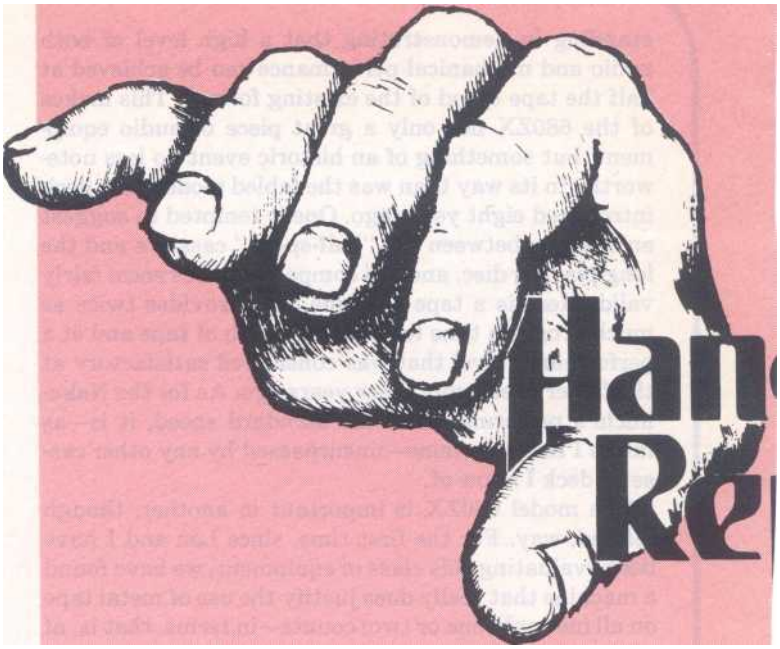
Ursa Major Space Station



By John Murphy and Jim Ford

The Space Station SST-282 from Ursa Major is a highly sophisticated audio signal processing unit which employs a digital delay line with multiple taps (outputs) to produce a wide variety of reverb, echo and comb filter effects. There are sixteen Audition Delay Programs which provide four basic families of effects: Rooms, Combs, Delay Clusters and Space Repeats. There is also a switch for selecting either reverb or echo mode of operation. The Space Station provides the user with front panel control over a wide variety of operating parameters with the result that many totally unique sound effects can be generated-in addition to the more familiar sounding reverb and echo effects.

Because of its solid state electronic construction the unit is insensitive to both high sound pressure levels and mechanical shock, this combined with the standard 19-inch rack mount packaging helps make the Space Station at home both in the studio and on stage. The Space Station is currently priced at approximately $1,995.

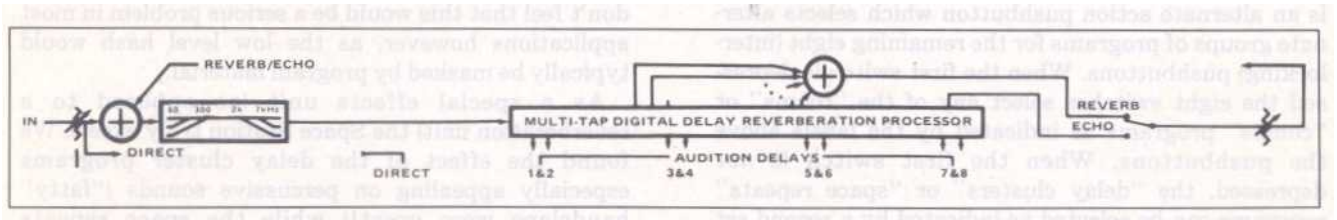
General Description: As is true of most complex signal processing equipment, it is necessary for the user to have some understanding of the unit's operation in order to employ it to maximum advantage. So before going over the front panel controls let's first consider how the Space Station works.

Ursa Major has provided a block diagram on the front panel of the Space Station for quick reference when in use (see photo of front panel). This diagram provides a good starting point for learning about the station. As you can see, the heart of the processor is a multi-tap digital delay line. The delay line provides a maximum of 255 milliseconds (about 1/4 second) of time delay with a signal bandwidth of 7 kHz. It has one input and two distinct groups of outputs as well as a separate echo output.

The first group of delay line taps (shown at the top of the delay line in the diagram) are summed together and fed back to the input to generate reverberation when the unit is used in the reverb mode. Reverb decay time is determined by the setting of the feedback control, greater feedback providing longer decay times. The unit is programmed internally to "randomize" the placement of the reverberation taps and avoid the harsh electronic sound of simple feedback delay line reverberators.

The other group of taps (shown at the bottom of the delay line in the photo) are used to audition the signal content of the delay line. There are a total of eight audition delay taps which are mixed in pairs through

The next group of programs is referred to as "Delay Clusters" and includes five programs. This family provides eight delays that are closely spaced in time with the cluster of repeats occurring at progressively later times going from the programs "Fatty" to "Echo." In the program labeled "Fatty" the delay of the echo cluster is less than 40 milliseconds. These programs provide extra richness for slap echo type effects.



four front panel level controls along with the direct signal (on its own level control) to make up the output signal. Taps 1, 3, 5 and 7 are summed and sent to the unit's left output while taps 2, 4, 6 and 8 appear at the right output. The position of the eight audition delay taps along the delay line determines the time delays and relative spacing of the initial echoes from the processor. These eight time delay values are set by selecting one of sixteen Audition Delay Programs. There are four groups of programs named "Rooms," "Combs," "Delay Clusters" and "Space Repeats." The first of these, rooms, uses semi-randomly chosen delays spaced to sound like the early reflections in the natural reverberant field of real rooms. The longer time delays are from the later taps so the user can readily adjust the signal level for the earlier or later taps to emphasize the earlier or later room reflections as desired. Rooms 1 through 4 provide increasing amounts of delay to simulate increasingly larger rooms.

The four comb programs are intended for special effects. Closely spaced delays are combined to produce the series of notches in frequency response commonly known as a "comb" filter (thus named because the closely spaced notches resemble the teeth of a comb). The comb programs provide good sci-fi effects on voices and can be used to add a tonality to percussive sounds.

"Space Repeats" is the name of the last group of programs. Three programs provide 2, 3, or 4 echoes evenly spaced over the 255 milliseconds of available delay. They provide left/right motion and are especially recommended for use with percussive sounds.

When the "echo" mode of operation is selected the reverb taps are disconnected from the feedback loop and the single "echo" tap is connected into the feedback control. The "Echo Delay Time" control is then used to establish the location of the echo tap anywhere along the delay line. Long delay times give rise to decaying repeating echoes, whereas short delay times produce comb filter effects. These effects can be further enhanced by auditioning them through more than one audition delay tap.

Now that we have some idea of how the Space Station works let's go over the front panel controls and rear panel connections. At the far left is an input level control which is used in conjunction with the LED peak level indicator below. The input signal level should be set as high as possible without flashing the 0 dB indicator, as signal levels above this will cause digital overload. To the right of the input level control are two smaller rotary controls labeled "equalization." These controls act on all signals entering the delay line including the feedback signal, providing up to 10 dB of high or low frequency cut. Since the feedback signal is affected, these controls have the effect of reducing the

decay times of the highs and lows.

The next five rotary controls constitute the output signal mixer with the first control providing direct signal at the output. The next four controls allow mixing of the signals from the eight audition taps. Each control adjusts the level from a stereo pair of taps with longer delays on the higher numbered taps.

Continuing across the face of the unit next there is a pair of push buttons, one for selecting either mixed or dry output signals, and the other for selecting either the reverb or echo modes of operation. With the first control in the "Dry" position the output consists only of direct signal still under control of the "Direct" level control. In normal operation this switch would stay in the "Mixed" position except to bypass the effects. The reverb/echo feedback control is located at the far right of the front panel. By varying the level of the reverb or echo signals fed back to the input of the delay line, the rate of decay of either type signal can be controlled.

The lower central portion of the front panel is occupied by a set of nine pushbuttons for selecting one of the sixteen audition delay programs. The first switch is an alternate action pushbutton which selects alternate groups of programs for the remaining eight (interlocking) pushbuttons. When the first switch is depressed the eight switches select any of the "rooms" or "combs" programs as indicated by the labels above the pushbuttons. When the first switch is *not* depressed, the "delay clusters" or "space repeats" programs can be selected as indicated by a second set of labels below the pushbuttons.

At the right of the program selector switches is another alternate action pushbutton which when depressed selects a "long" reverb program as opposed to a "medium" reverb program when not depressed. The medium program is said to provide for a normal build-up and smooth decay of reverberation as compared to a slower build up and longer decay time for the long reverb program. Continuing to the right there is a pair of controls for setting the echo delay time when the processor is in the echo mode. A rotary control is labeled 0 to 255 milliseconds and is first set to the desired echo time. The echo delay time is not affected until the associated "set" button is pushed, at which time the echo delay time is updated to the value selected. Finally, a power on/off pushbutton is located in the lower right corner of the front panel along with a pilot LED.

Input/output connections to the Space Station are by way of 3-pin, XLR-type connectors on the rear panel. The units accept either a balanced or unbalanced input signal and provides unbalanced stereo outputs. The pin connections for the input and output connectors are provided for easy reference on the rear panel. The only other item at the rear is a connector for the detachable line cord.

Field Test: The Space Station was field tested at a local 24-track studio where we had the freedom to hear it on a variety of tracks from multi-track master tapes. The Station was interfaced through the console patch bay so that its reverb quality could be readily compared with that of several other reverberation systems on hand. We compared the quality of the various reverb systems on a variety of program material including solo vocal tracks, solo acoustic piano, and solo drum tracks.

We heard some pretty good reverb from the Space Station, but it was not quite as "natural" sounding as either of the two spring reverbs (studio quality types) or the standard plate reverb with which it was compared. However, the Space Station provided reverberation clearly superior to that of another digital reverb unit to which we compared it. In contrast, the Station seemed more diffuse and less colored than the other digital unit. Reverb was most natural with the moderately long decay times that result from moderate amounts of feedback. Higher feedback levels seemed to result in an electronic sounding "hash" towards the end of the decay. We don't feel that this would be a serious problem in most applications however, as the low level hash would typically be masked by program material.

As a special effects unit (as opposed to a reverberation unit) the Space Station truly excels. We found the effect of the delay cluster programs especially appealing on percussive sounds ("fatty" handclaps were great!) while the space repeats programs gave an interesting "machine gun" effect on snare pops. The operator's manual provides over twenty "recipes" of control settings for various effects, most of which we auditioned. Needless to say, most of these have to be heard to be appreciated but they included such effects as: doubling, comb filtering, thickening, slap, ricochet reflections, resonance, fattened echo and pure delay. All in all we heard quite a wide variety of effects and especially combinations of effects (reverb through a comb filter for example). The unit's noise was not noticeable and there was no subjective impression of limited high frequency bandwidth.

We performed our usual listening test back at the shop by connecting the Space Station into a tape monitor loop of the preamp in our reference system. Listening to high quality discs through the direct signal path of the processor we noticed only a slight "softening" in the high frequency range when the unit was switched into the listening chain.

Lab Test: For specific results of the lab test see the accompanying Lab Test Summary. The input of the Space Station was found to be relatively insensitive with no less than a -0.6 dBV input signal level required for a 0 dB peak level indication. Thus, an auxiliary line amp may be required for interfacing with systems standardized on -10 dBV signal levels. Inter-

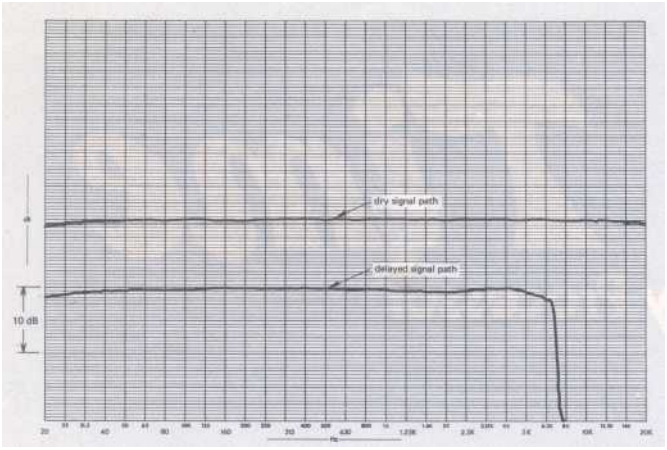


Fig. 1: Ursa Major Space Station: Frequency response of dry and delayed signal paths.

facing with +4 dBV systems should present no problem.

Noise performance through the dry signal path was not quite as good as some professional audio equipment we've encountered and the noise level for the left output was about 6 dB higher than for the right channel. The noise level increased when the four audition taps were set at maximum level but was still a respectable -66.8 dBV. THD through the direct signal path was quite low (about .003%) increasing about tenfold at 10 kHz (to about .03%). For 0 dB level signals through the delay line THD was about 0.12%.

Bandwidth through the dry path was 6 Hz to 20 kHz. The high frequency bandwidth through the delay path was limited to 7 kHz by a very steep anti-aliasing filter *(see Figure 1).* Although more extended high frequency bandwidth would be desirable we observed that the highest octave wasn't really missed in the reverb and effects (maybe because of the full bandwidth of the direct signal).

In testing the direct signal path of the unit we observed that the unit could be driven into slew limiting by high level, high frequency tones. The observed slew rate limit was 0.4 volts per microsecond which implies a slew rate ratio (slew rate limit divided by peak output voltage swing) of 0.054 volts per microsecond per peak volt out. When compared to the recommended minimum slew rate ratio for freedom from slewing induced distortion (0.5)[1] it appears that slewing headroom is marginal. A quick calculation reveals that the slew rate ratio will be maintained above 0.5 for input signal levels up to - 19.3 dB peak level. However, operating the unit with such a low input signal level would degrade its noise performance. The best compromise might be to operate the unit with somewhat reduced input levels, say by allowing the - 6 dB LED to only rarely flash.

[1] J.G. Jung; M.L. Stephens; C.C. Todd, "An Overview of SID and TIM, Part II." *Audio,* July, 1979

We noted that the unit is excellently constructed using modular printed circuit cards with all the integrated circuits (and there are lots of them!) in sockets for easy maintenance. The user's manual for the Space Station provided sufficient discussion of the processor's operation to allow a new user to obtain good results.

Conclusion: The Ursa Major Space Station is an audio signal processing unit which employs a multi-tap digital delay line to generate a wide variety of special effects as well as high-quality reverberation. The Space Station maintains a good level of audio quality. But a sound effects unit like this has to be heard to be appreciated. So if you're looking for a time delay effects unit we suggest you make sure to audition the Space Station.

LAB TEST SUMMARY

(Note: 0 dBV is referenced to.775 Vrms)

Input/Output Levels

Minimum input level for 0 dB peak level indication:	- 0.6 dBV
Output level for 0 dB indication: (dry signal only with the "direct" level control at maximum)	+ 7.0 dBV
Output clips at:	+ 16.6 dBV

Noise Performance

(20 kHz filter, unweighted)

For a dry signal only, noise of the output is:	- 74.2 dBV (R) - 67.9 dBV (L)
With the four audition taps at maximum, noise at the output is:	- 66.8 dBV

Distortion Performance

(THD plus noise at 0 dB peak level indication

Frequency	Dry Output	Delayed Output
10 kHz	.037%	–
1 kHz	.0036%	.12%
100 kHz	.0032%	.12%

Bandwidth

(– 3 dB points)

Dry signal path:	6 Hz to 20 kHz
Delayed signal path:	10 Hz to 7.1 kHz

Slewing Performance

Slew rate limit: (dry signal path)	0.4 volts per microsecond
Slew rate ratio (at 0 dB peak level, dry signal path)	0.054 volts per microsecond per peak volt