VLB ARRAY MEMO No. 319

WEATHER INSTRUMENTATION AT VLBA ANTENNAS

by Jon Spargo

I. Basic requirements

Because antennas will be located at remote sites, have minimum staffing and will essentially be remotely operated, it is necessary to know wind speed, direction and ambient temperature as basic safety precautions for antenna survivability. These sensors should have a reasonable accuracy, be interfaceable for remote readout through the monitor data system, produce outputs that are used as failsafe parameters for the servo-system and above all be extremely reliable and require minimal maintenance and calibration.

II. Extended requirements

Because of interest in water vapor measurements for phase correction it would be adventageous to have some additional weather data to use in calculating simple model atmospheres. The addition of barometric pressure and dew point sensors would provide the additional data needed for this.

III. System description

A system that incorporates all of the sensors listed has been in operation at the VLA since Sept., 1979. It has proven to be extremely reliable and has required very little maintenance. The total maintenance cost for the station since installation has been less than $500. Therefore I propose that similar stations be installed at each of the VLBA antenna sites. Though similar, there would be some differences and modifications for the new system. For example; it would be necessary to move the sensor tower away from the antenna by as much as 500 ft. to minimize blockage of the wind sensors by the antenna structure. Sensor signal conditioning and power modules would be rack mounted and be inside the control/electronics room as opposed to being mounted in a weather proof box at the sensor tower. One other desirable option might be the addition of a winch operated trolley to the 10 meter tower to raise and lower the sensors for maintenance as opposed to installing a flip down type tower. Optional sensors could also include a heated precipitation gage and perhaps a snow depth sensor at selected sites.

IV. Sensor Specifications

For the basic five sensors, wind speed, wind direction, temperature, dew point and barometric pressure the following should be considered as minimum specifications.

Wind Speed: Range for -10 to +10V output = 0 to 65 m/sec minimum.
Scale: $\geq$ 100 mV/m/sec
Absolute accuracy: $\pm$ 1 meter/sec

Non-repeatability: ± 0.2 meter/sec
Time Constant: ≤ 1 sec.

Wind Direction: Range for -10 to +10V output =
0-360° minimum
Scale: ≥ 10 mV/degree
Absolute accuracy: ±2°
Non-repeatability: ±1°
Time constant: ≤ 1 sec.

Ambient Temperature: Range for -10 to +10V output =
-30 to +50°C minimum
Scale: ≥ 100 mV/°C
over -20 to +40°C, ±1°C over remainder of -30 to +50°C range
Absolute accuracy: ± 0.1°C
Non-repeatability: ±0.05°C

Barometric Pressure: Range for -10 to +10V output=
300 mb span of sensor*
Scale: ≥ 100 mV/mb
Absolute Accuracy: ± 1 mb over 300 mb span.
Non-repeatability: ± 0.2 mb
Time constant: ≤ 1 sec.

*Manufacturer will provide sensor with 300 mb span adjusted for altitude of each VLBA antenna site.

Dew Point: Range for -10 to +10V output =
-50 to +50°C
Scale: ≥ 100 mV/°C
Absolute accuracy: ± 0.1 °C*
Sensitivity: ± 0.1°C

*NBS Traceable.

Note: To achieve specifications shown for the temperature and dew point sensors they must be mounted in a motorized aspirated radiation shield, Teledyne Geotech model 327B or equivalent.

Overall, the sensors must operate normally under the following specifications for weather and power.

Temperature range: -50 to +50°C
Relative Humidity: 0 to 100%
Rain rate: 5 inches/hr. maximum
Winds: 0 to 125 mph (0 to 65 m/sec)
Power: 100 to 130 VAC, 60 Hz, single phase

The analog DC output from each sensor will be fed to the VLBA monitor data acquisition system which will have the following input parameters.

Range: +10.235 to -10.240V
Maximum allowed overrange without degredation: ±12V
Maximum input voltage to system without ensuing damage: ±15.5V
Resolution: 5 mv per bit (12 bit conversion)

Input impedance in "OFF" state (non sampling) 100 megohms, 10 picofarads.
Input impedance in "ON" state (sampling) 100 megohms, 100 picofarads
Bias current: (0° to 20° C temp range) 50 nanoampers
Differential bias current: 10 nanoampers @ 25°C
Temperature sensitivity: 0.1 nanoamperes/°C

System Cost

The system proposed would consist of the five sensors described, the aspirated radiation shield, 10 meter flip down tower, 500 ft. of buried armored cable, lightning protection box and rack mounted chassis with power supply and signal conditioning cards. Teledyne Geotech estimates a cost of $16,700 for a single system or $15,210 per system in a lot of 10.

Options

Various options for the system include:

*Heated precipitation gage: $1600.00/system
Tower with trolley instead of flip down: add $1,000/system
*Snow depth gage: ~$1500.00/system

*May not be needed at all sites.

The prices estimated should be accurate to 5% for the next year. Beyond that we might expect about a 5% increase per/year. Teledyne is also working on a new generation of wind and temperature sensors. They estimate that these sensors will be available in about 1 to 2 years and should be slightly cheaper then the current models that meet our specs.

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