PROGRAMMING NOTE
5328A–1

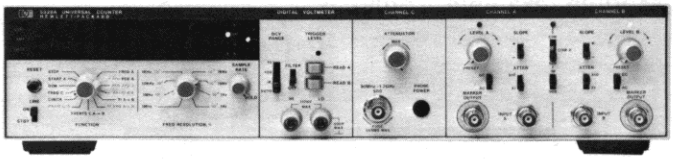
HEWLETT hp PACKARD

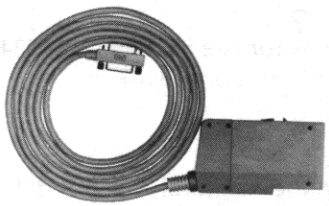
Beginner's Guide
(for 5328A Universal Counter with 9825A Controller)

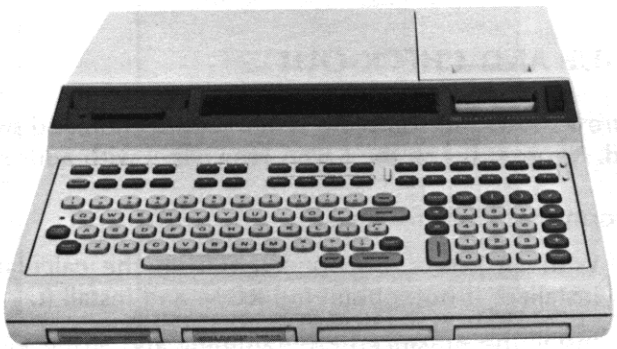
HP-IB

JANUARY 1979

Supersedes: none







INTRODUCTION

This beginners guide is an introduction to remote programming of the 5328A Universal Counter. The basic requirements for programming are discussed including system connection. You will be taken step-by-step through several programs and given detailed instructions on their function.

The 5328A with Option 011 provides full compatibility with the Hewlett-Packard Interface Bus (HP-IB). When used with a 9825A controller, a sophisticated measurement system is achieved. Option 011 allows remote control of function selection, gate times, measurement output mode, and with Option 041, programming of the input amplifier parameters.

For further information or a higher level explanation of the HP Interface Bus, these references should prove helpful:

1. 9825A Extended I/O Programming Manual.
2. 9825A General I/O Programming Manual.
3. HP-IB Programming Hints for Selected Instruments (9825A).

References for the 5328A are:

1. 5328A Universal Counter Operating and Service Manual
2. Option 011 HP-IB Interface (for Universal Counter 5328A) Installation and Service Manual
3. Option 041 Programmable Input Module Installation and Service Manual

For more information contact a local Hewlett-Packard Office. (Hewlett-Packard has 200 Sales and Service Offices in 75 countries). Or write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304, U.S.A.

EQUIPMENT REQUIRED

To perform all example programs described in this programming note, you will need the following equipment and accessories:

1. 9825A with:
   a. 98210A String-Advanced Programming ROM (example 4B and 5 only).
   b. 98213A or 98214A or 98216A General-Extended I/O ROM.
2. 5328A with:
   a. Option 011 HP-IB Interface.
   b. Option 041 Programmable Input Module (example 7 only).
3. Oscilloscope (example 7 only):
   a. 50 MHz bandwidth.
   b. 50 mV/div (minimum).

SET-UP AND CHECK-OUT

Figure 1 shows the complete system connection and switch settings for the 5328A and 98034A Interface Card. *Figure 2* shows the 5328A rear panel with address switches and connector.

Perform the following steps:

1. With all power disconnected from the calculator, verify the General-Extended I/O ROM is installed. If not, obtain the ROM and install it.
2. Install the Advanced Programming and String Variable ROM (98210A), if available.
3. Obtain the 98034A Interface card. Verify the rotary switch on the top is set to "7". If not, obtain a small blade screwdriver and set the pointer to "7". Seven (7) will then be the select code for the interface card and the basis for all programs found in this guide. Install the 98034A in any of the available sockets at the rear panel of the 9825A. Be sure the 98034A seats thoroughly into its' socket. This can be verifed when the latch on top of the interface pops up to lock the card into the socket.
4. Connect the 24-pin connector at the end of the 98034A cable to the 5328A counter. The connector is tapered to insure proper connection.

NOTE

Do not attempt to mate the black metric threaded screws with the silver English threaded nuts or vice-versa, as damage to the hardware may result. A metric conversion kit which will convert one cable and one or two instruments to metric hardware is available by ordering HP Part Number 5060-0138.

5. Facing the rear panel of the counter, note the seven small slide switches to the right of the HP-IB connector (see *Figure 2*). These are the ADDRESS switches. The five rightmost switches determine the counter's listen/talk address. The far-left switch is the Addressable/Talk Only switch. Since the counter will be required to accept programming information from the calculator the switch will be set to the Addressable position (up). The unmarked switch is not used. Set the address of the counter to '25' by setting the address switch positions as shown in *Table 1* and *Figure 2*.

Table 1. Address Switch Positions

SWITCH	A5	A4	A3	A2	A1	
POSITION	UP	UP	DOWN	DOWN	UP	
BINARY	1	1	0	0	1	11001
DECIMAL	16	8	—	—	1	25

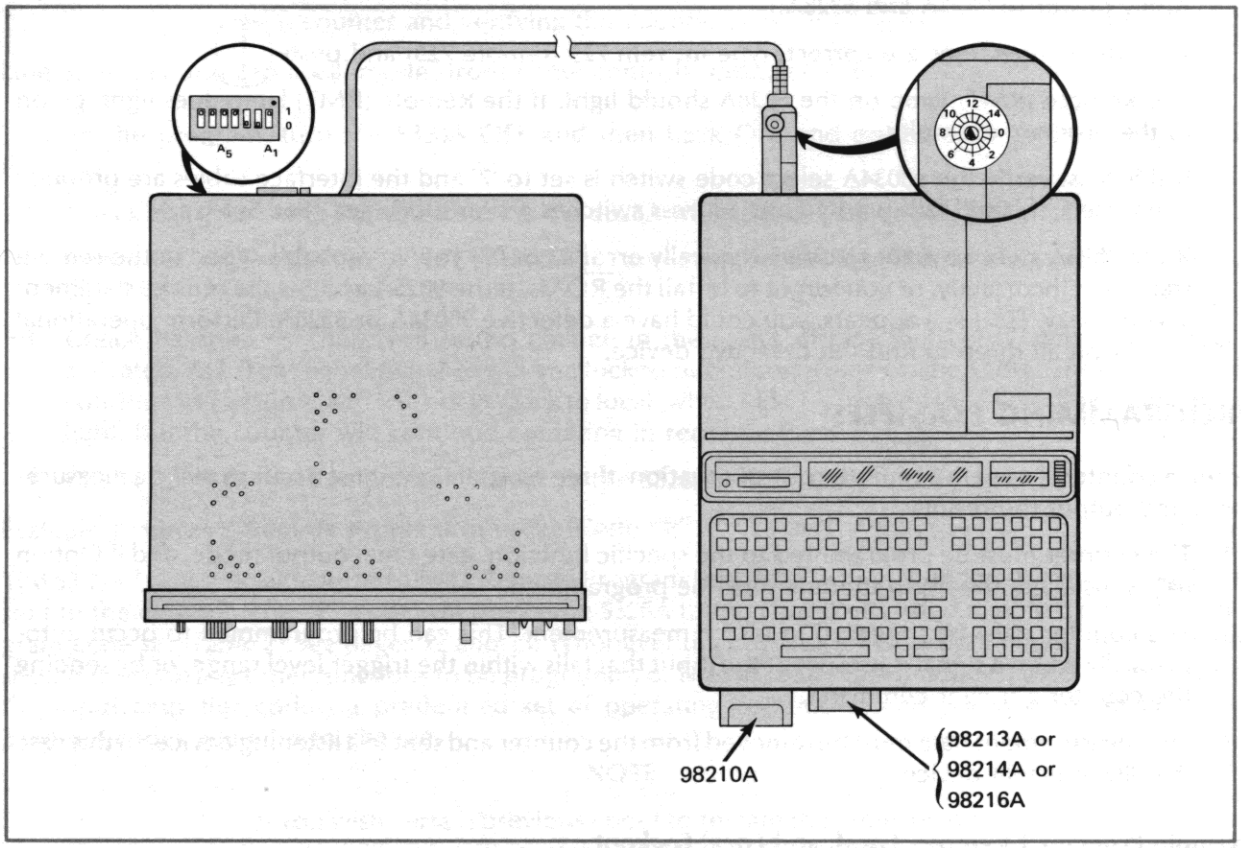


Figure 1. System Connection

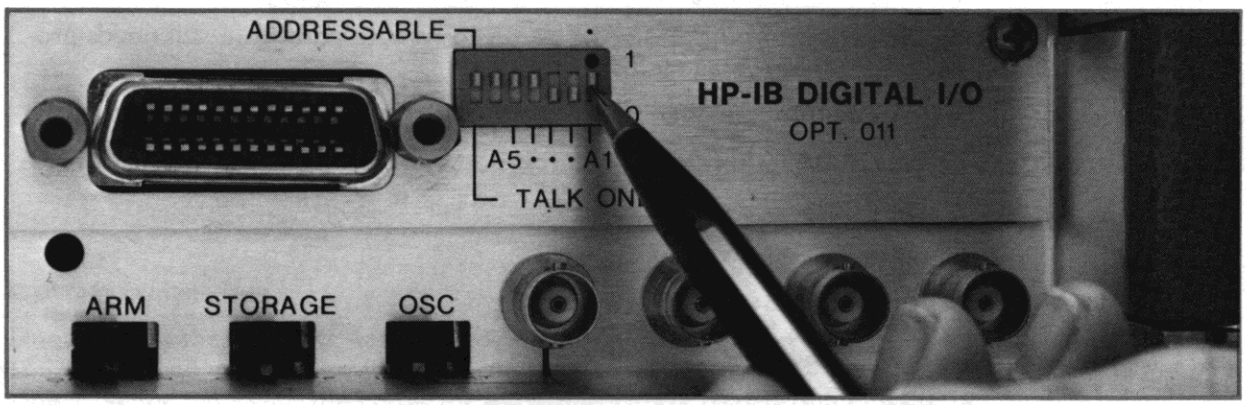


Figure 2. Setting Address Switches

6. Set 5328A front panel controls to:

   A. TI A→B
   B. 1 MHz Resolution.
   C. Sample Rate CCW.
   D. DVM (if installed) Autorange-Read Trigger Level OFF (Out position).
   E. Input Module - PRESET, +slope, AC coupling, X1 Attn (with Option 041 - 50Ω input impedance).
   F. Connect rear panel "OSC" to Channel A input.

   Apply power to 9825A and 5328A.

   To verify connections are correct, type in: rem 725 (remote 725) and push 

.

   The Remote (RMT) lamp on the 5328A should light. If the Remote (RMT) lamp does light, go on to the program examples.

   If this fails, verify the 98034A select code switch is set to '7' and the interface cables are properly connected. If it still fails, verify your address switches are properly set. (See Set-Up.)

   If the 9825A gives an error message (typically error 03 or 07) you've probably typed in the remote statement incorrectly, or you forgot to install the ROMs. If the 9825A accepts the remote statement and the lazy "T" (⊢) appears, you could have a defective 98034A or 5328A. Perform operational checks on all three to find the defective device.

PROGRAMMING EXAMPLES

When a counter is used in a remote control situation, three basic actions must occur to make a measurement and output the results:

1. The counter must be programmed to the specific function, gate time, output mode, and if Option 041 is installed, the input module must be programmed.
2. The counter must be triggered to take a measurement. This can be programmed to occur automatically when a signal is present at the input that falls within the trigger level range, or by sending the counter a trigger command.
3. The measurement data must be removed from the counter and sent to a listening device. In this case the 9825A is that device.

Example Program 1 Remote, Local, and Local Lockout

Example Program 1 demonstrates the following 9825A HP-IB commands:

1. Remote enable (rem) allows you to quickly set the 5328A to remote control (it still needs programming codes if not previousy programmed).
2. Local Lockout (llo) disables all front panel controls, in this case specifically the reset button.
3. Go to Local (lcl) — Returns 5328A to front panel control. Does not clear internal program storage.

PROGRAM 1

```
0: rem 725;dsp "CP #1";stp
1: wrt 725,"F<G1S134T";dsp "CP #2";stp
2: llo 7;dsp "CP #3";stp
3: lcl 725;dsp "CP #4";stp
*12381
```

Program Explanation:

Line Ø: Sets counter to remote; 9825A displays CP#1 (Check Point #1)

Line 1: Sends counter program string (self-check, 100 kHz resolution, multiple measurement cycle); displays CP#2.

Line 2: Sets interface bus to Local Lockout mode; 9825A displays CP#3.

NOTE

Local Lockout will be tested at this point by pressing reset on the counter and verifying the counter remains in remote.

Line 3: Sets counter to Local mode (front panel control); display CP#4.

Type in the program, turn the 5328A OFF and then back ON, and on the 9825A, press RESET, and then RUN.

1. Check Point #1 — the Remote lamp on the 5328A will light and the display will be 0. Press CONTINUE.
2. Check Point #2 — The "m", "Hz", and "GATE" annunciators will light (Remote lamp will still be on). The 5328A display will be 100. Press CONTINUE.
3. Check Point #3 — There will be no change in the 5328A display, but Local Lockout has been activated. **ALL** front panel switches will be "locked out". Press RESET on the 5328A. The counter will continue its functions and will not go back to local (when RESET is pressed the "Overflow" lamp may light, but the counter will continue operating in remote). Press CONTINUE.
4. Check Point #4 — The "Remote" lamp on the 5328A will go off.

Example Program 2 Remote Program Initialize Code "P"

The 5328A has a special feature called "Remote Program Initialize" which is initiated whenever a "P" is sent to the counter. The "P" code will preset the 5328A to the conditions listed in bold type in the program code set (*Table 2*).See pages 12 and 13. Whenever the counter is first programmed, the "P" code should precede any other functions to be programmed. The "P" codes presets the counter to (excluding the input amplifier codes) a predefined set of operating conditions, and you need send only the program codes you wish to change.

NOTE

If you wish certain previous codes to remain the same, do not send a "P". This will reset the 5328A back to the Remote Program Initialize and may alter codes you wish to remain the same.

PROGRAM 2

```
0: wrt 725,"P"
1: dsp "Remote Program Initialization";stp
2: wrt 725,"F4G5R"
3: dsp "'P' code altered";stp
*14573
```

Program Explanation:

Line Ø: Sends the 5328A its Remote Program Initialize.
Line 1: Displays what occurred in Line Ø.
Line 2: Sends the 5328A the codes for frequency, 10 Hz resolution, and a reset.
Line 3: Displays what occurred in Line 2.

Type in the program, press RESET , then RUN .

1. The Remote lamp on the counter will light and the display will be 0. . The 9825A will display "Remote Program Initialization". Press CONTINUE .
2. The "k" and "Hz" annunciator will light and the counter display will be 0.00 . The 9825A will display "P code altered".

The "P" code will set the 5328A to the STOP mode of the START/STOP function. This is indicated during Step 1 when no annunciators were lit. When Step 2 is executed, only those codes in Line 2 were altered, and all other "P" codes remained the same.

Example Program 3 Triggering a Measurement

This program demonstrates how to trigger the 5328A to take a measurement when the "SØ" single measurement code is used. Be sure to place an 'R' (reset) at the end of the program codes if the trigger is done in a separate line.

PROGRAM 3

```
0: rem 725;wrt 725,"PF4G5R"
1: dsp "5328A PROGRAMMED FOR FREQUENCY";stp
2: wrt 725,"T"
3: dsp "5328A TRIGGERED";stp
*2833
```

Program Explanation:

Line Ø: Sets counter to remote. Programs the counter for a single frequency measurement, 10 Hz resolution, and a reset.
Line 1: Displays what occurred in Line Ø.
Line 2: Triggers the 5328A to take a measurement.
Line 3: Displays what occurred in Line 2.

Type in the program, RESET the 9825A, and press RUN .

1. 5328A has been programmed for a frequency measurement. The "REMOTE" and "kHz" annunciator will light. The 5328A display will be 0.00 . The 9825A will display "5328A PROGRAMMED FOR FREQUENCY". Press CONTINUE .
2. The 5328A "GATE" lamp will flash on, the display will be 10000.00 kHz. The 9825A will display "5328A TRIGGERED".

There are two other ways to trigger a measurement.

1. trg 7 — Trigger **All Addressed** devices connected to interface "7". Group-Execute-Trigger.
2. trg 725 — Triggers the device set to address "25" connected to interface "7". Selective-Device-Trigger.

Line 2 in program 3 can be replaced with either of these statements. The use of "trg 725" is more appropriate in this case, but in a system you may want to trigger several devices at the same time, so "trg 7" would be used.

Example Program 4 Reading data from the 5328A to the 9825A.

Program example 4A makes a frequency measurement, reads the data into a simple variable and displays the results on the 9825A display.

PROGRAM 4A

```
0: rem 725;wrt 725,"PF4G6R"
1: wrt 725,"T"
2: red 725,A
3: prt A
4: stp
*23733
```

Program Explanation:

Line Ø: Sets counter to remote. Programs the 5328A for a frequency measurement, 1 Hz resolution, and a reset.
Line 1: Triggers the 5328A.
Line 2: Reads the data from the 5328A to the 9825A into simple variable "A".
Line 3: Prints the measurement value.
Line 4: Stops the program

Type in the program, RESET the 9825A, and press RUN.

1. The "REMOTE", "k", and "Hz" annunciator will light. The "GATE" lamp will flash on. The 5328A will display 10000.00 kHz. The 9825A will print 10000000.ØØ.

   Since a simple variable was used, all leading alpha (letters) characters are ignored. If for some reason the display had overflowed, there would be no indication of this. An "O" would have been output, but the simple variable would have ignored it. The overflow lamp on the 5328A will light, but it is inconvenient to have to depend on looking at the display to tell if the 5328A has overflowed. Under these conditions, the string variable can demonstrate its advantages.

   Using the same program as Example 4A, but instead of using a simple variable, let's use a string variable. Type in program 4B or alter 4A to match 4B.

PROGRAM 4B

```
0: dim A$[17]
1: rem 725;wrt 725,"PF4G7R"
2: wrt 725,"T"
3: red 725,A$
4: prt A$
5: stp
*10368
```

Program Explanation:

Line Ø: dimension statement; A$—17 characters.
Line 1: Change G6 to G7.
Line 3: Read into A$ instead of simple variable A.
Line 4: Print A$.

Reset the 9825A and press [RUN].

1. Note the difference in the printed characters. The 10 second gate time causes the 5328A to overflow. The leading "O" indicates this. Also, the printout is in scientific notation. Although the counter outputs in the same format regardless of what kind of variable is used, the string variable stores all of the characters, thus giving you the resulting printout. The simple variable ignores all non-numerical characters.

   Reconnect the "1 MHz OUT" to CHANNEL A.

Example Program 5 High Speed Measurement

This program performs what is called a "Read/Write buffer transfer". This is the fastest way to transfer data from the 5328A to the 9825A.

PROGRAM 5

```
0: dim H$[17]
1: 100→N
2: buf "HOLD",17*N,3
3: rem 725;wrt 725,"PF4G0S134R"
4: buf "HOLD"
5: tfr 725,"HOLD",N*17
6: if rds("HOLD")=-1;jmp 0
7: dsp "DONE";wait 1000
8: for X=1 to N
9: red "HOLD",H$;dsp H$,X
10: wait 500;next X
11: end
*6191
```

Program Explanation:

Line Ø: H$ is dimension for 17 characters.
Line 1: 100 is assigned to N (number of measurements).
Line 2: Specifying the name "Hold" for the buffer memory and allocating 1700 bytes of memory. 3 is the transfer type. (Refer to 9825A Extended I/O Manual for details.)
Line 3: Sets counter to remote and programs the counter's functions.
Line 4: Guarantees the buffer is empty.
Line 5: Transfer from device 725, 100 measurement directly into buffer "HOLD".
Line 6: Check to see if buffer is full.
Line 7: Display "Done", wait 1 second.
Line 8: Set up a for-next loop counter (1 to 100).
Line 9: Unload 17 bytes at a time, store them in H$, and display H$ and measurement number.
Line 10: Wait 200 ms, unload next 17 bytes.
Line 11: end.

Type in the program, [RESET] the 9825A, and press [RUN].

1. Within approximately 1 second, "Done" will be displayed on the 9825A, indicating 100 measurements have occurred.
2. The 9825A will unload and display each 17 byte measurement.

The advantage of this program is speed. Once the transfer has begun, all transfers occur with only one address of the 5328A as a talker. No time is lost readdressing the counter everytime the 5328A is ready to output. If you wish to run this program again, be sure you RESET the 9825A. If you wish for the program to loop continuously, change Line 11 to; gto 4. This will clear the buffer and begin another transfer.

Example Program 6 SRQ, Service Request

When measurement cycle code "S2" is used the 5328A will request service to indicate a measurement has been completed. Example 6 demonstrates this capability.

PROGRAM 6

```
0: oni 7,"SRQ"
1: eir 7
2: rem 725;wrt 725,"PF4G0S0247R"
3: wrt 725,"T"
4: dsp "WAITING";wait 500
5: gto -2
6: "SRQ":red 725,A
7: dsp A;wait 750;eir 7;iret
8: end
*11750
```

Program Explanation:

Line Ø: When the interrupt occurs, branch to subroutine labeled "SRQ".
Line 1: This enables the interrupt.
Line 2: Programs the 5328A for a one frequency measurement, 1 MHz resolution, wait to output, Service Request a end of measurement, and reset.
Line 3: Trigger a measurement.
Line 4: Displays "WAITING"; interrupt will occur during this line.
Line 5: Returns back to Line 3 for new trigger.
Line 6: Service Request Routine; Reads counter data into simple variable A.
Line 7: Displays measurement data; holds display for 750 ms; re-enables interrupt, returns to next line after interrupt (Line 5).
Line 8: End program (program actually never gets to this line).

Type in the program, [RESET] the 9825A and press [RUN].

1. The 9825A will display "WAITING" and then the measurement value alternately.
2. The program will run indefinitely.

   When an interrupt occurs, the 9825A will finish the current line and then branch to the service routine (End of Line branching —EOL). Once the service routine is complete, the program pointer will return to the next line after the line where the interrupt occurred. [RESET] must be pressed to run the program again after it has been stopped.

Example Program 7 Programming the Trigger Levels (Option 041)

Example Program 7 allows you to type in a desired trigger voltage and the program will send it to the counter in the format it requires. Example: A trigger voltage of +1.25V must appear to the counter as +125*. The decimal point must be removed and a asterisk placed at the end.

Connect an oscilloscope to Channel A Marker Out (to verify the trigger levels are being programmed).

Set oscilloscope to:
50 mV/div vertical
0.5 μs/div horizontal

PROGRAM 7

```
0: rem 725;wrt 725,"PF4G4S1347A7B7R"
1: ent "enter trigger voltage X.XX",V;V→K
2: 43→S;if sgn(V)=-1;45→S
3: abs(K)→V
4: int(V)+48→X
5: frc(V)*10→W
6: int(W)+48→Y
7: frc(W)*10+48→Z
8: dsp K;wait 250
9: wtb 725,65,S,X,Y,Z,42
10: wait 1000;gto 1
*7288
```

Program Explanation:

Line Ø: Sets counter to remote. Programs the 5328A to FREQ, 100 Hz resolution, continuous trigger and output, Channel A and B to X1 attenuator, and reset.
Line 1: Stores desired trigger voltage into "V".
Line 2: Interrogates the polarity of the trigger voltage and loads an ASCII + (decimal 43) into S if positive or a 45 (–) if negative.
Line 3: Takes the absolute value of "V".
Line 4—7: Removes the decimal point from the selected trigger level, separates each digit and stores them in X, Y, Z, respectively.
Line 8: Displays trigger voltage; waits 250 ms.
Line 9: Write binary line; sends binary formatted trigger voltage to 5328A followed by the required ASCII * (decimal 42).
Line 10: Return program pointer to Line 1.

Type in the program, and (RUN) on the 9825A.

1. When it asks you to "enter trigger voltage", enter 1.00, then press (CONTINUE). The 9825A will display the digits going to the 5328A and will then format it into binary and send it to the 5328A.

   Depending on the trigger voltage you choose, the duty cycle of the marker out will change proportionally. Try several different voltages (plus and minus), but don't go beyond +/–1.4V because the oscillator output from the rear panel is approximately 2.8V p-p, and if you go beyond that, the marker out will disappear.

   If you wish to try this on Channel B, change scope to Marker B and change the '65' in the write binary program (Line 4) to '66' (decimal equivalent of an ASCII B). Lines 2 through 7, and 9 could be used (with the proper software) to either increment the trigger voltage, or preset it as necessary.

Table 2. Program Code Set

Codes shown in **bold** face are start-up conditions. These conditions are set by the code "P", Remote Program Initialize, or by the bus commands Device Clear or Selected Device Clear. Code groups 12 to 18 apply only when Option 041 is installed.

1. Initialization
   - P — Remote Program Initialize

2. Function

FØ	**Stop**	F8	T.I. A→B
F1	Start A	F9	B/A
†F2	Start Clock	F:	T.I. Avg. A→B
†F3	DVM/A	F;	Events C, T.I. A→B
F4	Freq. A	F<	Check
†F5	DVM/T.I. A→B	F=	C/A
F6	Period A	F>	Freq. C
F7	Per. Avg. A	F?	DVM

3. Time Base

Code	Freq Res	Multiplier	Time Res (Std)	Time Res (Opt. 040 and 041)
GØ	**1 MHz**	**1**	**100 ns**	**10 ns**
G1	100 kHz	10	1 μs	100 ns
G2	10 kHz	10^2	10 μs	1 μs
G3	1 kHz	10^3	100 μs	10 μs
G4	100 Hz	10^4	1 ms	100 μs
G5	10 Hz	10^5	10 ms	1 ms
G6	1 Hz	10^6	100 ms	10 ms
G7	0.1 Hz	10^7	1 s	100 ms

4. Single-Multiple Measurement
   - **SØ** — Single measurement. Hold sample rate. Trigger required.
   - S1 — Multiple measurement. Not Hold. No trigger required.

5. Measurement Cycle
   - **S2** — Hold measurement until address to output SRQ at end of measurement.
   - S3 — Output only if a device is ready to accept data when 5328A is ready to output.

6. Output Mode
   - **S4** — Output at end of measurement - most universal.
   - S5 — Output during gate - usable only in START/STOP mode or if the decade reset is disabled.

7. Sample Rate
   - **S6** — **Maximum**
   - S7 — Manual control (from front panel)

8. Arming
   - **S:** — **Off**
   - S; — On

9. Display Storage
   - **S<** — **On (normal)**
   - S= — Off

10. Decade Reset
    - **S>** — **Normal**
    - S? — Disabled (for cumulative measurements)

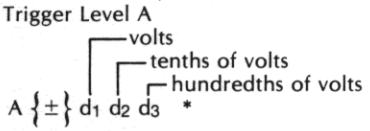
11. Display Blanking
    - **U** — **Normal Display**
    - Q — Blank display (digits and decimal point)

12. Channel A Signal Conditioning
    a. Impedance
       - **AØ** — **1 Megohm**
       - A1 — 50 Ohms
    b. Coupling
       - **A2** — **AC**
       - A3 — DC
    c. Slope
       - **A4** — **+slope**
       - A5 — -slope
    d. Attenuator
       - **A6** — **X10**
       - A7 — X1

13. Separate/Common
    - **A8** — **Separate**
    - A9 — Common A

14. Check
    - **A<** — **Normal Operation**
    - A? — Check, Measures internal clock

15. Trigger Level A



Permissible trigger level range: -2.50V to +2.50V.

The program sequence to set trigger level starts with the channel designation letter followed by a "+" or "–" sign. Next, three digits set the voltage level. An "*" terminates the sequence. The same sequence must be used even to set Ø volts

Examples: "A+100*" Ø volts
"A–123*" -1.23 volts

16. Channel B Signal Conditioning
    a. Impedance
       - **BØ** — **1 Megohm**
       - B1 — 50 ohms
    b. Coupling
       - **B2** — **AC**
       - B3 — DC
    c. Slope
       - **B4** — **+slope**
       - B5 — -slope
    d. Attenuator
       - **B6** — **X10**
       - B7 — X1

17. Trigger Level B
    B ± d1 d2 d3 *

    See Group 15, Trigger Leval A, for details

18. Channel Invert
    - **B8** — **Normal**
    - B9 — Invert A and B inputs

19. Reset; Trigger
    (Also see Bus Command GET)
    - R — Reset, no trigger
    - T — Reset and trigger

†Functions not labeled on instrument front panel.

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