1. Drive Level

Drive level denotes electric power required to oscillate a quartz crystal, which can be calculated in the following formula:

\[ \text{Drive Level (P)} = I^2 Re \]

Where \( I \) stands for current to pass in the quartz crystal, \( Re \) for effective resistance of quartz crystal and \( Re = R \left( 1 + \frac{C_o}{CL} \right)^2 \). If the Drive level (P) exceeds the specified level, oscillation frequency will shift. This occurs because an excessive level power causes stress for the crystal and consequent temperature rise. If excessive Drive level of power is applied to the quartz crystal oscillator, this may deteriorate or damage the characteristics.

3. Load Capacitance

Differences in the load capacitance of the oscillation circuit may result in different oscillation frequency from the desired one as shown in figure 3. Approximate expression of the load capacitance circuit:

\[ CL = (C_o + C_d)/(C_L + C_o) + C_s \]

Where \( C_s \) stands for stray capacitance of the circuit.

Example of Frequency-Load Capacitance Characteristics

C-Type, C-2-Type, MC=405/406 CA-301, MA-505/506 (Fundamental)

2. Allowance for Oscillation

Unless adequate negative resistance is allocated in the oscillation circuits, start-up time of oscillation may be increased, or no oscillation may occur. In order to avoid this, provide enough negative resistance in the circuitry design.

How to check for oscillation

1. Connect the resistance (R) to the circuit in the series with the quartz crystal.
2. Adjust R so that oscillation can start (or stop).
3. Measure R when oscillation just starts (or stops) in above (2).
4. Get the negative resistance: \( -R = R + C_L \) value.

Reference for Setting Parameters of Oscillation Circuit

<table>
<thead>
<tr>
<th>Model</th>
<th>Symbol</th>
<th>Frequency Range</th>
<th>( R1(M\Omega) )</th>
<th>( RD(\Omega) )</th>
<th>( CG(pF) )</th>
<th>( CD(pF) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/C2 Type</td>
<td>20 to 60kHz</td>
<td>20</td>
<td>500</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>MC405/406</td>
<td>60 to 165kHz</td>
<td>10</td>
<td>300</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>CA301, MA505/506</td>
<td>5.5 to 24MHz</td>
<td>1</td>
<td>0.5</td>
<td>5 to 15</td>
<td>5 to 15</td>
<td></td>
</tr>
</tbody>
</table>

Inverter: Equivalent to TC74HC04P
5. Timing Chart

Output waveform

* Duty (%) = TON/T x 100

6. Test circuit

1. C-MOS Load
2. TTL Load
3. Current Consumption

7. Test Conditions

1. Supply voltage
   • More than 1ms until voltage levels reaches 4.5V from 0V
   • Supply voltage impedance is more than approximate 2Ω resistance.

2. Oscilloscope
   • Impedance more than 1MΩ
   • Input capacitance less than 15pF
   • Frequency range more than 100MHz (around 300-400MHz)
   • Earth lead of the probe should be as short as possible.

3. Others
   • Probe impedance when measuring frequency is to be more than 1MΩ. Simultaneous measurement of waveform (frequency and waveform) is not possible as the waveform passes from the amplifier stage of an oscilloscope.
   • CL includes the probe capacitance.
   • Earth should be grounded at a point.
   • Ammeter with small internal impedance should be used.