

Long Term Stability of DataTrace Micropack III Temperature Data Loggers

Abstract

The Micropack III DataTrace system from Mesa Laboratories was found to provide highly accurate temperature measurements for up to one year and longer. By analyzing routine recertification data collected in Mesa's calibration laboratory it was demonstrated that 70% of the temperature data loggers maintained their published accuracy specification of $\pm 0.1^{\circ}\text{C}$ for one year or more, and 99% of the loggers were within $\pm 0.5^{\circ}\text{C}$ over this same time frame. Based on these data, it is recommended that the Micropack III data loggers are returned to Mesa for recalibration at 12 month intervals. This inherent stability, coupled with their small size, makes the Micropack III system ideally suited for quality control, validation, and process development applications in food, pharmaceutical, and medical device manufacturing.

DataTrace System

The DataTrace Micropack III system is a highly accurate, precision, wireless data logging instrument for the measurement and recording of temperature, pressure, humidity and other parametric data. Each Micropack III data logger, or "Tracer", is small enough to be placed extremely close to, or actually inside, the product being measured, to deliver extremely accurate measurements throughout the process. They are among the smallest devices of their kind on the market today.



Besides providing data loggers, Mesa operates a state-of-the-art calibration laboratory to ensure the utmost accuracy of its Tracers. After assembly, the temperature Tracers are calibrated against an NIST traceable temperature standard at 17 different points between -20°C and 140°C . In addition, Tracers returned for repair or for routine recertification are subjected to the same rigorous calibration process. Since introduction of the Micropack III system in 2002, Mesa Laboratories has performed thousands of calibrations on temperature Tracers and these data can be highly informative in regards to their long term stability.

Sampling Method

All data from Mesa's calibration laboratory is stored in a secure database, providing a complete history on the performance of every temperature Tracer, from the point of manufacture, all the way through subsequent recalibrations performed as a part of a repair or a routine recertification. This calibration data was examined to gain insight into the long term stability of the Micropack III Temperature Tracers.

When a Tracer is returned to Mesa's laboratory it is often checked for calibration accuracy prior to any repair or recertification. This "As Received Report" is highly indicative of the long term stability of the Tracer and a typical example is illustrated below. In the case of this particular temperature Tracer, it had been in use for 1 year in the customer's laboratory following its initial calibration. The report below illustrates the performance of the Tracer as it was received in Mesa's laboratory prior to any recalibration. As can be seen from the report, even though the

Tracer had been in use for one year, it was still well within its specified temperature accuracy of +/- 0.1°C at every point between -20°C and 140°C.

AS RECEIVED CERTIFICATE



SUBMITTED BY: **Company X**

SERIAL NUMBER: M3Txxxxx

PART NUMBER: 127523-505

MODEL: 7500T1

RANGE: -20 TO +140 DEGREES C

INSTRUMENT TYPE: MPIII - TEMP 1" TAPER TIP - THERMISTOR

RESULTS OF TEST

M3Txxxxx READING °C	REFERENCE ITS - 90 °C	DIFFERENCE °C
-19.981	-19.938	-0.043
-9.962	-9.942	-0.020
0.011	0.024	-0.013
9.998	10.004	-0.006
19.981	19.994	-0.013
29.957	29.969	-0.012
39.973	39.975	-0.002
49.935	49.943	-0.008
59.918	59.923	-0.005
69.888	69.895	-0.007
79.918	79.920	-0.002
89.894	89.899	-0.005
99.890	99.894	-0.004
109.888	109.892	-0.004
120.871	120.875	-0.004
129.847	129.851	-0.004
139.863	139.869	-0.006

Uncertainty of Measurement = ± 0.025 °C

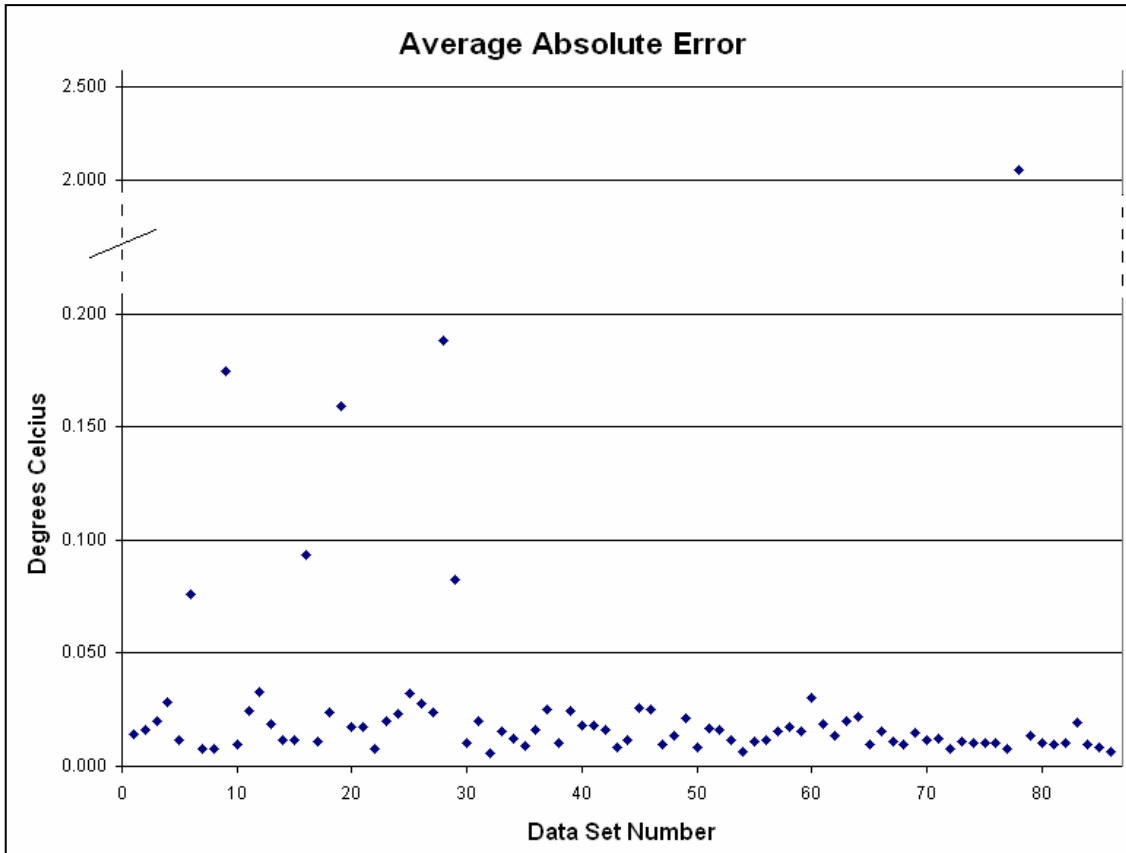
To determine if this degree of stability is typical of all Micropack III temperature Tracers, a random selection of calibration data was extracted and analyzed from Mesa's database according to the following criteria:

- Only "As Received" data was utilized, prior to any repair or recalibration
- Only Tracers in use for more than 90 days since the latest calibration were examined
- Data was included for only those Tracers returned for routine recertification
- Only Tracers using thermistor measurement technology were included

A total of 86 data sets were examined on 73 individual Tracers (some Tracers had been returned for recertification more than once). The median length of time since the latest calibration was 370 days, with an average of 353 days. The actual process temperatures, pressures and specific environments experienced by these Tracers are unknown. These 86 data sets represented 1462 individual temperature measurements.

Results and Discussion

Illustrated in the graph below is the average error for each data set in the study over the 17 different temperatures measured during a standard calibration. Of these 86 data sets randomly selected from Mesa's calibration database, only 1 was significantly out of calibration, with an average error over the 17 temperatures of $\sim 2^{\circ}\text{C}$. The other 85 data set had average errors of $<0.2^{\circ}\text{C}$. This degree of accuracy is noteworthy considering that these Tracers had been in use for an average of approximately 1 year since the latest calibration.



A Tracer is considered to be within its stated accuracy specification if all 17 measurement points are within +/- 0.1°C of the true temperature. The majority of the Tracers were still within this +/- 0.1°C accuracy specification when received at Mesa's calibration laboratory. Only 26 of the 86 Tracers examined, or 30%, had any reading outside of the +/- 0.1°C specification. However, most applications of the DataTrace data loggers are within the temperature range of 10°C to 120°C. Within this more narrow range, there were only 16 of the 1032 individual measurements (1.5%) that were off by more than +/- 0.3°C. And, within the commonly used range of 10°C to 120°C, only 7 Tracers (8%) were found to have any reading outside the +/- 0.1°C specification. Only a single Tracer had any of its 17 temperature readings off by more than +/- 0.5°C. In the table below are statistics for the 1462 temperature measurements (86 data sets at 17 measurements, each) that were a part of this study.

Data for 86 "As Received Reports" on 73 Micropack III Temperature Tracers

Temp Range	Median Error	Average Error	Total Num. of Measurements
-20 - 0°C	0.025°C	0.098°C	258
10 - 120°C	0.010°C	0.033°C	1032
130 - 140°C	0.006°C	0.052°C	172
All Data -20 - 140°C	0.010°C	0.047°C	1462

The thermistor and RTD measurement technologies used in the DataTrace data loggers provide long-term stability. In this study, all the Tracers used thermistors that have a drift specification of <0.01°C over 10 months at 25°C and only 0.12°C, if held at a constant 100°C for 10 months. Due to the inherent stability of the temperature measurement technology used in the DataTrace products and based on experience in the calibration laboratory, only annual re-certifications are recommended, which is common industry practice for thermistor-based data loggers.

As is evident from the data presented here, the Micropack III data loggers provide highly accurate temperature measurements for many months following their calibration. In contrast, thermocouple-based temperature measurement devices are prone to drift problems and require frequent recalibration, often prior to and following every use. The inherent stability of the Micropack III Tracers, coupled with their small size, makes them ideally suited for quality control, validation, and process development applications in food, pharmaceutical, and medical device manufacturing.