CyberAmp™ 380 and CyberAmp™ 320

COMPUTER-CONTROLLED AMPLIFICATION AND FILTERING

The **CyberAmp** with its **SmartProbes** is a measurement system a scientist or engineer can use to quantify any signal. And to quantify it in calibrated standard units. Under computer control. Quantify temperature, pressure, strain, light, acceleration, displacement, voltage or current. Axon had one simple goal in designing the CyberAmp family: **measuring any signal should be as simple as plugging in a sensor**.

Versatile Signal Conditioner

CyberAmps provide versatile signal conditioning for any electrode or transducer. The **CyberAmp 380** provides eight channels of analog amplification and signal conditioning. The **CyberAmp 320** furnishes two channels. **Every aspect of their function is under the control of your host computer.*** Gain, AC coupling, DC coupling, low-pass filtering with high order Bessel filters, notch filtering, auto-offset removal, and DC level shifting are under computer control. The host computer can ask for or set any CyberAmp parameter. Inputs are single-ended, differential, or through a SmartProbe connector. Outputs are suitable for input into a computer analog-to-digital interface, a chart recorder, or an analog tape recorder.

**The CyberAmp 380, but not the 320, also provides a manually controlled audio monitor.*

SmartProbes

SmartProbes contain the necessary circuitry to adapt transducers to CyberAmps. But they contain more. Each has a memory for the transducer it serves, and knows the conversion factors and units of its unique probe. It also knows the best settings of the CyberAmp required to condition its signal. This information can be passed through the CyberAmp to the host computer. **The host computer always knows the characteristics of the sensor on each channel.** Axon provides pre-calibrated SmartProbes for many popular transducers, as well as pre-amplifiers for sensitive voltage and current measurements. Need to recalibrate a sensor? The SmartProbe can be reprogrammed by the CyberAmp. Have a special sensor? With our connector kit you can make a SmartProbe for any transducer, including all your existing transducers or electrodes.

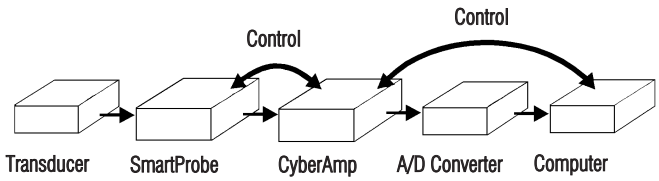
From the Leader in Bio-Amplifiers

Axon has long produced the finest voltage-clamp, current-clamp and patch-clamp amplifiers. And it produces the computer interfaces and software to back them up. The same exacting standards were applied to the design of the CyberAmp, a general purpose amplifier and signal conditioner.

The Evolution of Laboratory Instrumentation

Computers are now widely employed to acquire the analog signals produced by transducers. Signal

conditioners are used to prepare clean analog signals for analog-to-digital converters. In the CyberAmp this development has been extended by giving the computer knowledge of and control over the transducer and signal conditioner. The result? With a computer and acquisition software such as AxoScope, the CyberAmp provides a system that is a superior replacement for chart recorders, polygraphs and tape recorders. You get enhanced accuracy of measurement, conversion of measurements to real-world units, and the flexibility to easily change the configuration of the instrument under computer control.



Intelligent Signal Conditioner

With the CyberAmp you won't need to buy a series of amplifier and filter modules for dedicated operations. This intelligent instrument can be **configured for each application under software control**. To change applications you won't have to change or rewire modules — just plug in your sensor and reconfigure its CyberAmp channel with a few simple software commands.

Optimized Amplification

In each of the CyberAmp channels, the signal enters a sensitive AC/DC amplifier that boosts its gain and feeds into a low-pass filter that removes noise. The signal then enters a second amplifier that further boosts its gain and buffers its output. These three stages are independently controlled to optimize the dynamic gain and performance of the system. Outputs are provided for a computer A/D converter, a chart recorder, or a tape recorder.

Software Control

The front panel of the CyberAmp is all input and output. Gone are the manual gain and filter setting controls. **Total control is exercised by the host computer** via an RS-232 interface. Any computer that sends ASCII text out a serial port can control the CyberAmp. The CyberAmp automatically determines the baud rate of the port and replies in kind. CyberAmp Control is built into our acquisition programs Clampex 9 and AxoScope 9. The CyberAmp comes with DOS, Windows, and Macintosh programs for the computer that efficiently control all aspects of the CyberAmp operation. Also included are control subroutines you can incorporate into your own QuickBASIC or C programs. Software control is offered in the applications of other vendors such as Data Wave Technologies and Cambridge Electronic Design.

CyberAmp™ 380 and CyberAmp™ 320

SmartProbes Available

Axon supplies a variety of **SmartProbes** with pre-amplifiers for recording small voltages or currents. Axon also supplies SmartProbes that accept many of the popular transducers used in research and engineering, and new applications are being developed. You obtain a transducer from the appropriate manufacturer and simply plug it into one of our SmartProbes. Each SmartProbe comes from Axon with the correct scaling factors for its transducer, plus appropriate default settings for the CyberAmp itself. See complete descriptions for all available SmartProbes in the SmartProbe PDF file.

Quietest Amplifiers Available

Most electrodes and transducers can be connected directly to the CyberAmp. With an impedance of 1 MΩ and a common mode rejection of 110 dB at x100 or greater gain, its differential inputs have 1.4 μV_{RMS} noise in a 10 kHz bandwidth (9 $\mu V_{p\text{-}p}$); sufficiently quiet for the direct use of many EMG, ECG and EEG electrodes. For lower noise and higher input impedance, use the extraordinarily quiet AI 402 differential amplifier, featuring noise of 0.18 mVRMS in a 10 kHz bandwidth (1.1 $\mu V_{p\text{-}p}$).

Differential or Single Ended

Eliminate noise at the source with differential inputs and high-pass AC filtering from 0.1 Hz to 300 Hz. The inputs are tuned for optimal common mode rejection and linearity.

High Order Bessel Filtering

CyberAmp 380 cleans up any remaining noise with superb low-pass filtering. Each channel has a **noise-busting** low-pass 4-pole Bessel filter (80 dB/decade) adjustable from 2 Hz to 30 kHz. It can be bypassed for a frequency response exceeding 50 kHz at low gains. **CyberAmp 320** is even better, featuring 8-pole Bessel filters.

Notch Filter

It is sometimes desirable to remove interference occurring at the line frequency. Notch filters in each channel can be tuned in the field to reject either 50 or 60 Hz interference.

Amplification

The gain may be set from x1 to x20,000. For any given gain setting, the CyberAmp optimally sets the actual gains of the pre-filter amplifier and the post-filter amplifier. This avoids excessive pre-filter gain that would saturate the filter input and avoids excessive post-filter gain that could amplify the inherent noise of the filter. In the CyberAmp, **clipping and noise amplification are completely avoided**.

DC Offset

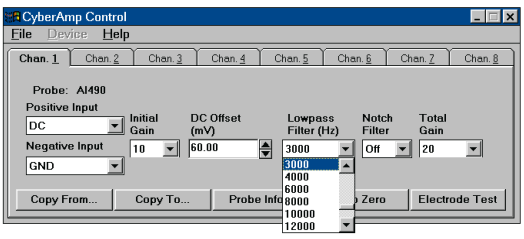
You can adjust the DC offset of the signal. DC offset is added after the pre-filter amplifier, thereby increasing the resolution for small signals. Offset ranges vary from ±3 V at 100 µV resolution for a x1 pre-filter amplification to ±0.03 V at 1 µV resolution for x100 pre-filter amplification.

Auto-Zeroing

The signal is zeroed without losing any AC information. Use the Zero command on any channel, and the DC level of the signal is sensed and automatically used as a DC offset value.

Automatic Offset Calibration

Some amplifiers allow you to manually zero their internal offsets. The CyberAmp **automatically calibrates its own offsets, when needed**. Whenever a gain is changed, or at power-up, the inputs to the pre-filter amplifier are grounded and the output is adjusted to zero. This takes only a few milliseconds. Then the input is reconnected and the DC offset value is added back to the signal.



Each CyberAmp comes with the CyberControl application which works on the Windows Desktop; the CyberAmp configuration is not communicated to your recording software.

BNC Input

For conventional signal conditioning, the positive input of each differential amplifier is available through a BNC connector on the front panel. The BNC shields are connected to ground.

Probe Input

SmartProbes plug into the CyberAmp's 15-pin D-SUB connectors. These connectors make available the positive and negative differential inputs, ±15 V power for the circuitry in the adapter, and a precision +5 V supply for direct use with *e.g.*, resistive transducers. Other test and sense pins are also present.

Overload

Each channel has a front-panel LED that lights when either the signal to the filter or the output from the post-filter amplifier exceeds ±10 V. The computer can request this information at any time.

Electrode Test

You can test the impedance of any electrode or transducer directly connected to the CyberAmp inputs. The CyberAmp automatically injects a small current into its attached electrode. SmartProbes with active amplifiers also provide a test electrode jack for semi-automatic electrode testing.

Convenient Computer Interfacing

The CyberAmp has a dedicated multipin connector for direct connection to your computer's A/D converter. All channels are represented at ±10 V, the most appropriate range for the input to most analog-to-digital converters. In addition, this connector has pins connected to six uncommitted BNC connectors, which may be used for further input or output.

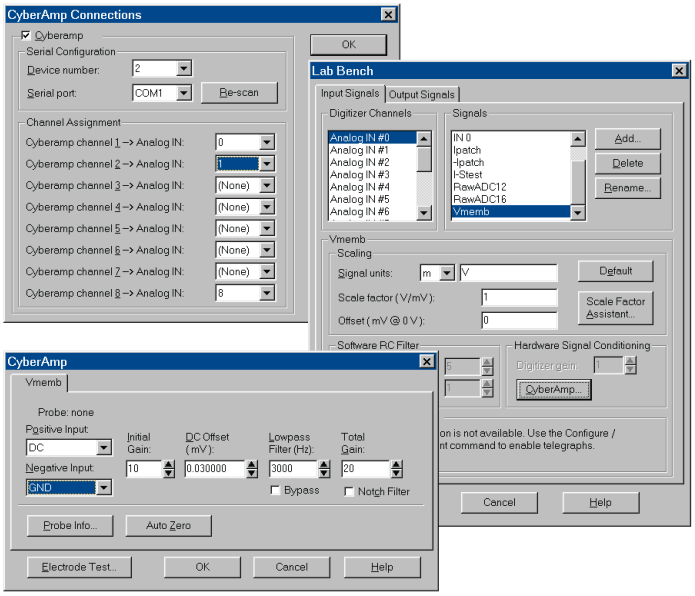
Chart Recorder to Polygraph

With the CyberAmp as a front end, **simple chart recorders become sophisticated polygraphs**. You can directly plug many sensors and electrodes into the CyberAmp, and easily configure it as an amplifier for temperature, ECG, EEG, EMG, pressure or acceleration.

SmartProbes are available for additional transducer needs. The CyberAmp has a dedicated chart recorder output: a multipin connector with all channels represented at ±1 V.

Audio Monitor

With the CyberAmp 380, obtain maximal information from your recordings with a versatile built-in audio monitor. Using controls on the front panel, choose any channel and hear its activity in one of two ways. Tone mode produces a tone proportional to the DC level; ideal for monitoring slowly changing signals such as cellular membrane potentials. Click mode, with squelch control, is ideal for listening to high frequency activity, such as spikes. The audio monitor is not available on the CyberAmp 320.



CyberAmp control is built into Clampex 9 and into AxoScope 9. Assigning a CyberAmp channel to an analog input automatically enters the CyberAmp gain in the software scaling of that input channel, and stores the CyberAmp filter settings in the recorded data file.

CyberAmp™ 380 and CyberAmp™ 320

Specifications

Unless otherwise noted: T_A=25 °C, ambient.

NUMBER OF CHANNELS

CyberAmp 380: 8 channels, 4-pole Bessel filters, audio monitor

CyberAmp 320: 2 channels, 8-pole Bessel filters

ANALOG INPUTS

Input signal range: ±10 V DC minimum linear range. ±12 V typical working range.

Safe input voltage: ±30 V power on. ±15 V power off.

Input resistance: 1 MΩ.

Input capacitance: 45 pF.

ANALOG OUTPUTS

Output signal range: ±10 V minimum, ±12 V typical, at BNC and Link outputs. ±1 V minimum, ±1.2 V typical, at recorder output.

Output impedance: Approximately 420 Ω in series with the output; 3,300 pF to ground. (Forms a passive 115 kHz low-pass filter.)

Output short-circuit duration: Indefinite.

Output offset: < ±20 mV. Automatically calibrated.

Offset calibration: Offset on individual channels is calibrated after gain changes and input coupling changes. Offset on all channels is automatically calibrated 5 minutes after power is switched on.

AMPLIFICATION

Total gain: x1, 2, 5, 10, 20, 50, 100, 200, 500, 1k, 2k, 5k, 10k, 20k.

Pre-filter gain: x1, 10, 100.

Post-filter gain: x1, 2, 5, 10, 20, 50, 100, 200.

Gain accuracy: 1.5%.

LOW-PASS FILTER

Filter type:

CyberAmp 380: 4-pole Bessel. 80 dB/decade, 24 dB/octave.

CyberAmp 320: 8-pole Bessel. 160 dB/decade, 48 dB/octave.

Selectable -3 dB frequencies: 57 discrete frequencies: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800, 3000, 4000, 6000, 8000, 10000, 12000, 14000, 16000, 18000, 20000, 22000, 24000, 26000, 28000, 30000. Filter can be bypassed.

NOTCH FILTER

Frequency: Tuneable from 45-70 Hz.

Depth: 40 dB.

-3 dB Width: 1 Hz.

AC COUPLING

Selectable coupling frequencies: 0.1, 1, 10, 30, 100, 300 Hz.

DC OFFSET & AUTOZERO

DC level control (input referred): ±3 V in 100 μV steps, pre-filter gain = x1

DC offset adjustment (input referred): ±300 mV in 10 μV steps, pre-filter gain = x10; ±30 mV in 1 μV steps, pre-filter gain = x100

Autozero lock-in range: Same as DC offset adjustment ranges.

NOISE

Input noise:	0.1 Hz - 10 kHz:	1.4 μV_{rms}, 9 μV_{p-p}
	0.1 Hz - 3 kHz:	1.0 μV_{rms}, 6 μV_{p-p}
	0.1 Hz - 1 kHz:	0.7 μV_{rms}, 4 μV_{p-p}
	0.1 Hz - 100 Hz:	0.6 μV_{rms}, 3.5 μV_{p-p}
Output noise:	0.1 Hz - 10 kHz:	70 μV_{rms}, 500 μV_{p-p}

Peak-to-peak noise is estimated using a factor of six times the measured RMS value. The RMS value is determined from a one-second acquisition of ten thousand or more samples. The AC coupling frequency (0.1 Hz) and the low-pass frequency are set in the CyberAmp itself.

COMMON MODE REJECTION RATIO

Same 100 Hz signal to differential inputs

With equal source resistances:	110 dB, pre-filter gain	= x100
	100 dB, pre-filter gain	= x10
	70 dB, pre-filter gain	= x1
With 1 kΩ source imbalance:	60 dB, all gains	

A higher CMRR is achieved in the presence of substantial source-resistance imbalances by use of one of the AI 400 series differential amplifier probes as pre-amplifiers to the CyberAmp.

FREQUENCY RESPONSE

DC-50 kHz, pre-filter gain = x1
DC-30 kHz, pre-filter gain = x10
DC-11 kHz, pre-filter gain = x100

OTHER FEATURES

Electrode test: ±0.5 V square wave applied simultaneously to all inputs via 1 MΩ resistors. For low-value source resistances, this corresponds to ±0.5 μA (1 μA_{p-p}) current; frequency 10 Hz.

Amplitude calibration waveform: 0 to +10.00 mV square wave at approximately 1 kHz. Available only on the CyberAmp 380.

Overload indicators: Overload is detected if either the pre-filter or post-filter amplifier output exceeds ±10.5 V. LED display remains on for 100 ms minimum.

HOST COMPUTER INTERFACE

Required host computer: Any computer type; must have an RS-232 interface.

Interface format of CyberAmp: An RS-232 serial interface modified to allow multiple compatible instruments on one port. Compatible instruments conform to the Axon Instruments Expandable RS-232 bus specification.

Auto baud rate: Responds at baud rate initiated by host computer.

Allowable baud rates: 75, 150, 300, 600, 1200, 2400, 4800, 9600 and 19200.

Configuration: Null modem (DTE mode).

Expansion: Up to ten CyberAmps can be "daisy chained" onto one RS-232 interface. Only one unit is controlled at a time.

Expansion cable length: A rate of 19,200 baud can be sustained if the total daisy-chained cable length is less than 6 m (20 feet). Longer cable lengths are permissible if the baud rate is reduced.

Device address range: 0-9. Each device must have a unique address.

AUDIO MONITOR (available only on the CyberAmp 380)

Sources: Outputs of channels 1 to 8, or external BNC.

Tone mode:

Frequency modulated: The DC level of signal determines the pitch.

Pitch range: 10 Hz to 3 kHz, with adjustable offset.

Offset range: ±10 V.

Click mode: Signal directly applied to speaker.

Bandwidth: 20 Hz to 5 kHz.

Squelch range: Level below which tone suppressed: bipolar band centered at 0 V, with range 4 V_{p-p}.

	Internal speaker: 0.2 watts max. **Phone jack:** Suitable for headphones or external speaker (8 Ω); 0.2 watts max.
CONNECTORS	
Input BNC:	One per channel; center conductor connected to positive input; shield connected to ground.
Output BNC:	One per channel.
Probe connection:	Connection for probe; one per channel. DB15 female connector. Provides differential analog input, power supplies to probe, electrode test, and SmartProbe EEPROM connections. **±15 V supply:** Maximal load not to exceed ±200 mA all channels combined. **+5.000 V excitation:** Maximal load not to exceed 200 mA all channels combined. **Unloaded accuracy:** ±2 mV. **Accuracy at 200 mA load:** +0, -10 mV.
Link connector:	DB15 female connector contains all channel outputs and six connections to uncommitted BNC connectors on the back panel. Suitable for direct connection to an A/D board.
Chart recorder connector:	DB15 female connector contains all channel outputs at 1/10th gain (*i.e.*, ±1 V swing).
RS-232 IN connector:	DB25 female connector.
RS-232 OUT connector:	Identical and in parallel to RS-232 IN connector, with the exception that +5 V and -5 V are only available on the RS-232 IN connector.
ACCESSORIES PROVIDED	Manual, Line cord, Spare fuse, RS232-01 null modem cable for PC or RS32-03 null modem cable for Macintosh.
SOFTWARE PROVIDED	MS Windows, DOS and Macintosh control programs. QuickBASIC and C libraries for PC compatibles.
POWER AND DIMENSIONS	
Line voltage:	100-125 V_{AC} or 200-250 V_{AC}. User selectable by an external switch.
Line frequency:	50-60 Hz.
Power:	30 watts.