Hardware Maintenance

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See also: General Station Troubleshooting
                      Operations, 13.0 Plotlog

Most electronic component repair down to the discrete level is usually beyond normal station activities due to Surface Mount Technology and difficulty of finding exact replacement parts. However it is still possible to maintain good station performance using the guidelines reported here.

Periodic maintenance of the data acquisition rack by station staff helps to prevent data loss and it allows with some level of confidence the system will pass the PRE-Checks check-off list before the start of an observing session.

Another valuable tool is the Mark-IV decoder. This device can display and test many different components in the DAT rack and provide a history for later troubleshooting. Mark-IV tests along with plotting station parameters after each session allows the operator to verify the system is operational and determine any possible decline in system performance.

Periodic maintenance

- General cleaning of the rack equipment using a damp rack and a non-abrasive cleaning detergent. Vacuuming dust from inside the DAT rack. Looking for loose hardware and other items in the bottom of the rack.

- Cleaning the filters, usually with air. Metal filters can be cleaned in water if allowed to dry completely. Commercial filter sprays are available to provide dust control.

- Inspection of the fans to verify all are spinning. All fans have a normal life span that can be increased if the blades are vacuumed for dust. Electronic components often fail due to excessive heat and that failure often can be traced to a simple fan failure. Some large fans have oil ports for the bearings.

- Verify all grounds are tight and secure. Grounding straps going to a single point ground buss prevent ground loops and possible noise introduced into the converters. It also allows a solid path to blow fuses if there is a failure in the primary of any power supplies.

- Precision measurement labs normally calibrate all the test equipment necessary for good VLBI data acquisition. Verify all the test equipment is in calibration specifications and good working order.

- Normally there are not a lot of spares for the DAT racks. What spares are on site should be verified operational and ready for use when necessary.

Power supply maintenance

The main power supplies of the Dat rack should be inspected before every session by verifying the meters are displaying normal current and voltage settings.

Modern supplies now have meters indicating length of life service available. The main failure of DC supplies is heat where the electrolyte in the electrolytic capacitors evaporates over time causing even more heat and finally failure. High quality military grade capacitors can last 20 years however.

Preventive maintenance requires reading each supply voltage using a Digital volt meter as the accuracy of the meter readings on the supplies can change with age. The second check is verifying each supply is providing solid DC with AC ripple equal to or less then the manufacturer's specifications. This can be measured on an oscilloscope using the AC input and setting the DC level to Milivolts.

- Ripple is the unwanted residual periodic variation of direct current. It happens when there is incomplete suppression of the alternating waveform within a power supply.

- High ripple will impact data by increasing the digital threshold of the logic in the formatter corrupting the data stream.
- Noise of any form on the DC supply rail will also corrupt data.
- High ripple in a power supply is caused by a filter capacitor failure.

Power supply repair

Depending on the failure most of the DAT rack power supplies can be repaired on site.

- Although a fuse will fail due to age, it usually is a sign of a failure. Always replace the fuse with the correct value taking note not to replace a fastblow fuse with a slowblow.
- It is often easer to use the simplified version of the schematic as most problems will be the filter capacitors or the diode stack.
- Visual inspection of the supply will often find the source of the problem. Look for hot spots, opens, bad solder joints, and any discolored components that may have been caused by heat.
- Excessive ripple is caused by the main filter capacitors usually marked C1 and C2 for most supplies.
- A failed diode stack in the bridge rectifier will always blow the main fuse quickly.
- Always replace failed parts with the correct value component. Fans come in different airflow values and wattage for example. Capacitors have different DC working values. Diodes have different amperage ratings.
- The overvoltage and undervoltage circuit can be hard to repair. Often they will be on separate circuit boards for replacement.
- Current regulators are another source of failure usually due excessive heat from a failed fan. They are large transistors wired in series located on a heat sink which will require special attention for mounting with the correct grease, etc.
- Often the source of the failed component can be found by isolating each section in turn. For example removing the connection from the secondary of the transformer going to the rectifier will prove the transformer and the crowbar circuit is okay. This also allows Ohm meter readings of the diode stack for shorts.

Formatter repair

The formatter is probably beyond most station repair without some help from experienced digital logic troubleshooting technicians. Using the Mark IV decoder and placing the system in single channel mode it is possible to follow the path from a converter to disk pack logic. This logic appears complex but is the same circuit repeated multiple times, (it is really just a big switch board between converters and track assignments) and by swapping the integrated computer "chips" it is possible to shift the error to another track which will allow you to identify the failed or stuck bit.

- Before attempting the hardware maintenance of the formatter it is best to have a good understanding of the failure.
- It is necessary to have the correct test procedures in place using the Field system to verify before and after the repair was done correctly and not shifted to another data logic stream.
- Just reseating the IC will sometimes clear the problem.
- Occasional an IC will be sensitive to heat and will fail again after a few hours.
- Formatters in some DAT racks cannot be repaired by the station staff.

IF Distributor

The common failure is poor connections on the IF cables. The automated switching found in the VLBA DAT rack and others has eliminated this source of error. Other common failures are relays and the power settings logic.

- IF cable repair is beyond the scope of this class but cable damage can be prevented by the operators using the correct tool.
[This tool and a cable with the connectors will be available for inspection by the class]

Video and Baseband Converters

The Video and baseband converters have standard failures that station staff can repair. Most converter failures can be detected in the Pre-checks tests and using the Mark IV decoder for extended tests described in the section General Station Troubleshooting. The Field System software checks each converter for all of its operational parameters during the session after each scan starts.

Hardware repair is often possible if these common failures arise.

- PC can not talk to the converter: Communication problems can be caused by the 'mat' board which contains the logic to pass information to and from the Field system. On this board is a microprocessor that usually fails.
- Converter reads zero power: All of the power and energy readings are done by a Total Power Integration logic circuit which is the normal cause of this failure.
- Converter will not show LO Lock: The high and low oscillator circuits are controlled by varactor diodes which are the normal cause of this condition.
- Converter locks to the wrong frequency. The frequency to the Voltage Controlled Oscillators flows through digital logic which can be replaced depending on which bits are missing or wrong.

Phase Cal Unit

The Phase Cal Unit works with the antenna unit. It builds the phase cal signal for data timing and also does a cable calibration measurement. Most failures are loss of signal from the antenna unit or loss of a reference signal.

- No phase cal: Switch may be off.
- Low or high phase cal reading on the unit's meter: Remove and reseat unit which forces a power reset.
- Cable measurements are in error: Start/stop counter not running correctly.

Data rack maintenance history

Data rack history of repair is an excellent tool for the station staff to provide a good understanding of their overall data quality and provide the reports necessary for the science staff. Good practice of history collection would be:

- Log book for each day with detailed analysis of any failure reported and repaired. Any comments from the science staff in e-mail or phone call should be in this log book. Any final solutions to problems discussed should be logged in detail.
- A log plot of the common parameters taken during the session should be kept in a file with the session notes and snap file.
- All normal preventive maintenance should be charted to be sure they are completed.
- A monthly calendar showing major repairs and sessions allows a quick investigation to any failures reported by the science staff. Dewar replacement for example.