GEN3 Precision as Standard

**Article**
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# GEN3 Reminds us that Engineering Reliability means Credibility

**Remember Remember the 5th of December. That's not accurate is it? And the one thing engineering predicts is accuracy! However, for many around the world, the 5th of December marks 'World Engineering Day.'**

By Andy Naisbitt, Operations Director at GEN3


GEN3 has been engineering and refining the CM series Contaminometer tester for over 40 years. Like all measurement systems, the difficulty is in what we are trying to measure, for example light is measured by how many candles produce a level of luminosity (Candela), but what if the measurement needs to identify a potential impact on a process or product reliability? In the car industry, you cannot paint metal when the surface Dew Point is closer than 3°C to the ambient air temperature, now this measurement is critical to the process finish, as the paint won't adhere well due to an invisible layer of moisture on the surface. The measurement is performed with a dew point meter that ensures the metal surfaces are above 3°C of the dew point prior to painting.

The GEN3 CM Series Contaminometer measures the conductivity for an equivalent weight of salt within a square centimetre of the circuit card to measure the effectiveness of your cleaning process for removing ionic contamination from your card.

## Why measure

The closer pitch devices used in modern manufacture (0.3mm or less) increases the electric field ($E = V/d$), which makes the electrochemical corrosion cell potential more likely during local condensation under humid environments.

The average size of dew droplet formation on surfaces at different temperatures varies from 20–50 µm at about 50% RH, to large droplets of water at >60%RH, add in the natural capillary action under low profile components with stand-off heights of 25µm, and water bridge shorts become a reality.


*One table salt crystal weighs about 60µg.*
*This one tiny 60µg crystal, spread thinly enough across a small card surface would be enough to fail the early standards like MIL-P-28809 >1.56µg/cm² or >6.45µg/inch².*

This describes the problem, even invisible amounts of salt (or salt equivalent) left on the board can present conditions suitable for electrochemical corrosion.

Although we understand that the salt, we are measuring may not be Sodium Chloride (baseline value), there are various known conversion factors that allow you to convert the baseline values for common PCBA contaminants.

*(Table 1. Ref: Colin Lee Scientific Guide to Surface Mount Technology)*

| Common PCBA Contaminants Reference to Sodium Chloride | Equivalent Value |
|---|---|
| *Carbonic acid* | 0.16 |
| *Hydrochloric acid* | 0.18 |
| *Sulphuric acid* | 0.24 |
| *Malonic acid* | 0.27 |
| *Succinic acid* | 0.31 |
| *Calcium Hydroxide* | 0.31 |
| *Sodium Hydroxide* | 0.35 |
| *Propionic acid* | 0.4 |
| *Ammonium Chloride* | 0.72 |
| *Calcium Chloride* | 0.88 |
| *Sodium Carbonate* | 0.96 |
| *Sodium Chloride* | 1 |
| *Potassium Chloride* | 1.02 |
| *Copper Chloride* | 1.12 |
| *Sodium Succinate* | 1.16 |
| *Copper sulphate* | 1.28 |

***Table 1.***

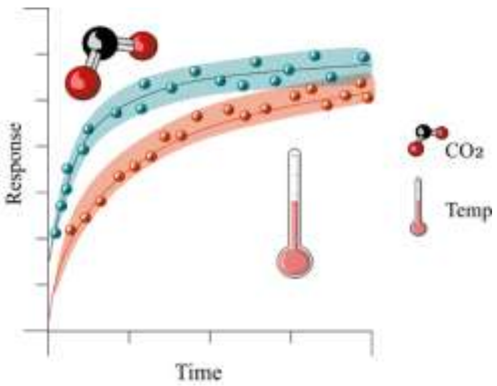
*Example from Table 1.*

If there is a reading measurement of 1µgNaCl/cm² (Salt), but we believe the contaminant to be Carbonic Acid residues ($H_2CO_3$), the equivalent concentration for Carbonic acid shown in Table 1 would be 0.16µg$H_2CO_3$ /cm², showing that a smaller amount of Carbonic Acid is more corrosive.

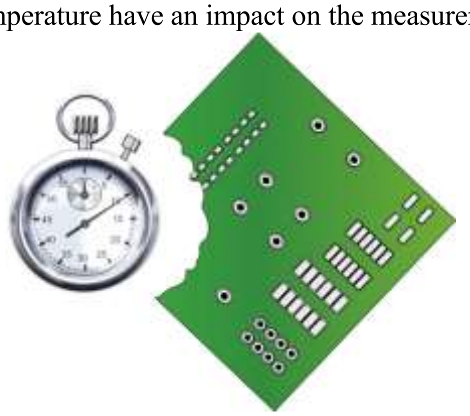
*The smaller amount 0.16µg$H_2CO_3$ required to produce the same reading as 1µgNaCl (Salt).*

Measurements need to be accurate and repeatable; we have the base line (Salt NaCl), but how do we measure accurately with such small trace amounts and do it repeatedly to achieve a Gage R&R <10?

- Variables that require tight controls to measure such minute quantities
- Calibrated solution (Polished to >8MΩ purest level of DI Water Type I)
- Temperature compensation required due to the sensitivity of the measurement to small changes of solution temperature
- Flow rate as fast as practical, but not so fast it generates turbulence/bubbles
- Measurement time <3 mins, longer dwell times can dissolve key components from the laminate
- Measurement accuracy 0.005µgNaCl/cm² required to achieve accuracy (6 sigma) and repeatability (Gage R&R <10)
  CO² compensation algorithm, however keeping low turbulence is essential, no amount of compensation algorithms can account for bubble generated CO²




The issue with such sensitive measurement is that variables like subtle changes in solution temperature have an impact on the measurement, exposure to air even in the small cavity between the lid and the solution can impact the final readings, more so if high turbulence is experienced which traps air in the solution and rapidly dissolves CO², the solution sounds simple, run the test as fast as possible, however, too fast and you generate bubbles, this impacts the readings as the measurement cell is measuring air (bubbles) not solution conductivity, however too slow means extended time in the tank, we know that water absorption into the laminate is enhanced by residues on the surface, and multiple reflows. The test solution has a low dyne value and therefor easily wets the board.



*The test solution is quite aggressive and extended time in the solution can penetrate deep into the laminate dissolving key components from the board.*

Recent studies have shown that solder mask enhances the moisture uptake by four times that of the laminate, which correlates to a study by the European Space Agency, that found that extended exposure in the IPA/DI water solution led to leaching the Bromide Flame retardant out of the laminate through the solder mask onto the board surface, severely degrading the material properties of the PCB.

GEN3 measuring accuracy down to ±0.005 µg/cm².

The analysis of solution with trace levels of ionic matter requires the precision of a solid gold conductivity measurement cell, within a solid-state measuring cell, and connected to a ballistic amplifier, this and a powerful pump, allows smooth flow throughout the operation, giving a 6 sigma repeatable measuring accuracy down to ±0.005 µg/cm².

## About GEN3

GEN3. Testing and measuring the electronics industry for over 40 years. For three generations, Gen3 have designed, engineered, manufactured, and distributed their test and measurement equipment into the electronics industry to shield their clients from failure in the field.

Their reputation for excellence has grown to a global scale. The team is made up of industry experts who work to set the standards around circuit testing, measurement, and compliance. They collaborate with key industry associations, offering our unique experience and expertise to educate all on what it takes to succeed. For product protection the preferred way is GEN3, where precision comes as standard, acting as a mentor and your front-line defender.

In the high-reliability arena, there is too much at stake to allow room for error. Testing must be finite and flawless. GEN3 understand the need for precision. Get closer to perfection by minimising your risk.

**GEN3. Precision as Standard.**

For more information, please visit our various platforms;

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