fo < 1MHz** **50Ω for Fo ≥ 1MHz**
Total Harmonic Distortion (THD) or harmonics	5% max.	-20dBc max.		
Sub-harmonics	-30dBc max.			
Start-up time	10ms max.			
Phase Noise at 25ºC (typ.) at:	10Hz		-70dBc/Hz	
	100Hz		-100dBc/Hz	
	1kHz		-125dBc/Hz	
	10kHz		-140dBc/Hz	
	100kHz		-145dBc/Hz	
Integrated Phase Jitter RMS (12kHz to 20MHz) typ.	1ps			
Aging (at 70ºC)	± 5ppm max. first year / ± 2ppm typ. per year thereafter			

(*) Frequencies less than 500Hz require an external 1µF AC coupling capacitor at the output pin.
(**) Higher frequencies are available with a Q-Tech custom part number.

Other Design and Test Options

Sine Wave options are available with a Q-Tech MCM part number:

- Supply voltage +5Vdc to +18Vdc
- Output power -10dBm to +13dBm into 50Ω (see note 1)
- Harmonics better than -20dBc (see note 2)
- Sub-harmonics better than -30dBc (see note 3)
- Amplitude stability versus temperature to within ±1% (see note 4)
- VCXO Sine Output (see details in VCXO data sheets)
- Phase Noise and Jitter built to specification including static and vibration.
- Low supply current
- QCI tests
- Tight frequency stability versus temperature, supply voltage, and load variations
- Low g-sensitivity and low phase noise
- Low spurious (see note 5)
- Low Harmonic Distortion (THD < 5%)
- Low frequency aging, Allan Variance
- High-shock resistant

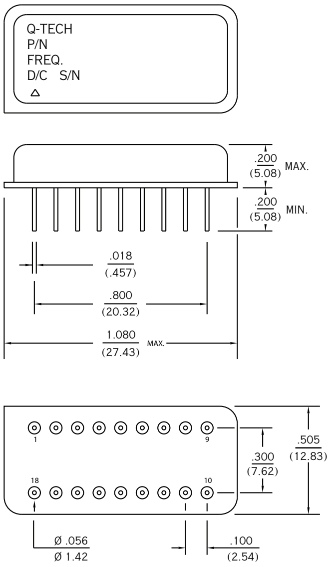
Notes:

1. The output level is determined by the supply voltage, load, and package size.
2. A specified harmonic level of -20dBc is easily achievable. The typical harmonics of Q-Tech Sine Wave source are better than -25dBc.
3. Sub-harmonic level is determined by frequency multiplication method, supply voltage, output power, and input current.
4. Typical amplitude stability over temperature is ±10% or less.
5. Typical spurious level is better than -60dBc over the spectrum of 100kHz to 1GHz.

Package Configuration Versus Pin Connections

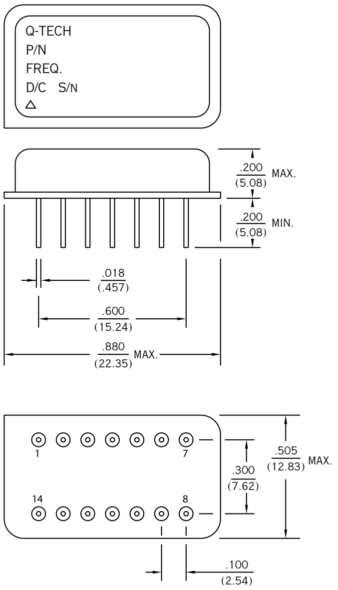
A

QT901S



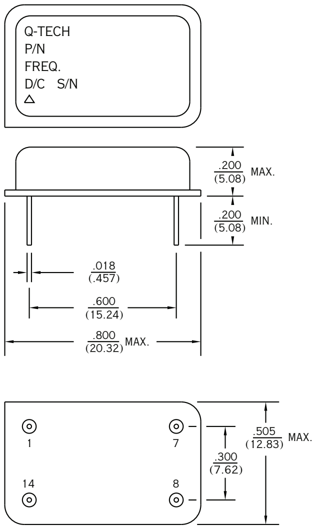
B

QT906S



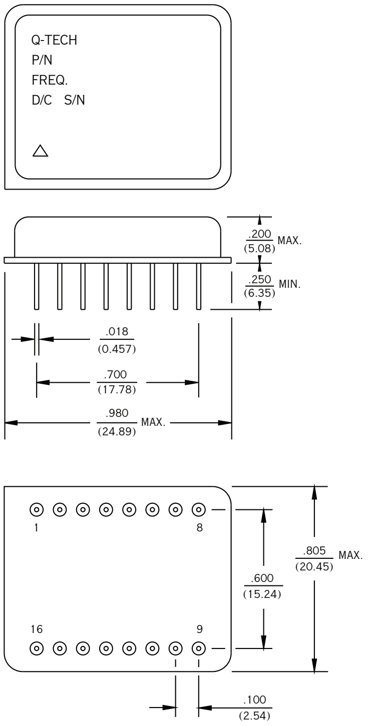
C

QT941S



D

QT957S

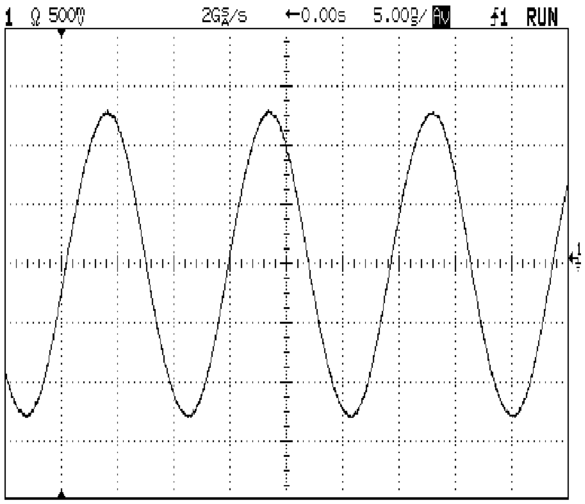


QT #	Conf	Vcc	GND	Case	Output	Equivalent MIL-PRF-55310 Configuration
QT901S	A	18	9	9	10	N/A
QT906S	B	14	7	7	8	N/A
QT941S	C	14	7	7	8	N/A
QT957S	D	16	8	8	9	N/A

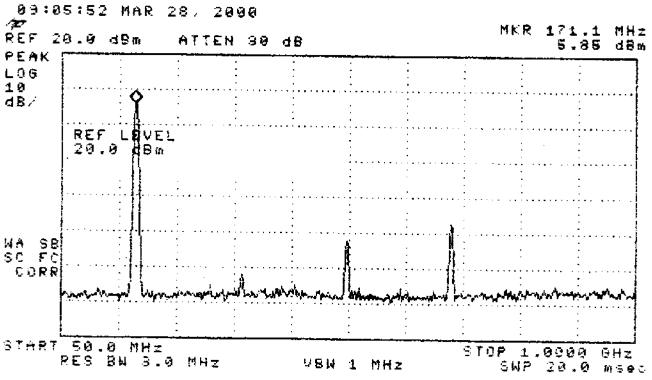
Please contact factory for pin connections on external capacitor (code 3).

Dimensions are in inches (mm)

Output Waveform into 50Ω load

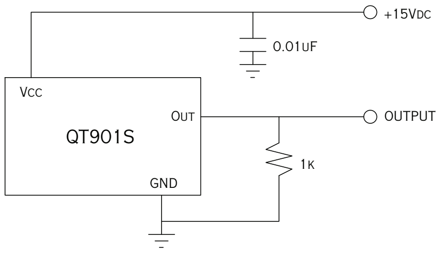


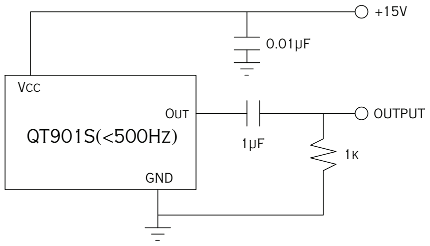
Typical output amplitude of QT957S-69.4MHz

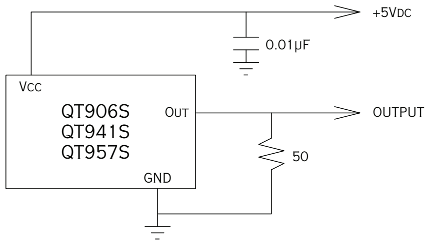


Typical spectrum output power and harmonics of QT957S-171MHz

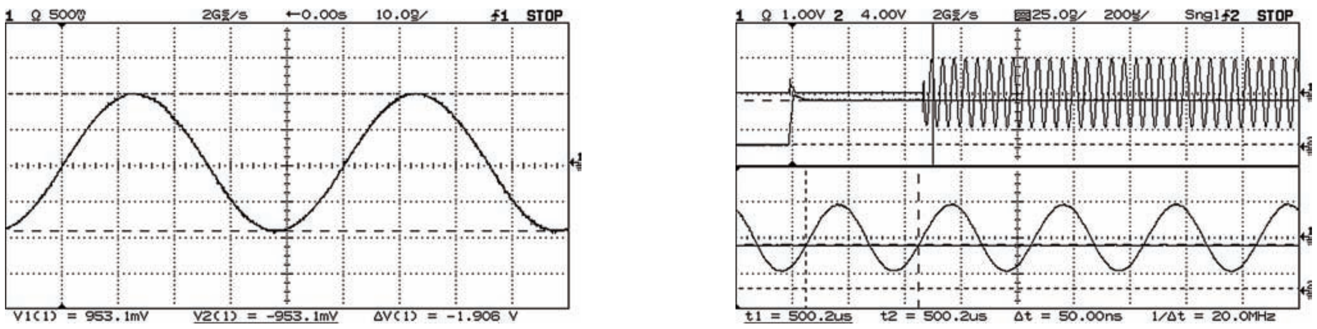
Test Circuit







Startup Time



Typical output amplitude and start-up time of QT957S-20.0166MHz

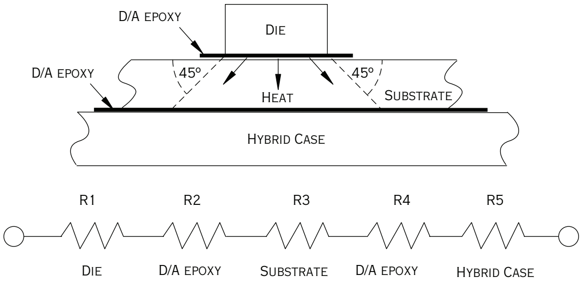
Thermal Characteristics

The heat transfer model in a hybrid package is described in figure 1 (Based on single ASIC design).

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.

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



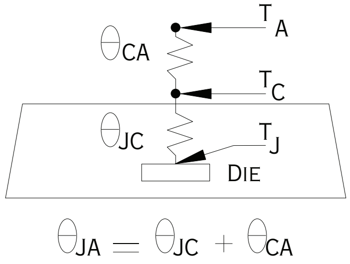
(Figure 1)

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 24°C/W.
- Theta case to ambient (Theta CA) for this part is 106°C/W.
- Theta Junction to ambient (Theta JA) is 130°C/W.

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



(Figure 2)

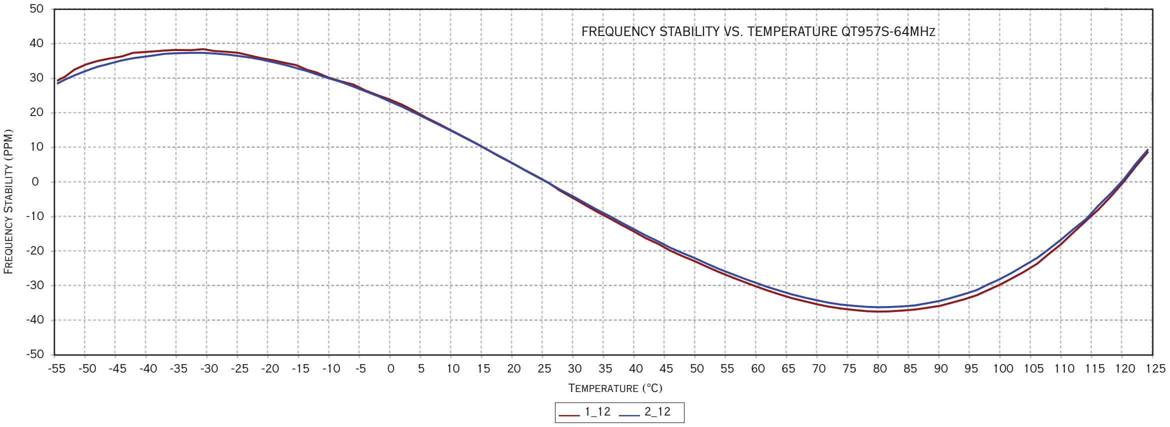
Environmental Specifications

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

Environmental Test	Test Conditions
Temperature cycling	MIL-STD-883, Method 1010, Cond. B
Constant acceleration	MIL-STD-883, Method 2001, Cond. A, Y1
Seal Fine Leak	MIL-STD-883, Method 1014, Cond. A
Burn-in	160 hours, 125°C with load
Aging	30 days, 70°C
Vibration sinusoidal	MIL-STD-202, Method 204, Cond. D
Shock, non operating	MIL-STD-202, Method 213, Cond. I
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. C
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

Please contact Q-Tech for higher shock requirements

Frequency vs. Temperature Curve



Phase Noise and Phase Jitter Integration

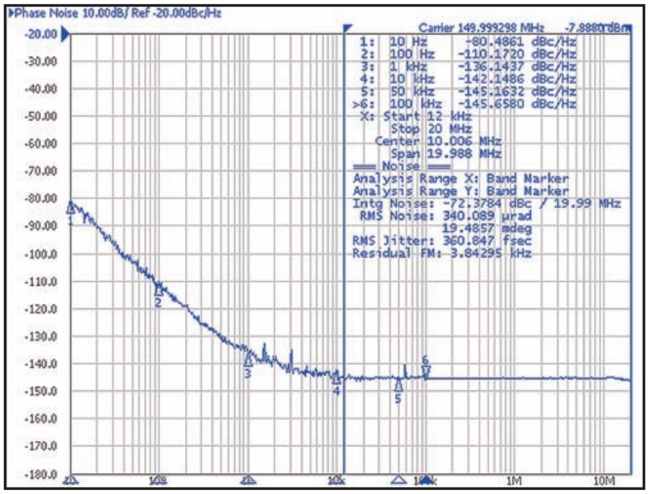
Phase noise is measured in the frequency domain, and is expressed as a ratio of signal power to noise power measured in a 1Hz bandwidth at an offset frequency from the carrier, e.g. 10Hz, 100Hz, 1kHz, 10kHz, 100kHz, etc. Phase noise measurement is made with an Agilent E5052A Signal Source Analyzer (SSA) 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
$\int L(f)$	Integrated single side band phase noise (dBc)
$S\varphi\ (f)=(180/\Pi)\text{x}\sqrt{2\int L(f)df}$	Spectral density of phase modulation, also known as RMS phase error (in degrees
RMS jitter = Sφ (f)/(fosc.360°)	Jitter(in seconds) due to phase noise. Note Sφ (f) in degrees.

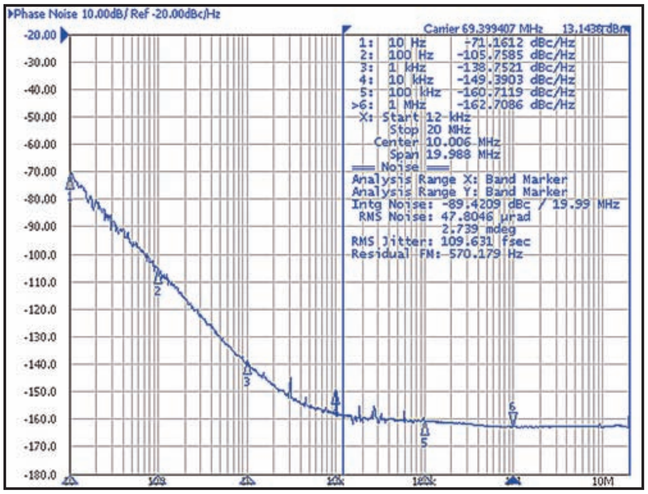
The value of RMS jitter over the bandwidth of interest, e.g. 10kHz to 20MHz, 10Hz to 20MHz, represents 1 standard deviation of phase jitter contributed by the noise in that defined bandwidth.

Figure below shows a typical Phase Noise/Phase jitter of a QT957S, +5Vdc, 150MHz and QT957S8M, +5Vdc, 69.4MHz clock at offset frequencies 10Hz to 10MHz, and phase jitter integrated over the bandwidth of 12kHz to 1MHz.



```
Carrier 149.999298 MHz   -7.8880 dBm
 1:  10 Hz     -80.4861 dBc/Hz
 2:  100 Hz   -110.1720 dBc/Hz
 3:  1 kHz    -136.1437 dBc/Hz
 4:  10 kHz   -142.1486 dBc/Hz
 5:  50 kHz   -145.1632 dBc/Hz
>6:  100 kHz  -145.6580 dBc/Hz
 X: Start 12 kHz
     Stop 20 MHz
   Center 10.006 MHz
     Span 19.988 MHz
=== Noise ===
Analysis Range X: Band Marker
Analysis Range Y: Band Marker
Intg Noise: -72.3784 dBc / 19.99 MHz
 RMS Noise: 340.089 µrad
            19.4857 mdeg
RMS Jitter: 360.847 fsec
Residual FM: 3.84295 kHz
```

QT957S, +5Vdc, 150MHz



```
Carrier 69.399407 MHz   13.1436 dBm
 1:  10 Hz     -71.1612 dBc/Hz
 2:  100 Hz   -105.7585 dBc/Hz
 3:  1 kHz    -138.7521 dBc/Hz
 4:  10 kHz   -149.3903 dBc/Hz
 5:  100 kHz  -160.7119 dBc/Hz
>6:  1 MHz    -162.7086 dBc/Hz
 X: Start 12 kHz
     Stop 20 MHz
   Center 10.006 MHz
     Span 19.988 MHz
=== Noise ===
Analysis Range X: Band Marker
Analysis Range Y: Band Marker
Intg Noise: -89.4209 dBc / 19.99 MHz
 RMS Noise: 47.8046 µrad
            2.739 mdeg
RMS Jitter: 109.631 fsec
Residual FM: 570.179 Hz
```

QT957S8M, 5.0Vdc, 69.4 MHz