3. The disk compartment contains 130S Recorder to be serviced without connecting a setup by displaying the 130S State-Of-Health.

5. User setup, control, status, and data monitoring are carried out either with the iFSC Controller or with a PC or Workstation running RTI... disciplined by an external GPS Receiver / Clock, which maintains time accuracy to better than 10 μsec.

**Time Base**
- **Type:** GPS Receiver/Clock plus Disciplined Oscillator
- **Accuracy with GPS:** 130 μsec after validated 3-D fix and locked
- **Free-Running Accuracy:** 0.1ppm over the temp. range of 0° to 70°C and 0.2 ppm from -20° to 0°C

**Recording Capacity**
- **Battery Backed SRAM:** 8 to 16 MB user specified
- **Hard Disk:** 8 GB or 16 GB CFII Card, settable in "Ring-Buffer" Configuration

**Recording Modes**
- **Continuous:** Record length
- **Time Trigger:** Specific record length at periodic interval
- **Time List Trigger:** A list of record times and lengths
- **Event Trigger:** STA/LTA with advanced features including bandpass filter LTA hold, etc.
- **Level Trigger:** Absolute value, user selectable: g, or % of full scale, or counts including bandpass filter
- **Vote Trigger:** Level trigger with weighting
- **External Trigger:** External pulse on trigger input line
- **Cross Trigger:** One stream triggers recording of another

**Recording Format**
- **Format:** PASSCAL Recording Format

**Specifications**

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**Related Sub-systems:**
- Strong Motion Accelerographs, 130-SMHR & 130-SMA
- Accelerometers, 147-01 & 131B
- Broadband Seismometers, 151B-120, 151B-60, 151B-30

**Applications:**
- Local and Regional
- Broadband
- Aftershock
- Active Source
- Micro-Zonation Survey
- Site Noise Survey
- Earthquake Early Warning
- Rapid Transportation

**Model 130S-01**

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**Key Features:**
- State-of-the-Art ADC
- Small Size and Lightweight
- Modular Hardware and Software
- IP Communications over Ethernet and Asynchronous Serial
- Embedded/Removable Mass Storage

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**Ref Tek 3rd Generation Broadband Seismic Recorder**

The 130S Broadband Seismic Recorder has been designed to be easier to use – more compact, lighter in weight, lower power, and requires less maintenance than other recorders. Not only is the hardware optimized for field deployments, software tools have been specially developed to support both field and base station operation. The 130S case is a clamshell design, inherently waterproof, with easy access to all user features on the top of the unit.

1. The 130S has 3 or 6 input channels for connection to any sensor available in the seismology market.
2. The network Command / Control and Data Telemetry is either Ethernet 10BaseT or serial PPP.
3. The disk compartment contains two CF-II slots, backup battery and status LEDs for easy servicing.
4. The LCD display allows the 130S Recorder to be serviced without connecting a setup controller by displaying the 130S State-Of-Health.
5. User set-up, control, status, and data monitoring are carried out either with the iFSC Controller or with a PC or Workstation running RTI application software set.
6. The 130S uses a high-precision TCXO disciplined by an external GPS Receiver / Clock, which maintains time accuracy to better than 10 psec.
**Hardware Modularity**

REF TEK 130S is constructed with up to five internal boards stacked together – an arrangement that is more reliable and less costly than a traditional backplane arrangement. The 130S comes with a Lid Interconnect Board, a Microcomputer Board, one or two ADC Boards and a Sensor Control Board.

One or two removable disks reside in a sealed compartment that is accessed by opening a lid located on the top of the 130S case. The main electronics section is sealed with the lid open or closed.

The GPS Receiver is separate from the main unit in order to allow the GPS antenna to be located some distance away.

<table>
<thead>
<tr>
<th>Module Description</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lid Interconnect Board (RT520)</td>
<td>Power Supply, Lightning Protection, Physical Interface, DC-DC Converter</td>
</tr>
<tr>
<td>Microcomputer Board (RT506)</td>
<td>CPU, Battery Backed SRAM (up to 16 MBytes), Serial Ports, Real-time Clock, Ethernet Controller, full stack, Enhanced Integrated Drive Electronics (IDE)</td>
</tr>
<tr>
<td>ADC (RT649)</td>
<td>24-bit ADC Channels (3 each), Input Pre-Amplifier, Digital Anti-Alias Filters, 1M SRAM, Direct Memory Access (DMA) Controller, DC-DC Converter</td>
</tr>
<tr>
<td>Removable Mass Storage (External)</td>
<td>Compact Flash (two slots available), 2 to 32 Gbytes total capacity</td>
</tr>
<tr>
<td>GPS Receiver (External)</td>
<td>Garmin GPS Receiver</td>
</tr>
</tbody>
</table>

**Noise Performance**

The 130S series recorder incorporates the 3rd generation 24-bit delta sigma type analog-to-digital converter with state-of-the-art design. The combination produces the highest performance low power 24-bit seismic recorder. Below is the power spectral density of the ADC with the full scale sine wave input.

![Power Spectral Density](image)

**Data Retrieval**

The 130S series recorder may be equipped with one or two Compact Flash Type I or Type II storage media (disks). CF flash storage is available in 8GB or 16 GB capacity. For example, 8 GB is enough storage to hold more than 200 days of three channel, 100 sps data recorded with Steim 2 compression.

Files are written in FAT32 format allowing high capacity disks to be used. To swap a disk during acquisition, simply open the cap that seals the disk compartment. A red LED indicates the disk is busy. When inactive a green LED signals to remove the disk and insert another one in its place. Replace the cap resealing the compartment.

Data from the disk may be read on any PC / Workstation using a CF-II reader. Data can also be remotely downloaded from the 130S disk using FTP over LAN/WAN.

**Time Keeping**

In order to maintain accurate time over a long period, the 130S recorder uses both a high-precision TCXO and an external reference provided by the GPS Receiver / Clock that uses the Global Positioning System (GPS) for time, frequency, and position reference.

When power is applied to the 130S recorder, rough time is set from a battery-backed clock. A few seconds after obtaining a 3-D position fix (typically seconds after power-up or minutes if the GPS has been moved a great distance since last operating), the 130S will set its time to GPS time. During the initial 15 minute period, the TCXO frequency and phase is measured and adjusted to the GPS, then the 130S time is set to UTC. Within an hour of operation, the internal clock will remain within a few uses of UTC while the GPS runs with a 5% duty cycle. The frequency setting is maintained across power cycles thus the oscillator’s frequency is compensated for aging and temperature drift automatically.

**Ordering Information**

**Part No.** | **Description** |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>97100-00</td>
<td>130S-01/3: Recorder, 3rd Generation, 3-Ch.</td>
</tr>
<tr>
<td>97100-01</td>
<td>130S-01/6: Recorder, 3rd Generation, 6-Ch.</td>
</tr>
<tr>
<td>97150-00</td>
<td>130-8023: Cable, NET, 130 to Ethernet RJ45, Crossover, Ext.</td>
</tr>
<tr>
<td>97180-00</td>
<td>130-FLASH/RGB: Disk, Flash Memory, RGB</td>
</tr>
<tr>
<td>97181-00</td>
<td>130-FLASH/16GB: Disk, Flash Memory, 16GB</td>
</tr>
<tr>
<td>97176-00</td>
<td>130-8002: Channel Input Mating Connector</td>
</tr>
<tr>
<td>97211-00</td>
<td>130-8004: Assembly, Cable, Ethernet/Modem, Ext.</td>
</tr>
<tr>
<td>97153-00</td>
<td>130-8015-33: Cable, 130 to GPS, 33ft. (~10m)</td>
</tr>
<tr>
<td>97170-00</td>
<td>130-8019: Cable, NET, 130 to Ethernet RJ45 Hub, Ext.</td>
</tr>
</tbody>
</table>

**Part No.** | **Description** |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>97171-00</td>
<td>130-8023: Cable, NET, 130 to Ethernet RJ45, Crossover, Ext.</td>
</tr>
<tr>
<td>97167-00</td>
<td>130-8075: Cable, Power B, 130S to Battery, 6ft. (~2m)</td>
</tr>
<tr>
<td>97182-10</td>
<td>iFSCW-Kit: iFSC Controller, WiFi Adapter &amp; CD</td>
</tr>
<tr>
<td>97192-00</td>
<td>130-Reader-USB: Reader, CF II/III, External, USB (readers with other interfaces available upon request)</td>
</tr>
<tr>
<td>97134-00</td>
<td>SW-RTI-NC: Software, REF TEK Interface</td>
</tr>
<tr>
<td>97162-00</td>
<td>130-FIeldCASE: Case, Transit (holds one 130, GPS, Cables)</td>
</tr>
</tbody>
</table>

**Phase Error vs. Time**

![Phase Error vs. Time](image)

**Field Operation**

REF TEK has developed two programs for Command / Control of the 130S. iFSC is an iOS app developed to work with iPod touch and iPhone with an iOS of 5.0 or later. REF TEK Interface (RTI) is a set of server / client applications which runs on Windows, Linux, or Solaris notebook / desktop computers. iFSC is used to edit and program the acquisition parameters of the 130S via the WiFi Serial Adaptor. RTCC (part of RTI) is used to edit and program the acquisition parameters of the 130S via the NET connector using standard WEB browsers. Additionally, State-Of-Health monitoring is accomplished with an extensive set of Status commands. The State-Of-Health information includes acquisition status, memory and disk usage, GPS status, main and backup battery voltage, time, and temperature. Additional commands are used to set up network connections and check their status. Data monitoring without stopping acquisition is available. RTDisplay (part of RTI) is a Windows client to RTPD. The data viewer provides browsing of data coming to the RTPD server in real-time..