J4 MICROPHONE REPORT

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**MICROPHONE USAGE – IMPORTANT!**

Four barrier strips are provided as connectors for each individual microphone. All connections should be made using the four screws that are NOT covered by dabs of black silicon. I would recommend connecting all wires to the barrier strip with soldered spade lugs. The four connectors correspond to:

*P (Positive supply– red wire)*
*S (Signal – yellow wire)*
*G (both power and signal Ground – black wire)*
*N (Negative supply – white wire).*

If the sticker with the wiring scheme is lost, simply open the black PVC cap and identify which terminal belongs to which color wire.

For effective microphone function, positive supply should range anywhere between +6V and +37V and negative supply should be –6V to –37V. A steady, well-regulated supply is preferable, but laboratory tests indicate that the microphones are fairly immune to a noisy supply. When hooking up power, BE ESPECIALLY CAREFUL about connecting the proper polarity supply to the instrument to avoid damaging the microphone. I am not sure what (if any) damage might occur. Signal is measured between the S (signal) terminal and G (ground) terminal. Signal can swing +/-4.5 V. To take advantage of a +/-10 V dynamic range, a digitizer gain of two could be used.

For lab bench testing I often use two 9V batteries for a test supply. In the package I sent, there is an envelope with two 9V battery tabs with three output wires. Connect these wires to the barrier strip as indicated if you wish to test the microphones with two 9V batteries. Alternatively, there are two 9V battery tabs contained WITHIN each microphone PVC cylinder so that it is possible to temporarily operate the microphones off of 9V batteries which can fit inside the enclosure. When removing an internal 9V supply, MAKE SURE to cover the tab terminals with electrical tape to avoid unpleasantness.

At Erebus, these microphones will be run off of external +/-12 V supplies. The common ground is also the signal ground so it may take some consideration to fit all conductors to the G (ground) terminal screw. In the field, some sort of strain relief may be advisable for the conductors protruding from the barrier strip.

In extremely wet, caustic environments it may be desirable to seal the cylinder/cap boundary with electrical or silicone tape. However, the PVC seal appears to be airtight and unless you are deploying the microphone directly next to a fumarole, the package can be set on the ground as is.

Although the primary electronics are protected from the elements within the PVC enclosure, the electret condenser elements are by necessity exposed to the atmosphere. These elements could conceivable deteriorate/drift over time and are thus designed to be modular. To replace sensor buttons, unscrew the threaded PVC head cap and pull sensors straight out of IC socket. When replacing sensors, take care to reposition the pins as marked. Note, for the deployment this year, no replacement sensors have been included.

In addition to connecting positive and negative power supplies and signal out, connect the garden hose to the head of the PVC cylinder. Place the entire unit at a site that is out of the most vigorous wind. If possible, bury the microphone and two-meter porous garden hose in rock and/or snow. The orientation of the hose and direction of the PVC pipe is unimportant.

Note: If the microphone is to be operated at the terminus of a very long cable run (tens of meters or more), consider using Microphone #2 or Microphone #6 because the internal op-amp (LT1355) is specially chosen to handle long cable runs. However this may not be a real issue as all microphones performed admirably with test cable lengths of 100 meters.

## MICROPHONE SPECS

The individual button elements dictate the sensitivity and response of the microphones. Microphones were calibrated during co-location with a reference CTBT microphone inside a calibration chamber. The calibration chamber was fed high-amplitude square-waved pressure pulses at approximately 0.125 Hz. Amplitude and phase responses are calculated from the frequency domain transfer function. The low frequency cut-off is dependent upon the individual instrument and its button sensors, determined by the cumulative response of their FETs and capacitive leakages. The high-frequency corner is determined by the associated circuitry which is identical for all instruments.

The following is a summary of microphone specs for the four units (refer also to the included figure):

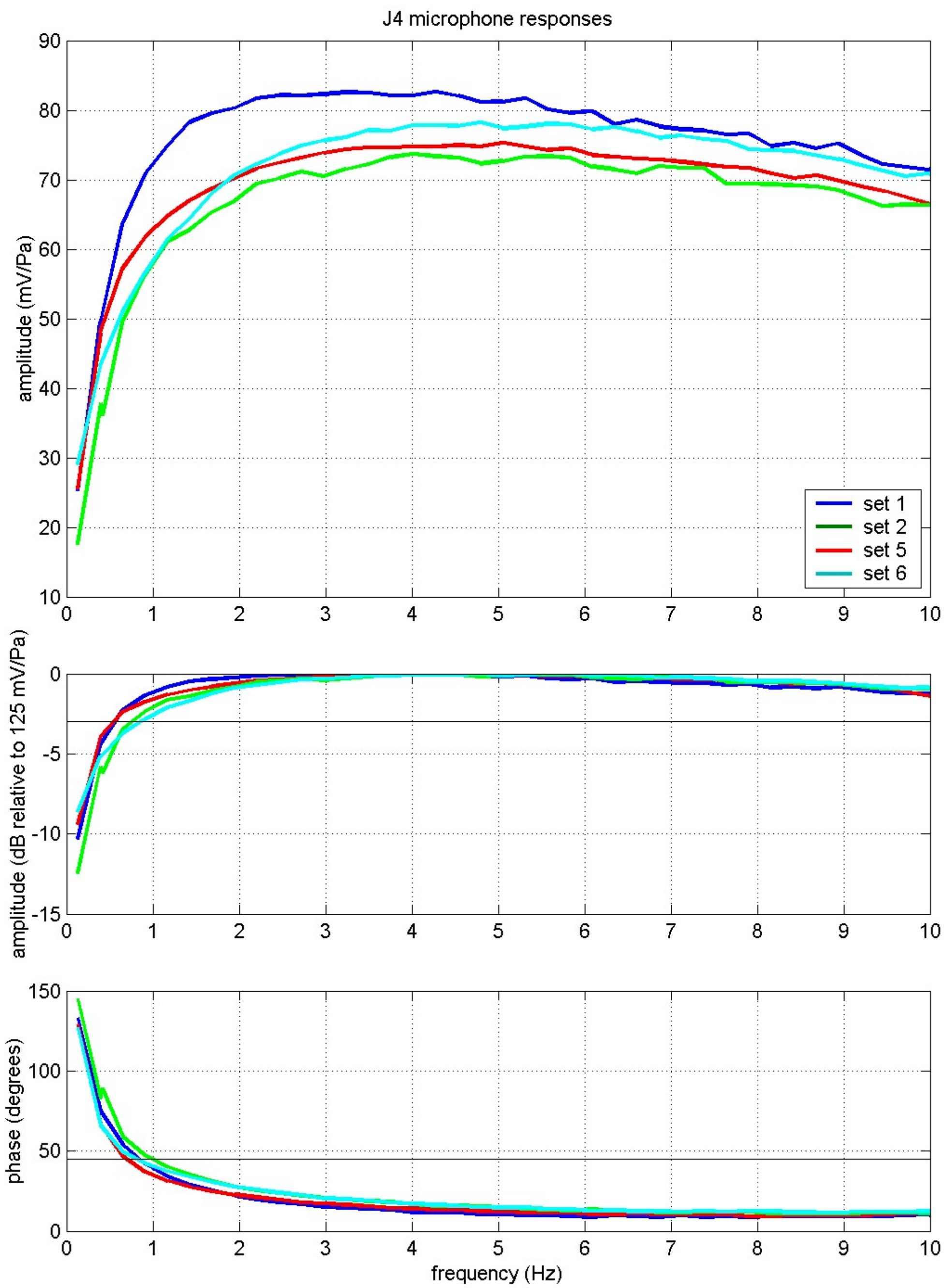
*Mic 1 – 83 mV/Pa, 3 dB down @ 0.56 Hz*

*Mic 2 – 75 mV/Pa, 3 dB down @ 0.55 Hz*

*Mic 5 – 74 mV/Pa, 3 dB down @ 0.76 Hz*

*Mic 6 – 78 mV/Pa, 3 dB down @ 0.86 Hz*

These sensitivities agree with the manufacturer specified sensitivity of 8 mV/Pa +/- 3dB (x 4 elements) and an analog gain of 2.



Absolute noise floors for these microphones are difficult to assess in the lab but with the final circuitry configuration, they appear at LEAST as low as 3 mV (or about 0.04 Pa). However the lab is a noisy environment and we should expect better in the field (at least when wind noise is low). Note that the benefit of using four microphone elements in each instrument is to improve the inherent noise floor in the near-infrasound bandwidth.

The WM034BY microphone buttons were selected based upon their superior low-frequency response. However one potential deficiency is their finite dynamic range. In laboratory tests, their maximum response appears to be about 100 Pa peak-to-peak. Thus signal clipping may occur at about +/- 4 V. Note that Erebus is able to produce large amplitude infrasound. If possible, it would be beneficial to deploy one microphone a few kilometers from the lava lake to avoid clipping.

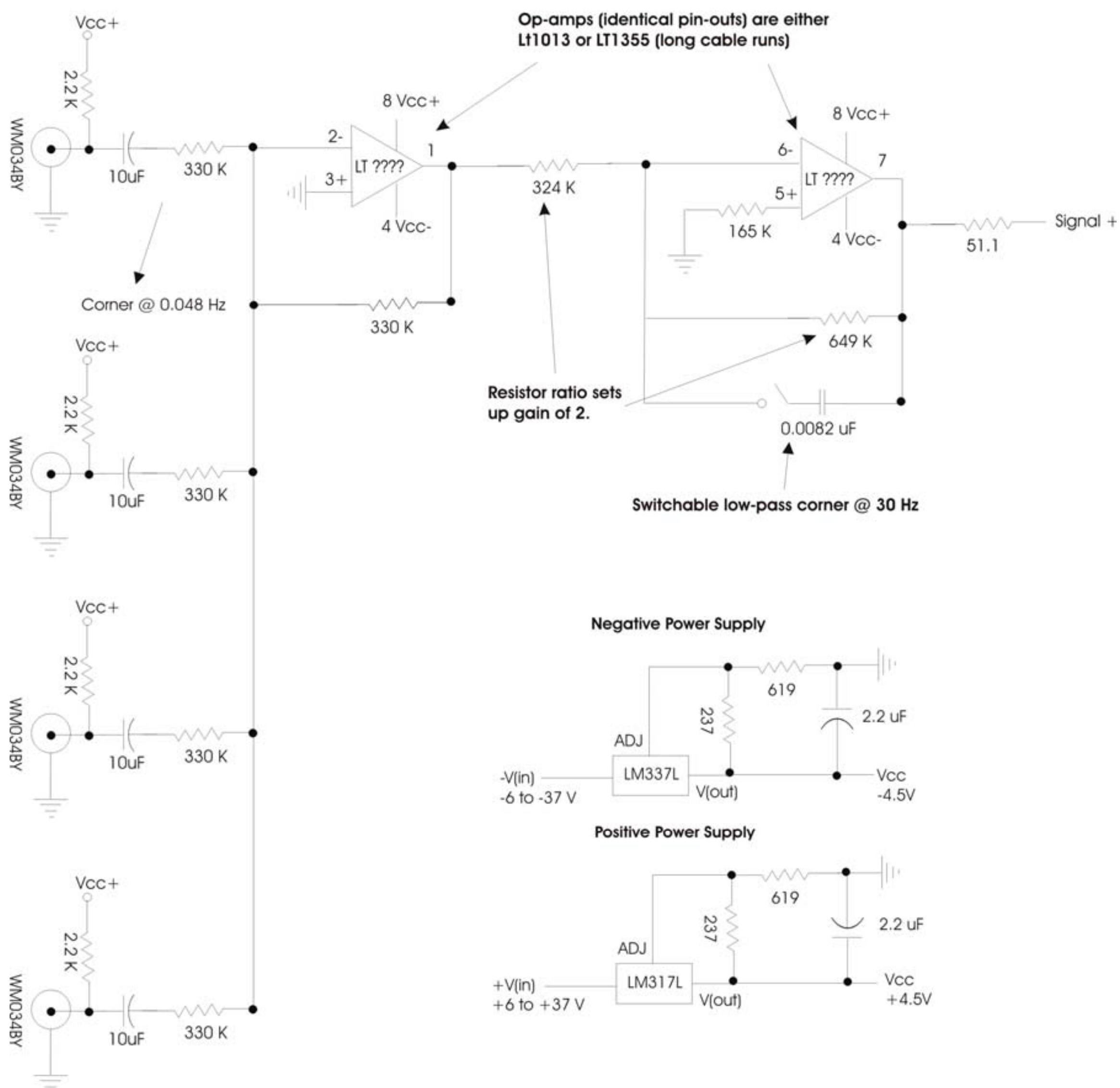
**CIRCUITRY**

The simple circuitry of the J4 microphone is designed to optimize the response of multiple WM034BY microphones via a current summing amplifier. It also serves to produce a low-noise, band-passed, buffered output. The circuit can be run off of positive and negative voltage supplies either external to the enclosure or internal (small 9 V batteries). In either case, Vcc is regulated down to +/-4.5 V.

The two-stage amplifier consists of two inverting stages receiving the microphone output from four individual buttons that are isolated and independently high-passed filtered at 0.048 Hz. The second stage amplifier has a gain of two and a single pole low-pass filter at 30 Hz. This acts as a very soft anti-aliasing filter. It is best to use additional anti-aliasing filters associated with the digitizers, or else sample data at very high sample rates (hundreds of Hz). The output signal is buffered allowing data logging on both low and high impedance acquisition systems.

The only performance difference between the various microphones (aside from variable responses for the button sensors) is the difference in selected op-amps. Microphones #2 and #6 use an LT1355 op-amp which is intended to power long-cable runs (including a 1000-foot length up to the crater rim). The other op-amp (LT1013) is less expensive and has more appealing specs in terms of noise and thermal stability.

# J4 Microphone Circuitry (10/26/2002)




*Circuit Gain – 2*

*Low Pass Filter – single pole at 30 Hz*

*Output Impedance – 51.1 Ohm*

*Current Consumption (positive) – 10 mA*

*Current Consumption (negative) – 3 mA*

*Output Signal - +/-4.5 V*