

MTBF of 700-Series Platform and Surface Mount Tiltmeters

Tech Note

Background

We reviewed our repair records for all 700-Series Platform and Surface Mount Tiltmeters sold during an 11-year period between February 9, 1995 and February 8, 2006 to obtain an estimate of the mean time between failures (MTBF) for these instruments. These tiltmeters include all units with root model numbers between 701 and 716.

During this period 610 tiltmeters with these model numbers were sold. During the same period two units were repaired under warranty for failures caused by "infant mortality": both failures were discovered within the first hour of operation by the customer. Defective crimps on a sensor connector had broken in one unit. An integrated circuit had failed in the other.

A total of 16 other tiltmeters were returned and repaired during this same 11-year period. These 16 tiltmeters all failed because they were operated outside of their specified environmental or electrical range. For this reason, we did not incorporate them into our MTBF calculations. The problems included water damage in nonsubmersible units, failures from transient overvoltages, cables pulled from the tiltmeters by vandals, and even being run over by a taxicab during load testing of a bridge.

Our 700-Series tiltmeters are typically used for long-term monitoring and measurement, meaning that they are installed and operated on the same machine, volcano, earthwork or structure for many years. Our records indicate that about 75% are operated in this manner. The remainder are used for periodic testing and have operating times ranging from a few days to several weeks per year.

MTBF Calculation

Based on the dates of sale of the 610 tiltmeters sold in the February 9, 1995 to February 8, 2006 time period, these tiltmeters have been in the possession of our customers for a total of approximately 3202 unit-years, or 28,049,520 unit-hours.

Dividing 28,049,520 unit-hours by the two failures yields an MTBF value of 14,024,760 hours. If we more conservatively estimate an operating time (duty cycle) of 50%, the value is:

$$\text{MTBF} = (50\% \times 28,049,520 \text{ hours}) / 2 = 7,012,380 \text{ hours}$$