5328A Universal Counter

HP-IB/HP 1000 Programming Example

HEWLETT hp PACKARD

HP-IB

DATA SYSTEMS DIVISION

Application Note 401-5

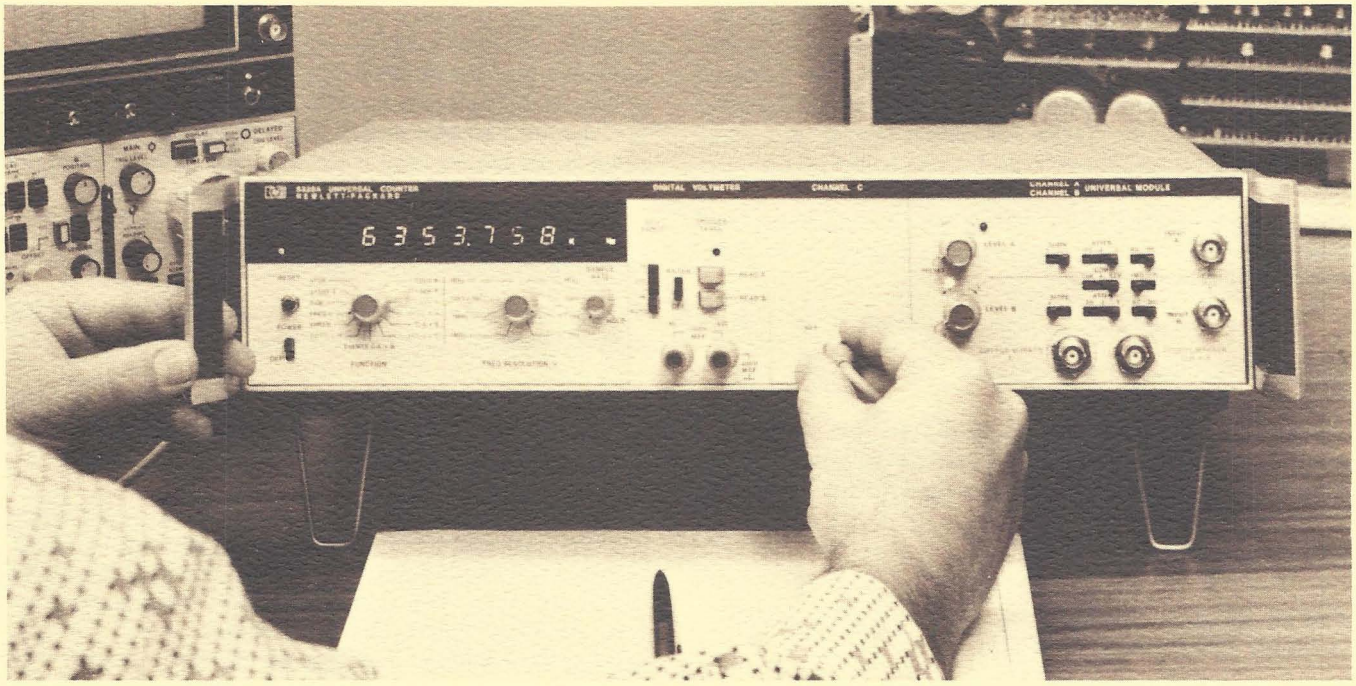

Figure 5-1. HP 5328A Universal Counter

Device Introduction

The standard 5328A counter (figure 5-1) provides an 8-digit readout measurement of frequency, period, period average, time interval, time interval average, and ratio of frequencies in the range from 0 to 100 MHz. Other options are available for extending measurements to 1.3 GHz.

Each of the two input channels has an attenuator, trigger slope detector, level control, ac-dc coupling, and an oscilloscope marker output. Rear panel connectors provide a gate output, a time base output and an input for an external frequency standard. An ARM switch on the rear panel allows arming by the signal being measured (switch off) or by another input signal (switch on).

Option 011 makes the 5328A Universal Counter compatible with the HP-IB.[1] At the simplest level the 5328A can output data to other devices such as the 5150A Thermal Printer or the 59303A Digital-to-Analog Converter. In more sophisticated systems an HP 1000 or other system controller can remotely program the 5328A, trigger measurements, and read the results. With the addition of Option 041, the 5328A allows full programmabiliy of the input signal conditioning controls. Other programmable options add digital voltmeter capability and the ability to measure frequency to 512 MHz.

Addressing

To use the 5328A in an HP-IB system, the first step is to set the rear panel address switches (figure 5-2).

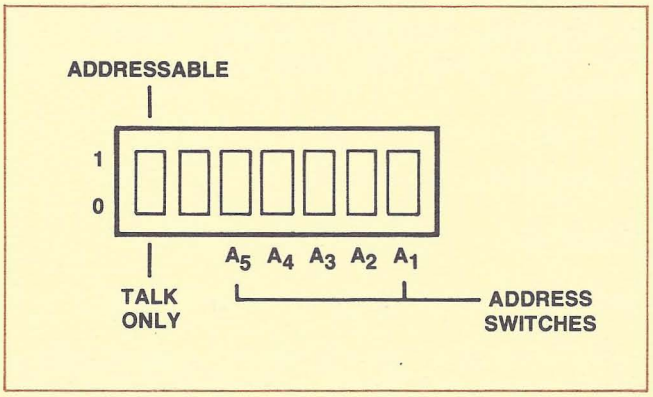

Figure 5-2. 5328A Address Switches

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[1]*This note should be used in conjunction with the 5328A User's Manual (05328-90017) and Application Note 401-1 (5953-2800).*

The leftmost switch sets the counter to ADDRESSABLE or TALK ONLY mode. ADDRESSABLE mode is used whenever a computer or other controller is used within the system. TALK ONLY mode is used when the counter will be controlled manually, but the 5328A will output results to a data logging device on the bus such as a printer or D-A converter.

The five right-hand switches, A5 through A1, set the talk and listen addresses of the 5328A when it is used in the ADDRESSABLE mode.

System Preparations

Taking measurements from the 5328A can be a straightforward task if a procedure is established to cover all details. A suggested procedure is outlined below.

LU Assignment

One LU (IDLU) is needed for the 5328A. It can be assigned using the File Manager command,

```
:SYLU,20,10,3
```

if logical unit 20 on equipment table 10 were to be assigned to 5328A address 3.

Buffering

The buffering option for the 5328A EQT should not be specified until the device has been configured and tested for the application in question. Buffering (only works on output) is an added performance feature and will only serve to complicate matters during initial setup. Use the File Manager command,

```
:SYEQ,10,UN
```

to unbuffer equipment table 10.

Time-out

The time-out value must be specified for the bus.

Note that the 5328A must be triggered either internally or externally to return a reading to the HP 1000. If the input signal is discontinuous for a period of time, care must be taken when specifying the time-out value. (See "Handling SRQ's from the 5328A".)

For example, given the signal input is discontinuous for 2 seconds, one of two choices may be made. When this is an error condition, the time-out value may be set for 2 seconds or less. In this case, the condition will be processed either by the operating system or the user program. If the time-out value is set greater than 2 seconds, the user program will simply wait 2 seconds for the measurement.

Configuration

The configuration word for the device should be examined for possible changes to the default mode.

A decision must be made as to whether DMA should be specified. See "Performance Characteristics of the 5328A" for DMA operation.

When the "E" bit of the device configuration word is set to one, the user program may be written to process a time-out or error condition, instead of having the operating system set the device down. This is one solution to the discontinuous input condition since this is seldom an error. The I/O request/abort scheme may also be changed. All other bits default to the proper configuration.[2]

The statement,

`:CN,IDLU,25B,37000B`	will allocate DMA from File Manager.
`:CN,IDLU,25B,17000B`	will deallocate DMA from File Manager.
`CALL CNFG(IDLU,1,37000B)`	will allocate DMA, in FORTRAN.
`CALL CNFG(IDLU,1,17000B)`	will deallocate DMA, in FORTRAN.

Remote

The 5328A must be programmed into remote before data messages will be recognized. The File Manager command,

`:CN,IDLU,16B`	sets the counter to remote from File Manager
`CALL RMTE(IDLU)`	sets the counter to remote from FORTRAN.

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[2] *See the HP-IB User Manual, part no. 59310-90064.*

Programming

Three steps are required to obtain a measurement or begin a series of measurements in the 5328A.

1. Program the instrument.
2. Trigger the instrument.
3. Read the measurement from the instrument.

Several user options are available during each step, as detailed below.

Messages to the 5328A

Table 5-1 should be referenced while programming the instrument, because the programming codes must be transmitted to the 5328A in the same order as listed in the table. (Default codes may be skipped.)

Table 5-1. 5328A Programming Codes

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.

1. Initialization
   - P Remote Program Initialize
2. Function
   - **FØ Stop**
   - F1 Start A
   - †F2 Start Clock
   - †F3 DVM/A
   - F4 Freq. A
   - †F5 DVM/T.I. A→B
   - F6 Period A
   - F7 Per. Avg. A
   - F8 T.I. A→B
   - F9 B/A
   - F: T.I. Avg . A→
   - F; Events C,T.I. A→B
   - F< Check
   - F= C/A
   - F> Freq. C
   - F? DVM
3. Time Base

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

4. Single-Multiple Measurement
   - **SØ Single Measurement**
   - S1 Multiple Measurement
5. Measurement Cycle
   - **S2 Wait to output; Service Request at end of measurement**
   - S3 Continue cycle; no Service Request

†Functions not labeled on instrument front panel

Table 5-1. 5328A Programming Codes (Continued)

6. Output Mode
   - **S4 Output at end of measurement**
   - S5 Output when addressed (on-the-fly)
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

Code groups 12 to 18 apply only when Option 041 is installed.

13. Separate – Common
    - **A8 Separate**
    - A9 Common A
14. Check
    - **A< Normal Operation**
    - A? Check, Measures internal clock
15. Trigger Level A

    A{+/−}d_1 d_2 d_3 *

    (d_1: volts; d_2: tenths of volts; d_3: hundredths of volts)

    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 0 volts.

Examples: "A+000*" 0 volts
"A–123*" –1.23 volts

Table 5-1. 5328A Programming Codes (Continued)

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{+/−}$d_1\ d_2\ d_3$ *
    See Group 15, Trigger Level 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

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.

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→
†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)
GØ	**1 MHz**	**1**	**100ns**	**10ns**
G1	100 kHz	10	1 μs	100ns
G2	10 kHz	10^2	10 μs	1 μs
G3	1 kHz	10^3	100 μs	10 μs
G4	100 Hz	10^4	1ms	100 μs
G5	10 Hz	10^5	10ms	1ms
G6	1 Hz	10^6	100ms	10ms
G7	0.1 Hz	10^7	1s	100ms

†Functions not labeled on instrument front panel

Table 5-1. 5328A Programming Codes (Continued)

4. Single-Multiple Measurement
   - S**Ø** **Single Measurement**
   - S1 Multiple Measurement
5. Measurement Cycle
   - **S2 Wait to output; Service Request at end of measurement**
   - S3 Continue cycle; no Service Request
6. Output Mode
   - **S4 Output at end of measurement**
   - S5 Output when addressed (on-the-fly)
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
       - **A**Ø **1 Megohm**
       - A1 50 Ohms

    b. Coupling
       - **A2 AC**
       - A3 DC

    c. Slope
       - **A4 +slope**
       - A5 -slope

    d. Attenuator
       - **A6 x10**
       - A7 x1

    Code groups 12 to 18 apply only when Option 041 is installed.
13. Separate - Common
    - **A8 Separate**
    - A9 Common A
14. Check
    - **A< Normal Operation**
    - A? Check, Measures internal clock
15. Trigger Level A

    A{±}d_1 d_2 d_3 *

    (d_1: volts; d_2: tenths of volts; d_3: hundredths of volts)

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

Table 5-1. 5328A Programming Codes (Continued)

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 0 volts.

Examples: "A+000*" 0 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
    $B\{{+\atop -}\}d_1\,d_2\,d_3\;*$
    See Group 15, Trigger Level 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

No more than one code from a group should be used in a program code string. The alphanumeric character (the letter "S" for example) need only be given once during the sequence (as shown in figure 5-3).

Several different programming configurations exist for the 5328A. The "S" functions can be somewhat tricky and table 5-2 describes what each function does.

Figure 5-4 illustrates example strings which were used to program "frequency channel A" measurements on the counter. Pay particular attention to the "S" functions and how they are used. The "S" functions also determine service request (SRQ) operation. Using SRQ with the HP 1000 will be discussed in detail later.

Typical Code String	Equivalent
"S1S3S4S6"	"S1346"
"A1A7A9A+123*"	"A179+123*"

Figure 5-3. 5328A Equivalent Strings

Table 5-2. 5328A Programming S Functions

S0 -	Must be used when it is desired to trigger each measurement from the user program before the reading is taken.
S1 -	The 5328A triggers the measurement internally. No trigger is needed in the user program.
S2 -	May be used with either S0 or S1 and causes a service request after each measurement.
S3 -	May only be used with S1 and suppresses a service request after each measurement.
S4 -	5328A will output only after a measurement is taken. This function produces the most predictable results, however, care must be taken so that the bus is not held in suspension during 5328A measurements. (The RTE timeout facility may be used.)
S5 -	The 5328A will output continuously whether a measurement has been taken or not.
S6 -	This function means "maximum sample rate". It will work in default mode and need not be programmed.

EXAMPLE	DESCRIPTION	SRQ GENERATED?

`   WRITE (IDLU,10)`
`10 FORMAT ("F4G0S024A9R")`
`   DO 20 I=1,10`
`   CALL TRIGR (IDLU)`
`   READ (IDLU,*)A`
`20 CONTINUE`
	Measures frequency on channel A. Single measurement. Triggered by the user's program (S0S2).	Yes

`   DIMENSION A(10)`
`   WRITE (IDLU,10)`
`10 FORMAT/"F4G0S124A9R")`
`   READ(IDLU,200)A`
`200 FORMAT (E15.4)`
	Measures frequency on channel A. Multiple measurements. Triggers on waveform (S1S2).	Yes

`   WRITE(IDLU,10)` `10 FORMAT("F4G0S034A9R")`	Measures frequency on channel A. Single measurement. Triggered by the user's program (S0S3).	Invalid instruction. S3 requires "continuous cycle" and can only be used with S1.

`   WRITE (IDLU,10)`
`10 FORMAT("F4G0S134A9R")`
`   READ (IDLU,100)A`
`100 FORMAT (E15.4)`
	Measures frequency on channel A. Multiple measurements. Triggers on waveform (S1S3).	No

NOTE: Free field input was used in these examples. See "Messages from the 5328A."

Figure 5-4. Example FORTRAN Programs

The first two examples show methods which produce a service request at the end of each 5328A measurement. It is important to understand that serial polling is performed automatically when,

a. DVR37 with SRQ program scheduling has been implemented in the HP 1000 system, and

b. at least one device on the same bus is set up to schedule a program on an SRQ. If no devices are set up for SRQ program scheduling, then no serial poll will occur.

The 5328A is capable of generating measurements rapidly, likewise SRQ's. The SRQ capability isn't needed for rapid measurements in the HP 1000. (Overhead generated by the serial polling sequence is greater than simply waiting for the measurement in the user program.) The 5328A should be used as in the fourth example in figure 5-4, or care should be taken to see that no devices are set up for SRQ program scheduling. See "Handling SRQ's from the 5328A" for more information on the SRQ scheduling ability and when to use it.

Messages from the 5328A

The 5328A transmits the string of characters to output a measurement as shown in figure 5-5.

An "O" in the first position indicates measurement overflow. Leading 0's in positions 3 to 12 are output as space (SP) if they occur more than one position to the left of the decimal point and there is no overflow. The decimal point may appear at positions 4 to 12. The output string is always 17 characters long. Typical character output strings are shown in figure 5-6.

Position	1	2	3 thru 12	13	14	15	16	17
Character	0 SP	+ -	9 digits and a decimal point	E	+ -	d	CR	LF

Figure 5-5. 5328A Measurement Output Format

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
SP	+	5	0	3	2	1	7	.	6	9	8	E	+	3	CR	LF
SP	+	SP	SP	SP	5	4	3	2	.	1	0	E	-	3	CR	LF
0	+	0	5	3	1	8	.	5	4	2	0	E	+	3	CR	LF

Figure 5-6. Example Character Output Strings

The 5328A inserts a zero in position 12 of the output string for all measurements that don't use the ninth digit (leftmost digit) of the counter's display. This extra "0" fills the output string to a constant 17 characters.

Reading a Measurement

The measurement format in figure 5-5 indicates that the leading character in the message will be either a numeric value or an "O" indicating overflow. When it can be assumed that an overflow will not occur, a very convenient form of input, free field input can be used in FORTRAN.

```
READ(IDLU,*) A
```

If an overflow can occur, an alternate form of input should be used, which breaks the message into two component parts. An illustration of this idea is shown in figure 5-7.

The example program in figure 5-8 shows the 5328A programmed for internal trigger, frequency measurements on channel A. There will be no service request after the measurement in this configuration. Notice that "R" must be included in the programming string to reset the counter. The frequency resolution is "G7" or a one-second gate time.

```
0001   FTN4,L
0002         PROGRAM TS328(3),06-22-78 (GWG) CHECK OVERFLOW
0003         COMMON       ILU,ILST,IDLU          Parameters in common are supplied by the
                                                 function 'INPRM'. Only ILU and IDLU are used in
                                                 this program.
0004   C
0005         DATA         YES/2HYE/

0006         IF(INPRM(ID).EQ.YES) GO TO 10       Get input LU and device LU. If IDLU#0 then
                                                 INPRM=YES.

0007   C
0008   C
0009   C
0010   999   WRITE(ILU,100)
0011   100   FORMAT(/" TS328: ':RU,TS328,ILST,IDLU'")
0012         STOP
0013    10   IF(IFBRK(IM).LT.0)GO TO 500         The break flag means stop taking
                                                 measurements.
0014         READ(IDLU,111)ISTAT,A
0015   111   FORMAT(A1,E14.4)                    Notice the input format.
0016         IF(ISTAT.NE.2HO )GO TO 30           Status arrives as, SPSP or OSP.
0017         WRITE(ILU,112)A
0018   112   FORMAT(" OVERFLOW!!     "E14.4)
0019         GO TO 10
0020    30   WRITE(ILU,113)A
0021   113   FORMAT(" A = "E14.4)
0022         GO TO 10
0023   500   END
```

Figure 5-7. Checking for 5328A Overflow

```
0001  FTN4,L
0002        PROGRAM T5328(3),
0003       &6-12-78 (GWG) SPECIAL READ FROM 5328A
0004        INTEGER      YES
0005        COMMON       ILU,ILST,IDLU      Parameters in common are supplied by the function
                                            'INPRM'. Only ILU and IDLU are used in this program.
0006        DATA         YES/2HYE/

0007        IF(INPRM(ID).EQ.YES)GO TO 10     Get input LU and device LU.
0008  C
0009  C
0010  C
0011        WRITE(ILU,100)
0012  100   FORMAT(/" T5328: ':RU,T5328,ILST,IDLU'")
0013        STOP
0014  10    WRITE(IDLU,101)                  Program the 5328A.
0015  101   FORMAT("F4G7S1346A9R")           F4  = Freq. Ch. A
                                            G7  = Freq. Res. 0.1 Hz
                                            S1  = Mult. Meas.
                                             3  = Cont., No SRQ
                                             4  = Out at end
                                             6  = Max Sample Rate
                                            A9  = Common A
                                            R   = Reset, No trig.

0016   119  READ(IDLU,*)A                    Read from the 5328A, free field input.
0017        IERR=IBERR(IDLU)                 Check for HP-IB time-out error. To do this, the EQT must
                                             be unbuffered, and the E bit must be set in the device
                                             configuration word.
0018        IF(-IERR.LT.0)WRITE(ILU,111)IERR
0019  111   FORMAT(" T5328: HP-IB ERROR "I2)
0020        WRITE(ILU,110)A
0021   110  FORMAT("A = "E14.6)
0022        IF(IFBRK(IM).LT.0)GO TO 500      Break Flag means terminate program.
0023        GO TO 10
0024   500  END
```

Figure 5-8. Internal Trigger, Frequency, Free Field Input

For the program to work correctly, the time-out value must be set for some time greater than 1 second (or the counter will time-out before the measurement is returned). For example, the File Manager command,

```
:SYTO,10,500
```

will set the time-out to 5 seconds. Note also, that in line 0017 of figure 5-8, that HP-IB errors are set to be handled by the user program. This means that buffering must be turned off and the device configuration word E bit must set to 1.[3] For example, the File Manager command,

```
:CN,IDLU,25B,17400B
```

will set the device configuration for user program error processing.

If a time-out occurs, the error will be reported to the user, instead of aborting the program. The program will then attempt to continue.

Handling SRQ's from the 5328A

The HP 1000 HP-IB driver (DVR37 with SRQ program scheduling) has the ability to automatically schedule a user program when an interrupt (SRQ) is generated by the 5328A. When scheduled, this program can obtain the current 5328A status, check for errors, or read one or more measurements.

In some situations, a user may wish to use the SRQ generating facility in the 5328A to schedule a user program. This application arises when the input signal to the 5328A is discontinuous and a long period of time elapses between the triggering of a measurement and actually reading the measurement.

The general idea is to write a user program which sets up the HP-IB system software to schedule a program when a service request is seen from the 5328A. The user program then completes in a special way (called "saving resources") saving the value of the LU's for the SRQ device and the list device (5328A counter, and the CRT terminal, respectively, etc.) on a mass storage device (disc).

The user program will be scheduled each time the 5328A generates an SRQ. During each event the program reads a measurement from the 5328A and completes, saving the measurement on the disc. This method of using SRQ is very useful when infrequent measurements are expected from the counter as it gives the HP 1000 the freedom to perform many other tasks between SRQ's instead of spending lengthy periods of time waiting for measurements. For complete details, see figure 5-9.

NOTE

Recognize the inherent implications when dealing with SRQ on the HP-IB. When a device asserts the SRQ control line on the bus, the system controller has no idea which device needs attention because there is only one SRQ line and up to 14 devices. The controller determines which device generated the SRQ by sending the serial poll enable command (SPE) and then sending the talk address of each device set up for SRQ program scheduling. These devices each return one byte of status within which is a bit denoting if this was the device that generated the SRQ.

Suppose two LU's on a bus are configured to schedule programs on interrupt. If one of the devices is physically removed from the bus, it must also be unconfigured in the software. SRQ is a device-dependent function. Even though an SRQ interrupt arrives from only one device, all configured devices will be polled, and if the device is not physically present, the bus will "hang" or time-out, before the serial poll sequence completes. This will cause unpredictable results and at the very least, a performance degradation.

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[3] *See the HP-IB Users Manual (59310-90064) for more details concerning device configuration.*

```
0001  FTN4,L
0002        PROGRAM S5328(3),09-12-78 (GWG) SRQ PROGRAM
0003  C
0004  C SYSTEM PREPARATIONS:
0005  C SET THE E BIT IN THE DEVICE CONFIGURATION WORD
0006  C UNBUFFER THE EQT
0007  C
0008  C THE RTE SAVE RESOURCES OPTION HAS BEEN
0009  C USED IN THIS PROGRAM. IT IS SCHEDULED
0010  C ONCE MANUALLY FOR SETUP, THEN 10 TIMES
0011  C BY 5328A INTERRUPTS.
0012  C
0013  C RMPAR IS CALLED 10 TIMES.
0014  C
0015  C
0016        INTEGER IPM(5),IPRG(4),ISTT(2),ISTAT(10)
0017        COMMON  ILU,ILST,IDLU                    Function 'INPRM' supplies ILU and IDLU.
0018  C
0019        DATA    NO/2HNO/
0020        DATA    IPRG/5,2HS5,2H32,2H8 /,LOOP/0/   Note that IPRG(1) must contain the number of
                                                     characters
0021        IF(INPRM(ID).EQ.NO)  GO TO 999           Get run parameters.
0022        WRITE(ILU,100)IDLU
0023    100 FORMAT(" S5328A: SRQ PROGRAM SETUP",
0024       &       " IN PROGRESS FOR FOR LU "I2"."/)
0025        CALL SRQ(IDLU,16,IPRG)                   Setup SRQ scheduling. Check for error.
0026        IF(IERR(NN).LT.0) GO TO 20               Program the 5328A.
0027        WRITE(IDLU,110)
0028    110 FORMAT("F4G7S0246A9R")
0029     10 LOOP=LOOP+1                              Track the # of measurements taken.
0030        CALL TRIGR(IDLU)                         Trigger the 5328A.
0031        CALL EXEC(6,0,1)                         Terminate saving resources.
0032        CALL RMPAR(IPM)                          Get device status.
0033        ISTAT(LOOP)=IPM
0034        READ(IDLU,*)A(LOOP)                      Read the measurement.
0035        IF(LOOP.EQ.10) GO TO 20
0036        GO TO 10
0037    999 WRITE(ILU,130)                           No IDLU was specified.
0038    130 FORMAT(" :RU,S5328,ILST,IDLU"/)
0039        STOP
0040     20 DO 30 LOOP=1,10                          Print the measurements.
0041     30 WRITE(ILU,140)ISTAT(LOOP),A(LOOP)
0042    140 FORMAT(5X,I6,5X,D17.11)
0043        END
0044  C
0045  C
0046        FUNCTION IERR(N),
0047       &07-26-78 (GWG) HANDLE BUS ERRORS
0048        COMMON ILU,ILST,IDLU
0049  C
0050  C
```

Figure 5-9. SRQ Program for the 5328A

```
0051          I=IBERR(IDLU)
0052          IERR=0
0053          IF(I.EQ.0)GO TO 10
0054          IERR=-I
0055          WRITE(ILU,20)I,IDLU
0056  20      FORMAT(" S5328: BUS ERROR "I2" ON LU "I2,
0057         &       " .")
0058  10      RETURN
0059          END
```

Figure 5-9. SRQ Program for the 5328A (Continued)

Performance

Appendix B describes the performance characteristics of HP-IB in the RTE operating system. The performance programs in Appendix C were used for the examples in this chapter. Table 5-3 shows typical times for different methods of input.

A simple EXEC call for input using DMA is the fastest method shown here. The EXEC call simply performs an ASCII read request into a buffer 17 bytes long. No ASCII to binary conversions were performed (figure 5-10).

```
Example:  DIMENSION IBUF(9)
          .
          .
          .
          CALL EXEC(1,IDLU,IBUF,-17)
```

Figure 5-10. 5328A Fast Method of Input

The formatted input graph (figures 5-11 and 5-12) for both the internal and external triggering cases used the methods shown in the "Programming" section.

Table 5-3. 5328A Performance Times

Input Format	No. of Readings	Task Time (in seconds)	Utilization
Non-DMA Internal trigger Free field input[4]	10	.29	91.66 %
	20	.59	95.75 %
	30	.88	97.13 %
	40	1.17	97.81 %
	50	1.47	98.23 %
	60	1.76	98.50 %
	70	2.06	98.70 %
	80	2.35	98.85 %
	90	2.64	98.96 %
	100	2.94	99.05 %
DMA Internal & external trigger Free field input[4]	10	.23	84.71 %
	20	.46	89.96 %
	30	.69	91.72 %
	40	.92	92.60 %
	50	1.16	93.12 %
	60	1.39	93.47 %
	70	1.61	93.72 %
	80	1.85	93.91 %
	90	2.08	94.06 %
	100	2.31	94.17 %
Non-DMA Internal trigger EXEC Call input[4]	10	.18	84.78 %
	20	.36	91.53 %
	30	.54	93.83 %
	40	.71	94.90 %
	50	.89	95.59 %
	60	1.08	96.04 %
	70	1.25	96.35 %
	80	1.43	98.35 %
	90	1.60	96.82 %
	100	1.78	97.00 %
DMA Internal trigger EXEC Call input[4]	10	.10	61.57 %
	20	.20	73.66 %
	30	.30	77.90 %
	40	.39	79.98 %
	50	.49	81.21 %
	60	.59	82.04 %
	70	.69	82.64 %
	80	.79	83.00 %
	90	.89	83.32 %
	100	.99	82.53 %

---

[4] *The programming string for these measurements was "F4G051346A9R". See example 4 in figure 5-4.*

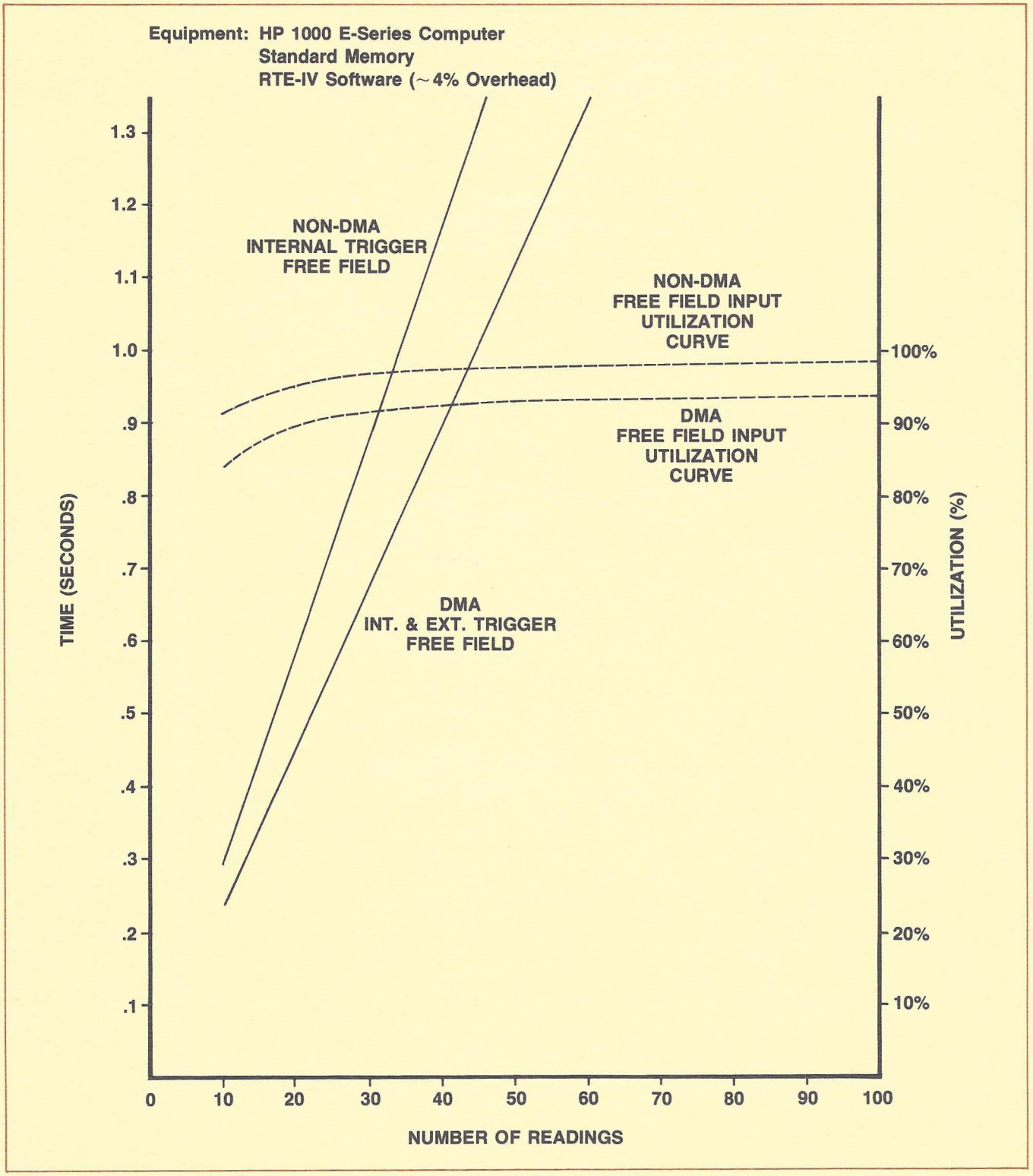

Figure 5-11. Performance, Formatted Free Field Input

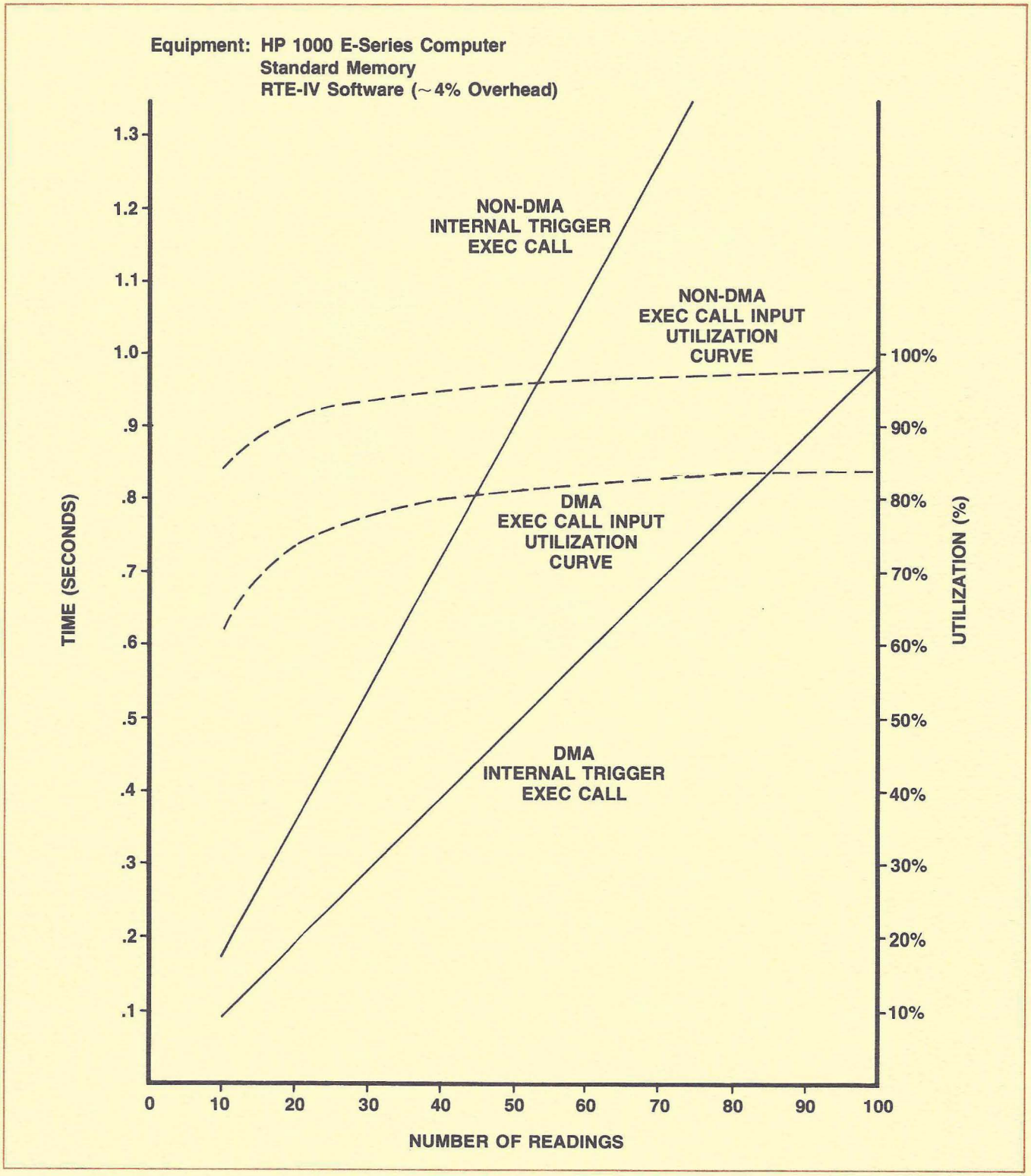

Figure 5-12. Performance, EXEC Call Input