Technical Note

Testing Capabilities at INFICON EDC

Crystal Testing During Manufacturing

At INFICON, we manufacture each crystal to the highest standards of quality assurance, beginning with the raw quartz and continuing through to the final packaged products. This includes cleanroom manufacturing and the testing of each crystal. One hundred percent of the crystals produced undergo a thorough testing regiment to ensure the highest quality and reliability under the following criteria:

- Resistance: checked to assure measurement stability and longer coating life
- Frequency: verified before and after the application of electrodes to ensure an accurate thickness measurement
- Visual conformity: inspected for electrode uniformity, surface flaws, and other imperfections which might indicate poor adhesion or contamination

In addition to 100% crystal testing, a percentage of crystals from each batch manufactured undergo an outgoing audit by the quality assurance department to guarantee that only highly reliable quartz crystals are shipped. This testing includes testing curvature to assure resonance stability.

Crystal Testing of Returned Crystals

If a crystal has not been deposited on, and has been returned for specification verification, INFICON EDC can test resistance, frequency, and visual conformity, as is done during the manufacturing of crystals.

Resistance and frequency are already specified for all of the part numbers included in the TF Crystal Catalog.

Additionally, INFICON is able to test for a multitude of electrical characteristics of each crystal, but there is no defined ranges or pass/fail criteria for these. Upon customer request, these values can be measured. See below for an example.

Reference Frequency: 5,985,000.000

Power: 15.00 µW into RR

PL: No Load

CL: 20.00 pF

Crystal	First Failure	DLD2	RLD2	FDLD2	SPDB	FR	FR	RR	C0	Q	C1	C0/C1	L	TS	PWR	SPFR
		Ohms	Ohms	ppm	dB	MHz	ppm	Ohms	pF	k	fF	NA	mH	ppm/ pF	uW	MHz
High Limit		0.8	13	0.8	-1.5	5.995	1,671	15	18	320	14	1,400	58	40	20	NA
Low Limit		0	5	0	-10	5.975	-1,671	0	13	150	1	1,000	53.5	20	5	NA
1	PASS	0.36	10.57	0.02	-4.52	5.978	-1,154	10.81	17	197	13	1,329	56.17	21.35	15.09	6.240
2	PASS	0.32	10.7	0.17	-4.17	5.978	-1,161	11.22	17	191	12	1,372	57.04	20.17	15.1	6.238
3	PASS	0.65	11.12	0.3	-1.95	5.981	-662	11.67	16	181	12	1,291	56.21	22.41	15.01	6.188
4	PASS	0.49	10.81	0.23	-4.37	5.981	-664	10.95	16	191	13	1,252	55.67	23.57	15.08	6.238
5	PASS	0.58	10.74	0.12	-4.67	5.980	-766	10.79	16	197	13	1,300	56.63	22.28	15.04	6.242

6	PASS	0.5	10.89	0.1	-2.09	5.980	-898	11.22	17	190	13	1,355	56.58	20.53	15.03	6.189
7	PASS	0.53	10.86	0.43	-1.83	5.981	-622	11.73	17	179	13	1,353	55.95	20.38	14.96	6.189
8	PASS	0.44	10.48	0.11	-4.25	5.980	-839	10.98	17	193	13	1,361	56.33	20.25	15.03	6.242
9	PASS	0.4	10.74	0	-4.65	5.983	-470	11.26	17	189	12	1,340	56.65	21.01	15.02	6.240
10	PASS	0.44	11.01	0.25	-2.12	5.978	-1,179	11.44	17	184	13	1,366	56.16	20.05	14.9	6.186

The data above is detailed electrical performance data.

DLD2 (ohms)	Drive Level Dependency 2	The difference between the maximum impedance and the minimum impedance obtained when driving the crystal at different powers.
RLD2 (ohms)	Drive Level Dependency	The maximum impedance measured in the specified varying power range.
FDLD2 (ppm)	N/A	Under different driving powers, the difference between F_{max} and F_{min}.
SPDB (dB)	Spur	The resistance of the largest spurious resonant frequency over a specified frequency range with respect to the main mode.
FR (Hz)	Resonant frequency	N/A
FR (ppm)	N/A	The resonant frequency shift difference between consecutive iterations.
RR (ohms)	Resonant resistance	The residual impedance at the resonant frequency.
C0 (pF)	Shunt capacitance	N/A
Q (k)	Resonator	N/A
C1 (fF)	Motional capacitance	N/A
C0/C1	N/A	The ratio of the shunt capacitance to the motional capacitance.
L (mH)	Motional inductance	N/A
TS (ppm/ pF)	Trim sensitivity	A measure of the incremental fractional frequency change for an incremental change in the value of load capacitance.
PWR (uW)	Power	N/A
SPFR (Hz)	Spurious frequency response	The frequency of the minimum resistance spur.

Some of these crystal parameter values are not fixed, and most of them will change with temperature, frequency, load capacitance, and excitation power. Each parameter is different and whether a higher or lower value is better depends on the customer application and the associated equipment dependencies.

The parameter limits above were determined based on a customer request and not set by INFICON. Most of the parameters above have pass/fail criteria. This means the customer will not see a difference in their application whether the crystal is on the high or low end of the associated range. If the customer has specific parameters and limits that are important to their application, inform your service representative so that a crystal tailored to their need can be designed or recommended.

All testing is currently performed at INFICON EDC, which has the knowledge, equipment, and processes for testing.

Used Crystal Testing

With accurate and complete Safety Datasheets (SDS) for the material coated on the crystal, it is possible to complete limited analysis of used crystals when they are returned for testing.

Scanning the used (or deposited-on) crystal with a Zygo® profilometer allows an analysis of the uniformity of the deposition. It can be determined if the deposited material and crystal were influenced by any of the following:

- uneven material deposition
- obstruction (shutter, chopper, mask, etc.)
- poor material adhesion

Testing Limitations

INFICON has limited test capabilities outside of testing for the previously mentioned specifications or deposition anomalies.

The behavior of a crystal is often influenced by other attributes of the system. One example is the electrical connectivity at any point between the crystal and the monitor and controller. This includes e-beam arcing, electrical interference, and poor connection or contact points. The crystal behavior can also be influenced by process parameters, such as the process temperature, the distance between the sensor and the source, the pressure, the source type, and the material. INFICON EDC will not be able to replicate the exact conditions under which a problem occurred. It is highly recommended that on-site or system-wide troubleshooting be employed prior to sending a crystal in for investigation.