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To: Space Geodesy Project
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Subject: KPGO 12m Signal Chain Cryo-con Failure Analysis and Repair

Problem: The cryogenic monitoring sensor by Cryogenic Control Systems, Inc. (Cryo-con) is used in the Kokee Park Geophysical Observatory (KPGO) broadband VLBI signal chain frontend failed, and was shipped to MIT Haystack Observatory (MHO) for analysis and repair. The failure mode that triggered its shipping was that the system would not boot up after being power cycled. Other bugs noted that were associated with the unit include the network IPv4 address assigned to it had changed as well as intermittent communication from the monitoring software. **Failure Analysis:** Failure analysis of the device started with the visual inspection of the unit and by applying power to the system. The visual inspection of the system did not reveal any cold solder joints, cables disconnected, or other visible failures. Applying power to the system resulted in the same state reported by the team at KPGO with no visual display of power up.

The components of the McDonald Texas (MCD) VLBI cryogenic monitoring system were used to attempt to isolate the problems to hardware components, of which there were two. The LCD display was the first component swapped and, after power was applied, the system displayed self-test execution, initialization, and became operational. It was surmised that the display failure of the monitoring device was causing the firmware on the system to not reach a normal operating state. It was also noticed that the firmware version of the MCD sensor was newer than that of the system at KPGO. Therefore, to ensure proper operation, the Cryo-con sensor purchased for MCD was swapped for the system at KPGO. The system was repackaged and stress-testing of the system began. The stress tests were chosen to verify steady state operation and that the IP address bug and potential problems with communication to the device with the MCI software were resolved.

Stress Tests: The stress test setup for the system (Figure 1) utilized two resistors to emulate the sensors and the MCI software polling the monitoring system.

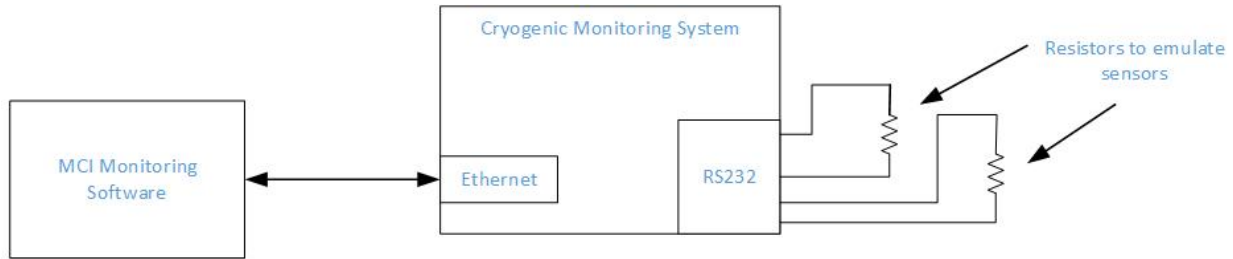


Figure 1 Cryogenic Monitoring System Stress Test

The stress tests completed on the system were:

1. With the monitoring system in an operational state, defined as being polled by MCI software, at random intervals power cycle the device, with power removed for various durations, and verify the system boots into a known state and the MCI software re-establishes communication with the device.
2. Remove power from the system during bootup and verify the system returns to previous programmed state.
3. Increase the MCI polling cycle from the standard once-per-minute to every once-per-20-seconds, and repeat test 1.

Stress Test Results

Test 1 was executed for 2 days with power off durations ranging between 1-5 minutes; no problems were detected. A power off of 25 minutes resulted in a communication failure that was isolated to the MCI software. Investigation into the problem resulted in the version of the software executing not being equivalent to that at KPGO. The software was updated and the test executed for an additional day with up to 1-hour power off duration; no problems were encountered.

After successfully completing Test 1, Test 2 was executed multiple times, in various states of bootup initialization; the system returned to a known state and the MCI software was fully operational.

As for Test 3, the polling cycle of the MCI software was increased to 20 secs, then Test 1 was executed for 3 days; the outcome was once again successful.

Conclusion

The power up issue of the KPGO Cryo-con appears to have been caused by a display failure, and the IP communication issue a combination of MCI software and potential monitoring system firmware mismatch. The system was been successfully rebuilt, updated, stress-tested, and shipped back to KPGO for installation.