The Nicolet 2090 Digital Oscilloscope

1 TIME PER POINT
Selects sweep rate. (EXT) provides for user input clocking pulses when a nonlinear sweep is required.

2 STORAGE CONTROL
Hold Last—Retains any displayed signal for analysis.
Live—Restores continuous signal acquisition.
Hold Next—Arms scope to retain the next triggered sweep.

3 RETAIN REFERENCE
Holds one or more reference signals on the screen for easy comparison with live incoming signals. Waveforms stored permanently on diskette may be displayed with live waveforms for quality control or calibration procedures.

4 DUAL CHANNEL INPUTS
Simplicity of offset and range controls eases measurement setup. Separate analog-to-digital converters for each channel.

5 EXPANSION
Vertical and horizontal expansion up to X64 of any section of a waveform without loss of the original data. Signal expands around the intersection of the horizontal and vertical cursors.

6 AUTOCENTER
Automatically centers waveform in expansion. Indicates which waveform is referenced by voltage and time numerics when multiple waveforms are displayed simultaneously.

7 FUNCTION
Selects inversion, subtraction or base line correction (data move) of waveforms. The EXECUTE button performs the selected operation. ΔT, ΔV measurements are simplified using Reset Numerics. Pen outputs are provided at constant slew rates suited for analog XY recorders. Any whole waveform or expanded segment of a waveform becomes a permanent hard copy record in seconds.

8 MEMORY
Allows storage of important signals in one section of memory while live signals are acquired in another. Using memory group selection, up to eight waveforms can be displayed simultaneously.

9 XY
Displays one waveform as a function of the other, without loss of time-related data.

10 INPUT/OUTPUT
Indicates communication with the computer interface. Computer interface options include 13-bit parallel, IEEE-488, and RS-232C. The 2090 is a talker and a listener—it can both send and receive data. This enables a computer to retrieve data, manipulate it, and return it to the 2090 for display. The versatile interfaces can control the disk and storage control functions of the 2090.

11 LONG SWEEP
At digitizing speeds 500 microseconds (1 msec for dual channel) and slower, a continuous 32K signal is recorded on disk (2090-3C with 206 or 207 plug-in only).

12 SEMIAUTOMATIC
When the oscilloscope is manually armed, the next triggered sweep will be stored on the disk.

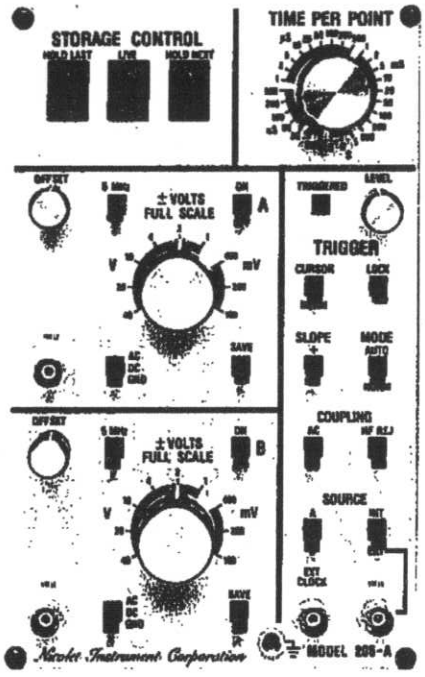
13 AUTOCYCLE
Allows fully automatic data storage—captures transients unattended, filling a diskette with eight 4K records, sixteen 2K records, or thirty-two 1K records.

14 FLOPPY DISK
Single sided, single density, 48 TPI, 5¼″ disk drive.

15 TRACK
Selects disk track for storage or recall of waveforms.

16 PROTECT
When ON, data on this track cannot be destroyed. If an attempt is made to store data on a protected track, the disk will skip to the next available track for storage.

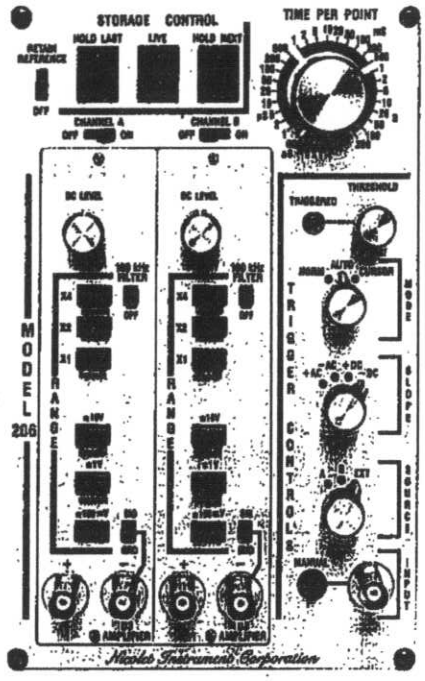
Plug-in Digitizers



205A–High Speed, 2 Channels

8-bits, 50 MHz

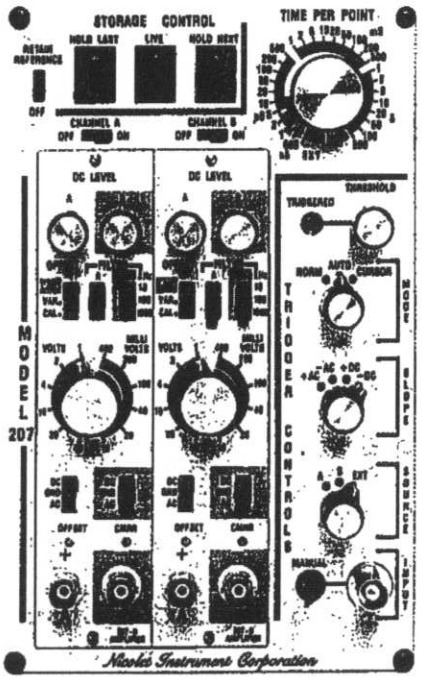
The 205A is ideal for applications in video, electronics troubleshooting, and fast impulse testing. When digitizing at its maximum rate of 20 nanoseconds/point, a 10 microsecond pulse is defined by 500 data points, or a 1 microsecond pulse by 50 points. Each channel has its own separate digitizer, so speed is not sacrificed during dual channel operation. The channel inputs have single-ended amplifiers, 5 MHz filters, AC or DC coupling, and resolution to 0.4%. Like other Nicolet plug-ins, the 205A provides a "save reference" feature for each channel .



206–High Resolution, 2 Channels

12-bit, 2 MHz

This single or dual channel unit sets a high standard for precision digital oscilloscopes. With 0.025% full scale resolution at 500 nanoseconds per point, it is widely used in mechanical, biological, acoustic, ordnance, power and geophysical applications. It has dual differential inputs, 100 KHz filters, low noise and low drift. The 2090's ability to expand any signal portion up to X64 both horizontally and vertically allows you to take full advantage of the 206 plug-in's resolving power.



207–High Resolution: 2 or 4 Channels

4 Channels, 12-bits (100 KHz)
2 Channels, 12-bits (2 MHz)

The 207 is a very versatile addition to any 2090 mainframe. It can be operated just like a 206 for 2-channel operation to 2 MHz, or it can multiplex its two digitizers to attain 4-channel operation at speeds up to 100 KHz (10 μS/pt). Each waveform in a 4-channel operation contains 1024 data points and is located in one of the four quarters of memory. It can be viewed alone or in combination with one or all of the other input signals. The 207 also extends the voltage range selection beyond the sensitivity of other plug-ins by adding ±10, ±20, and ±40 millivolt full scale settings.

Background signals may be subtracted in real time by using differential inputs for 2-channel measurements. 10 KHz, 100 KHz, and 1 MHz filters help reduce high frequency noise, whether running differentially or in the single-ended 4-channel mode.

Save Signals Permanently

Floppy Disks for Instant Retrieval

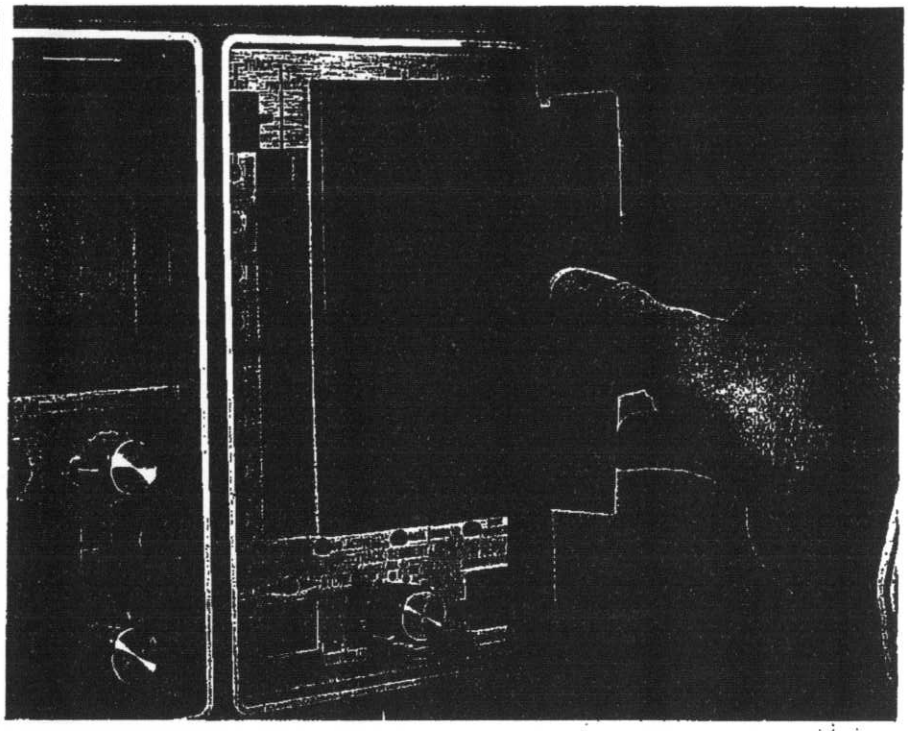
The most accurate data storage is achieved with floppy disks. A waveform stored minutes or years ago can be recalled with all of its original time and voltage parameters. Repeating an important test is unnecessary when you can recall the original signals and reexamine them in detail.

Storage is an easy operation because the disk drive controls are built-in. No keyboards or programming steps are needed. A simple push button operation stores a 4K waveform on one disk track. Eight tracks per diskette allow up to 32K data points on one disk. Waveforms may also be stored on track segments, then recalled into a particular display memory segment for the easy comparison of up to four signals.

Automatic Capture & Store

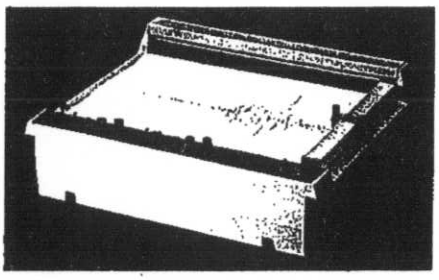
With the unique "autocycle" function, the 2090 captures a transient, sends it to disk, then rearms itself to capture the next event. This process of monitoring, capturing, and storing yields up to thirty-two 1024-point waveforms in unattended operation. Faults in power lines, lightning strikes on communications lines, and equipment failures are examples of intermittent problems the 2090 can easily store on disk while trained personnel are available for other activities.

For digitizing rates slower than 1 KHz, 206 and 207 plug-ins can store one continuous 32K record, providing sweeps of up to 72 days in length.



Hard Copy Records

For permanent report-ready documents the 2090 provides analog outputs to XY recorders. Constant slew rate outputs (0-5 volts) and pen speed controls avoid difficulties stemming from the low writing rates of XY recorders. Any particular waveform section displayed on the screen can be plotted, whether made up of 4096 data points or expanded to show only a small segment of the waveform. This method of creating documents is far superior to the usual photographic snapshots because of its greater accuracy. But for familiar ease and convenience, a camera accessory is also available for the 2090.

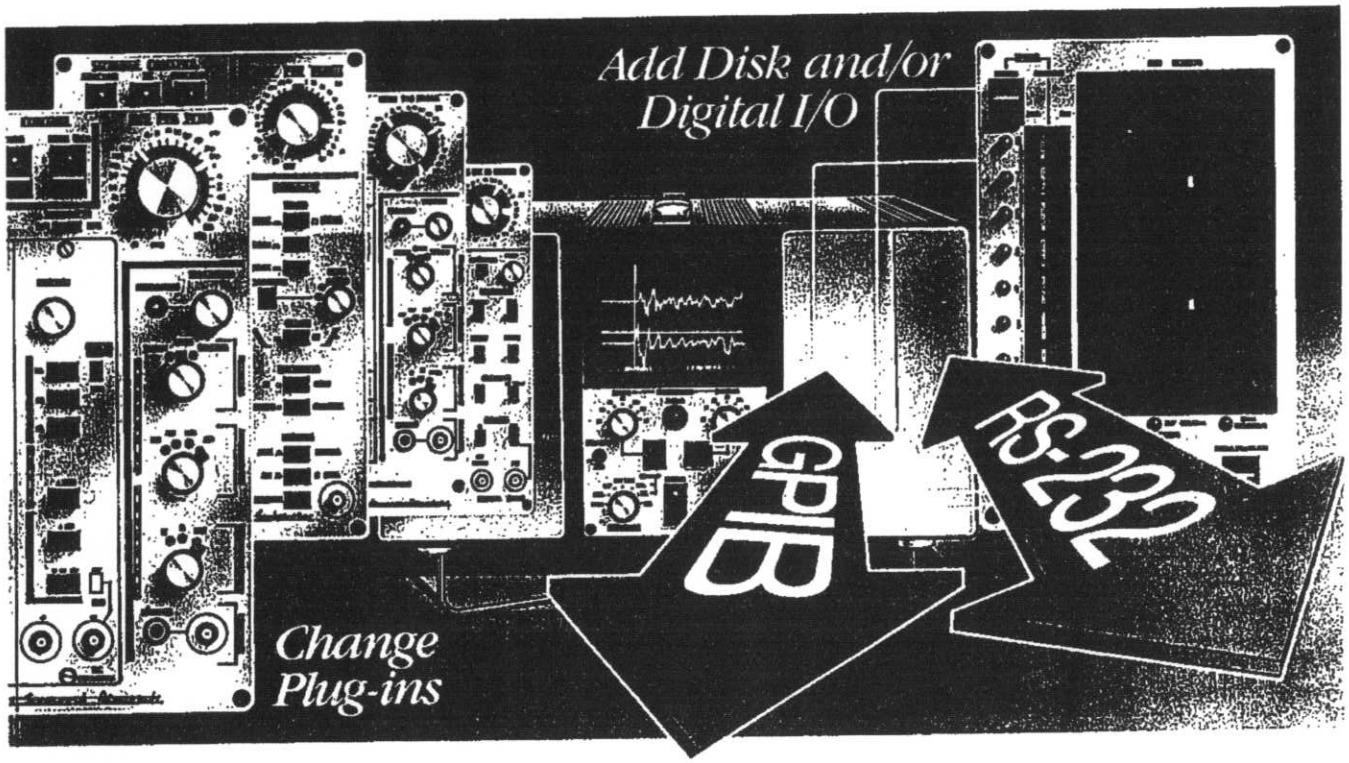


Computers for Storage

An alternative to the 2090's disk storage is permanent storage on a computer. Whether the computer uses floppy disks, hard disks, or tape cartridges, it can become the means of storing waveform information.

Connected via one of the 2090's industry standard interfaces, the computer inputs data point information and stores it for mathematical analysis or for transmission and redisplay on the screen.

A Front End for Data Analysis Systems



When connected to a computer, the 2090 becomes an intelligent digitizer and display device for an entire data analysis system. Two industry standard interfaces (RS-232C and IEEE-488) and a fast parallel interface are available to suit most interfacing needs. All interfaces are fully bidirectional, so signals can be either extracted from the scope's memory or sent back to the memory for display. Signal data may be output to a computer in ASCII or binary format to suit varied programming requirements.

The following program illustrates a simple data transfer of 4096 points to a Hewlett Packard computer. Although written in BASIC, it transfers all the data points in the 2090's memory in seconds.

```
10 DIM D(4096)      Sets dimensions of computer array "D"
20 OUTPUT 715; "D1DO"  Commands oscilloscope to send out data
30 FOR I=1 to 4096  Sets up loop to accept data
40 ENTER 714; D(I)  Inputs data point values into array "D"
50 NEXT I           Loops until 4096 points have been accepted
60 END              End of program
```

Automatic Capture and Store

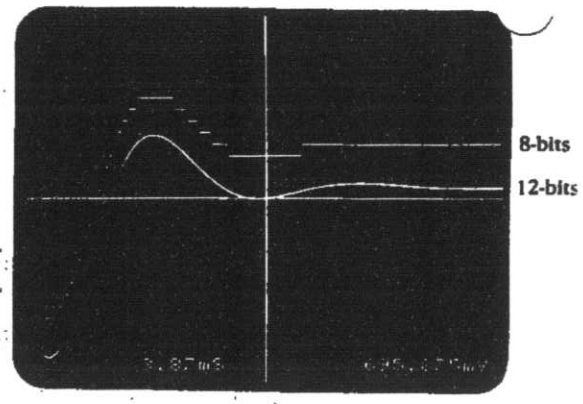
In many testing situations, you may want to sample the input voltages at regular time intervals, perhaps once an hour. The computer-oscilloscope combination can do this. The computer commands the 2090 to arm itself for data capture. When the scope receives a trigger and the sweep is complete, the oscilloscope lets the computer know so that the newly acquired data can be sent out. An hour later, the process is repeated. This type of program may ultimately save a great deal of time and money, for the measurements may be made automatically, without having to tie up the time of technicians and engineers.

Digitizing Rate vs. Resolution—the trade-offs

The time required to convert an analog signal sample to a digital word is highly dependent on the length of the digital word itself. Typical conversion rates are 20 nanoseconds for an 8-bit word (a digitizing rate of 50 MHz) and 500 nsec. for a 12-bit word (2MHz). These rates should not be confused with analog bandwidth. A 20 MHz bandwidth in an analog oscilloscope means that a 20MHz input sine wave will be attenuated 3dB. A 20MHz digitizer sampling the same input would sample only once per cycle. A rule of thumb for both the analog and digital instruments is to use them to look at signals 5-10 times slower than their bandwidth or digitizer rating. With the rapid advance of A/D technology, maximum digitizing rates are expected to increase, but applications in electromechanical design, acoustics, mechanics, electricity, the biological sciences and many other fields are extremely well-served by present digitizing speeds. High accuracy, resolution, and storage are often far more important.

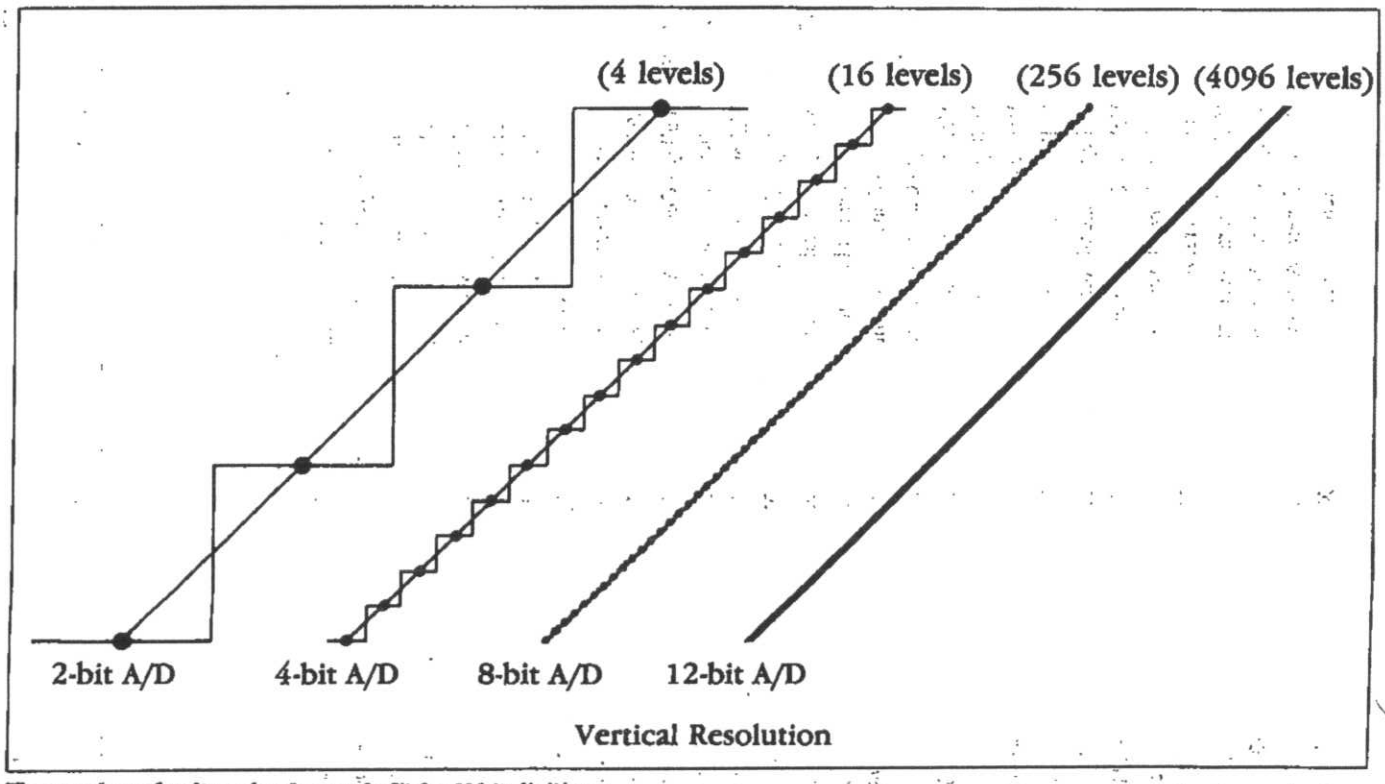
Resolution–Bits, Words and %'s Full Scale

The smallest change discernible on a full scale voltage signal defines an instrument's resolving power. Analog oscilloscope resolution is limited by the thickness of the trace, graticule markings, parallax and the human eye. A good digital oscilloscope totally eliminates these analog inaccuracies by displaying voltage and time values for each individual data point. Resolution in a digital scope depends primarily upon the number of bits in the digitizer word. An 8-bit digitizer resolves 1 in 2^8 to yield a resolution of 1 in 256, or 0.4% of full scale. This means that a change of 4 millivolts is distinguishable on a 1 volt signal. The resolution of some digital scopes reaches 1 in 2^{15}, giving us the ability to detect a change of 30 microvolts on a 1 volt signal. Expansion of important segments



Signal traces showing differences in resolution for 8- and 12-bit digitizers. (Expanded X16 vertically)

of the acquired signal make these small signal variations visible, eliminating the guesswork necessary in analog scopes, whose resolution reaches 2 to 3% of full scale at best.



The number of voltage levels equals 2^N for N-bit digitizers.

Model 2090 Specifications

Mainframe

Memory Size: 4K words x 12-bits.
Addressable Subgroups: Halves (2K), Quarters (1K).
Storage Capacity: Up to 16 waveforms.
Display: 5-inch, high definition.
Expansion: Up to x64, both axes, cursor-interactive.
Numerics
YT Display Mode: Time and voltage.
XY Display Mode: X-voltage and Y-voltage.
Numeric Displays (XY/YT)
Normal: Absolute numerics.
Reset Numerics: Relative numerics.
Autocenter:
Unexpanded Display: Automatic lock of cursor to waveform.
Expanded Display: Automatic waveform centering.
Arithmetic Functions: Subtract, Invert, Data Move.
Pen: Analog output to XY pen recorder.

Disk Recorder

Disk Recorder Type: 5¼" Floppy, 48 TPI, single sided, single density, soft-sectored.
Storage Capacity/Diskette: Eight 4K, sixteen 2K, or thirty-two 1K records.
Record Identification: One L.E.D. per track.
Write Protection: Switchable, track specific.
Autocycle: Automatic, consecutive capture-and-store of up to 32 records.
Long Sweep: Continuous recording of up to 32K of data at sweep speeds of 500 µS per point or slower, (available with plug-in models 206 and 207).

Digital I/O

Interfaces Available: 13-bit Parallel Binary, IEEE-488 (GPIB), RS-232C.
Min. Transfer Times (4K)
- Parallel Binary, 8 milliseconds.
- IEEE-488 (GPIB) ASCII, 7 seconds.
- IEEE-488 (GPIB) binary, 1.5 seconds.
- RS-232C ASCII, 22 seconds.
- RS-232C binary, 9 seconds.

Dimensions (Approx.)

Mainframe
- 16.9 in (W) × 9.9 in (H) × 18.6 in (D).
- 43 cm (W) × 25 cm (H) × 47 cm (D).

Typical Weight

Mainframe (with plug-in & disk recorder): 46 lbs (21 kg).

Power Requirements

101, 115, 202, 230 VAC, ±10%, single-phase, 50-60 Hz (±5%).
300 volt-amperes (for 2090-3).

Model 205-A Plug-in

Vertical Resolution: 8-bits (0.4%).
Sweep Length (max.): 4,096 points.
Inputs: Two single-ended.
Coupling: DC/AC/GND.
Ranges (Full Scale): ±100 mV to ±40 V.
Impedance: 1 Megohm, 47 pF.
Time Base Accuracy: 0.01%.
Digitizing Rate:
Maximum: 20 nS per point.
Minimum: 5 Sec per point.
Filter (switchable): 5 MHz.
Trigger Range
External: ±5V
Internal: 100% Full Scale.
Pretrigger (max): 100% of sweep time.

Model 206 Plug-in

Vertical Resolution: 12-bits (0.025%).
Sweep Length (max.): 4,096 points (Note 1).
Inputs: Two differential.
Coupling: DC/GND.
Ranges (Full Scale): ±100 mV to ±40 V.
Impedance: 1 Megohm, 47 pF.
Time Base Accuracy: 0.01%.
Digitizing Rate
Maximum: 500 nS per point.
Minimum: 200 Sec per point.
Filter (switchable): 100 kHz.
Trigger Range
External: ±3V
Internal: 100% Full Scale.
Pretrigger (max): 100% of sweep time.

NOTE 1: Longer sweeps are possible with the optional disk recorder.

Model 207 Plug-in

Vertical Resolution: 12-bits (0.025%).
Sweep Length (max.): 4,096 points (Note 1).
Inputs: Two differential or four single-ended.
Coupling: AC/DC/GND.
Ranges (Full Scale): ±10 mV to ±40 V.
Impedance: 1 Megohm, 47 pF.
Time Base Accuracy: 0.01%.
Digitizing Rate
Maximum, 2 inputs: 500 nS per point.
Maximum, 4 inputs: 10 µS per point.
Minimum: 200 Sec per point.
Filter (switchable): 10 kHz, 100 kHz, 1 MHz.
Trigger Range
External: ±3V
Internal: 100% Full Scale.
Pretrigger (max): 100% of sweep time.

NOTE 1: Longer sweeps are possible with the optional disk recorder.

Specifications are subject to change without notice.