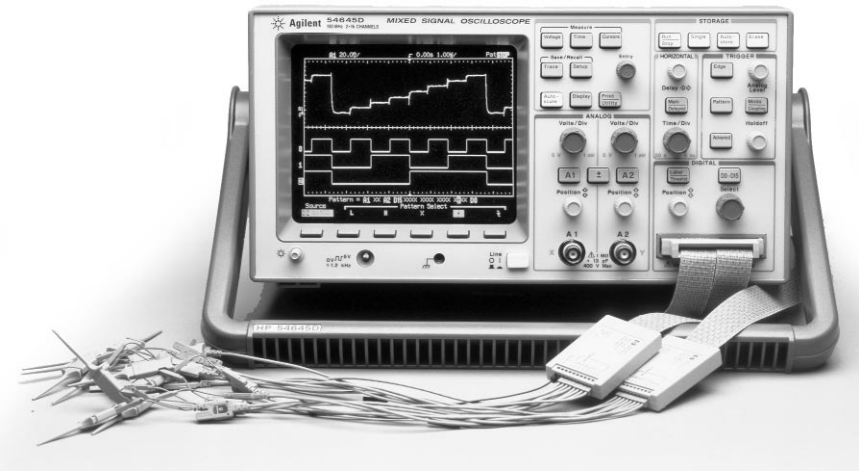
Agilent 54645D
Mixed Signal Oscilloscope

Product Overview



- **Dual-channel 100-MHz scope with 200 MSa/s**
- **1 MB of memory per scope channel**
- **16 logic timing channels with 400 MSa/s on 8 channels (2 MB memory/ch) 200 MSa/s on 16 Channels (1 MB memory/ch)**
- **Ideal for debugging 8- or 16-bit microcontroller systems**
- **MegaZoom technology for easy-to-use responsive deed memory**
- **Simple easy-to-use controls**
- **Powerful triggering**

New mixed-signal testing power

With the introduction of the Agilent Technologies 54645D mixed-signal oscilloscope (MSO) to your lab, you will be able to easily view the complex relationships of your circuit's analog and digital operation. Seamless integration of scope and logic channels in the 54645D MSO allow you to view both the analog circuit operation on the two 100 MHz scope channels and the logic timing displayed on the 16 logic channels. Analog and digital events are aligned in time so that you can easily relate cause and effect in many difficult mixed-signal troubleshooting situations, such as those encountered in debugging 8- or 16-bit microcontroller systems.

The 54645D gives you an oscilloscope-like operation of both the scope and logic channels. For example, simply turn the time-base knob to set the time/division for all scope and logic channels. Press Autoscale for the display of all active analog (scope) and digital (logic) channels. There is no scope-logic mode switch, just a seamless integration of logic channels into a scope.

Agilent MegaZoom Technology

When you try to view analog and digital signals, the events of interest either take place over a long time span or they are widely separated from the trigger event. With 1 million samples per channel, MegaZoom technology captures long time spans while maintaining the high sample rate, allowing you to see the fine detail needed to solve elusive problems.

Before the introduction of the 54645D MSO with MegaZoom technology, deep-memory oscilloscopes were considered specialized tools because of their complex operation, non-responsive control panel, and excessive display dead time. These problems have been greatly reduced with the development of MegaZoom technology, which uses multiple processors optimized for the task of waveform acquisition, storage, and display. Now you can have a deep memory scope in your lab that is also a scope you will use every day, as it is a deep-memory scope that responds instantly to your control inputs, has a high speed, low dead time display and deep memory with easy-to-use pan-and-zoom.

With an easy-to-use control system, the 54645D MSO provides the triggering power you need to troubleshoot problems. You will find it ideally suited for everyday use because of its familiar scope edge triggering mode. This familiar scope mode is the one that can be used to solve most of your problems, as you can trigger on a rising or falling edge on any of the MSO's 18 input channels.

Pattern triggering is provided in the 54645D MSO. This triggering mode allows you to establish a trigger pattern of high, low, and "don't care" levels across all 18 of its channels.

Agilent Technologies

Innovating the HP Way

The advanced mode gives you the choice of glitch, TV, and advanced pattern triggering. In the glitch mode, the 54645D MSO can search for a glitch that is less than a specified width on any of its 18 input channels, allowing you to find abnormally short pulses that may indicate circuit failures. In addition you can search for a pulse that is greater than a specified width or within upper and lower limits.

In advanced pattern trigger mode, the 54645D MSO will search for a combination of two trigger pattern terms. These terms may be combined in one of several Boolean relationships (AND, OR, THEN).

In TV mode the 54645D MSO may be triggered on field 1, field 2, or line of a composite TV waveform.

Computer and hardcopy I/O

For connection to your PC, printer, or workstation, the 54645D is fully compatible with the full line of 546XX interface modules. Select the module that best fits your needs and you are ready to either print the screen or interface to your PC or workstation. With the addition of the 54657A or 54659B Measurement/Storage module you will have both the interface capabilities described above, as well as additional measurements such as FFT.

Software for enhanced connectivity

With the addition of HP BenchLink Scope software for Microsoft® Windows™, you have the ability to easily interface this powerful instrument to your PC. This versatile software, which is compatible with Windows 3.1, 95 or NT, makes the movement of waveform data or trace images fast and easy.

Built to last

The 54645D MSO is designed and built to the rugged requirements of MIL-T-28800. This means that the product is built to withstand the rigors of daily use as you test and debug your circuits, backed up with a three-year warranty.

Specifications

Vertical System

Scope Channels:	CH 1 and 2
Bandwidth (3dB)	dc to 100 MHz @≥ 10 mv/div (> 75 MHz @ < 10 mv/div)
ac coupled	1.5 Hz to 100 MHz
Risetime (calculated)	≈ 3.5 ns @ > 10 mv/div, (< 4.6 ns @ < 10 mv/div)
Dynamic Input Range	± 32 V or ± 8 div whichever is less
Math Functions	channel 1 + or - channel 2
Input Resistance	1 Mohm
Input Capacitance	≈ 13 pf
Maximum Input	400V (dc + peak ac)
Range	1mV/div to 5V/div
Vertical Gain Accuracy	± 1.5% full scale
Vernier	Fully calibrated, accuracy ± 3% full scale
Single Cursor Accuracy	Vertical gain accuracy ± 1% full scale ± 0.5% position value
Dual Cursor Accuracy	Vertical gain ± 0.8% full scale
BW Limit	Approx. 20 MHz
Coupling	ac, dc, GND
Channel Isolation	dc to 20 MHz > 40 dB (with channels at same v/div) 20 MHz to 100 MHz > 30 dB
Inversion	Channel 1 and Channel 2

Logic Channels

16 channels (0-15) in two pods of 8 channels each

Maximum Input Voltage	± 40 volts peak
Threshold Range	± 6.0 volts in 50 mV increments
Threshold Accuracy	± (100 mV + 3% of threshold setting)
Input Dynamic Range	± 10 Volts about threshold
Minimum Input Voltage Overdrive	To meet the timing specifications the threshold value must be within 20% of the 50% voltage point of the input signal
Minimum Input Voltage Swing	500 mV peak to peak
Input Resistance	100 K Ω
Input Capacitance	Approx 8 pF
Channel-to-Channel Skew	2 ns typical, 3 ns max
Pre-defined Thresholds	TTL = 1.4V, CMOS = 2.5V, ELC = -1.3V

Horizontal System, Scope & Logic Channels

Sweep Speeds	50s/div to 5 ns/div main and delayed
Accuracy	± 0.01%
Vernier	Accuracy = ± 0.05%
Horizontal Resolution	40 ps

Scope Cursor Accuracy

Single Channel	Horizontal accuracy ± 0.2% screen width ± 40 ps
Channel to Channel	Horizontal accuracy ± 0.2% screen width ± 80 ps

Logic Cursor Accuracy

Single Channel	Horizontal accuracy ± 0.2% screen width ± 1 logic sample period
Channel to Channel	Horizontal accuracy ± 2% screen width ± 1 logic sample period ± chan-to-chan skew < 10 ppm
Delay Jitter	< 10 ppm

Delay Range

Pre-trigger (negative delay): At least 1 screen width or 2.5 msec

Post trigger (from trigger point to end of sweep): 500 seconds

Delayed Sweep

Delayed timebase can be as fast as 5 nsec/div but must be at least 2X the main timebase. Delayed sweep display is the same data acquisition as was the main.

MegaZoom technology (Post acquisition Pan and Zoom): The time/div and delay controls allow any part of the acquired waveform display to be expanded to the full extent of the memory available.

Trigger System

Modes	Auto, Autolevel, Normal, and Single
Holdoff	≈ 200 ns to ≈ 25 seconds
Edge Triggering	Rising or falling on any of the 18 input channels

Pattern Triggering	A pattern of high, low, and don't care levels and a rising or falling edge can be established across all 18 channels. The analog channel's high level is defined by that channel's trigger level.
Advanced Triggering	Selectable as glitch, advanced pattern, or TV
Glitch	Less than, greater than, or within specified range
Source	Any of the 18 input channels
Polarity	Rising or falling
Minimum Pulse Width Setting	8 ns
Advanced Pattern	Up to two trigger terms (P1 and P2) and two edge terms (E1 and E2) may be established and these terms can be combined as follows: AND, OR, Then, Entered, Exited, Duration <, Duration >, Duration range.
TV	Available on scope channels only
TV Line and Field	0.5 divisions of composite sync required for stable display

Oscilloscope Analog Triggering

Sensitivity	DC to 25 MHz > 10 mV/div ≤ 3.5 div or 3.5 mV < 10 mV/div ≤ 1 div or 2 mV 25 MHz to 100 MHz > 10 mV/div ≤ 1 div or 10 mV < 10 mV/div, ≤ 1.5 div or 3 mV
Sources CH 1, CH 2, and line	

Coupling

dc, ac, HF reject, LF reject, noise reject
HF reject and LF reject -3dB @ 50 kHz.

XY

Bandwidth	100 MHz
Phase error @ 1 MHz	1.8 degrees

Acquisition System

Maximum Display Rate	3 million samples per second with sufficient trigger rate, and vectors off. 60 full screens per second, vectors on
Average	Selectable as smoothing, 4, 8, 16, 32, 64, 128, and 256 averages
Roll Mode	At sweep speeds of 200 ms/div and slower, data moves across the display from right to left with no dead time.

Oscilloscope Acquisition System

Maximum Sampling Rate	200 MSa/s on each channel
Single Shot Bandwidth	50 MHz
Simultaneous capture on both channels	
Vertical Resolution	8 bits
Peak Detection	Can capture and display a pulse at least 5 nsec wide at any timebase setting
Maximum Memory Depth	1 MB samples per channel

Logic Acquisition System

Vertical Resolution	1 bit
Maximum Sampling Rate	400 MSa/s on one pod, 200 MSa/s on two pods
Simultaneous capture on all channels	
Peak Detection	Will capture and display a pulse at least 5 nsec wide at any timebase setting
Maximum Memory Depth	2 MB samples per channel on one pod, 1 MB samples when both pods are used

Display System

Display	7-inch raster monochrome CRT
Resolution	255 vertical by 500 horizontal points
Controls	Front-panel intensity
Vectors	Selectable on/off
Graticle	8 x 10 grid, frame, and none

Advanced Features

Automatic Measurements	(Measurements are continuously updated, markers indicate measurement)
Voltage	V_{AVG} (dc), V_{RMS}, V_{PP}, V_{MIN}, V_{MAX}, V_{TOP}, and V_{BASE}
Time	Frequency, period, + pulse width, - pulse width, duty cycle, rise time and fall time (rise time and fall time are scope only)
Cursors	Manually or automatically placed read out of time, 1/time, voltage. Additionally logic channels can be displayed as binary or hex values.

Setup Functions

Autoscale	Finds and displays all active scope and logic channels, sets edge trigger mode on highest numbered channel, sets vertical sensitivity on scope channels and thresholds on logic channels, time base to display 1.8 periods
Save/Recall (non-volatile)	10 set-ups can be saved and recalled from non-volatile memory
Trace Trace (pixel) Memory	2 volatile
User-Defined Channel Labels	All channels may be assigned a user defined label of up to 6 characters. Labels displayed in place of 1st division of wave form

General

Calibrator Output:	
Frequency	≈ 1.2 kHz
Amplitude	5V

EMI

Commercial	Meets FTZ 1046 class B
Mil-T-28800D	Meets requirements in accordance with paragraph 3.8.3 EMI Type III, and MIL-STD-461C as modified by table XII.
CE01, CE03	Yes
CS01, CS02, CS06	Yes
RE01	15 dB relaxation to 20 kHz; exceptioned from 20 kHz to 50 kHz
RE02 (with Opt 002)	Full limits of class A1c and A1f
RE02 (without OPT 002)	10 dB relaxation from 14 kHz to 100 kHz
RS02	Exceptioned
RS03 (with OPT 001)	Slight trace shift from 80 Mhz to 200 mHz

General Information

Size	35.258 x 17.272 x 31.75 cm, 12.7W x 6.8H x 12.5D in (excluding handle)
Weight	≈ 6.35 kgs (14 lbs)
Power Usage	≈ 90 W
Voltage	88-250 VAC
Line Voltage selection	Automatic
Frequency	45-440 Hz

Environmental Characteristics

This instrument meets the requirements of MIL-T-28800D for Type III, Class 3 Style D equipment as described below.

Shock: Agilent class B1 and MIL-T-28800 style D, Class 3 operating: 30g, 1/2 sine, 11 ms duration, 3 shocks per axis along major axis. Total of 18 shocks.

Vibration Operations: 15 minutes along each of 3 major axes; 0.64 mm (0.025 inch) p-p displacement, 10 Hz to 55 Hz in one-minute cycles. Held for 10 minutes at 55 Hz (4 g at 55 Hz).

Altitude: Operating to 4500 M (15,000 ft), non-operating to 15,000 M (50,000 ft).

Humidity: Operating 95% RH at 40°C, 24 hrs, Non-operating 90% RH at 65°C, 24 hrs
Ambient temperature: Operating -10°C to 55°C, non-operating -51°C to +71°C

Safety: CSA Certification, IEC 348

Ordering Information

54645D Mixed Signal Oscilloscope

Accessories included

Two each Agilent 10074A 10:1 divider probes with readout; 10089A 16 channel logic input probe assembly; Removable front panel ground connector; User's Guide and service manual; power cord.

Accessories and Options Available

Opt. 001 RS-02 magnetic interference shielding added to the CRT
Opt. 002 RE-02 Display shield added to the CRT to reduce radiated interference
OPT 101 10098A Front panel cover and pouch kit
OPT 103 54645A Customer training kit
OPT 104 1185A Carrying case
OPT 106 34810B HP BenchLink Scope software
OPT 1CM 5062-7345 Rack mount kit
OPT W50 Additional two years of warranty
10074A 10X probe with readout
10070A 1X probe
10085A 16:16 logic cable and termination
10089A 16:2 x 8 logic input probe assembly

Modules Fully Supported

* 54650A, GPIB I/O
* 54652B RS-232 and Centronics I/O
* 54657A GPIB Measurement/storage
* 54659B RS-232 and Centronics Measurement/storage
* E2657A GPIB Connectivity kit
* E2658A RS-232 Connectivity kit

* includes measurement/storage module, BenchLink Scope and cable.

Agilent Technologies' Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise

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Operating Characteristics

Operating Characteristics are specified with the Measurement/Storage Module installed on an Agilent 54600–Series Oscilloscope.

Measurements

Voltage	Vamp, Vavg, Vrms, Vpp, Vpre, Vovr, Vtop, Vbase, Vmin & Vmax
Time	Delay, Duty Cycle, Frequency, Period, Phase Angle, Rise Time, Fall Time, +Width, & –Width
Thresholds	User-selectable among, 10%/90%, 20%/80% or voltage levels
Cursor Readout	Voltage, time, percentage, and phase angle.
Waveform Math Functions	Addition, subtraction, multiplication, differentiation, integration, and FFT.

Fast Fourier Transforms

Test Region	Each pixel is selectable to be tested or not.
Inputs	On either ch1, ch2, or F1
Freq Cursor Resolution	From 1.22 mHz (milliHz) to 9.766 MHz (1.22 mHz to 48.828 MHz for 54615/54616)
Points	Fixed at 1024 for all models except 54615/54616 Fixed at 1024 for 54615/54616 with vectors off Fixed at 512 for 54615/54616 with vectors on
Peak Find:	Find Peak automatically snaps cursor to the two largest peaks located anywhere in the displayed frequency span. Measurement information is automatically displayed at the bottom of the screen together with the difference in frequency between the two selected peaks.
Variable Sensitivity and Offset	Sensitivity and vertical offset (position) are controlled from the front panel to display an optimum view of the spectrum. Sensitivity is calibrated in dB per divisions; vertical offset is calibrated in dBV.
Time Record Length	10x main sweep speed.
Horizontal Magnification and Center Frequency Control	As the frequency span is changed, the display is magnified about center frequency so that you get a closer view.

Selectable Windows Four windows are selectable: Hanning, for best frequency resolution and general purpose use; flattop, for best amplitude accuracy; rectangular, for single-shot signals such as transients and signals where there are an integral number of cycles in the time record, and exponential for best transient analysis.

Window Characteristics

Window	Highest Side Lobe (dB)	3dB Bandwidth(bins)	6dB Bandwidth(bins)	Scallop Loss (dB)
Rectangular	–13	0.89	1.21	3.92
Hanning	–32	1.44	2.00	1.42
Flattop	–70	3.38	4.17	0.005

FFT Freq Range dc to 100 MHz (54600/54601/54645)
dc to 150 MHz (54602)
dc to 60 MHz (54603)
dc to 500 MHz (54610/54615/54616)

Freq Span Control This control allows you to specify the frequency span of the FFT display. When the Span is adjusted the display will expand or contract about the center frequency as set by the Center Frequency control. Refer to Figure 3-1 for the limits of the Frequency Span control.

Center Freq Control This control allows you to specify the frequency at the center of the FFT display. When the Frequency Span is changed, the FFT display will expand or contract about the frequency at the center of the display. Refer to Figure 3-1 for the limits of this control.

Move 0 Hz to Left Pressing this soft key will move the FFT display so that the left hand edge of the display will be 0Hz.

FFT Vector display When the time domain display is turned off the FFT display will be displayed in vector drawing mode. The time domain display can be turned off by pressing the Channel # key twice

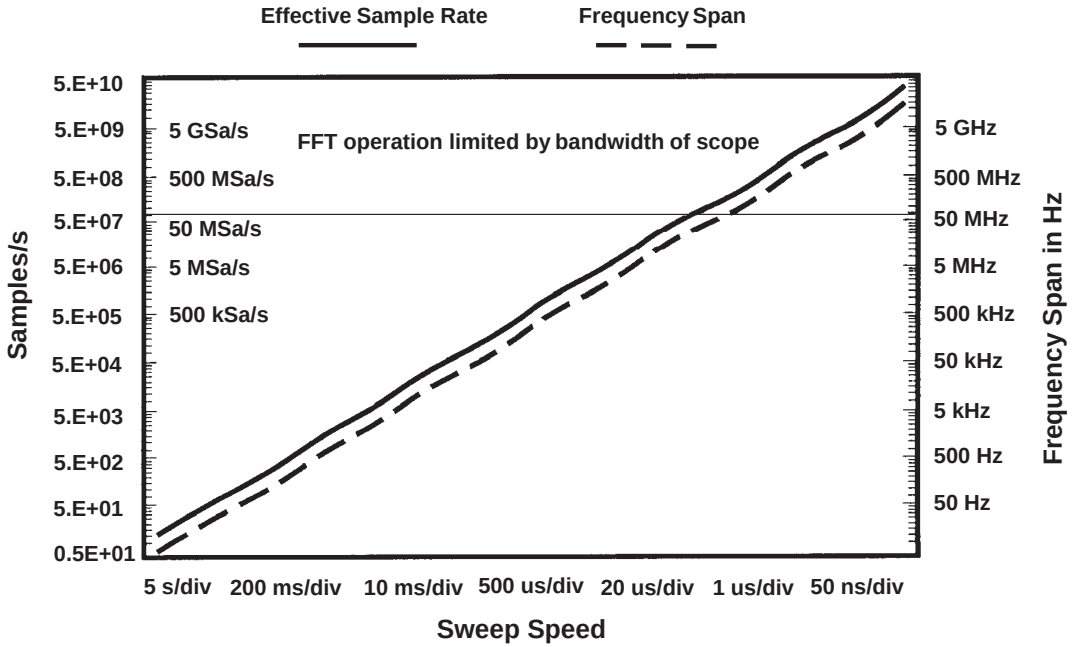
Display FFT vertical units in dB.

Units/Div This control allows you to adjust the vertical scaling of the FFT display in a 1-2-5 sequence from 1 dB/div to 50 dB/div.

Reference Level This control allows adjustment of the reference level of the FFT display across a range of 400 dBV. The minimum setting is -196 dB at 1 dBV/div decreasing to 0 dBV at 50 dBV/div. The maximum setting is 400 dBV at 50 dB/div, decreasing to 204 dB at 1 dBV/div.

Programmability All front-panel controls are fully programmable over GPIB (54657A) or RS-232 (54658A and 54659B)

Figure 3-1



Sweep Speed	Effective Sample Rate	Maximum Frequency Span	Sweep Speed	Effective Sample Rate	Maximum Frequency Span
5 s/div	20 Hz	9.75 Hz	50 µs/div	2 MHz	975k kHz
2 s/div	50 Hz	24.4 Hz	20 µs/div	5 MHz	2.44 MHz
1 s/div	100 Hz	48.85 Hz	10 µs/div	10 MHz	4.885 MHz
500 ms/div	200 Hz	97.5 Hz	5 µs/div	20 MHz	9.75 MHz
200 ms/div	500 Hz	244 Hz	2 µs/div	50 MHz	24.4 MHz
100 ms/div	1 kHz	488.5 Hz	1 µs/div	100 MHz	48.85 MHz
50 ms/div	2 kHz	975 Hz	500 ns/div	200 MHz	97.5 MHz
20 ms/div	5 kHz	2.44 kHz	200 ns/div	500 MHz	244 MHz
10 ms/div	10 kHz	4.885 kHz	100 ns/div	1 GHz	488.5 MHz
5 ms/div	20 kHz	9.75k Hz	50 ns/div	2 GHz	975 MHz
2 ms/div	50 kHz	24.4 kHz	20 ns/div	5 GHz	2.44 GHz
1 ms/div	100 kHz	48.85 kHz	10 ns/div	10 GHz	4.885 GHz
500 µs/div	200 kHz	97.5 kHz	5 ns/div	20 GHz	9.75 GHz
200 µs/div	500 kHz	244 kHz	2 ns/div*	50 GHz	24.41 GHz
100 µs/div	1 MHz	488.5 kHz			
* 2 ns/div FFT valid only on 54615/54616					

FFT Operation
Frequency Span and Effective Sampling Rate vs Sweep Speed

Mask Template Testing	
Number of mask templates	2, nonvolatile
Mask template generation	Automask generates a mask from waveform data with variable tolerances.
	Mask editor allows pixel-by-pixel editing and line drawing editing. Smooth mask function performs a running average of 3 pixels.
Test Region	Each pixel is selectable to be tested or not
Fail Region	Inside-signal fails if it falls inside the region bounded by the maximum and minimum limit lines.
	Outside-signal fails if it falls outside the region bounded by the maximum and minimum limit lines.
Failure indication	Failure zone indicator shows where the signal fails the mask template.
Failure mode	Failure modes are stop or continue on failure. Failure(s) can be saved to trace memory or printed

Trace Memory (all nonvolatile)	
1 through 3	High-speed storage without compression.
4 through 100	Storage with compression, number of traces is a function of complexity. Storage time is less than 10 seconds.

Real Time Clock	
Can be set from front panel.	24-hour format with battery back-up.

Hardcopy Output	
Printer/Plotter Supported	HP ThinkJet, HP QuietJet, HP PaintJet, HP DeskJet, and HP LaserJet printer. HP-GL compatible plotters.
54658A and 54659B only	Epson FX-80 or compatible printer.

RS-232 Configurations

Connector Type	With the adapter cable connected, at the end of the cable is a 9 pin/25 pin DTE port; a printer cable is required to connect it to hardcopy devices or a computer.
Protocols	XON/XOFF, hardware.
Data Bits	8
Stop Bits	1
Parity:	none.
Baud Rates	1200, 2400, 9600, 19200.

Programmability

All instrument settings and operating modes may be remotely programmed via RS-232 and GPIB (IEEE-488).