HP 71600B Series of Error Performance Analyzers and Pattern Generators

Introduction

The HP 71600B Series modular 3 Gbit Error Performance Analyzer and Pattern Generator offers a new, flexible approach to high speed testing.

Two modular measurement products are offered:

The HP 71603B provides complete solutions for error performance analysis to 3 Gbit/s.

The HP 71604B is a high-performance pattern generator operating to 3 Gbit/s.

Both products include the HP 70004A color display and the HP 70001A mainframe.

The differences in the products are shown in the following table.

	Error Performance Analyzers	**Pattern Generators**
	HP 71603B 100 Mbit/s to 3 Gbit/s	**HP 71604B 100 Mbit/s to 3 Gbit/s**
Color Display	HP 70004A	HP 70004A
Mainframe	HP 70001A	HP 70001A
Pattern Generator Module	HP 70841B	HP 70841B
Error Detector Module	HP 70842B	-
Clock Source Module	HP 70311A	HP 70311A

Both HP 71600B Series products can be adapted by, for example, adding extra modules. A test solution can also be built which includes modules in almost any combination.

With compliments
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General Information

Remote Control

HP-IB Interface and Capability:

Operates according to IEEE standard 488.1 and 488.2, 1987. Also conforms, where appropriate, to the Standard Commands for Programmable Instruments (SCPI) standard 1990.0

Capability:

SH1,AH1, T6, TEO, L4, LEO, SR1, RL1, PP0, DC1, DT0, C1, C2, C3, C28.

Modes:

Addressable or Controller.

Addressable:

An external Controller has access to all the current results, status and alarms and can control all module functions except HP-IB, HP-MSIB addresses and power switch. An HP 71600B Series System cannot be configured as a Controller over HP-IB by a Controller.

Controller:

The HP 70842B error detector module can print results using an external printer over HP-IB without an external Controller.

Power Requirements

Voltage Range:

Selectable 100, 120, 220 and 240 V ac (±10%) nominal.

Frequency Range:

44 to 66 Hz and 400 Hz nominal.

Power Consumption:

HP 71604B or HP 71603B: 1000 VA max.
All module power requirements are supplied by the mainframe or display.

Environmental

Operating Temperature Range:

0°C to 45°C.

Storage Temperature Range:

-40°:C to +65°:C.

Humidity:

Operation 15% to 95% relative humidity at 40°C, non-condensing.

EMC:

Conducted and Radiated interference is in compliance with CISPR Pub 11, FTZ 526/1979, and MIL-STD 461B RE02/part 7.

Noise:

LpA < 70 dB	LpA < 70 dB
operator position	am Arbeitsplatz
normal operation	Normaler Betrieb
per ISO 7779	nach DIN 45635 T. 19

Calibration Interval:

Recommended one year.

Options

Option 100:	Delete HP 70311A or HP 70312A clock source module
Option 200:	Delete HP 15680A RF accessory kit.
Option 910:	One additional set of Operating, Verification and Installation manuals.
Option 908:	484 mm (19 in) rack mount kit for equipment without front handles fitted.
Option 913:	484 mm (19 in) rack mount kit for equipment with front handles fitted.
Option +W30:	Two years additional hardware support beyond the standard one year warranty.

Ordering Information

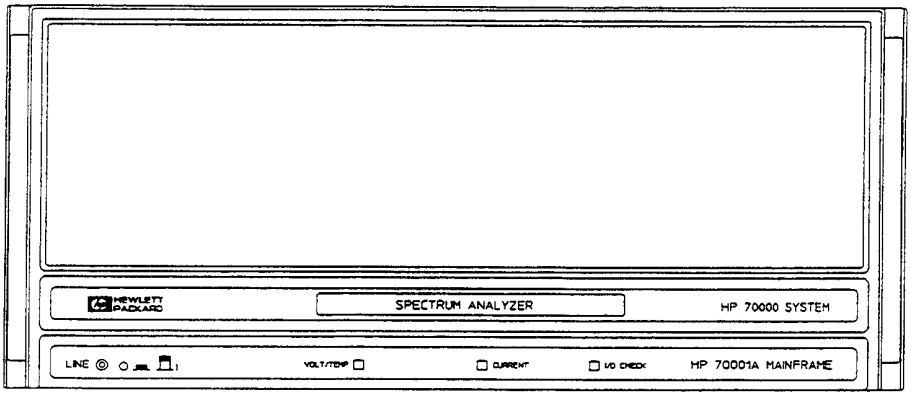
For advice on how to order individual instruments, modules, accessories or manuals refer to the HP 71600B Series Technical Data Sheet (HP Part number 5091-2911E).

Instrument and Module Descriptions

Introduction

An explanation is given here of the mainframe, display and modules that comprise an HP 71600B Series Error Performance Analyzer or Pattern Generator system. For detailed information on the HP 70001A mainframe and HP 70004A display refer to the Operating manuals provided with these instruments. The instruments and modules are described individually, rather than as part of a system.

HP 70001A Mainframe

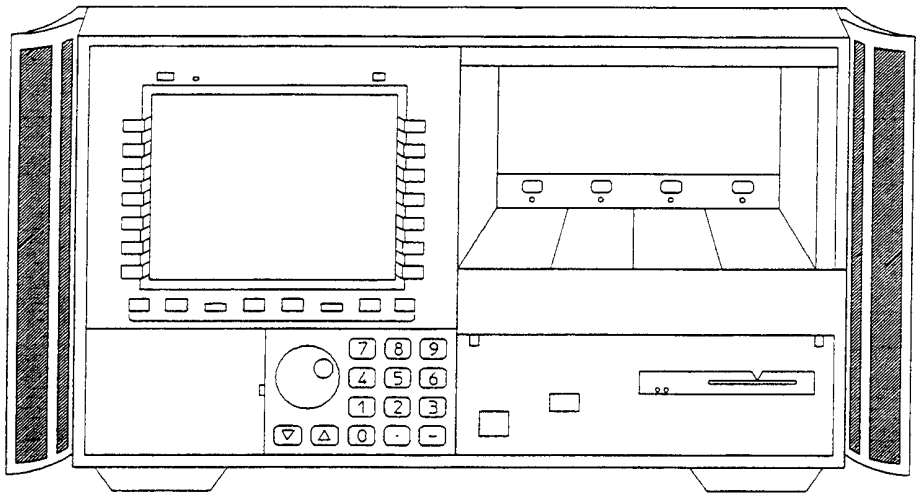


Description

The HP 70000 Modular Measurement System mainframe provides the structural environment for plug-in instrument modules along with cooling, power, and digital communication bus interface. It is compatible with 1/8, 1/4, 3/8 and 1/2 width modules and has a maximum capacity of eight one-section (1/8 width) modules. Rack compatibility is provided and benchtop use is facilitated with integral bails and optional handles.

Two digital control buses are provided: HP-IB for remote operation in automatic test applications, and a new high performance bus called (Module System Interface Bus) for intermodule communication. The mainframe has good EMC performance (MIL-STD 461B) and has been designed to withstand the rigors of tough, industrial environments. It provides a solid, reliable base around which error performance analyzer systems may be easily configured.

HP 70004A Graphics Display



Description

The HP 70004A display provides a graphic display and menu-driven interface for the HP 70000 Modular Measurement System. The display section of the HP 70004A fulfills the same function as the HP 70206A system graphics display or the HP 70205A graphics display module. The mainframe section of the display also provides the structural environment for plug-in instrument modules along with cooling, power, and digital communication interface buses.

The display shows system configuration information, measurement results, text, graphics, and built-in trace in up to 16 simultaneous colors (selectable from a palette of 4096 colors) at a resolution of 1024 horizontal by 400 vertical pixels. Menu keys are used to establish an interactive front panel for any modular instrument. A 7.5 inch diagonal display screen, menu keys, data and control keys, and a digital knob assist system operation. The display may be stacked or racked with the HP 70001A system mainframe or located remotely away from the rest of the system.

The displays mainframe can accommodate 1/8, 1/4, 3/8, and 1/2 width modules, and has a maximum capacity of four 1/8-width modules. Standard rack compatibility is provided, and bench-top use is enabled with retracting bails and built-in handles.

The HP-MSIB supports high-speed digital communications between modules within the display and instruments connected to the external HP-MSIB loop.

Every module in the display has access to the standard Hewlett-Packard Interface Bus (HP-IB). This bus provides a path of communication among controllers, other HP-IB instruments, and individual modules. The ac power input is switchable between several ranges.

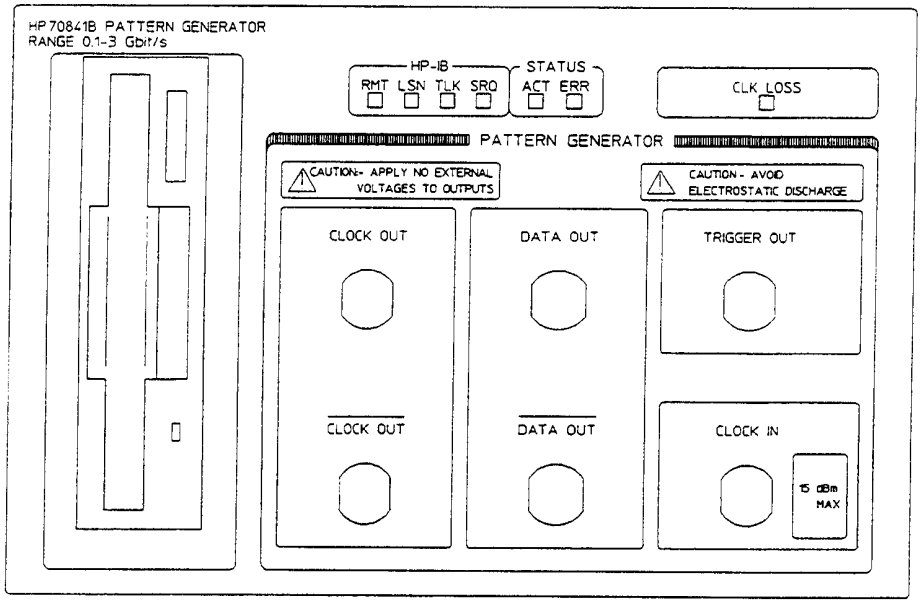
- 87-132V ac, 47-66 Hz
- 174-264 Vac, 47-66 Hz
- 87-132 V ac, 356-444 Hz

The display power supply processes the ac line power to produce regulated 40 kHz ac power for the modules, 5V dc for the HP-MSIB, dc power for the cooling fan, and a TTL-compatible line synchronization signal.

A fan provides cooling for both the display and up to four 1/8-width modules.

Note: The memory card shipped with the HP 70004A display can not be used with the HP 71600 Series Error Performance Analyzer or Pattern Generator systems.

HP 70841B Pattern Generator



Description

The HP 70841B pattern generator module in Hewlett-Packard's Modular Measurement System (MMS) occupies a 4/8 module slot and has eight Input/Output ports, six on the front panel and two on the rear panel. A floppy disc drive enables the user to store user defined patterns up to 4 Mbits in length.

Specifications

The following gives an abbreviated version of pattern generator module specifications; refer to the HP 71600B Series Installation and Verification manual for detailed specifications.

Operating Frequency Range

HP 70841B: 100Mbit/s to 3 Gbit/s

Patterns

The following test patterns are provided:

PRBS Test Patterns:

- 2^{31}-1, polynomial $D^{31}+ D^{28}+1=0$, inverted.
- 2^{23}-1, polynomial $D^{23}+ D^{18}+ 1=0$, inverted (as in CCITT Rec 0.151).
- 2^{15}-1, polynomial $D^{15}+ D^{14}+ 1=0$, inverted (as in CCITT Rec 0.151).
- 2^{10}-1, polynomial $D^{10}+ D^{7}+ 1=0$, inverted.
- 2^{7}-1, polynomial $D^{7}+ D^{6}+ 1=0$, inverted.

Zero Substitution/Variable Mark Density Test Patterns

- 8192 bits, based on 2^{13}-1 PRBS;
- 2048 bits, based on 2^{11}-1 PRBS;
- 1024 bits, based on 2^{10}-1 PRBS;
- 128 bits, based on 2^{7}-1 PRBS;

Zero Substitution

Zeros can be substituted for data to extend the longest run of zeros in the above patterns. The longest run can be extended to the pattern length, minus one. The bit after the substituted zeros is set to 1.

Variable Mark Density

The ratio of 1s to total bits in the above patterns can be set to 1/8, 1/4, 1/2, 3/4 and 7/8.

Word Test Patterns

Variable length user patterns from 1 to 4194304 bits are provided.
Resolution from:
1 to 32 kbits in 1-bit steps.
32 kbits to 64 kbits in 2 bit steps
64 kbits to 128 kbits in 4 bit steps
128 kbits to 256 kbits in 8 bit steps
256 kbits to 512 kbits in 16 bit steps
512 kbits to 1 Mbits in 32 bit steps
1 Mbits to 2 Mbits in 64 bit steps
2 Mbits to 4 Mbits in 128 bit steps

Pattern Stores

Four internal user pattern stores capable of holding up to 8192 bits, and eight disc pattern stores capable of storing up to 4 Mbits of data are provided.

Alternating Word Test Patterns

Alternate between two user-programmable 16-bit words under the control of the rear-panel Auxiliary input; changeover is synchronous with the end of the word.

Alternate Patterns

Switch between two patterns (A and B) with the switch occurring at the end of a pattern. There are two modes of operation as follows:

- Switch between two data patterns (A and B), for example from (A to B) or (B to A).
- Enable a single insertion of a number of instances of pattern B to be output. The number of *B* instances is equal to the smallest integral multiple of the pattern length, that divides exactly by 128.

Patterns A and B must be as follows:

- The same length.
- 1 bit to 2 Mbits in length.

Resolution

1 bit to 16 kbits in 1 bit steps
16 kbits to 32 kbits in 2 bit steps
32 kbits to 64 kbits in 4 bit steps
64 kbits to 128 kbits in 8 bit steps
128 kbits to 256 kbits in 16 bit steps
256 kbits to 512 kbits in 32 bit steps
512 kbits to 1 Mbits in 64 bit steps
1 Mbits to 2 Mbits in 128 bit steps

Add Errors

Single errors or fixed error rates from one error in 10^9 bits to one error in 10^3 bits may be added to the data. External errors may be input to the data via the rear panel ERROR INJECT port.

Error Inject

The rear panel ERROR INJECT input adds a single error to the data output for each rising edge (TTL levels) at the input.

Trigger Pulse

When a pure PRBS is selected (2^{n-1}), the TRIGGER OUTPUT produces a pulse which is either synchronized to the pattern (Pattern mode) or is the input clock divided by 32 (Clock/32 mode).

In PATTERN mode the trigger pattern that the user has entered is matched to the pattern being generated and a trigger pulse is output when the two correspond. If an alternating - word pattern is selected the trigger output pulse is either a regenerated version of the rear panel *AUX* input, which is used to switch between the words or the input clock divided by 32.

Trigger Pattern for Zerosub PRBS, Mark Density PRBS, or User Pattern

When either of the above patterns are selected the trigger pattern is selected with the `TRIGGER BIT` softkey, and can be set anywhere within the pattern.

Alternate Pattern Trigger

When an alternate pattern is selected, the user can select between a trigger pulse synchronized to the input or one pulse per pattern.

Frequency Measurement

Measure the incoming clock frequency to five significant digits. If an integral MMS clock source is used (for example HP 70311A or HP 70312A) then the frequency set up on this clock is displayed to ten significant digits.

Status Indicators

Front Panel LEDs:

Clock Loss: Indicates nominal low clock power at Clock Input.
HP-IB and HP-MSIB: Six LEDs indicate status.

Clock Input/Output and Data Output

Specifications for the Clock Input, Data Output and Clock Output ports, and Trigger Output are given in the HP 71600B Series Installation and Verification manual.

AUX INPUT

Introduction

The rear panel AUX INPUT port can be used to control alternate patterns, alternate words or inhibit data. The following paragraphs explain each mode of operation.

Auxiliary Input Control of Alternate Patterns

Path

(MENU) `select pattern` `user pattern` `ALT PAT CONTROL` `SOURCE AUX USR`

When `ALT PAT CONTROL` and `SOURCE AUX` are selected the instrument will output one of two patterns (A or B). The setting of the `OUTPUT ALT ONCE` softkey, and the signal at the rear panel AUX INPUT control which pattern is output in one of two modes as follows:

- `ALT` selected: The logic state of the signal at the AUX INPUT determines which pattern is output. A logic zero will output pattern A.
- `ONCE` selected: The rising edge of a signal (pulse width >100 ns) at the AUX INPUT causes a number of instances of pattern B to be output. The number of pattern B instances is equal to the smallest integral multiple of the pattern length that divides exactly by 128.

Note 

In both modes switching between patterns is at the end of a pattern and is hitless or error free.

Auxiliary Input Control of Alternate Words

Path

(MENU) `select pattern, more 1 of 3, alt words`

In Alternate Word mode two user-definable sixteen bit words, WORD 0 and WORD 1 are generated. The rear panel AUX input is used to switch between WORD 0 and WORD 1 at the end of either pattern. A TTL level signal is necessary at the AUX input to switch between words, TTL low selects WORD 0 and TTL high selects WORD 1.

If Alternate Word is selected and there is no input signal present at the AUX input, WORD 1 is selected. The following figure illustrates how the AUX input signal switches the Data Output between WORD 0 and WORD 1, and also gives the position of the Pattern Trigger Output pulse relative to the AUX input signal.

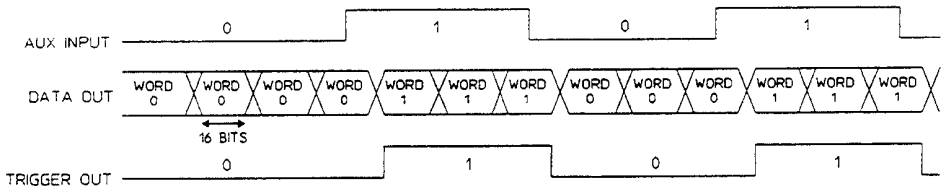


Figure 1-1. AUX Input Timing Diagram

Data Output Inhibit

If neither an alternate pattern nor an alternate word are selected, the data output pattern is gated to zero when the AUX INPUT signal is active (TTL low). See figure 1-2.

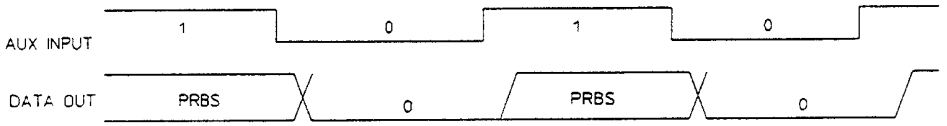
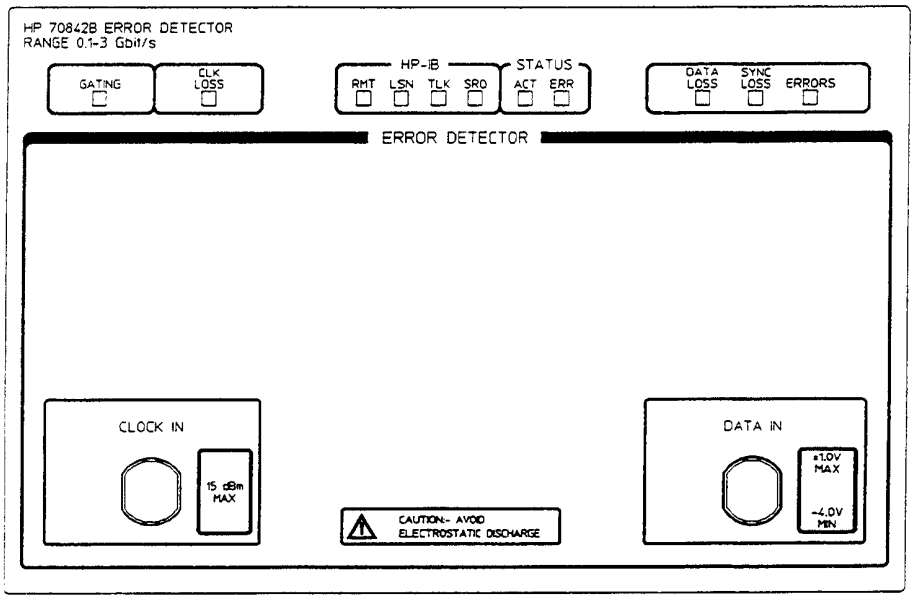


Figure 1-2. Data Output Inhibit

HP 70842B Error Detector



Description

The HP 70842B error detector module complements the pattern generator module.

The HP 70842B occupies 4/8 MMS module slot and has five Input/Output ports, two on the front panel and three on the rear panel.

Specifications

The following gives an abbreviated version of the error detector module specifications; refer to the HP 71600B Series Installation and Verification manual for detailed specifications.

Operating Frequency Range:

HP 70842B: 100Mbit/s to 3Gbit/s.

Patterns

PRBS, zero substitution/variable mark density test patterns, and word test patterns are as specified for pattern generator modules.

Error Measurements

The Error Detector counts bit errors by comparing the incoming data bit-by-bit with the internally generated reference pattern. All measurements run during the gating periods, with the exception of Delta Error Count and Delta Error Ratio which run continuously. The measurements performed are:

- Error Count
- Delta Error Count
- Error Ratio
- Delta Error Ratio
- Errored Intervals (second, decisecond, centisecond, millisecond)
- Error Free Intervals (second, decisecond, centisecond, millisecond)
- Error Count 0 → 1
- Error Count 1 → 0
- Error Ratio 0 → 1
- Error Ratio 1 → 0

Error Analysis

The error analysis measurements are based on CCITT Rec G.821 and derived from the bit error results.

- %Unavailability
- %Availability
- %Errored Seconds
- %Severely Errored Seconds
- %Degraded Minutes

Power-loss Seconds

Displayed as the number of seconds the error detector is not able to perform measurements during a gating period due to ac-power-loss. The gating continues to the end of the selected period following restoration of power.

Frequency Measurement

The incoming clock frequency is measured and displayed to five significant digits.

Measurement Definitions

Refer to Appendix B for definitions of measurements performed by HP 71600B Series Systems.

Measurement Period

Real-time Clock:

Provides time and date information for event logging. Battery back-up allows clock to continue running when the instrument is switched off or power fails.

Gating Periods:

There are three gating (measurement timing) modes: Manual, Single and Repeat.

Manual:

Gating period is controlled by the Run/Stop Gating keys. Accumulating results are displayed throughout the measurement and the end of measurement results are held until a new gating period is started.

Single:

Gating period is started by pressing the `RUN GATING` softkey and terminates at the end of the gating period set by the user or when the `STOP GATING` softkey is pressed. Accumulating results are displayed throughout the gating period and the end of gating results are held until a new gating period is started.

Repeat:

Similar to Single but when one timed gating period ends, a new identical period starts. This continues until the measurement is terminated by pressing the Stop Gating key. The measurement results displayed during any period can be the final results of the previous period or the accumulated results for the current period. There is no *deadtime* between consecutive periods.

Gating Period Format

The gating period format can be specified in one of three modes.

- A time period ranging from 1 second to 99 days, 23 hours, 59 minutes, 59 seconds, (resolution 1 second).
- The time for a number of errors to occur, (resolution 1 second). The number of errors can be 10, 100 or 1000.
- The time for a number of bits to be received, (resolution 1 second). The number of bits can be in the range 1E7 through 1E15 in decade steps.

Results summary can be logged to an external printer over HP-IB at the end of each consecutive period.

Gating after a Power Loss

On instruments configured for Master/Slave operation and with AUTO sync selected, gating will restart after a power loss in the following manner.

ON regaining power after a power loss the error detector will attempt to regain sync for approximately 25 seconds.

- If sync is regained within 25 seconds gating will restart immediately.
- If after 25 seconds has elapsed and sync has not been regained, gating is forced to start.

Gating Period Elapsed % Display

This display shows the percentage of gating period which has elapsed (time, errors or bits). When gating by errors or bits, it is a feature of the error detector that the displayed value can be greater than 100%. This arises because the gating period is only completed at 1 second boundaries. If the error or bit threshold is exceeded before the next 1 second boundary occurs then one of the following will be displayed:

Condition	Display
Threshold $\leq$ Count $<$10 $\times$ Threshold	100 to 999
Count $\geq$10 $\times$ Threshold	*****

ERROR OUTPUT

The rear panel ERROR OUTPUT port produces an NRZ output pulse when errors occur.

Pattern Synchronization

Synchronization to the incoming pattern can be performed automatically or manually. In manual mode, the Sync Start key forces the error detector to attempt synchronization with the received pattern.

Sync Gain/Loss Criteria:

Synchronization is gained when the measured error rate is less than the set sync threshold. Synchronization loss occurs when the measured error rate exceeds the selected sync threshold. Selectable thresholds between 1 x 10^{-1} and 1 x 10^{-8} are provided.

Sync Gain Times

For most RAM based patterns synchronization should occur in approximately 2 to 3 seconds. However synchronization times are dependent on pattern length and pattern content, and will increase as pattern length increases. For very long patterns (for example 4 Mbits) times could be of a minute or more.

Clock and Data Inputs

Refer to the HP 71600B Series Installation and Verification manual for detailed specifications for these inputs.

ERROR COUNT INHIBIT (on rear panel)

An ECl (active high) signal present at the input will inhibit the error counting of errors in the instrument for a multiple of 16 clock periods.

TRIGGER OUTPUT (on rear panel)

The trigger output pulse is synchronous with the error detector reference pattern. For RAM based patterns the pulse position can change as follows following a resynchronization:

- The absolute position of the pulse can vary by 15 bits.
- The position of the trigger pulse relative to a pattern generator trigger can vary by a number of pattern lengths for patterns which are not a multiple of 128 bits.

Result Logging

Results can be logged to most standard HP-IB 80 column printers. There are two modes of operation; with and without an external controller.

With an external controller, information on results, status and alarms is provided for the controller.

Without an external controller, the error detector module can be set in controller mode to permit output of results, status and alarms to an external printer or other logging device.

Print Modes

Two modes are provided:

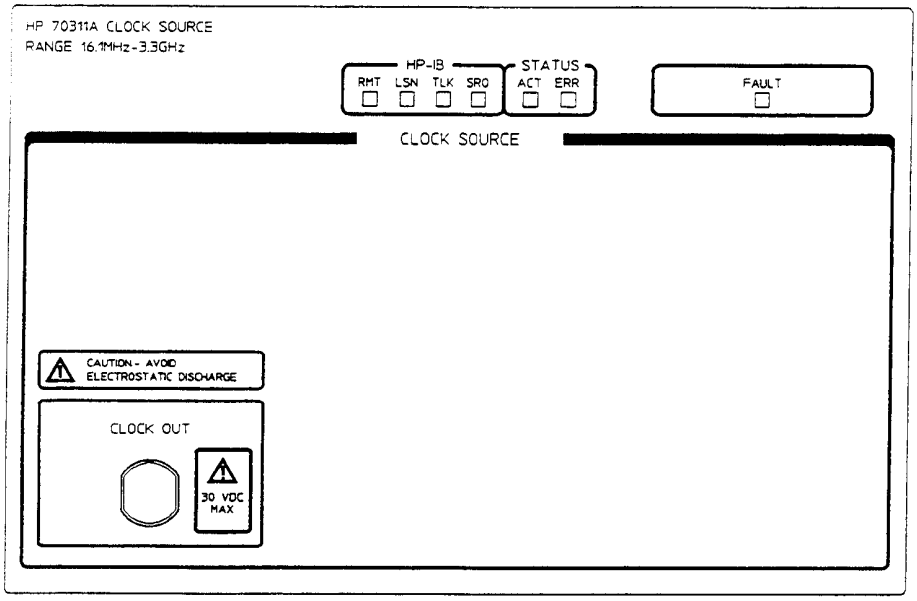
On-Demand:	Prints time-of-day and selected set of results when `Log On Demand` key is pressed.
Gating:	Logs time-stamped events during gating and/or a user selected summary of measured results and alarm durations at the end of each gating period. A conditional printing trigger can be set so that printing occurs only on errors or error ratios exceeding a value selected by the user.

Status Indicators

Front Panel LEDs:

Gating:	Signifies measurements in progress.
Clock Loss:	Indicates nominal low clock power at Clock Input.
Data Loss:	Indicates no transitions in the last decisecond. Under certain circumstances, this LED will not be illuminated when there is no signal connected to the DATA IN port. With no input, 'auto-threshold' sets the input 0/1 threshold to the mean of the idle input. Noise is seen as valid transitions around that threshold. The Data Loss indicator is operative when 'manual threshold' is selected and the 0/1 threshold level altered from the 'auto-threshold' mean value.
Sync Loss:	Illuminated in accordance with sync gain/loss criteria as specified.
Errors:	Indicates one or more data errors in the last decisecond.
HP-IB/MSIB:	Six LEDs indicate status.

HP 70311A/HP 70312A Clock Source Modules



Description

The HP 70311A and HP 70312A modules are synthesized clock sources designed to operate from 16 to 3300 MHz and 16 to 1500 MHz respectively. Both modules are part of the Hewlett-Packard Modular Measurement System (MMS) and may be used as a clock source for the HP 71600B Series of error performance analyzers and pattern generators, or any other MMS system with a suitable display (for example HP 70004A).

The clock source contains a non-volatile memory store which can be used to store and recall 10 user-definable instrument setups.

User Interface

The HP 70311A clock source does not itself have a display or keyboard capability. It formats information suitable for an MMS display and communicates with the display over the HP-MSIB interface. The HP 70312A clock source user interface is identical to the HP 70311A. The recommended display for use with the clock source is the HP 70004A.

Using Softkeys to Select User Functions

Clock source functions are set up using softkeys on either side of the display.

Specifications

The HP 70311A/HP 70312A clock source, Operating and Calibration manual (Part number 70311-90000) provides detailed information on specifications, installation and user operation.