The ADS 200 Advanced Digital Synthesizer is characterized by the following features:

- 64 Digital Oscillators (expandable to 256)
- 36.3 kHz Sampling Rate
- DC to 10 kHz Frequency Response
- Stereo 16-bit DAC's (expandable to quad)

Each oscillation can have one of the following waveforms:

- Sine
- Triangle
- Sawtooth
- Square
- Pulse
- Random Noise

Each oscillator can have two 16-segment envelopes, one controlling the amplitude of the waveform and one controlling the frequency.

The oscillators can be configured for a variety of versatile applications including:

- Additive Synthesis
- Phase Modulation
- Frequency Modulation
- Nested Phase Modulation
- Nested Frequency Modulation
- Chorus Modulation

An example of a typical timbre is given schematically below:

\[ \text{ indicates phase modulation} \]
\[ \text{ indicates Additive Synthesis} \]
\[ \text{ indicates Frequency Modulation} \]
\[ \text{ indicates Output Channel} \]
\[ \text{ Sine Wave} \]
\[ \text{ Sawtooth Wave} \]
\[ \text{ Square Wave} \]
\[ \text{ Noise} \]

Implementation of the example above would require 6 of the instrument's 64 oscillators. The instrument incorporates full self-scaling graphic synthesis capabilities permitting display of 16-segment amplitude and frequency envelopes.
on the Video Monitor.

The ADS 200 features dual 61 note keyboards. Each keyboard can be split into two sections. The split point is adjustable. Any timbre or combination of timbres can be assigned to either of the ADS 200's stereo (expandable to quad) output channels. Three alternate (not well-tempered) tunings can be assigned to the keyboards simultaneously. The ADS 200 features a 4-track record/playback capability. A sequence of up to 64,000 notes can be stored on a single ADS 200 floppy disk. Each track can have independent voicing and, using the ADS 200's unique ensemble feature, changes in voicing, keyboard split, channel assignment, transposition, and keyboard tuning can all be recorded as part of the performance. The ADS 200 has a metronome/clock track feature permitting the musician to synchronize to external sources in a recording studio.

With the ADS 200's music scoring feature the musician can display his composition in conventional music notation. Using the Music Programming feature the score can be edited and corrected. Finally, a printed version of the score can be obtained on the optional Ilse printer.

The ADS 200 features a variety of real time controls including vibrato, pitch bend, release rate, and playback tempo.

Interfacing to analog synthesizers is made possible using four voltage controlled inputs, four outputs and corresponding gates and triggers.

The design staff at Con Erio has given special attention to solving two fundamental problems that plague digital synthesizers:

Problem #1 - The Hardware Oscillator Update Problem

Typical configurations of digital synthesizers rely on a microcomputer calculating new values for the envelopes and writing this data into registers on the hardware oscillator cards. Consider a typical example in which a musical instrument would strike two four-note chords using a 5 oscillator timbre for each note played. In conventional systems, a minicomputer would be required to update 40 oscillators (40 envelopes, each with 2 parameters per update—time and rate), all in the minimum rise time of the instrument (typically 2 to 5 milliseconds). Assuming a 3.5 millisecond rise time, a new parameter must be made available to the digital oscillator card every 22 usec., if the computer is to update all 100 data words. This 22 usec. update rate outstrips the capability of large, expensive minicomputers. If the computer cannot keep up with the oscillator cards, then every note of the 8 note chord will have a different and unpredictable attack time. In the case of phase or frequency modulation, the timbral characteristics of the instrument would be inconsistent.

In the ADS 200, special hardware was designed to solve this problem. The ADS 200 is capable of updating 350 oscillators (1024 parameters) every 3 usec. Furthermore, the time slots in which the update of each parameter occurs are defined to within 10 usec. This insures that an envelope executing the maximum rate of frequency modulation (250Hz/sec.) will arrive at the 578
desired target frequency within 2.83 Hz. To achieve this update rate, exceeding 300,000 words per second, would otherwise require a very large computer facility.

Problem #2 - The Timbral Update Problem

If a digital synthesizer is to be used to achieve the effects of a small symphony orchestra, then new timbral varieties must be accessible instantly. In the ADS 300 this problem was solved in two ways. First, we incorporated the fastest possible floppy disk drive into the unit along with an intelligent floppy disk DMA controller. As a result, we have typically 3 second access time and we do not halt the main computer while data is being transferred. Unfortunately, 3 second access time to a new timbre is sometimes too slow. So orchestral conductor would be satisfied with his brass section entering 1/3 of a second after the downbeat. For this reason we incorporated the second feature—The Ensemble. The Ensemble is a software routine which solves two problems:

1.) Timbral Access Time

The Ensemble permits pre-programmed sequences of timbres to be stored in the floppy disk. By employing doubly-buffered software the computer always has access to both the current timbre and the next set of required timbres. As a result, the instrument can be completely revolved in typically 500 microseconds.

2.) Musician Access Time

Storing sequences of timbral changes in advance eliminates the need for the musician to address the front panel of the instrument—he no longer needs to hit switches one at a time to achieve results. He need only press the "Ensemble Forward" foot pedal which will effect all desired changes. He can continue his performance on the keyboards because these changes occur transparently. The Ensemble feature can also be coupled with the 4-track Record/Playback feature. Each of the 4 tracks can have independent Ensembles with independent timbral evolution, all controlled automatically and instantly by the software.

With the solution of the two fundamental problems that have plagued digital synthesizers a composing musician can, with an ADS 300W software, simulate a small orchestra in real time with performance and necessary performance precision.
CON BRIO ADS 200 SPECIFICATIONS

31.2 KHz sampling rate
Frequency response DC to 15 KHz
At programmable digital oscillators
Optional expansion to 256 oscillators
16 bit accuracy maintained at outputs
96 dB dynamic range
Stereo outputs
Optional expansion to Quadraphonic output

OSCI L LATOR SPECIFICATIONS

WAVEFORMS

Sine: 4096 point resolution, 0.01% harmonic distortion maximum
Square: 65,536 point resolution, 98.8 usec. rise and fall times
Triangle: 65,536 point resolution
Sawtooth: 65,536 point resolution, 18.8 usec., full time
Pulse: 65,536 point resolution, 98.8 usec. rise and fall times
Random Noise

Amplitude
Dynamic Range: 16 bits (96db)
Rise and Fall Times: 00 db in 3 msec. maximum
Accuracy: 21 bit arithmetic

Frequency
Dynamic Range: 24 bits
Resolution: 0.013 Hz
Rise and Fall Times: 283 KHz, usec. maximum
Accuracy: 36 bit arithmetic

synthesis Modes
Additive Synthesis
Phase Modulation (linear F.M.)
Frequency Modulation
Nested Phase Modulation
Nested Frequency Modulation
Combinations of the above modes

Control
Each Oscillator's amplitude and frequency can be controlled by independent envelopes, each comprised of 16 line segments.

ADDITIONAL FEATURES

Raw Time Control
Sustain
Vibrato Rate
Vibrato Depth
Playback Tempo

560
Tuning Control

The ADS 200 can be brought up or down in pitch by
up to 1 step, and the locked in to tune with
acoustic instruments.

Programming Console

Musicians oriented interface consists of 115 pushbuttons
and 10 knobs that provide complete control of the ADS 200.

Auxiliary Inputs/Outputs
4 Voltage Inputs, 1 volt/octave
4 Volt Outputs, 1 volt/octave
4 Gate Inputs
4 Gate Outputs

These auxiliary inputs/outputs permit the ADS 200
to be a slave or master to other synthesizers or
sequencers.

The ADS 200 interfaces to an optional alphanumeric keyboard and line printer.
Available software includes: an operating system, text editor and macro-
assembler. The ADS 200 is also equipped with an 8 bit bi-directional port
for interfacing to any external computer including any PDP 11, PDP 10, LSI 11,
Nova, or IBM.

SINGLE DISK CAPACITY

100 files maximum single disk capacity

Typical single disk allocation:
10 voices
10 prerecorded tracks (individual track lengths up to
81,000 notes)
10 ensembles (20 keyboard setups each)
10 keyboard tunings