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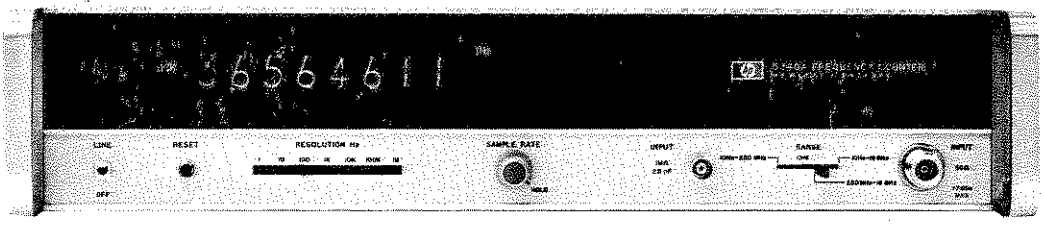
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5235A-3C

OPERATING AND SERVICE MANUAL

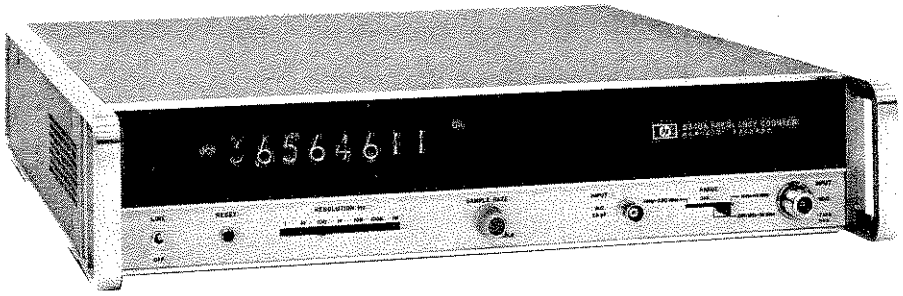
FREQUENCY COUNTER

5340A



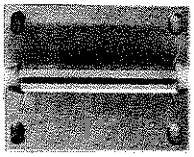
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Figure 1-1. Model 5340A Frequency Counter, Rack Mount Kit, and Power Cord



Model 5340A

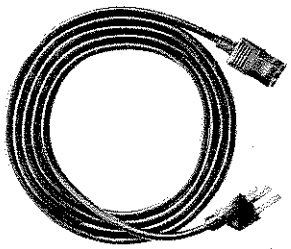








Rack Mount Kit



Power Cord

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION

1-2. The Hewlett-Packard Model 5340A Frequency Counter measures frequencies from 10 Hz to 18 GHz. Sensitivity is -30dBm (7.07 mV) from 10 Hz to 500 MHz, -35dBm (3.98 mV) from 500 MHz to 10 GHz and -25dBm (12.6 mV) from 10 GHz to 18 GHz. The counter makes direct measurements from 10 Hz to 250 MHz and uses an automatic transfer oscillator technique for frequencies above 250 MHz. Features include a single input connector for the entire frequency range, excellent AM and FM characteristics, eight-digit display, auto-amplitude discrimination, variable resolution from 1 Hz to 1 MHz, fast acquisition time, and wide dynamic range.

1-3. Electrical and mechanical specifications are listed in Table 1-3.

1-4. INSTRUMENT IDENTIFICATION

1-5. Hewlett-Packard instruments have a 2-section, 10-character serial number (0000A00000), located on the rear panel. The 4-digit serial prefix identifies instrument changes. The 5-digit number is the serial number of each instrument. If the serial prefix of your instrument differs from that listed on the title page of this manual, there are differences between this manual and your instrument.

1-6. For lower serial prefixes it will be necessary to backdate this manual to conform with your instrument. Refer to Section VII for a listing of the changes needed.

1-7. For higher serial prefix 5340A's, changes were made after this manual was published and it will be necessary to change this manual to conform with your instrument. A manual change sheet is included with this manual. If the change sheet is missing, contact your local Hewlett-Packard office.

1-8. APPLICATIONS

1-9. Since one input connector accepts all signals from 10 Hz to 18 GHz, the 5340A is particularly adaptable to automatic systems and high speed production testing. The high sensitivity is extremely useful in microwave measurements where signal levels are typically below the sensitivity of most counters. When the 5340A is equipped with Option 003, all front panel functions can be remotely programmed. In addition, the remote programming option allows for digital outputing and programming of the octave ranges of the internal phase lock loops. Octave range selection allows for measurements in a single frequency band to reduce the acquisition time to typically less than 25 milliseconds. Other options include rear panel input connectors Option 002, and high-stability time base Option 001.

1-10. OPTIONS

1-11. The 5340A can be ordered with the following options: Option 001, high-stability time base; Option 002, rear panel input connectors; and Option 003 remote programming and digital output. Table 1-3 lists the specifications for the options; Section VII describes field installation and gives an overall description of each option. Section II covers programming for Option 003.

1-12. EQUIPMENT SUPPLIED AND ACCESSORIES AVAILABLE

1-13. Table 1-1 lists equipment supplied and Table 1-2 lists accessories available.

Table 1-1. Equipment Supplied

Description	HP Part Number
Detachable Power Cord 7-½ ft. (231 cm) long	8120-1378
Rack Mount Kit (see Table 6-1 for a listing of parts)	05326-60046

Table 1-2. Accessories Available

Description	HP Part Number
ASCII to Parallel BCD Converter (Interfaces 5340A equipped with Option 003 to HP 5050A, 5050B, 5055A, or 562A Digital Recorders). Includes interconnect cable to 5340A.	K01-5340A
Digital Recorder (Use with K01-5340A above).	5055A
Interconnect Cable (Connects K01-5340A to 5050A/B, 5055A, or 562A Digital Recorders).	562A-16C
Interface Kit (For use with HP Computers and 5340A's equipped with Option 003).	59310A
Interface Kit (For use with HP 9820A Calculators and 5340A's equipped with Option 003).	11144A Option 20
ASCII Connecting Cables (Each cable end has stacked male and female type 57 connectors to allow multiple cable connections). 3 feet 6 feet 12 feet	 10631A 10631B 10631C

Table 1-3. Specifications

SIGNAL INPUT

Input 1

Range: 10 Hz to 18 GHz.
Symmetry: Sine wave or square wave input (40% duty factor, worst case).
Sensitivity: -30dBm, 10 Hz to 500 MHz; -35dBm, 500 MHz to 10 GHz; -25dBm, 10 to 18 GHz.
Dynamic Range: 37dB, 10 Hz to 500 MHz; 42dB, 500 MHz to 10 GHz; 32dB, 10 GHz to 18 GHz.
Impedance: 50Ω.
VSWR: <2:1, 10 Hz to 12.4 GHz; <3:1, 12.4 to 18 GHz.
Connector: Precision Type N
Coupling: DC to load, AC to instrument.
Damage Level: +30dBm ±7V dc (total power not to exceed 1W)
Acquisition Time: <150 ms mean typical.

Input 2

Range: 10 Hz to 250 MHz direct count.
Sensitivity: 50 mV rms. 150 mV p-p pulses to 0.1% duty factor minimum pulse width 2 nsec.
Impedance: 1MΩ shunted by <25 pF. Option 002 (rear panel input) 1MΩ shunted by <100 pF. 50Ω termination (provided for front panel input) required to meet all specifications with Option 002 installed.
Connector: Type BNC female.
Coupling: AC.
Maximum Input:
10 Hz to 100 Hz 200V rms.
100 Hz to 100 kHz 20V rms.
100 kHz to 250 MHz 2V rms.

Automatic Amplitude Discrimination: The counter will automatically select the largest of all signals present (250 MHz to 18 GHz phase-lock range), provided that signal is 20dB (10dB typical) larger than any other.

Maximum AM Modulation: Any modulation index as long as the minimum voltage of the signal is not less than the sensitivity specification. For example, with a -10dBm input signal at 10 GHz, 94.5% modulation index will cause the signal to drop to -35dBm (4 mV) at its lowest amplitude and would be the limit of modulation.

TIME BASE

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: $<\pm 3 \times 10^{-7}$ per month.
Short Term: $<5 \times 10^{-10}$ rms for 1 second averaging time.
Temperature: $<\pm 2 \times 10^{-6}$ over the range of -20°C to +65°C.
Line Variation: $<\pm 1 \times 10^{-7}$ for 10% line variation from 110V or 230V.
Output Frequency: 10 MHz ≥2.4V square wave (TTL compatible) available from rear panel BNC.

External Time Base: Requires 10 MHz approximately 1.5V p-p sine wave or square wave into 1 KΩ via rear panel BNC. Switch selects either internal or external time base.

Table 1-3. Specifications (Continued)

OPTIONAL TIME BASE (Option 001)

Option 001 provides an oven controlled crystal oscillator time base with an aging rate near that of a time standard. This option results in better accuracy and longer periods between calibration. A separate power supply keeps the crystal oven ON and up to temperature when the instrument is turned off as long as it remains connected to the power line.

Frequency: 10 MHz.
Aging Rate: $<\pm 5 \times 10^{-10}$/day after 24 hour warm-up[1] and $<1.5 \times 10^{-7}$/year.
Short Term Stability:
1×10^{-11}/1 s Avg. time.
1×10^{-11}/10 s Avg. time.
2×10^{-11}/100 s Avg. time.
Line Variation: $<\pm 5 \times 10^{-10}$ 10% change[2].
Temperature: $<\pm 1 \times 10^{-8}$ frequency change over a -55°C to 65°C temperature range.
$<\pm 2.5 \times 10^{-9}$ over 0 to 40°C range.
Warmup: Within 5×10^{-9} of final[3] value 15 minutes after turn-on, at 25°C.
Frequency Adjustment Range: $>2 \times 10^{-6}$ (>±40 Hz from 10 MHz) with 18-turn control.
Frequency Adjustment: 1×10^{-9} (0.01 Hz) 18-turn control.

GENERAL

Accuracy: ±1 count ± time base error.
Resolution: Front panel switch selects 1 MHz, 100 kHz, 10 kHz, 1 kHz, 100 Hz, 10 Hz, or 1 Hz.
Display: Eight in-line long life display tubes with positioned decimal point and appropriate measurement units of kHz, MHz, or GHz.

"DIR" lamp indicates measurement is direct.

"LOCK" lamp indicates phase-lock has been achieved and measurement technique is indirect.

GATE" lamp indicates measurement is in progress.

"RMT" lamp indicates instrument is controlled via external or remote device.

"OVFL" indicates most significant digits will not be displayed. Digits displayed when "OVFL" is lighted are accurate ±1 count ± time base accuracy. "OVFL" is necessary for some high frequency measurements where resolution of 100 Hz, 10 Hz, or 1 Hz is required.

"*" lamp indicates Option 001 crystal oven time base is in the process of warming up (10-15 min. approximately).

Self-Check: Counts and displays 10 MHz for resolution chosen.

Sample Rate: Controls time between measurements. Continuously adjustable from approximately 200 milliseconds to 5 seconds. Hold position holds display indefinitely. Reset button resets display to zero and activiates a new measurement.

Operating Temperature: 0° to 50°C.

Power: 115V or 230V ±10%, 50-60 Hz, 100 VA.

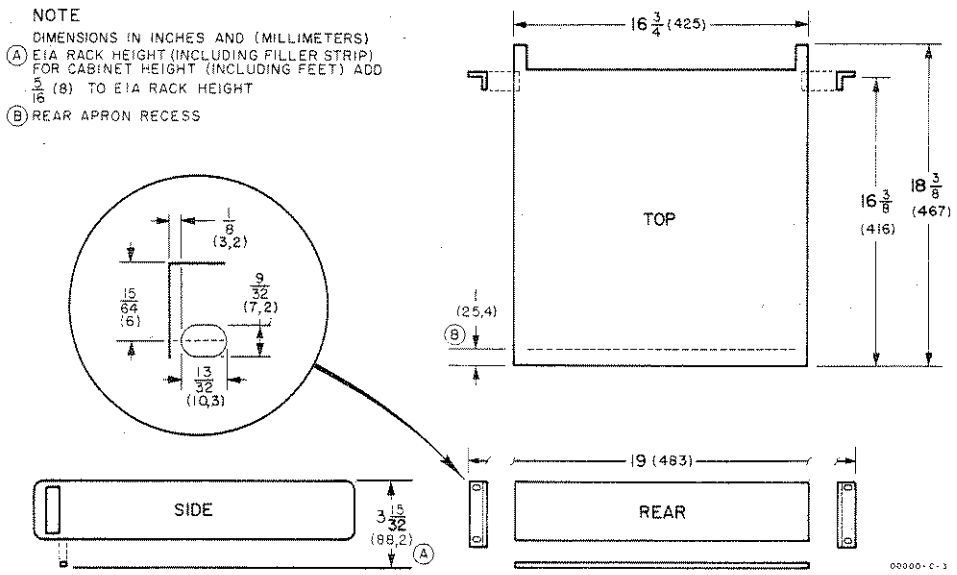
Weight: Net: 25 lb. (11, 3kg). Shipping: 31 lb. (14, 1kg).

[1]For oscillator off-time less than 24 hours.
[2]1 minute required for unit to stabilize.
[3]Final value is defined as frequency 24 hours after turn-on.

Table 1-3. Specifications (Continued)

GENERAL (CONTINUED)

Dimensions:



Accessories Furnished: Power cord 7½ ft (200 cm), NEMA plug (HP Part Number 8120-1378).

Accessories Available: 59310A Interface Kit for use with 5340A Option 003 and Hewlett-Packard computers.
11144A, Option 20 Interface Kit for use with 5340A Option 003 and Model 9820A Calculator.
ASCII (Option 003) to parallel BCD converter K01-5340A.

Rear Panel Connectors (Option 002)

This option provides input connectors on the rear panel. Input specifications remain the same. Input 1 (Type N) is on the rear panel in place of installation on the front panel. Input 2 (BNC) is available on the front and rear panels. Input impedance is reduced to 50Ω.

Remote Programming and Digital Output (Option 003)

Option 003 adds the capability of digital outputting and remote programming via a 24-pin, series 57 microribbon connector on the rear panel marked DIGITAL INPUT/OUTPUT. The TTL and DTL compatible, bi-directional bus consists of eight data lines plus seven status and control lines. Both program and output information are seven-bit ASCII (USA Standard Code for Information Interchange) characters. The are passed over the data lines on a character-serial basis.

Connector: 24-pin female Amphenol #57-20240-2, HP #1251-3283.
Mating connector male, Amphenol #57-10240, HP #1251-0389.

SECTION II

INSTALLATION AND REMOTE PROGRAMMING

2-1. INTRODUCTION

2-2. This section tells how to set up the 5340A Frequency Counter. Instructions for unpacking, inspecting, installing, and remote programming are included.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, inspect the counter for visible damage (scratches, dents, etc.). If the counter is damaged, notify the carrier and the nearest Hewlett-Packard Sales and Service Office immediately (offices are listed at the back of this manual). Keep the shipping carton and packing material for the carrier's inspection. The Hewlett-Packard Sales and Service Office will arrange for repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5. INSTALLATION REQUIREMENTS

CAUTION

BEFORE CONNECTING THE INSTRUMENT TO AC POWER LINES, BE SURE THAT THE LINE SELECTOR IS PROPERLY POSITIONED.

2-6. LINE VOLTAGE REQUIREMENTS. The 5340A is equipped with a line voltage switch to select 115-volt or 230-volt ac operation. Before applying power, the rear panel screwdriver-operated switch must be set to the correct position ("115" or "230" visible) and the correct fuse (as labeled on the rear panel) must be installed. See Figure 3-4 for rear panel features.

2-7. LINE FREQUENCY REQUIREMENTS. The counter will operate at line frequencies between 48 Hz and 66 Hz.

2-8. THREE CONDUCTOR POWER CABLE. To protect the operator, the counter uses a grounded three-conductor detachable power cable. The male connector end is a NEMA type connector, and the female connector end is a C.E.E. type connector that mates with the 5340A rear panel power connector. Connect the power cable to a power source receptacle with a NEMA grounded third conductor. If the line power receptacle is a standard two-pin type instead of the NEMA three-pin receptacle, use a two-to-three pin adaptor (HP Part No. 8120-1348) and connect the green pigtail on the adaptor to ground.

2-9. TEMPERATURE LIMITS. Maximum and minimum allowable operating temperatures are listed in Table 1-3. If these limits are exceeded at the installation site, auxiliary cooling or heating should be used to keep the environment within limits.

2-10. RACK INSTALLATION. The counter is ready for bench operation as shipped from the factory. Additional parts necessary for rack mounting are packaged with the instrument. To convert the instrument to rack installation, refer to Figure 6-1 for parts identification and proceed as follows:

a. Remove tilt stand MP14 by removing the two outside front feet MP11 from the bottom cover MP9. The feet are removed by pressing the foot-release button and sliding the foot toward the center of the instrument.

b. Remove the remaining three feet from the bottom cover.

c. Remove the two adhesive-backed trim strips MP1 from side frames MP3 and MP12.

d. Using the three screws provided, attach the filler strip from the rack mount kit along the front of bottom cover MP9.

e. Attach the flanges from the rack mount kit to the front end of side frames MP3 and MP12. Orient the larger corner notch toward the bottom of the instrument.

2-11. REPACKING FOR SHIPMENT

2-12. If it becomes necessary to reship a counter, good commercial packing should be used. Contract packaging companies in many cities can provide dependable custom packaging on short notice. Instruments should be packed securely in a strong corrugated container (350 lb/sq. in bursting test) with suitable filler pads between the instrument and container. Before returning instruments to Hewlett-Packard, contact the nearest Hewlett-Packard Sales and Service Office for instructions.

2-13. ENVIRONMENT DURING STORAGE AND SHIPMENT

2-14. Conditions during storage and shipment should normally be limited as follows:

a. Maximum altitude: 25,000 feet
b. Minimum temperature: -40°F (-40°C).
c. Maximum temperature: +167°F (+75°C).

2-15. REMOTE PROGRAMMING AND DIGITAL OUTPUT

2-16. Option 003 adds remote programming and digital output capability to the 5340A Frequency Counter. These are accomplished with a bi-directional bus, via a 24-pin connector on the rear panel marked DIGITAL INPUT/OUTPUT. Associated with this connector are six slide switches used to address the instrument. A 5340A can be addressed to either send output data (TALK) or to accept program information (LISTEN). For the purposes of the Option 003 description, several terms are defined as follows:

a. A TALKER is the sender of information on the bus.

b. A LISTENER is the receiver or acceptor of information on the bus.

c. A CONTROLLER is an instrument that has the responsibility of managing the instruments connected to the bus. It is capable of addressing other instruments on the bus as TALKERS or as LISTENERS. It is a TALKER and may be a LISTENER.

d. "High" or "Ø" level of a line or switch is the relatively more positive signal level (≥2.4V).

e. "Low" or "1" level of a line or switch is the relatively less positive signal level (≤0.4V).

2-17. What Can Be Programmed

2-18. All front panel switch functions, except power, are programmable. Also, the 5340A's octave range and its output mode can be selected. In addition, a controller can command the 5340A to make a measurement by sending either a SAMPLE TRIGGER or RESET instruction. The controller can elect to give control to the front panel controls (LOCAL) or have the 5340A operate according to the information stored in its remote program storage cells (REMOTE). These are listed in Table 2-3 along with their associated codes.

2-19. When addressed to output, the 5340A sends a string of 16 ASCII characters (USA Standard Code for Information Interchange). It includes the measurement technique (direct or by using phase locked loops), overflow, eight data digits (blank display digits are outputed as 0's) E

followed by the appropriate multiplier to make the reading Hz, and a word terminator. Table 2-4 lists the order outputed and a description of the 16 output characters.

2-20. Bus Description

2-21. The 15-line bus consists of 8 data lines plus 7 control and status lines. Addresses, program and output information are communicated on the data lines. These are based on a character-serial, seven-bit ASCII code set.

2-22. Three control lines are used to execute the transfer of each byte of information on the data lines. They employ an interlocked "handshake" technique to pass information. This allows for asynchronous data transfer without timing restrictions being placed on either the 5340A or its controller. One line is driven by the 5340A to inform the controller of its status. The controller uses the three remaining lines to manage the 5340A's on the bus.

2-23. Several 5340A's can be connected to a common bus. The exact number depends on the drive capability of the controller (see LINE CHARACTERISTICS). A specific 5340A is made to send output data (TALK) or accept program data (LISTEN) by addressing it to do so.

2-24. All bus lines have been given names and mnemonic acronyms that convey the message being carried on that line. Each line is described below, followed by a table listing the relationship of the Multiple Response Enable and the three handshake lines. Also a Figure is included showing the signal levels and timing relationship of the handshake and data lines. ALL INSTRUMENTS CONNECTED TO THE BUS, INCLUDING THE CONTROLLER, MUST OBEY THESE DESCRIPTIONS.

a. SERVICE REQUEST (SRQ)

By setting SRQ low, a 5340A indicates to the controller that it has completed a measurement and is ready to output. It drives SRQ only if programmed to "WAIT" in the output phase of its operating cycle until addressed to output. When programmed in the other output mode "output ONLY IF addressed", the 5340A sets SRQ high at all times. When SRQ is high, service is not being requested.

If two or more 5340A's are connected to the bus and one of them sets SRQ low, the controller must go through a process of elimination to determine which one requests service. It does this by addressing each one to TALK in an orderly manner. Only the 5340A with output information will respond.

b. REMOTE ENABLE (REN)

REN can be used by a controller to select remote or local (front panel) control of the operating of a 5340A. It works in conjunction with the information stored in the local-remote program storage cell (see Table 2-3). When REN is low and the 5340A has been sent an ASCII "0", it will operate according to the information previously stored in its remote-local program storage cells. It operates according to its front panel controls for all other combinations of these, i.e., REN is low and the remote-local storage cell contains an ASCII "N" or when REN is high regardless of what is stored in the remote-local cell. ASCII "N" is stored in the local-remote program storage cell when either the power is turned on or the RESET pushbutton is depressed.

c. END OUTPUT (EOP)

A controller uses EOP to clear the bus. When it sets EOP low, all 5340A's immediately stop driving the data lines (DIO1 through DIO7) and handshake lines (RFD, DAC, and DAV). EOP will not clear a 5340A's service request (SRQ). A controller may drive EOP low at any time. When EOP is high, it has no effect on the bus operation. The 5340A monitors EOP at all times.

d. MULTIPLE RESPONSE ENABLE (MRE)

MRE is used by a controller to address a 5340A. The 5340A monitors MRE at all times. When MRE is low, all 5340A's connected to the bus interpret the information on the data lines as an address. They will handshake on the appropriate lines and will not drive the data lines. The 5340A requires the controller to hold MRE low for 1 μsec before it sets the handshake line DATA VALID low.

When MRE is high, a 5340A that has been addressed to TALK will drive the data lines. Those that have been addressed to LISTEN will interpret the information on the data lines as program data. Those that have not been addressed will not drive the data lines.

e. DATA LINES (EIGHT-BITS DIO1, DIO2...DIO8)

DIO1 through DIO7 carry data between the 5340A and its controller. The 5340A drives these lines when it has been addressed to TALK. The 5340A receives information on the data lines when addressed to LISTEN or when MRE is low. DIO8 is permanently terminated in the 5340A.

When a DIO line is high, the data bit is a logic zero (Ø).

When a DIO line is low, the data bit is a logic one (1).

f. READY FOR DATA (RFD)

RFD is the handshake line that indicates LISTENERS are ready to accept information on the data lines. Its relationship to the other handshake lines and MRE is shown in Figure 2-1 and Table 2-1.

RFD is driven by LISTENERS: all 5340A's when MRE is low and those instruments addressed to listen when MRE is high. It is sensed by TALKERS: the controller when MRE is low, and the instrument addressed to talk when MRE is high.

When RFD is high, all listeners are unconditionally ready for data. The TALKER may, at its own time, put a byte of information on the data lines and set DAV low. When RFD is low, one or more listeners are not ready for data.

When the controller sets MRE low, all 5340A's will set RFD to its valid state within 200 ns. When the controller sets MRE high, all 5340A's that have not been addressed to listen will not drive RFD.

The listener must not set RFD low until it senses DAV is low. It may do so before or at the same time that it sets DAC high. It must not return RFD high until it senses DAV is high and may do so before, or at the same time that it sets DAC low.

g. DATA ACCEPTED (DAC)

DAC is the handshake line that indicates the acceptance of information on the data lines. Its relationship to the other handshake lines and MRE is shown in Figure 2-1 and Table 2-1.

DAC is driven by LISTENERS: all 5340A's when MRE is low and those instruments addressed to listen when MRE is high. It is sensed by TALKERS: the controller when MRE is low and the instrument addressed to talk when MRE is high.

When DAC is high, all LISTENERS have unconditionally accepted the byte of information on the data lines and no longer need it. The TALKER may, at its own time set DAV high, remove that byte of information and continue. When DAC is low, one or more LISTENERS have not accepted the information on the data lines.

When the controller sets MRE low, all 5340A's will set DAV to its valid state within 200ns. When the controller sets MRE high, the 5340A's that have not been addressed to listen will not drive DAC.

The listener must not set DAC low until it senses DAV is high. It may do so before or at the same time that it sets RFD high. It must not return DAC high until it senses DAV is low and may do so before or at the same time that it sets RFD low.

h. DATA VALID (DAV)

DAV is the handshake line that indicates the validity of information on the data lines. Its relationship to the other handshake lines and MRE is shown in Figure 2-1 and Table 2-1.

It is driven by TALKERS: the controller when MRE is low and by the instrument addressed to talk when MRE is high. It is sensed by LISTENERS: all 5340A's if MRE is low and by the instruments addressed to listen when MRE is high.

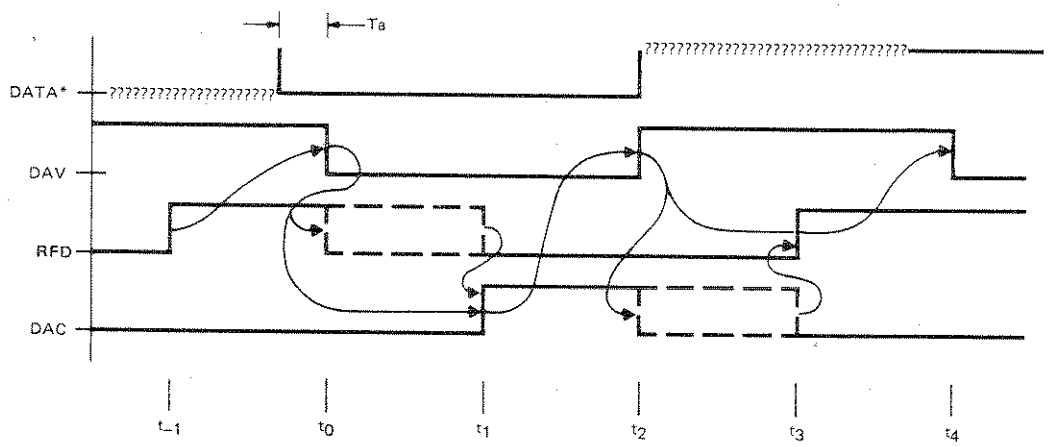
When DAV is low, the states of data lines DIO1 through DIO7 are unconditionally valid and may be accepted by all listeners at their own time. To allow for cable rise time, ringing, etc., the 5340A, when addressed to TALK, does not set DAV low until 2 μsec after it has placed valid data at its output connector. It assumes that the controller has taken similar precautions. DAV can only be driven low if RFD and EOP are high. When DAV is high, the information on the data lines is not valid. DAV cannot be set high unless DAC is high and RFD is low.

Table 2-1. Relation of MRE and the Handshake Lines (RFD, DAC, DAV)

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">READY FOR DATA (RFD)</th><th colspan="2">DATA ACCEPTED (DAC)</th><th colspan="2">DATA VALID (DAV)</th></tr>
<tr><th>LOW</th><th>HIGH</th><th>LOW</th><th>HIGH</th><th>LOW</th><th>HIGH</th></tr>
<tr><td rowspan="4">STATE of MULTIPLE RESPONSE ENABLE LINE (MRE)</td><td rowspan="2">LOW</td><td>One or more 5340A's not ready for data</td><td>All 5340A's are ready for data</td><td>One or more 5340A's has not accepted the data</td><td>All 5340A's have accepted the data</td><td>Controller has valid data on lines</td><td>Controller's data not valid</td></tr>
<tr><td colspan="4">(1) Driven by all 5340A's
(2) Sensed by controller
(3) 5340A's drives to its valid state within 200 ns of MRE going low</td><td colspan="2">(1) Driven by controller
(2) Sensed by 5340A's</td></tr>
<tr><td rowspan="2">HIGH</td><td>One or more LISTENERS are not ready for data</td><td>All addressed LISTENERS are ready for data</td><td>One or more LISTENERS have not accepted data</td><td>All addressed LISTENERS have accepted the data</td><td>The addressed TALKER has valid data on lines</td><td>The addressed TALKER'S data not valid</td></tr>
<tr><td colspan="4">(1) Driven by ALL instruments addressed to LISTEN
(2) Sensed by the instrument addressed to TALK
(3) All instruments not addressed will not drive</td><td colspan="2">(1) Driven by the instruments addressed to TALK
(2) Sensed by ALL instruments addressed to LISTEN</td></tr>
</table>

Figure 2-1. Handshake Timing

SEQUENCE REQUIREMENTS OF THE THREE WIRE HANDSHAKE



EVENTS

t_{-1} : Listener becomes ready to accept data.

t_0 : Talker has put data on the lines at $t_0 - T_a$ and indicates the data is valid.

t_1 : Listener has accepted the data and no longer requires it held valid.

t_2 : Talker indicates the data is no longer valid and may change it.

t_3 : Listener indicates it is ready for new data.

t_4 : A new cycle begins (equivalent to t_0).

T_a : Time data is put on lines before DAV is set low.

*A composite of the DIO1 through DIO7 lines for illustrative purposes.
(The curved lines indicate interlocked signal sequence.)

2-25. Data Transfer

2-26. Transfer of data on the bus is asynchronous. It places no restrictions on the data rates of instruments connected to the bus. The timing and levels required to transfer a byte of information on the data lines are shown in Figure 2-1. Transfer is under the control of three handshake lines DAV, RFD, and DAC. The TALKER (sender of data) drives DAV (Data Valid) and the LISTENER (acceptor of data) drives both RFD (Ready for Data) and DAC (Data Accepted).

2-27. The transfer of a byte is initiated by the LISTENER signifying it is ready for data by setting RFD high. When the TALKER recognizes RFD is high and has placed valid data on the data lines it sets DAV low. When the LISTENER senses that DAV is low and is finished using the data, it sets DAC high. Notice that the assertive or action state of both RFD and DAC is high. Since all instruments on the bus have their corresponding lines connected together (e.g., RFD), all LISTENERS must be in a high state before that line goes high. This wire-AND situation allows a TALKER to recognize when the slowest listener has accepted a byte of data and is ready for the next byte.

2-28. Let's look at the timing of the transition to the non-assertive state for these lines. DAV may be driven high by the TALKERS after it recognizes that DAC is high. RFD may be set low as soon as the LISTENER recognizes that DAV has been set low. The 5340A requires RFD to be set low no later than 50 nsec after the LISTENER sets DAC high. When the 5340A is a listener it drives RFD low at the same time it sets DAC high. The timing of DAC is similar to RFD, i.e., it may go low as soon as DAV is high and it must be low no later than 50 nsec after RFD is driven high. The 50 nsec permits a controller, when working with only one 5340A on the bus, to generate either DAC or RFD and invert it to get the other.

2-29. Addressing the 5340A

2-30. Before a 5340A can send output data or accept program information it MUST be addressed to TALK or LISTEN. The method used to address it depends on the rear panel switch marked TALK ALWAYS — ADDRESSABLE (See Figure 2-2). When in the TALK ALWAYS position, the 5340A is addressed to TALK - it outputs ONLY. It operates according to the front panel controls and outputs each measurement. This position is intended for operation where there is no controller, e.g., with a digital recorder. When the rear panel switch is set to ADDRESSABLE, the 5340A can either be:

a. Sent program information by a controller and the measured results are observed visually, or

b. Both program and output information are passed on the bus managed by a controller.

2-31. Addresses are communicated on the data lines. When the controller sets MRE low, all 5340A's interpret the information on data lines, DIO1 through DIO5 as an address. During this time, the signal levels on DIO6 and DIO7, designate whether the addressed 5340A is to communicate as a TALKER or a LISTENER.

DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1	
1	Ø	A_5	A_4	A_3	A_2	A_1	- TALK ADDRESS*
Ø	1	A_5	A_4	A_3	A_2	A_1	- LISTEN ADDRESS*
Ø	Ø	X	X	X	X	X	- Ignored by 5340A
1	1	X	X	X	X	X	when MRE is low

A_i - Address switches on rear panel

X - Don't care

* - The clear address characters (11111) not allowed.

2-32 The thirty-one (31) possible LISTEN and TALK address characters and their signal levels are shown in Table 2-2. A unique character is selected for each 5340A with the five (5) slide switches on the rear panel marked ADDRESS (A5, A4, A3, A2, A1). These switches may be set to either Ø or 1 (Ø represents a high level and 1 a low level).

2-33. Two characters are reserved for the special function of clearing or removing a 5340A from the active state of an addressed TALKER or LISTENER. The 5340A is cleared as a LISTENER if it is sent an ACSII "?" while MRE is low. The 5340A is cleared as a TALKER if another instrument is addressed to TALK or it is sent an ASCII "_" while MRE is low. It is cleared as either a TALKER or LISTENER when EOP is low.

Table 2-2. Talk and Listen Addresses

USA STANDARD CODE FOR INFORMATION INTERCHANGE

BITS				b_7 b_6 b_5	$0\,0\,0$	$0\,0\,1$	$0\,1\,0$	$0\,1\,1$	$1\,0\,0$	$1\,0\,1$	$1\,1\,0$	$1\,1\,1$
b_4	b_3	b_2	b_1	COLUMN / ROW	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	|
1	1	0	1	13	CR	GS	–	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

ADDRESS | CLEAR ADDRESS | ADDRESS | CLEAR ADDRESS

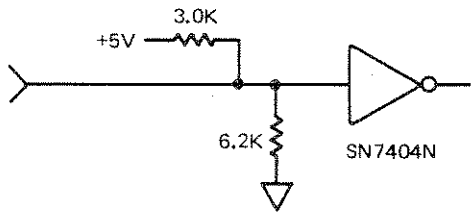
LISTEN | TALK

STANDARD CODE		DATA LINE		ADDRESS SWITCH
b_1	≡	DI01	≡	A1
b_2	≡	DI02	≡	A2
b_3	≡	DI03	≡	A3
b_4	≡	DI04	≡	A4
b_5	≡	DI05	≡	A5

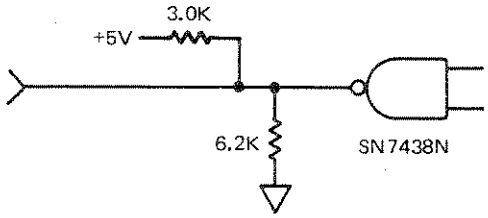
2-34. Line Characteristics

2-35. All 15 bus lines are designed to be compatible with TTL or DTL integrated circuits. Because wire-ANDing is used on some lines the TTL line drivers must be either open collector or tri-state. Each line in the 5340A is terminated in a resistor divider consisting of a 3K connected to 5V and a 6.2K connected to ground. All receivers are hex inverters (SN 7404N or equivalent) and the drivers are open collector NAND gates (SN 7438N or equivalent). These may be put into four groups:

a. EOP, MRE, and REN are receivers only. They require -3.2 mA max. at 0.4V to drive.



b. SRQ is output only: It is capable of sinking 45 mA at +0.4V.



c. Data lines (DIO1 through DIO7) and the handshake lines (RFD, DAC, and DAV) are bi-directional. They are a combination of a and b, i.e., when a TALKER, capable of sinking 45 mA at 0.4V. When a LISTENER, requires -3.2 mA at 0.4V to drive.

d. DIO8 is connected to a similar divider and is always at 3.2V at 2K impedance.

2-36. Hardware

2-37. The 5340A's digital INPUT/OUTPUT connector is on the rear panel (Figure 2-2). Pin connections to this Type 57 Microribbon connector are shown in Figure 2-3.

2-38. Cables of three different lengths are available for connecting a 5340A to a controller or another 5340A:

a. 3 feet long HP Part No. 10631A.
b. 6 feet long HP Part No. 10631B.
c. 12 feet long HP Part No. 10631C.

2-39. These have one overall shield to reduce susceptibility to external noise. The cables use a mixture of individual wires and twisted pairs to reduce crosstalk. Both ends are identical. They are terminated in two 24-pin piggy back connectors; one male and one female. This termination permits several cables to be connected to the same 5340A. Pin connections of these connectors are shown in Figure 2-4. There is a restriction of no more than 12-feet between the first two instruments in the system and 6 feet between the remaining instruments. The 5340A can drive a maximum of 50-feet of this cable.

Figure 2-2. 5340A Rear Panel

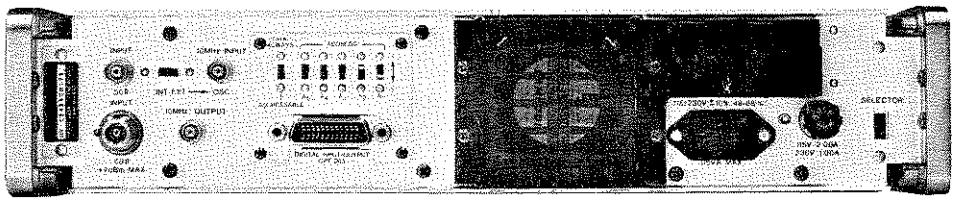


Figure 2-3. 5340A Digital Input/Output

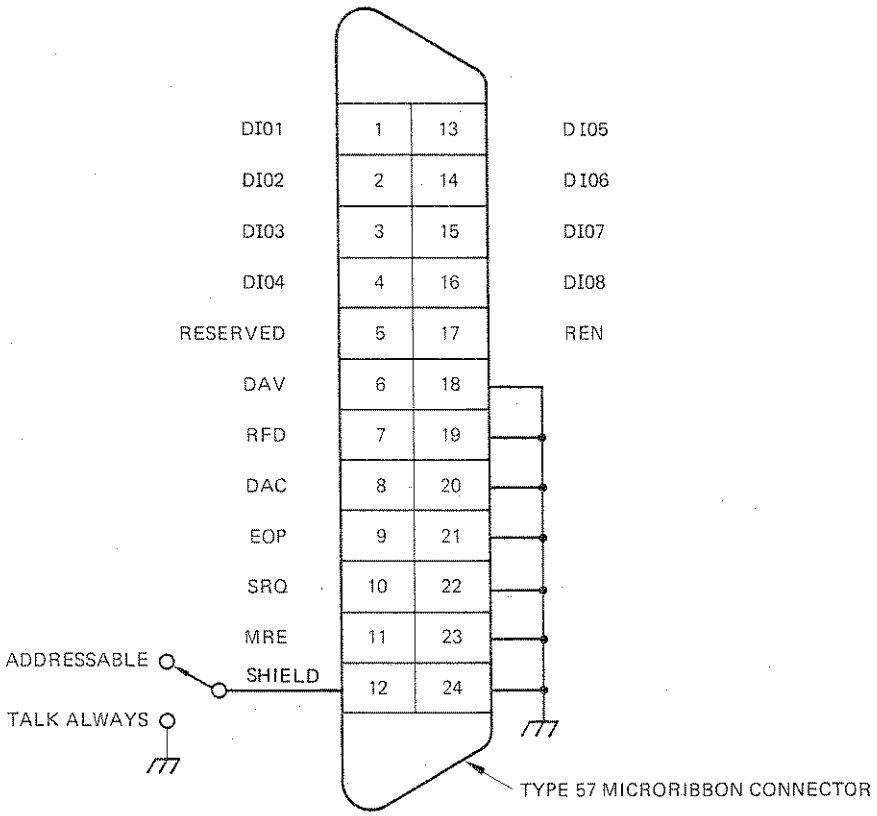
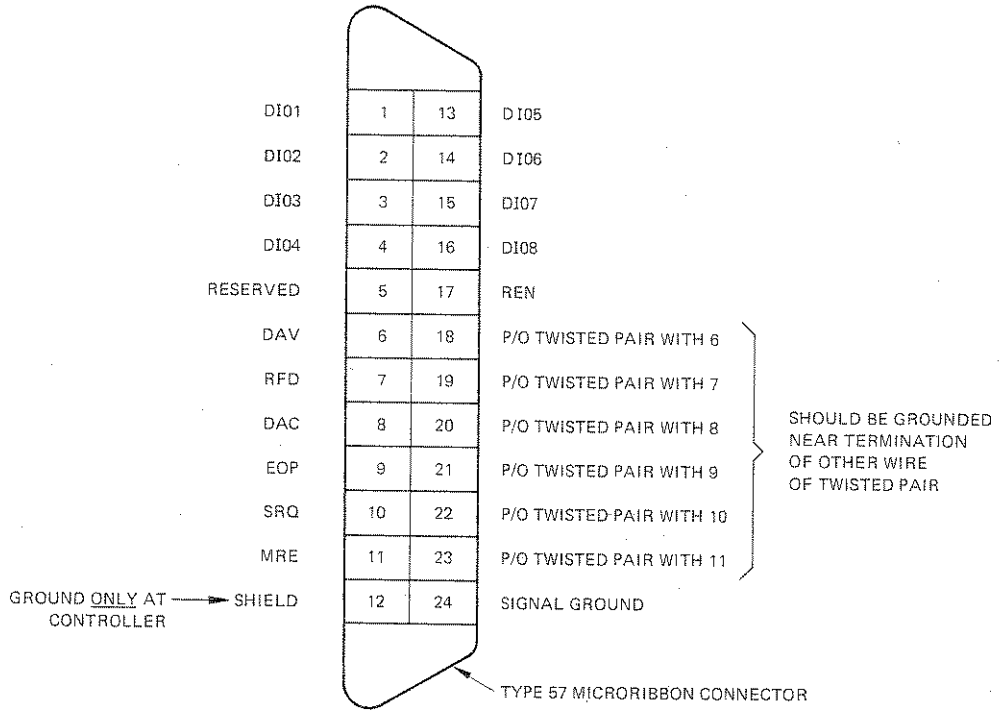


Figure 2-4. Pin Connections of the 10631A, B, C Cables



Note 1: Pins 18 through 23 should be grounded near the termination of the other wire of its twisted pair. Pin 12 is grounded ONLY at the controller.

2-40. Programming the 5340A

2-41. The 5340A has a group of storage cells that are used to store program information. They are used ONLY when a controller has the 5340A operating under remote control. The ASCII characters that can be stored in each cell and their relationship to the 5340A's operation are shown in Table 2-3. (Refer to Table 2-2 for signal levels.)

Table 2-3. Program Code Set

Resolution	Hz	ASCII*	Binary							Octal
			B_7	B_6	B_5	B_4	B_3	B_2	B_1	
1	10^0	Ø	0	1	1	0	0	0	0	060
10	10^1	1	0	1	1	0	0	0	1	061
100	10^2	2	0	1	1	0	0	1	0	062
1K	10^3	3	0	1	1	0	0	1	1	063
10K	10^4	4	0	1	1	0	1	0	0	064
100K	10^5	5	0	1	1	0	1	0	1	065
1M	10^6	6	0	1	1	0	1	1	0	066
Ranges										
10 Hz - 250 MHz (hi Z)		S	1	0	1	0	0	1	1	123
Check		U	1	0	1	0	1	0	1	125
250 MHz - 18 GHz (50Ω)		T	1	0	1	0	1	0	0	124
10 Hz - 18 GHz (50Ω)		P	1	0	1	0	0	0	0	120
Octave Ranges (use with T&P only)										
Auto		@	1	0	0	0	0	0	0	100
≥8 GHz		A	1	0	0	0	0	0	1	101
4 GHz - 8 GHz		B	1	0	0	0	0	1	0	102
2 GHz - 4 GHz		C	1	0	0	0	0	1	1	103
1 GHz - 2 GHz		D	1	0	0	0	1	0	0	104
500 MHz - 1 GHz		E	1	0	0	0	1	0	1	105
250 MHz - 500 MHz		F	1	0	0	0	1	1	0	106
10 Hz - 250 MHz		G	1	0	0	0	1	1	1	107
Sample Rate										
Internal Sample Rate		J	1	0	0	1	0	1	0	112
Hold		K	1	0	0	1	0	1	1	113
SAMPLE TRIGGER (measure)		I	1	0	0	1	0	0	1	111
RESET		H	1	0	0	1	0	0	0	110
OUTPUT MODES										
ONLY IF addressed		L	1	0	0	1	1	0	0	114
WAIT until addressed		M	1	0	0	1	1	0	1	115
Local-Remote										
Local (front panel) control		N	1	0	0	1	1	1	0	116
Remote (progarm storage cell) control		O	1	0	0	1	1	1	1	117

RESET PUSHBUTTON/POWER UP conditions are Ø, P, @, J, L, N

*Signal levels also shown in Table 2-2.

2-42. The program storage cells are loaded with a pre-determined set of conditions when either the front panel RESET pushbutton is depressed or when power is turned on. The initial conditions are listed in Table 2-3 under RESET PUSHBUTTON/POWER UP. Notice that each time either the RESET pushbutton is depressed or power is turned OFF - then ON, the 5340A operates according to its front panel controls.

a. Resolution and Range - Relate directly to the front panel controls and are self-explanatory. For example, ASCII "S" selects the 10 Hz - 250 MHz range and the BNC input connector.

b. Octave Ranges - The 5340A can be made to operate in a particular octave range by sending it the proper ASCII character. This feature can save up to 110 msec of search time when the signal to be measured is in one of the octave ranges. When a controller wants to take control of the 5340A's operation, it only changes those cells where initial conditions are different than the desired program. Program information may be sent in any sequence. The 5340A will not make a measurement if there is either no signal in the selected range or there is one with a larger amplitude in some other range. When AUTO is selected, the 5340A automatically sweeps through all ranges until it finds the signal to be measured.

c. Sample Rate Modes

(1) Internal Sample Rate - Sample rate time is determined by the 5340A's SAMPLE RATE control.

(2) Hold - The 5340A waits in the Sample Rate phase of its operating cycle until made to continue by either a SAMPLE TRIGGER instruction, a RESET instruction or the front panel RESET pushbutton is depressed.

d. Sample Trigger Instruction - Is intended to be used in conjunction with the SAMPLE RATE HOLD mode. It makes the 5340A leave the Sample Rate HOLD phase of its operating cycle and make a measurement. Sample trigger does not reset the display nor does it initialize the phase locked loops (make the 5340A go through its search procedure). The 5340A will ignore the Sample Trigger command unless it is waiting in the Sample Rate phase of its operating cycle.

e. Reset Instruction - Clears the display, initializes the phase locked loops and starts a new measurement procedure. It may be sent at any time in the 5340A's operating cycle. A reset instruction does not initialize the remote program storage cells as does the front panel RESET pushbutton. The 5340A obeys the Reset instruction if addressed to LISTEN whether in local or remote operation.

f. Output Modes - A 5340A outputs in one of two modes providing it has been addressed to TALK.

(1) ONLY IF addressed (ASCII "L" stored in the program storage cell). The 5340A will output each measurement if it has been addressed to TALK. If not so addressed, it bypasses the entire output phase of its operating cycle.

(2) WAIT until addressed (ASCII "M" stored in this program storage cell). The 5340A will make a measurement then wait in the output phase of its operating cycle until it is addressed to TALK. As soon as it is so addressed it will output and continue according to the information in its program storage cells.

Notice that the 5340A ALWAYS outputs when it reaches the output phase of its operating cycle IF it has been addressed to TALK. When programmed ONLY IF, the 5340A continues to go through its operating cycle bypassing the Output phase until addressed to TALK. When programmed to WAIT, the 5340A will stop at its output phase and stay there until addressed to TALK.

g. Local-Remote

(1) Local - The 5340A operates according to its front panel controls.

(2) Remote - Used in conjunction with the control line REN (Remote Enable) to have the 5340A operate according to the information in its program storage cells.

h. Reset Pushbutton/Power Up

When power is first turned on (Power UP) or the front panel RESET pushbutton is depressed, the 5340A performs according to its front panel controls. However, it has stored in its remote programming storage cells the initial conditions of Ø, P, @, J, L, and N. There are:

Ø - 1 Hz resolution
P - 10 Hz to 18 GHz range
@ - AUTO (sweeps through all ranges)
J - Internal Sample Rate
L - Output ONLY IF addressed
N - Local operation

When taking remote control of the 5340A it is necessary to change only those cells that are different from the above. For example, if the 5340A is to be used under remote control, 1 Hz resolution, 10 Hz to 18 GHz range, automatic searching, sample rate HOLD and WAIT in output phase until addressed; it is only necessary to change the ASCII "J" to "K", "L" to "M", and "N" to "0". These changes can be made in any order.

2-43. What is Outputed

2-44. When addressed to TALK the 5340A outputs a string of 16 ASCII characters provided there is an addressed LISTENER on the bus. The handshake routine, necessary for passing information on the data lines, cannot be started unless there is both an addressed LISTENER and TALKER on the bus. The LISTENER must be able to recognize LF (line feed) as the end of the 5340A's output data. As soon as the LISTENER accepts LF (sets DAC high) the 5340A leaves the output phase and continues through its operating cycle.

2-45. The 16 output characters, their description and the order in which they are outputed are shown in Table 2-4. Refer to Table 2-2 for signal levels.

2-46. Modes of Operation

2-47. The 5340A has several remote operating modes. They depend on the Sample Rate and Output modes and the method used to initiate a measurement procedure. This section includes a description of these modes, a simplified flow chart (Figure 2-5) showing all operating modes and a sample program.

Table 2-4. 5340A Output Code Set

ORDER OUTPUTED	CHARACTER	DESCRIPTION
1	D/L	D - measurement made direct or L - measurement made using phase locked loops
2	O/SP	O - 5340A's display has overflowed or SP - Space (0 100 000 binary, 040 octal)
3	SP	Space
4 thru 11	Ø - 9	Digits Ø thru 9 (blank display digits outputed as Ø) most significant digit first
12	E	Power of 10 exponent to follow
13	+	Exponent is positive (0 101 011 binary, 053 octal)
14	Ø - 6	One digit exponent
15	CR	Carriage return (0 001 101 binary, 015 octal)
16	LF	Line feed (used as a word terminator) (0 001 010 binary, 012 octal)

2-48. The two principal modes of remote operation based on the Sample Rate and Output modes are described in (a) and (b) below. Modes (c) and (d) are possible by selecting the remaining combinations of the Sample Rate and Output modes.

a. Internal Sample Rate (J) and Output ONLY IF (L)

(1) If NOT addressed to TALK the 5340A makes measurements continuously at a rate determined by its Sample Rate time plus measurement time. It skips the output phase of its operating cycle.

(2) If 5340A is addressed to TALK, it no longer skips its output phase. The next and all subsequent measurements are outputed.

b. Sample Rate HOLD (K) and WAIT until addressed (M) the 5340A sequence is:

(1) Addressed to LISTEN.
(2) Instructed to make a measurement.
(3) Makes a measurement and stops in its output phase.
(4) Addressed to TALK.
(5) Outputs and stops in its Sample Rate phase.
(6) Addressed to LISTEN.
(7) Instructed to make measurement, then repeats 3 through 6.

c. Internal Sample Rate (J) and WAIT until addressed (M) the 5340A:

(1) Makes a measurement and stops in its output phase.

(2) Is addressed to TALK.

(3) Outputs, goes through its sample rate, and makes another measurement and if:

(a) Still addressed to TALK it repeats (3).

(b) Not addressed to TALK it stops in its output phase and waits until so addressed then repeats (3).

d. Sample Rate HOLD (K) and Output ONLY IF addressed (L) the 5340A is:

(1) Addressed to LISTEN.

(2) Instructed to make a measurement.

(3) Makes the measurement and if:

(a) Addressed to TALK by the end of the measurement phase it outputs and stops in the Sample Rate phase until (1) and (2) are repeated.

(b) Not addressed to TALK by the end of the measurement phase it skips output and stop in the Sample Rate phase until (1) and (2) are repeated.

2-49. Starting a Measurement Procedure

2-50. When operating the 5340A under remote control, a measurement procedure may be initiated by sending a Reset or Sample Trigger Instruction or by letting its sample rate time run out.

a. Internal Sample Rate (J) - a measurement starts at the end of sample rate time.

b. Reset Instruction (H):

(1) Can be given at any time during a 5340A's operating cycle.

(2) Does not change the information in the program storage cells.

(3) Clears the display.

(4) Initializes the phase locked loops forcing a new search procedure.

(5) Starts measurement phase of the 5340A's operating cycle.

c. Sample Triggers Instruction (I):

(1) Can be given only if the 5340A is stopped in the Sample Rate phase of its operating cycle. If given at any other time it will be ignored by 5340A.

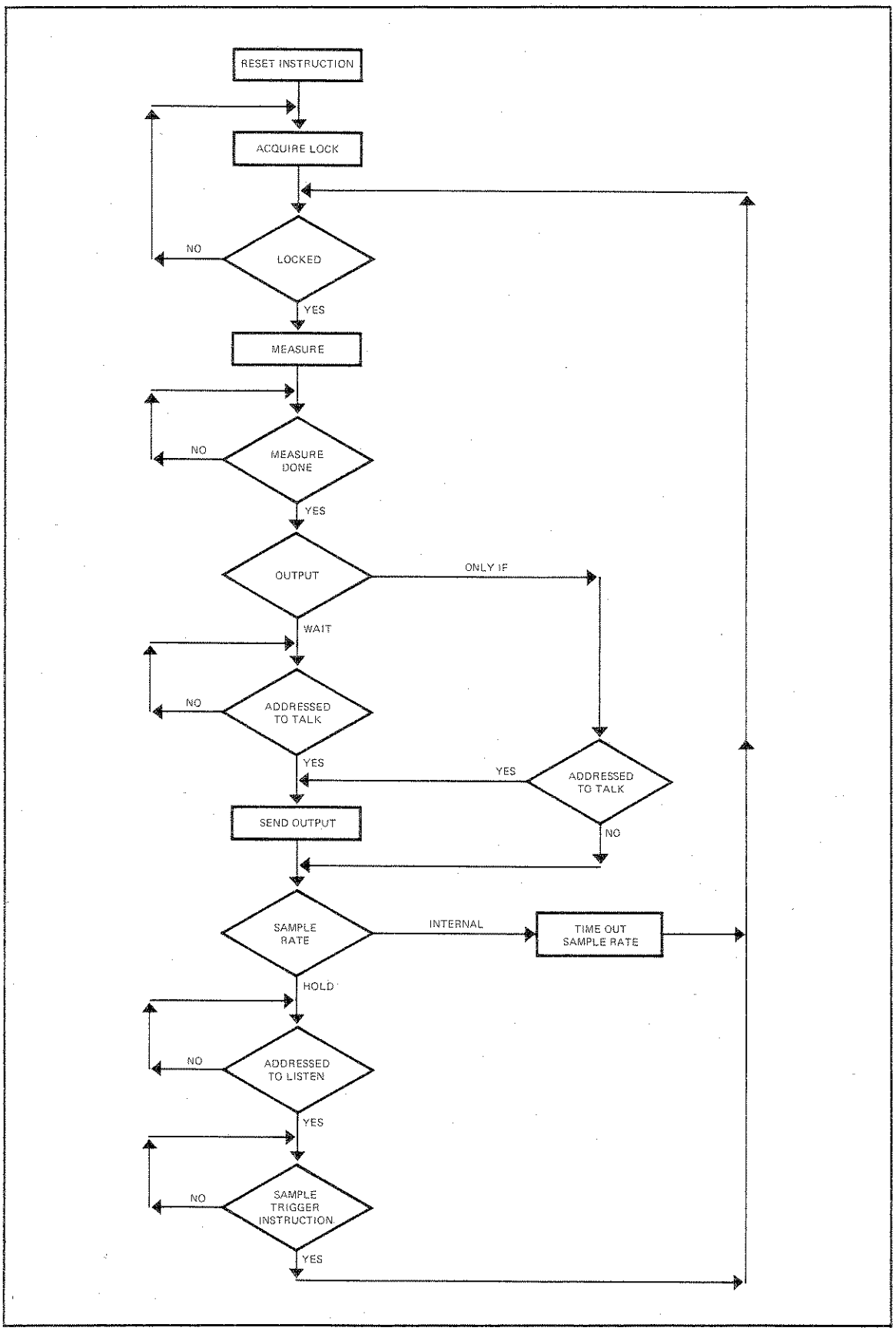
(2) Does not change the information in the program storage cells.

(3) Does not clear the display.

(4) Does not initialize the phase locked loops, i.e., the 5340A does not go through a search procedure unless it has lost phase lock since the previous measurement.

(5) Starts the measurement phase of the 5340A's operating cycle.

Figure 2-5. 5340A Remote Operation



2-51. Examples of Programming

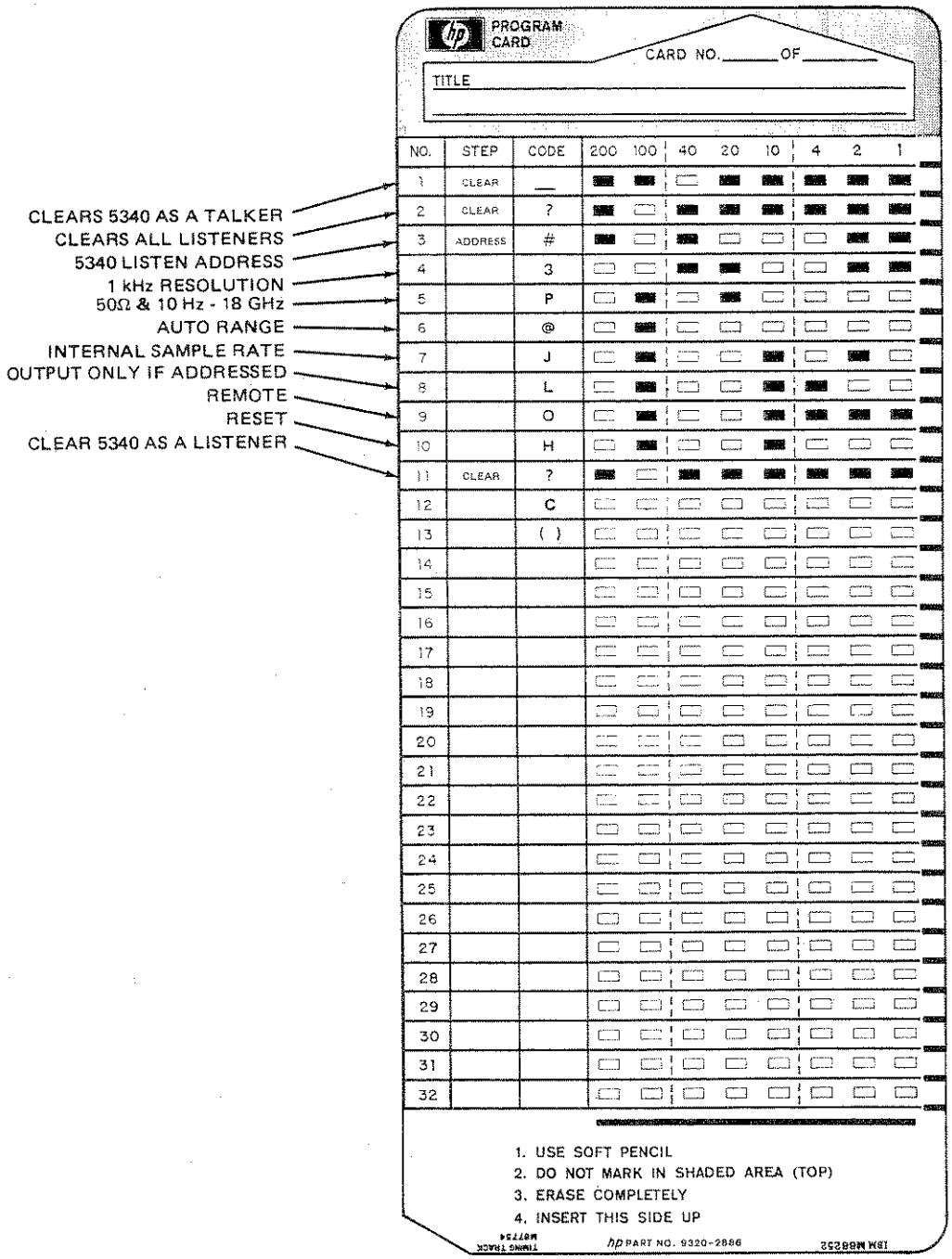
2-52. Assume that it is desired to program a 5340A for a measurement of approximately 3.5 GHz to a 1 kHz resolution. In addition, it is desired to instruct the 5340A to make a measurement and subsequently output when so instructed. One method of programming this is shown in Table 2-5. (Assume the 5340A listen address is ASCII "#" and the talk address is ASCII "C".)

Table 2-5. 5340A Programming Example

Sequence	Control and Status Lines				Data Lines ASCII Codes	Description of Program Sequence
	SRQ	EOP	REN	MRE		
1	H	H	H	L	_ (underscore) or controller's talk address	Clears 5340A as a TALKER
2					?	Clears all LISTENERS
3					#	5340A LISTEN ADDRESS is on Data Lines
4				H		5340A is addressed to LISTEN
5					3 T C K M O	1 kHz resolution is selected 250 MHz to 18 GHz range selected 2 to 4 GHz range selected Sample Rate HOLD selected WAIT until addressed to TALK 5340A remote-local cell loaded with REMOTE } Loading program cell operation (can be loaded in any order)
6			L			5340A in REMOTE control (operates according to Sequence 5)
7					H	RESET and start search procedure
8	L					5340A has completed measurement and is ready to output
9				L	C	5340A TALK ADDRESS is on Data Lines
10					?	Clears all LISTENERS
11					Listener's Address	LISTENER'S ADDRESS on Data Lines
12				H		LISTENER'S are addressed, 5340A addressed to TALK, it OUTPUTS and waits in the SAMPLE RATE phase of its operating cycle
13	H	H	H	L	_ (underscore) or controller's talk address	Clears 5340A as a TALKER
14					?	Clears all LISTENERS
15					#	5340A LISTEN ADDRESS is on Data Lines
16				H		5340A is addressed to LISTEN
17					I	Sample Trigger Instruction initiates a new measurement
Repeats from Sequence 8						

2-53. Another example of programming is with a mark sense card reader. Assume that it is desired to program a 5340A using a 3260A Mark Sense Programmer for an automatic measurement to a 1 kHz resolution (where a digital output is not required). Figure 2-6 shows the marked program card.

Figure 2-6. Example Program Card



For digital output, add C and ( ) (5340 TALK ADDR).

SECTION III

OPERATION

3-1. INTRODUCTION

3-2. This section contains operating information including operating characteristics, input cable considerations, controls and indicators, and operating procedures.

3-3. OPERATING CHARACTERISTICS

3-4. The following paragraphs describe the operating ranges and modes, resolution, sample rate, AM and FM characteristics, and auto-amplitude discrimination.

3-5. Operating Ranges

3-6. There are two basic operating ranges available: 10 Hz to 250 MHz and 250 MHz to 18 GHz. Frequencies in the lower range are measured directly while measurements in the 250 MHz to 18 GHz range are made with an indirect transfer oscillator technique. Provision is made to select three operating ranges, these are:

a. 10 Hz to 250 MHz at the BNC connector (1 MΩ, 25 pF).

b. 250 MHz to 18 GHz at the N connector (50Ω).

c. 10 Hz to 18 GHz at the N connector (50Ω).

3-7. The 10 Hz to 250 MHz range restricts the counter to direct measurements. The 250 MHz to 18 GHz range restricts the counter to the transfer oscillator mode, and the 10 Hz to 18 GHz range allows both modes of operation to be in effect. Annunciator lights are included to indicate when the counter is measuring directly (DIR light) or indirectly (LOCK light). It should be noted that during the 10 Hz to 18 GHz operation, the counter may lock on a signal in the 10 Hz to 250 MHz range in preference to a signal in the transfer oscillator range. Thus, to measure a high frequency signal (>250 MHz) containing high levels of residual low frequencies, it is necessary to select the 250 MHz to 18 GHz range. Otherwise, the switch position is dictated by the impedance requirements and frequency of the input signal.

3-8. Resolution and Blanking

3-9. In a frequency counter, resolution can be defined as the value represented by the least significant digit (LSD). In the 5340A, a maximum resolution of 1 Hz can be selected. Decade multiples of 1 Hz to 1 MHz are available. For example, with an input of 12,345,678 Hz, setting the RESOLUTION switch to 1, the counter displays the 8 in the LSD. Selecting 100 on the RESOLUTION switch places the 6 in the LSD. If a frequency such as 123,456,789 Hz is measured with 1 Hz resolution selected, the counter will overflow so that the 1 is not displayed and the 9 will appear in the LSD. For high resolution of measurements which would result in an overflow, two measurements can be made. The first measurement is made with a resolution setting that is adequate to display the most significant digits. The second measurement is made with maximum resolution to display the least significant digits.

3-10. The counter blanks all digits to the left of the most significant digit, suppressing leading zeros.

3-11. Sample Rate, Measurement Time, and Reset

3-12. The sample rate control sets the interval between measurements, but not the interval of the measurement. On the 5340A, the minimum sample rate is variable between approximately 200 milliseconds and 5 seconds. For 1 Hz RESOLUTION settings, an additional 1 sec delay is incurred. A hold feature can be selected to "freeze" a measurement display indefinitely.

3-13. The measurement interval (gate time) is the time that the counter's gate remains open to accumulate counts. In the 5340A, the gate time is a function of the resolution selected and the input frequency. Typical measurement time for an 18 GHz signal with 1K resolution selected is about 120 msec. With 1 Hz resolution selected and an 18 GHz input, the gate time is quite long, approximately 120 seconds. However during this time, the LOCK annunciator lights to indicate that a measurement is in progress.

3-14. Reset is accomplished by pressing the RESET switch or changing the RESOLUTION or RANGE switch. When the counter is reset, the display reads all zeros and a new measurement cycle is initiated.

3-15. AM Characteristics

3-16. The 5340A will measure inputs containing amplitude modulation provided that the minimum level of the input signal is greater than the sensitivity specification. The maximum modulation permissible can be calculated by the following formula:

$$\frac{Vu - Vs}{Vu} = \% \text{ modulation}$$

where: Vu is the unmodulated rms input level.
Vs is the sensitivity specification at the frequency of interest.

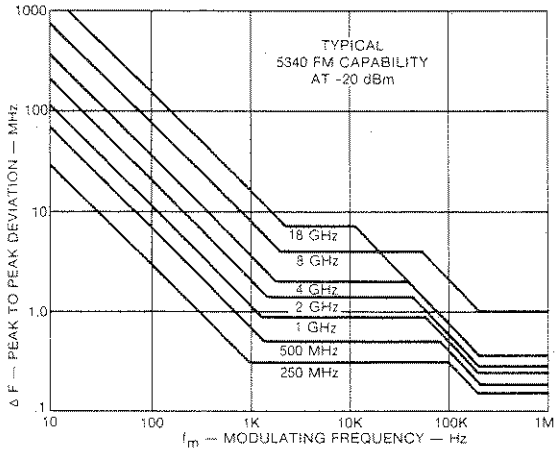
As an example of the use of the formula, calculate the maximum permissible modulation for a -10 dBm (70 mV) input at 10 GHz. At 10 GHz, the sensitivity specification is -35 dBm (4 mV) Using the formula:

$$\frac{Vu - Vs}{Vu} = \frac{70\text{ mV} - 4\text{ mV}}{70\text{ mV}} = \frac{66\text{ mV}}{70\text{ mV}} = 94.5\% \text{ modulation}$$

3-17. FM Characteristics

3-18. The 5340A will measure carrier frequencies in the presence of frequency modulation, phase modulation, or residual noise. The FM characteristics are a function of the modulation rate and carrier frequency as shown in Figure 3-1.

Figure 3-1. FM Characteristics



3-19. Auto-Amplitude Discrimination

3-20. This feature allows the counter to select and measure the signal with the largest amplitude in the 250 MHz to 18 GHz range. This is with the provision that the largest signal is 20 dB greater in amplitude than any other signal present. Although 20 dB is the guaranteed specification, typical operation is about 10 dB. The auto-amplitude discrimination feature is useful for discriminating against harmonics, and spurious signals.

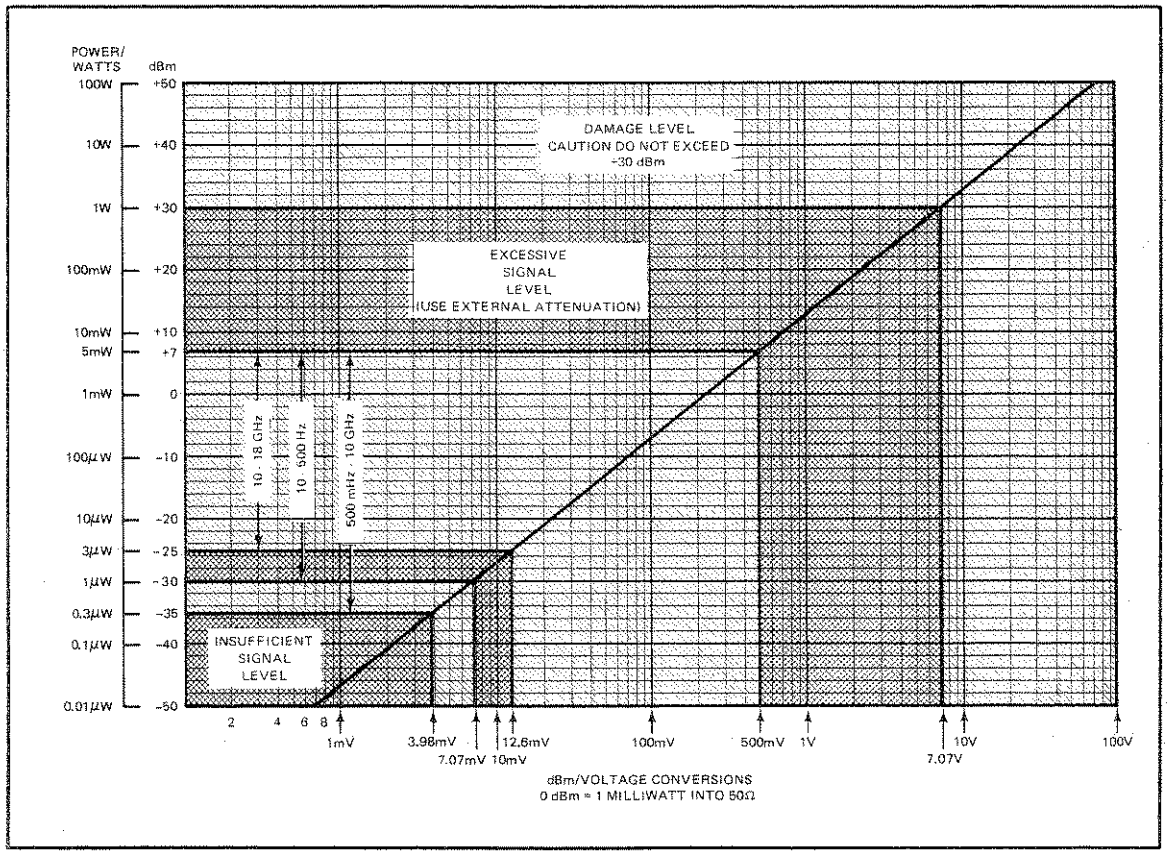
3-21. MAXIMUM INPUT SIGNAL POWER

CAUTION

DO NOT EXCEED 1 WATT OF INPUT POWER AT THE 50-OHM N CONNECTOR. DAMAGE TO THE INTERNAL SAMPLERS MAY OCCUR. PLEASE READ PARAGRAPH 3-22 FOR FULL EXPLANATION OF INPUT LEVELS.

3-22. The 5340A will function within specifications for signal inputs up to +7 dBm (5.012 milliwatts or 0.5006 volts into 50-ohms). Under no circumstance should the input level exceed 1-watt (+30 dBm RF power or ±7 volts dc into 50-ohms, dc power). If the input power exceeds 1-watt, damage to the internal samplers may occur and these are quite expensive to replace. Measurements from +7 dBm to +30 dBm are not recommended because false harmonic locks and readings may occur. When signal levels exceed +7 dBm, external attenuators should be used. The 1-watt maximum input level is the total RF and dc power at the input connector. Figure 3-2 shows power levels with conversions to volts and dBm.

Figure 3-2. DBM to Volts Conversions



3-23. INPUT CABLE CONSIDERATIONS

3-24. Consideration should be given to input cable losses at higher frequencies. For example, a 6-foot RG-214/U coaxial cable has about 15 dB loss at 18 GHz. Such losses should be taken into consideration along with the sensitivity specifications given in Table 1-3.

3-25. For low capacity input measurements, a 10:1 low capacity oscilloscope probe (HP 10004A) can be used on the BNC connector for frequency inputs up to approximately 100 MHz.

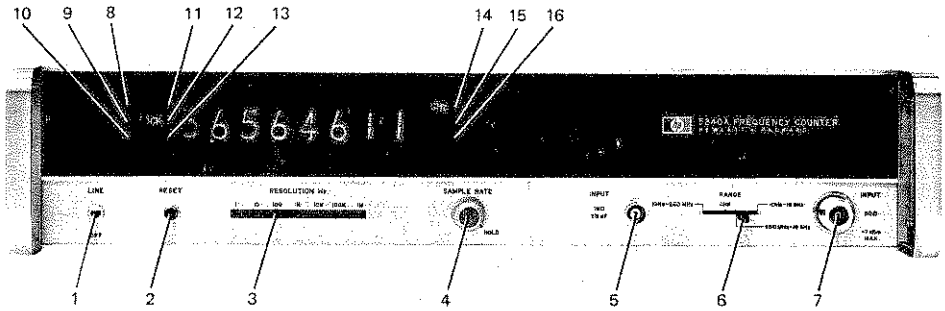
3-26. CONTROLS, INDICATORS, AND CONNECTORS

3-27. Figure 3-3 describes the front panel controls, indicators, and connectors. Figure 3-4 describes the rear panel connectors and controls.

3-28. OPERATING PROCEDURES

3-29. Figure 3-5 illustrates the operating procedures. Self check procedures are given in Figure 3-6.

Figure 3-3. Front Panel Controls and Indicators



1. LINE switch. Applies primary power to all circuits except crystal oven Option 001, when so equipped. When the counter is equipped with Option 001, the crystal oven connects through a thermal circuit breaker and fuse to the ac line. This allows the oven to maintain its operating temperature and accuracy when the LINE switch is OFF, thereby eliminating warm-up delays.

2. RESET switch. Resets display and internal count to zero and initiates a new measurement.

3. RESOLUTION Hz selector. Determines resolution of the measurement. See Paragraph 3-8 for a detailed description. In general, the 1 kHz setting is a good starting point.

4. SAMPLE RATE control. Adjusts the interval between measurements from approximately 200 milliseconds to 5 seconds. For 1 Hz RESOLUTION settings an additional 1 second delay is incurred. When rotated to the HOLD position, the display will be held indefinitely.

5. BNC 1 MEG Ω Input Connector. High impedance (1 Megohm) input for direct count measurements in the 10 Hz to 250 MHz range. Shunt input capacity is 25 pF maximum. Measurements made at this input require that the RANGE switch is set to the 10 Hz - 250 MHz position. Sensitivity is 50 millivolts rms and the coupling is ac.

6. RANGE switch. Selects input connectors and ranges as indicated by the black leader lines. When set to the CHECK position, the circuits count the frequency of the internal clock to verify proper counter operation.

Figure 3-3. Front Panel Controls and Indicators

CAUTION

DO NOT EXCEED +30 dBm (1 WATT) INPUT AT THE 50Ω N CONNECTOR. DAMAGE TO THE INTERNAL SAMPLERS MAY OCCUR. PLEASE READ PARAGRAPH 3-21 FOR DETAILS OF ACCEPTABLE INPUT LEVELS.

7. N Type 50Ω Input Connector. Input for measurements in the 10 Hz to 18 GHz or 250 MHz to 18 GHz range as determined by the RANGE switch. Sensitivity is -30 dBm from 10 Hz to 500 MHz, -35 dBm from 500 MHz to 10 GHz and -25 dBm from 10 GHz to 18 GHz.

8. RMT annunciator. For counters equipped with Option 003 only. Lights when the counter is in remote operation.

9. DIR annunciator. Lights when counter is in direct measurement mode. (10 Hz to 250 MHz.)

10. * annunciator. Operative with Option 001 only. Lights when the oven is heating to indicate oscillator is not stabilized. Full counter accuracy is obtained when the oven has stabilized. Fifteen minutes after turn on, additional oscillator error is less than 5 parts in 10^9 at 25°C.

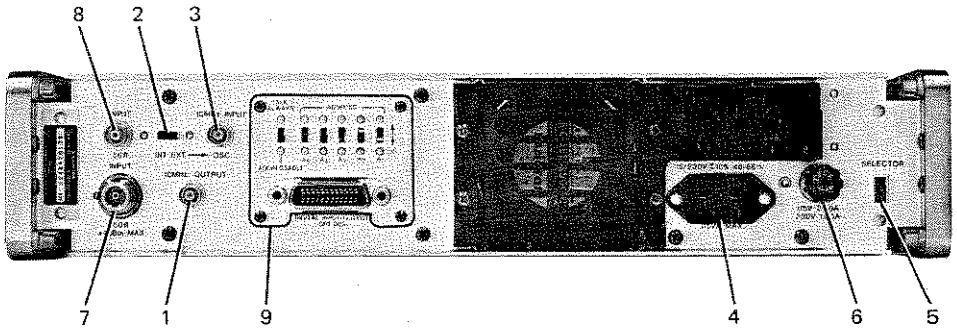
11. OVFL annunciator. Indicates that one or more of the most significant digits (digits left most from the decimal point) are not displayed. The digits that are displayed will be accurate to within ±1 count ± the time base accuracy. For example, if 123,456,789 Hz is measured with 1 Hz RESOLUTION selected, the OVFL annunciator will light, the 1 will not be displayed, and the numbers 23456789 will be displayed and are valid.

12. LOCK annunciator. Indicates that phase LOCK has occurred and a measurement is being made with the transfer oscillator technique.

13. GATE annunciator. Indicates when the counter's main gate is open and a measurement is in progress.

14, 15, 16. GHz, MHz kHz annunciators. Indicates the units multiplier of the measurement.

Figure 3-4. Rear Panel Controls and Connectors



1. 10 MHz OUTPUT. Supplies a 10 MHz square wave output at 2.4 volts peak-to-peak or greater. Output is TTL compatible.

2. INT-EXT OSC switch. Selects time base source. When set to INT, the counter operates from its internal 10 MHz oscillator. When set to EXT, it allows an external 10 MHz sine wave or square wave at the 10 MHz INPUT jack to operate the counter. External oscillator requirements are 10 MHz at approximately 1.5 volts peak-to-peak into 1 kΩ.

3. 10 MHz INPUT jack. Accepts external time base signal. Requirements are a 10 MHz sine wave or square wave at approximately 1.5 volts peak-to-peak (1 kΩ impedance). The INT-EXT switch must be set to EXT to accept the external OSC input.

4. AC Input Connector. Ac power receptacle. IEC type with offset pin connected to the chassis. Accepts 115 volts or 230 votls ±10%, 48 to 68 Hz. Maximum power draw is 100 volt amperes.

5. SELECTOR switch. Allows the 5340A to operate off of 115 volts or 230 volts ac. Use a narrow bladed screwdriver and slide the switch to show the desired operating voltage.

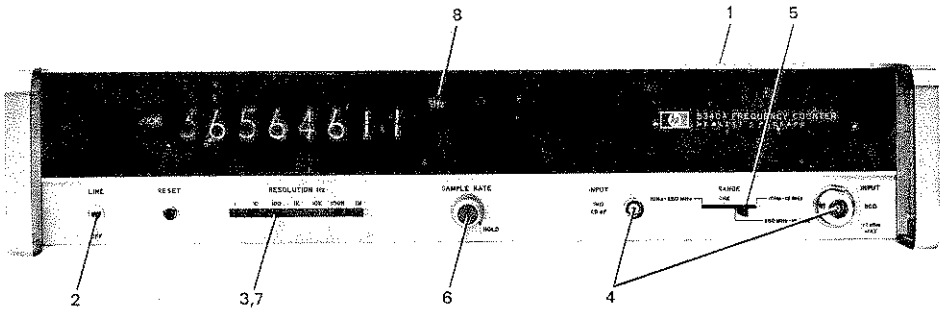
6. FUSE. Requires a 2.0 amp normal blow fuse for 115-volt operation or a 1.0 amp normal blow fuse for 230-volt operation.

7. Input Option 002 N connector. Same as front panel N connector, see Figure 3-3.

8. BNC input connector Option 002. Similar to front panel BNC input except that this option includes a 50-ohm termination on the front panel BNC connector.

9. Digital Input/Output Option 003. Connector and address switches for remote programming and digital output. See Section II for details of operation.

Figure 3-5. 5340A Operating Procedures



1. On Rear Panel set INT-EXT switch to INT position.

2. Set LINE switch to on (up) position.

3. Set RESOLUTION Hz to desired resolution. Recommended starting setting is 1 kHz.

CAUTION

DO NOT EXCEED +30 dBm (1 WATT) INPUT AT THE 50Ω N CONNECTOR. DAMAGE TO THE INTERNAL SAMPLERS MAY OCCUR. PLEASE READ PARAGRAPH 3-21 FOR DETAILS OF ACCEPTABLE INPUT LEVELS.

4. Connect input signal to appropriate input connector according to input frequency and impedance requirements.

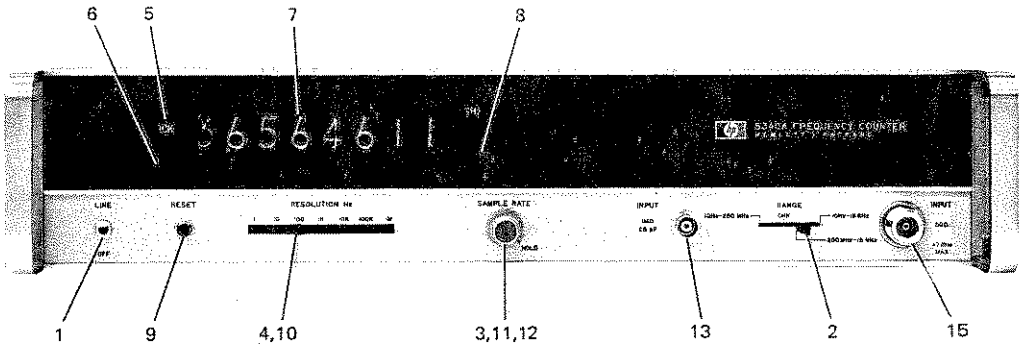
5. Set RANGE switch to correspond with input connector being used.

6. Adjust SAMPLE RATE control for desired interval between measurements.

7. Adjust RESOLUTION Hz switch for desired number of significant digits.

8. Display is in units shown with correct decimal point and significant digits.

Figure 3-6. Self Check and Operational Check Procedures



1. Set LINE switch to on (up) position.
2. Set RANGE switch to CHK position.
3. Rotate SAMPLE RATE control fully ccw.
4. Set RESOLUTION switch to 1 Hz.
5. Check that DIR annunciator lights.
6. Check that GATE light flashes.
7. Check that display indicates 10.000000 ±1 count.
8. Check that MHz annunciator lights.
9. Press and hold RESET switch, DIR and GATE lights should go out and display should be 00.000000. Release RESET switch, check that display is 10.000000 MHz ±1 count.
10. Change RESOLUTION switch to the following positions and check for proper display. When the switch is in between positions, the DIR light and GATE light should go out and the display should reset (all zeros).

RESOLUTION Switch	DISPLAY (B = Blank Display Tube)
10 Hz	B10.00000 MHz ± 1 count
100 Hz	BB10.0000 MHz ± 1 count
1 kHz	BBB10.000 MHz ± 1 count
10 kHz	BBBB10.00 MHz ± 1 count
100 kHz	BBBBB10.0 MHz ± 1 count
1 MHz	BBBBB.010 GHz ± 1 count

Figure 3-6. Self Check and Operational Check Procedures (Continued)

11. For the 1 MHz RESOLUTION setting, check that GATE light flashes rapidly. Rotate SAMPLE RATE control fully clockwise but not in HOLD. Gate light should flash once approximately every 5 seconds.

12. Set SAMPLE RATE to HOLD and check that GATE light goes out and display is held indefinitely.

13. Connect a 220 MHz signal at 0 dBm (0.2236 volts rms) to the 10 Hz - 250 MHz INPUT. Set RANGE switch to 10 Hz to 250 MHz. Set RESOLUTION switch to 1K. Rotate SAMPLE RATE control fully ccw.

14. Check that gate lamp flashes, DIR lamp lights, and counter displays proper frequency for all positions of RESOLUTION switch.

15. Connect the 220 MHz signal (0 dBm) to the 50Ω INPUT and set RANGE switch to 10 Hz - 18 GHz. Set RESOLUTION switch to 1 kHz.

16. Check that GATE lamp flashes, DIR lamp lights, and counter displays correct frequency for all positions of the RESOLUTION switch.

17. Set RANGE switch to 250 MHz - 18 GHz. Check that LOCK lamp lights, GATE lamp flashes, and counter displays correct frequency for all positions of the RESOLUTION switch.

18. For each position of the RESOLUTION switch, move RANGE switch between "250 MHz - 18 GHz" and "10 Hz - 18 GHz" positions. The displayed frequencies should agree within 1 count.

19. If counter fails in any of the above steps, refer to Section V.

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