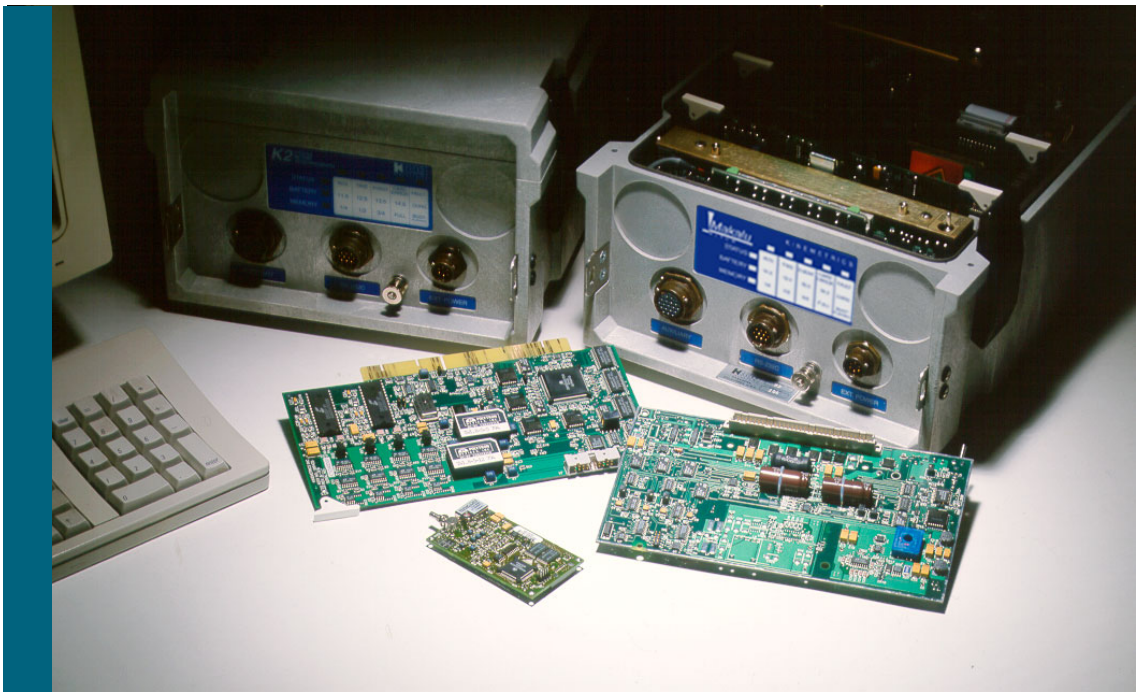
KINEMETRICS

Makalu

Digital Recorder



KEY BENEFITS

- 24-bit Recorder with dynamic range ~130 dB (100 sps)
- Multi-tasking operating system that allows simultaneous data acquisition and interrogation
- Timing accuracy to ±0.5 ms due to synchronized sampling with GPS timing system
- Zero Channel Skew through the utilization of individual A/D converters for each channel
- Serial data stream for full-duplex telemetry
- Remote alerting capability for system event or auto diagnostic failure
- Interconnectivity with other Altus family recorders for common triggering and shared GPS (option)
- Common user interface, file format, and support tools with other *Altus* family recorders.

MAJOR APPLICATIONS

- Local, regional and national seismic networks and arrays
- Dense arrays, two and three dimensional
- Aftershock study arrays

INTRODUCTION

Kinemetrics' Altus ***Makalu*** is a 24-bit digital recorder designed to provide high-resolution data for applications with high dynamic range transducers. The ***Makalu*** can be used either as a stand-alone recorder or as a digitizer in a network configuration for seismic monitoring.

The ***Makalu*** connects directly to most seismometers and accelerometers available in the market. The ***Makalu*** digitizes the input signals and time stamps the data using the GPS receiver for all the channels. The data is recorded on the removable memory card (PC card format).

When installed in a network configuration, the ***Makalu*** broadcasts time-stamped data packets using standard duplex serial interfaces over radio, telephone or satellite communication links. The ***Makalu*** uses an advanced and flexible compressed data format for transmission to maximize the utilization of limited telemetry bandwidth, therefore reducing network costs.

The standard ***Makalu*** comes with 3 high-resolution A/D Converters (24-bit) and one memory card. Additional channels and storage media are also available.

The ***Makalu*** comes with QuickTalk® and QuickLook® software to provide a user-friendly environment for making system setup, communications and rapid data analysis quick and easy.

Input Channels

Sensor channels:	3 standard; 6 optional
Input level:	40 Vpp (±10V differential)
Pre-Amplifier:	Optional

Data Acquisition

Type:	24-bit Delta Sigma converter with 24-bit DSP
Anti-alias filter:	Brickwall FIR filter. Cut-off at 80 % of output Nyquist; 120 dB down at output Nyquist
Dynamic range:	Typical 200 sps~129 dB (RMS noise to RMS clip) 100 sps~131 dB (RMS noise to RMS clip) 20 sps~135 dB (RMS noise to RMS clip)
Frequency response:	DC to 80 Hz @ 200 sps
Sampling rates:	20, 40, 50, 100, 200, 250 sps
Chan.-chan. skew:	None – simultaneous sampling of all channels
Acquisition modes:	Continuous, trigger
Output data format:	24 bit signed (3 bytes)
Parameter calculations:	Calculations of key parameters in real-time
Real time digital output:	RS-232 output of digital stream (contact factory for available formats)

Trigger

Type:	IIR bandpass filter (three types available)
Trigger selection:	Independently selected for each channel
Threshold trigger:	Selectable from 0.01% to 100% of full scale
Trigger voting:	Internal, external and network trigger votes with arithmetic combination
Additional trigger:	STA/LTA

Storage

Type:	Fully compliant PCMCIA storage system (two slots)
Compatibility:	PCMCIA standard 2.1; sockets accept Type I, II, III card formats Type I or II modem ———————————————————— Ethernet 10 Base-T LAN interface
Storage primary slot:	32 MB (minimum) memory card. Larger sizes available.
Storage 2nd slot:	Same as primary slot
Parallel 2nd slot:	Accepts Type I or II modem with connectors
Recording capacity:	Approximately 22 minutes per channel per MB on Memory Card, 24-bit data @ 200 sps.
Recording format:	Data is stored in DOS file system allowing cards to be read directly by PC.

Firmware

Type:	Multi-tasking operating system supports simultaneous acquisition and interrogation; boot loader allows remote firmware upgrades
System control:	Configure sample rate, filter type, trigger type and voting, maintains communications and event storage
User interface:	Packetized protocol and simple terminal loop control and data retrieval via RS-232 interface
Intelligent alerting:	System can be configured to initiate communications when an event is detected or if an auto-diagnostic failure occurs
Auto-diagnostics:	System can be configured to continuously check system voltages, temperature, RAM and code integrity, and timing system integrity
Rapid setup:	Unit can be configured from parameter file stored in PCMCIA memory card

Timing

Type:	Free running disciplined oscillator (standard); GPS (opt)
GPS option:	Integrates completely with system, providing timing, internal oscillator correction and position information
Timing:	Accuracy: 5 microseconds of UTC with GPS
Power:	Power cycling is software controlled Power consumption: 110 mA at 12V (active)

I/O and Display

Display:	Matrix of 8 LEDs. Display indicates acquisition mode, event, recording, battery voltage, memory capacity used
Power input:	Mil-style connector for 24 Vdc charge input, external battery, standby power
RS-232 input:	Full RS-232C interface with modem control
Aux. input:	Mil-style connector for IRIG out, IRIG in, clock sync., 1 pps out, trigger in, trigger out, alarm out, real time digital output (tx & rx), ext 12V out
EMI/RFI protection:	All I/O lines are protected from both EMI/RFI emission and susceptibility problems by ferrite filters and transient suppressors

Power Supply

Type:	High efficiency switched power supply and charger system
Input:	Nominal 24 Vdc from charger
Operating range:	10.5V to 15V
Ext. charger voltage:	100-250 Vac 50/60 Hz
Charging voltages:	Temperature compensated for lead acid gel cell, 2 outputs with separate protection circuitry allows unit to recharge flat battery and work with reversed or damaged battery in multi battery system
Fuses:	Four 2 amp fuses for charger and batteries
Batteries:	Internal battery 12V 12 Ah (standard); external battery (opt)
Current drain:	< 350 mA @12V (standard configuration)
Power autonomy:	>36 hours with internal battery

Communications

RS-232 interface: Parameter setup, real-time telemetry and event retrieval.

PCMCIA modem: Remote access, initiated by user or by the Makalu. Optional

Ethernet interface: Connect the Makalu directly to your IP based Wide Area Network (WAN). Optional

FTP via Modem: FTP transmission of events via dial-up ISP. Optional

Support Software

QuickTalk®*:	Windows-based control and data retrieval program for easy setup and data retrieval by direct connection or modem.
QuickLook®*:	Windows-based data retrieval program for rapid review of waveforms and event information. Also operates with DOS communication software
Antelope:	Comprehensive commercial network operational and mgmt system for medium and large networks
Earthworm:	Comprehensive public domain network operational and management system for medium and large networks
NMS:	Commercial PC-based network management system for small to medium sized networks via modem or real-time data
SMARTS:	Commercial open architecture user-extensible real-time data collection and processing software that runs on a variety of computers
PSD:	Commercial Pseudo Spectral Density software for earthquake data analysis
SMA:	Commercial Strong Motion Analyst software for earthquake data analysis and processing
*K2COSMOS**:	Conversion software from Altus EVT file format to COSMOS v1.20 format
Format Converters*:	Provides option to convert and store data in ASCII and other formats. Contact Kinemetrics for other options.

*No charge

Environment

Operating temperature:	-20° to 70°C
Humidity:	0-100 RH