HP 3852A Data Acquisition/Control Unit

HP 44721A/44722A
16-Channel/8-Channel Digital Input Accessories

Configuration and Programming Manual

This is the HP 44721A/44722A 16-Channel/8-Channel Digital Input Accessories Configuration and Programming Manual. Insert this manual and tab page into the Plug-In Accessories Configuration and Programming Manuals Binder supplied with your HP 3852A Data Acquisition/Control Unit.

44721-90002

HEWLETT PACKARD

Printed in U.S.A.

HP 3852A Data Acquisition/Control Unit

HP 44721A/44722A
16-Channel/8-Channel Digital Input Accessories

Configuration and Programming Manual

HEWLETT PACKARD

Manual Part Number: 44721-90002
Microfiche Part Number 44721-99002

Printed: NOVEMBER 1988 Edition 2
Printed in U.S.A. E1088

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition or a new update is published. No information is incorporated into a reprinting unless it appears as a prior update; the edition does not change when an update is incorporated.

Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

Edition1(Part Number 44721-90001)..JANUARY 1987
Update 1 (Part Number 44721-90090)..AUGUST 1987
Edition 2 (Part Number 44721-90002)..NOVEMBER 1988

HEWLETT PACKARD

Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät/System HP 3852A in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation fur Meß- und Testgeräte

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet, so ist vom Betreiber sicherzustellen, daß die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's declaration

This is to certify that the equipment HP 3852A is in accordance with the Radio Interference Requirements of Directive FTZ 1046/84. The German Bundespost was notified that this equipment was put into circulation, the right to check the series for compliance with the requirements was granted.

Additional Information for Test- and Measurement Equipment

If Test- and Measurement Equipment is operated with unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the Radio Interference Limits are still met at the border of his premises.

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment fron the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States Na tional Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilitie. of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in materials and workmanship for a perioc of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, eithe repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepa shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shal pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Duration and conditions of warranty for this instrument may be superceded when the instrument is integrated int (becomes a part of) other -hp- instrument products.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execut its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that th operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifica tions for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIM THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSE QUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard product.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the bac of this manual.

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Under certain conditions, dangerous voltages may exist even with the instrument switched off. To avoid injuries, always disconnect input voltages and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

C

HEWLETT PACKARD

Operating and Safety Symbols

Symbols Used On Products And In Manuals

~ LINE — AC line voltage input receptacle.

Instruction manual symbol affixed to product. Cautions the user to refer to respective instruction manual procedures to avoid possible damage to the product.

Indicates dangerous voltage – terminals connected to interior voltage exceeding 1000 volts.

OR — Protective conductor terminal. Indicates the field wiring terminal that must be connected to earth ground before operating equipment – protects against electrical shock in case of fault.

Clean ground (low-noise). Indicates terminal that must be connected to earth ground before operating equipment – for single common connections and protection against electrical shock in case of fault.

OR — Frame or chassis ground. Indicates equipment chassis ground terminal – normally connects to equipment frame and all metal parts.

ATTENTION Static Sensitive — Affixed to product containing static sensitive devices – use anti-static handling procedures to prevent electrostatic discharge damage to components.

NOTE

> **NOTE**
>
> *Calls attention to a procedure, practice, or condition that requires special attention by the reader.*

CAUTION

> **CAUTION**
>
> *Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.*

WARNING

> **WARNING**
>
> *Calls attention to a procedure, practice, or condition that could possibly cause bodily injury or death.*

WARNING, CAUTION, and NOTE Symbols

Some labels on the HP 3852A, HP 3853A, and plug-in accessories include an international warning symbol (triangle with subscripted number) which refers the reader to the manuals for further information. This table shows the warning symbols used for the HP 3852A/3853A and plug-in accessories. Refer to the manual set for specific information on WARNINGS, CAUTIONS, or NOTES referenced with a warning symbol.

HP 3852A WARNING, CAUTION, and NOTE Symbols

Symbol	Meaning	Location
⚠ 1	Shock hazard originating outside the instrument (field wiring)	. Analog Extender Connector on Power Supply Modules . Terminal modules on plug-in accessories . Component module covers on plug-in accessories
⚠ 2	Treat all channels as "one circuit" for safety purposes.	. Inside terminal modules on plug-in accessories . Metal cover on component modules of plug-in accessories
⚠ 3	Maximum number of certain plug-in accessories to be installed into an HP 3852A or HP 3853A.	. HP 44701A, HP 44702A/B, HP 44727A/B/C plug-in accessories
⚠ 4	If High-Speed FET multiplexers are used with the HP 44702A/B, ribbon cable may be connected.	. HP 44711A, 44712A, 44713A (referenced on HP 44702A and HP 44702B)
⚠ 5	The instrument should not be operated at a line frequency of 440 Hz with a line voltage of 200 V or greater as the AC leakage current may exceed 3.5 mA.	. HP 3852A, HP 3853A Power Supply Modules

TABLE OF CONTENTS

Chapter 1
Introduction

Contents

Chapter 1

Introduction

Manual Contents

This manual shows how to configure and program the HP 44721A 16-Channel Digital Input with Totalize and Interrupt accessory (16-channel digital input) and the HP 44722A 8-Channel AC Digital Input with Totalize and Interrupt accessory (8-channel digital input). Refer to the HP 3852A Mainframe Configuration and Programming Manual for additional information on the acessories. Chapter sections are:

- **Introduction** contains an overview of the chapter, describes the digital inputs, and shows a suggested getting started sequence.

- **Configuring the 16-Channel Digital Input** shows how to hardware configure the 16-channel digital input.

- **Configuring the 8-Channel Digital Input** shows how to hardware configure the 8-channel digital input.

- **Programming the Digital Inputs** shows how to program the digital inputs for four main functions: detecting the input state, counting input edges, generating event interrupts, and generating counter interrupts.

Digital Input Descriptions

The 16-channel and 8-channel digital inputs can be used to detect the state of the input, count input state changes (edges), and generate interrupts on state changes and/or counter overflow conditions. A description of each digital input follows.

16-Channel Digital Input

The 16-channel digital input consists of a digital input component module and a 16-channel terminal module. The terminal module can be jumper-selected for nominal input voltages of 5, 12, 24 or 48 VDC in each of the 16 input channels. In addition, +5 VDC is supplied on the terminal module for use with dry-contact external inputs such as switches or mechanical contacts.

The accessory has digital debounce circuitry for accurate counting and edge detection. Debounce settings for input frequencies ranges of 10 Hz, 100 Hz and 1 kHz are jumper-selectable. Since the card has a single debounce jumper, the debounce jumper setting applies to all channel inputs.

8-Channel Digital Input

The 8-channel digital input consists of a digital input component module (the same as the one used for 16-channel digital input accessory) and an 8-channel terminal module. The accessory accepts inputs up to 250 VDC or 250 VAC rms @ 47-470 Hz. Each channel of the terminal module can be independently jumper-selected for nominal voltage inputs of 24, 120, or 240 volts. The accessory has a debounce jumper which is fixed at 10 Hz.

Digital Input Functions

As shown in Figure 1-1, each digital input physical channel consists of two "logical" channels: a count channel and an event (state) channel. Logical count channels are 0-15 (0-7 for the 8-channel digital input) while logical event channels are 16-31 (8-15 for the 8-channel).

For example, a 16-channel digital input in slot 1 of the mainframe has physical channels 100 through 115. For channel 100, the associated logical count channel is 100 and the logical event channel is 116, etc. Refer to Chapter 4 - Programming the Digital Inputs for details.

The digital input accessories have four main functions: detecting the input state; counting input edges; generating event interrupts; and generating counter interrupts. To perform these functions, the accessories detect input edges. The 16-channel digital input detects DC input edges while the 8-channel digital input detects both DC and AC input edges.

NOTE

For a DC input, a positive edge is an input change from LOW to HIGH while a negative edge is an input change from HIGH to LOW. For an AC input, a positive edge is an input change from OFF to ON while a negative edge is an input change from ON to OFF. Thus, for AC inputs, the channel state does NOT change with each cycle of the input.

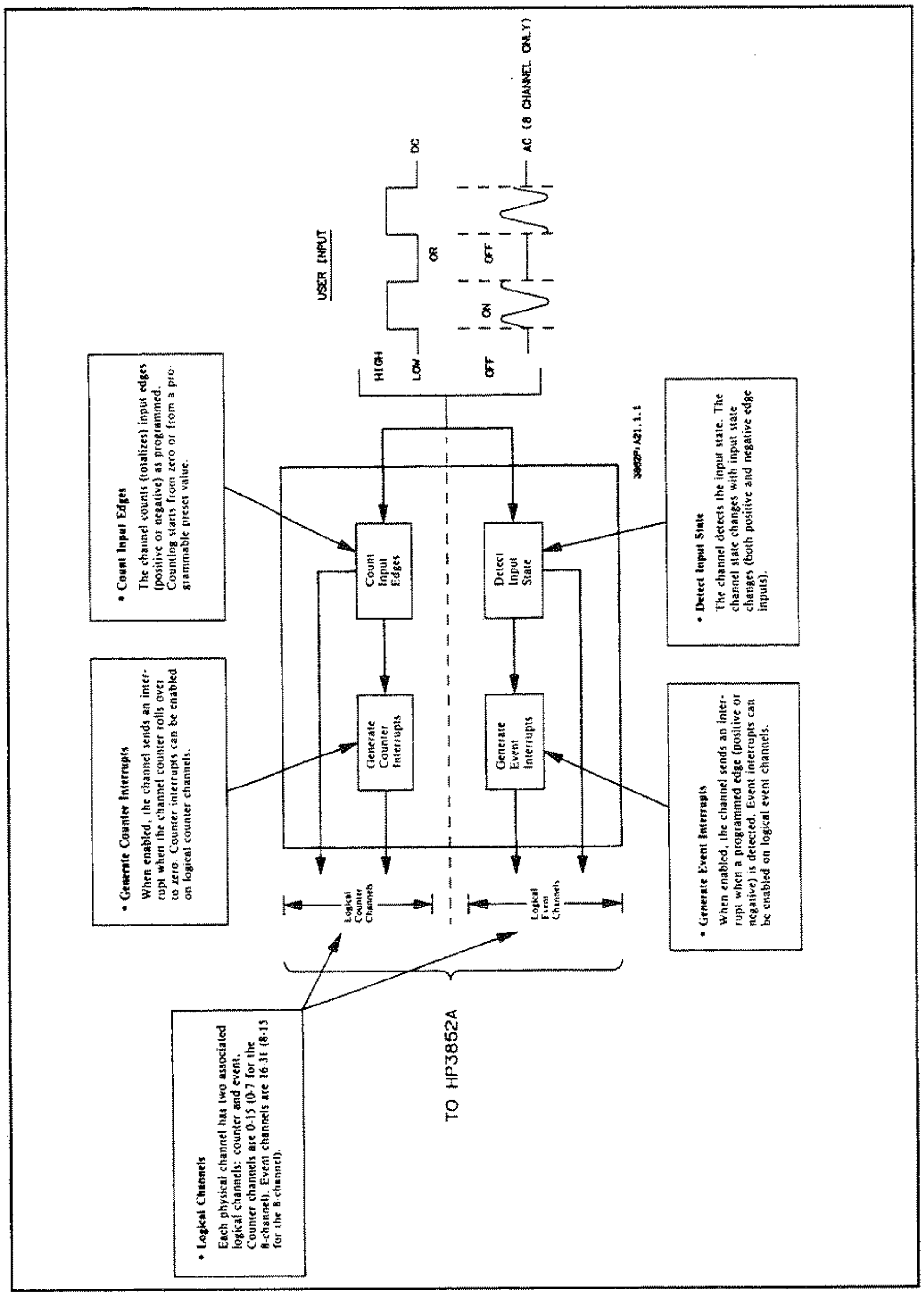


Figure 1-1. Digital Input Functions

Detect Input State

Each digital input channel continuously detects the input state and changes state with input state changes. For example, when a DC input goes from LOW to HIGH, the channel state goes from "0" to "1". Or, when an AC input goes from ON to OFF (8-channel digital input only) , the channel state goes from "1" to "0". You can read each channel state or the slot state to determine the input state.

Count Input Edges

Each channel has a separate counter which counts (totalizes) positive or negative edges, as programmed. Counting starts from zero or from a programmable preset value. You can read the totalized count to determine the number of counts (programmed input edges) on the channel. You can also read and zero the count on any channel.

Generate Event Interrupts

Each channel can be enabled to generate an interrupt when a programmed edge (positive or negative) is detected. This is defined as an event interrupt. Note that each channel can be programmed for event interrupts, counter interrupts, or for both event and counter interrupts.

Generate Counter Interrupts

Each channel can also be enabled to generate an interrupt when the channel counter rolls over to zero. This is defined as a counter interrupt. Again, each channel can be programmed for event interrupts, counter interrupts, or for both event and counter interrupts.

Getting Started

To use a 16-channel or 8-channel digital input for your application, you will need to do three things:

- Define your application.
- Configure the digital input.
- Program the digital input.

Define Your Application

The first step is to define your application and select the devices to connect to the digital input. When selecting devices, refer to the Specifications appendix in the HP 3852A Mainframe Configuration and Programming Manual to ensure that device voltage, current, and frequency are within digital input specifications.

Configure the Digital Input

The next step is to configure each digital input channel for the devices selected. Although there are four primary functions for the digital inputs (detecting input states, counting input edges, generating event interrupts, and generating counter interrupts), digital input hardware configuration is identical for any function.

Refer to Chapter 2 - Configuring the 16-Channel Digital Input to configure a 16-channel digital input. Refer to Chapter 3 - Configuring the 8-Channel Digital Input to configure an 8-channel digital input.

Program the Digital Input

The third step is to program the digital input channels used for your application. Refer to Chapter 4 - Programming the Digital Inputs to program the 16-channel or 8-channel digital input for your application.

Chapter 2
Configuring the 16-Channel Digital Input

Contents

Chapter 2

Configuring the 16-Channel Digital Input

Introduction

This chapter shows how to hardware configure the 16-channel digital input. It includes guidelines to set the attenuator jumpers and the debounce jumper on the terminal module, shows typical field wiring connections, and shows how to install and initially check the accessory.

Chapter Contents

This chapter has three sections:

- **Introduction** includes a chapter overview and lists WARNINGS, CAUTIONS, and NOTES which apply to the 16-channel digital input.

- **Terminal Module Configuration** shows how to set the attenuator and debounce jumpers and how to connect field wiring to the terminal module.

- **Installation and Checkout** shows how to install and initially check the 16-channel digital input.

Warnings, Cautions, and Notes

This section summarizes WARNINGS, CAUTIONS, and NOTES which apply to the 16-channel digital input accessory. You should review the WARNINGS and CAUTIONS shown before handling or configuring the accessory.

WARNING

⚠ 1 *SHOCK HAZARD. Only qualified, service-trained personnel who are aware of the hazards involved should install, remove, or configure any accessory. Before touching any installed accessory, turn off all power to the mainframe, extenders, and to all external devices connected to the mainframe, extenders, or accessories.*

WARNING

⚠2 *POSSIBLE OPERATOR INJURY. For safety, consider all accessory channels to be at the highest potential applied to any channel.*

CAUTION

MAXIMUM VOLTAGE/POWER LIMITATIONS. To avoid circuit damage to the 16-channel digital input, maximum input voltage is 80 VDC. Maximum total input power to avoid degrading accessory specifications is six (6) watts.

CAUTION

STATIC SENSITIVE. Use clean-handling techniques when handling the accessory. Do not install an accessory without the metal covers attached.

NOTE

HP-IB ADDRESS. The example programs in this manual use "709" as the HP-IB address for the HP 3852A. Specific slot and channel numbers are also used. Program syntax and data return formats apply to HP Series 200/300 controllers. Modify slot and channel numbers and program syntax as required.

Terminal Module Configuration

This section shows how to set the attenuator and debounce jumpers and how to connect field wiring to the 16-channel digital input terminal module.

Setting Attenuator Jumpers

To begin terminal module configuration, remove the terminal module cover. (If the accessory is installed in the mainframe or an extender, refer to the HP 3852A Mainframe Configuration and Programming Manual to remove the terminal module.)

Terminal Module Description

Figure 2-1 shows the 16-channel terminal module with the cover removed. The terminal module has 16 attenuator jumpers (J100 through J115), one for each channel. J100 sets channel 0, J101 sets channel 1,. . ., J115 sets channel 15. Each jumper can be set to 5V, 12V, 24V, or 48V. However, to properly set the attenuator jumper, we will first need to define some terms.

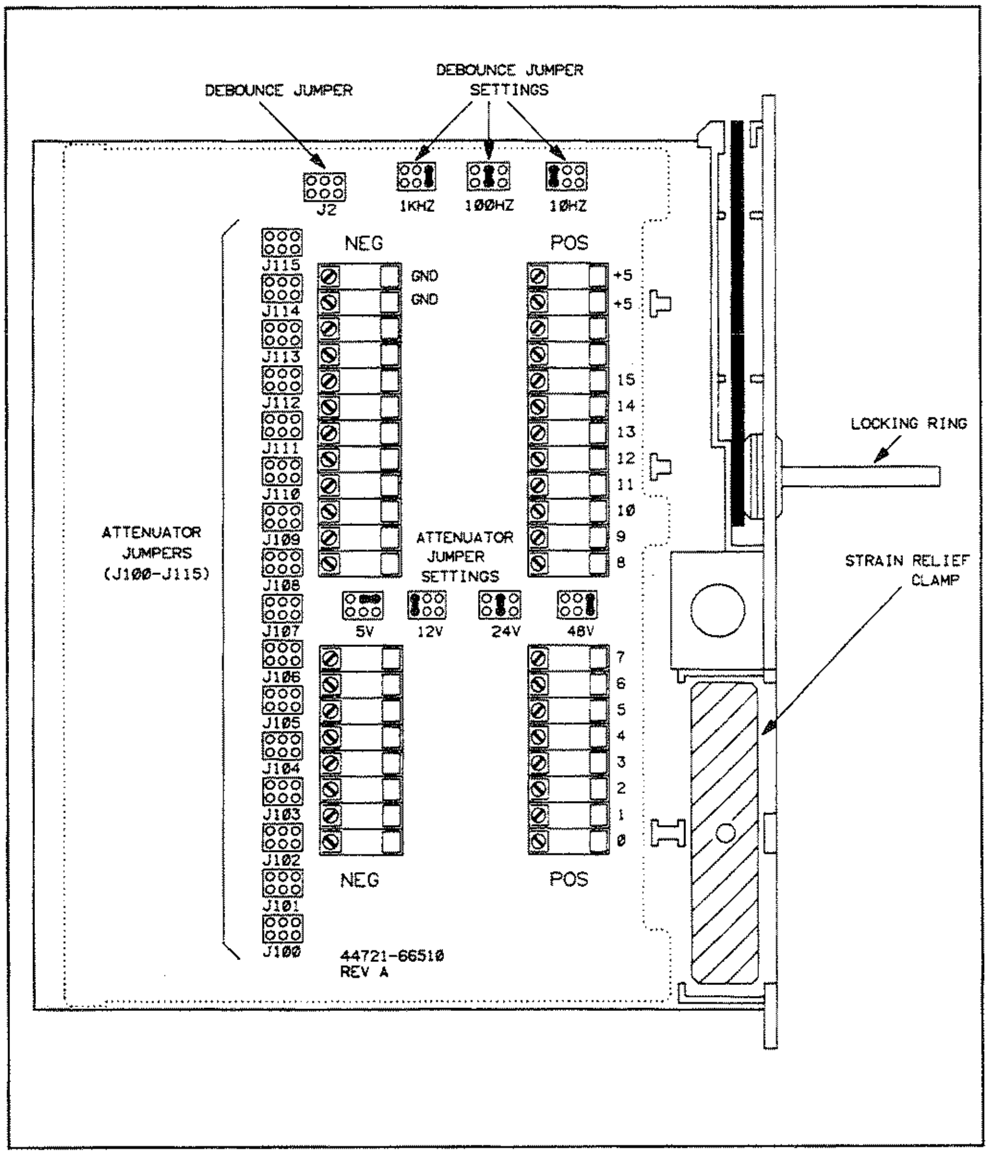


Figure 2-1. HP 44721A Terminal Module

Determining Jumper Setting

Figure 2-2 shows guidelines to select the proper attenuator jumper setting for a typical DC input, where Vhigh is the MINIMUM value of the input HIGH state and Vlow is the MAXIMUM value of the input LOW state. Vmax and Vmin are the Threshold Voltages shown in Table 2-1.

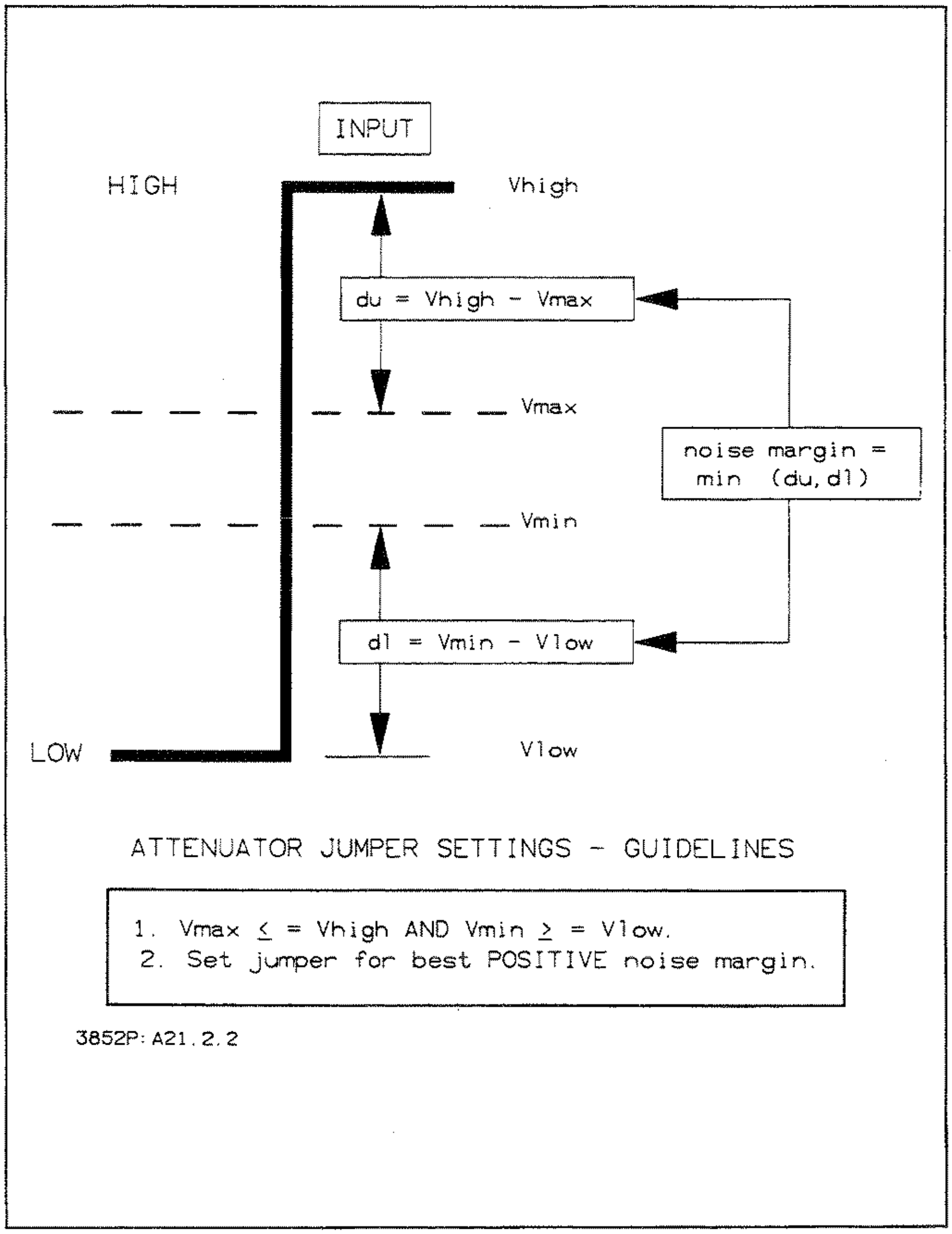


Figure 2-2. Attenuator Jumper Setting Guidelines

To determine the appropriate jumper setting, use the setting (5V, 12V, 24V, or 48V) which has the best POSITIVE noise margin, where noise margin = min (du, dl) = min (Vhigh - Vmax, Vmin - Vlow).

Table 2-1. Threshold Voltages

Attenuator Jumper Settings	Threshold Voltages Vmin	Vmax	Nominal Current for Setting
5 V	1.0 VDC	4.0 VDC	0.5 mA
12 V	2.5 VDC	9.5 VDC	1.3 mA
24 V	7.0 VDC	17.0 VDC	2.8 mA
48 V	14.0 VDC	31.0 VDC	5.8 mA

Example: Selecting Attenuator Jumper Setting

You want to select the best attenuator jumper setting for a DC input with Vlow = 1.5 V and Vhigh = 30 V. The first step is to compute the noise margin for each jumper range, as shown in Figure 2-3. For example, the noise margin on the 5V range = min [(30 - 4), (1 - 1.5)] = min (26, -0.5) = -0.5.

Thus, the 5V and 48V settings cannot be used, since the noise margins (-0.5 and -1.0) are both negative. Both the 12V and 24V settings have positive noise margins. However, since the noise margin for the 24V setting (+5.5) is better than the noise margin for the 12V setting (+1), use the 24V setting.

NOTE

The 30 volt input in this example exceeds the nominal value for the 24V range. For any attenuator setting the 16-channel digital input can accept up to 80 VDC. However, to avoid degrading accessory specifications, total power to the accessory must not exceed six watts.

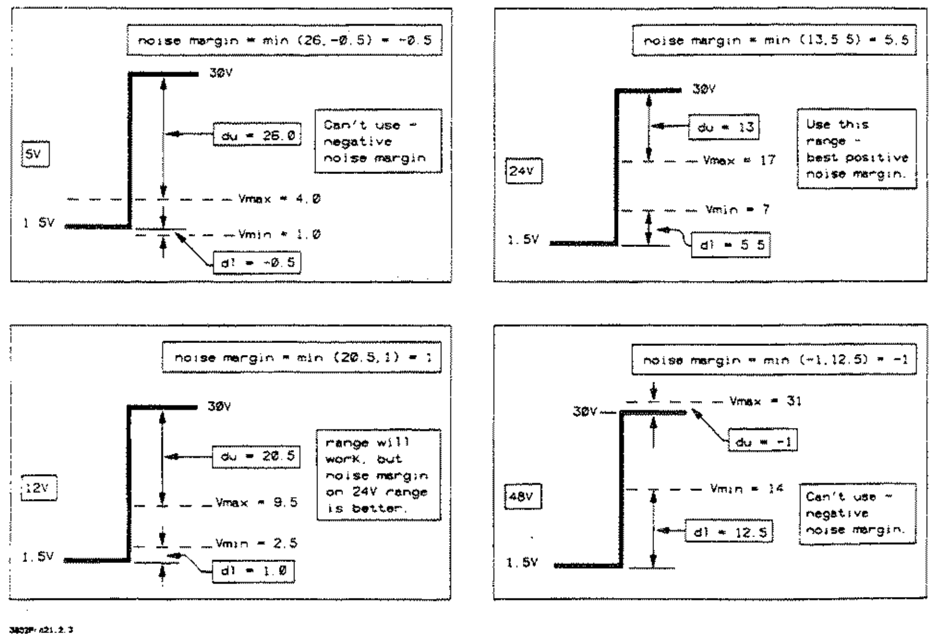


Figure 2-3. Example: Setting Attenuator Jumper

Setting Debounce Jumper

When the attenuator jumpers have been set for all channels to be used, the next step is to set the debounce jumper (J2). However, to properly set the debounce jumper, we will again need to define some terms.

Input Signal Definitions

Figure 2-4 shows input signal definitions and guidelines to set the debounce jumper. Since there is a single debounce jumper, input signal definitions refer to the maximum and minimum values for inputs to ALL channels.

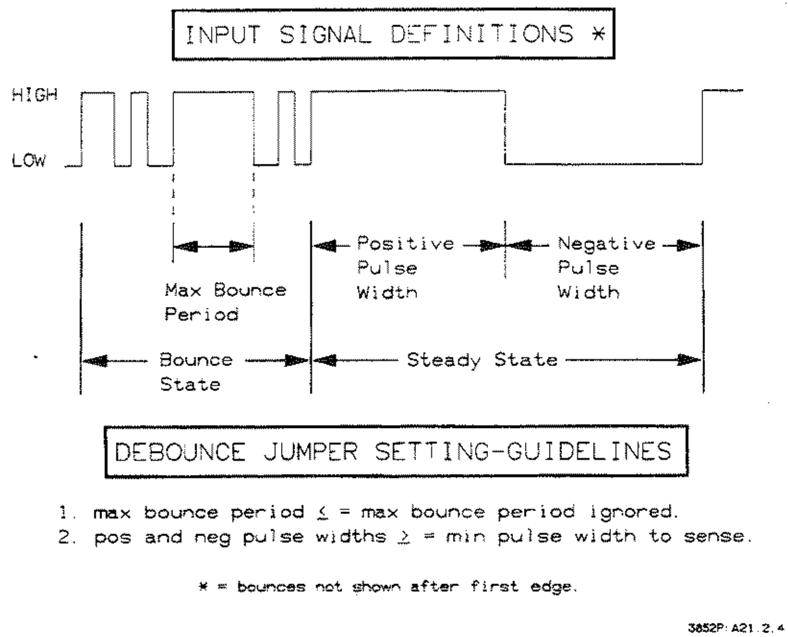


Figure 2-4. Debounce Jumper Setting Guidelines

The input signal has two distinct states: a Bounce State and a Steady State. During the Bounce State, the signal rapidly switches states due to contact bounce. In the Bounce State, the Max Bounce Period is defined as the longest time the input is in the HIGH state. During the Steady State, the Positive Pulse Width is the time the signal is in the HIGH state and the Negative Pulse Width is the time the signal is in the LOW state.

Debounce Jumper Setting Guidelines

There are two guidelines to select the best debounce jumper setting: (1) the Max Bounce Period must be ≤ Maximum Bounce Period Ignored values in Table 2-2 and (2) both the positive and negative pulse widths must be ≥ the Min Pulse Width to Sense values in Table 2-2. In addition, the input frequency (number of state changes/second) must be within the Input Freq Range in Table 2-2 for the jumper setting selected.

Table 2-2. Debounce Jumper Ratings

Debounce Jumper Setting	Maximum Bounce Period Ignored	Minimum Pulse Width to Sense	Input Freq Range
10 Hz	20 msec	50 msec	0 - 10 Hz
100 Hz	2 msec	5 msec	0 - 100 Hz
1 kHz	.2 msec	1 msec	0 - 500 Hz

Determining Maximum Bounce Period

The first step to select the debounce jumper setting is to determine the Max Bounce Period of all the inputs. To ensure that the digital input will ignore input signal bounces, select the debounce jumper setting for which the Max Bounce Period of ALL inputs is ≤ the Maximum Bounce Period Ignored value in Table 2-2.

For example, if the Max Bounce Period is 10 msec, use the 10 Hz setting since it is the only setting with Max Bounce Period (10 msec) ≤ Maximum Bounce Period Ignored (20 msec). With the 100 Hz or 1 kHz settings, the accessory may sense the bounces as state changes and give false readings.

Determining Minimum Input Pulse Widths

When the Maximum Bounce Period of the input is determined, the next step is to determine minimum input pulse widths. To ensure that the digital input will sense the input, BOTH the positive pulse widths and negative pulse widths must be ≥ the Minimum Pulse Width to Sense times shown in Table 2-2.

As shown in Figure 2-5, inputs with one or both pulse widths > Maximum Bounce Period Ignored but < Minimum Pulse Width to Sense may or may not be sensed. Inputs with one or both pulse widths < Maximum Bounce Period Ignored will not be sensed.

NOTE

For each debounce jumper setting, the 16-channel digital input has a different interrupt delay time. Since system interrupt delay depends on the controller used and customer application, maximum system delay must be determined by the user. If you have time-critical interrupt applications, refer to Chapter 4 - Programming the Digital Inputs for details on delay times.

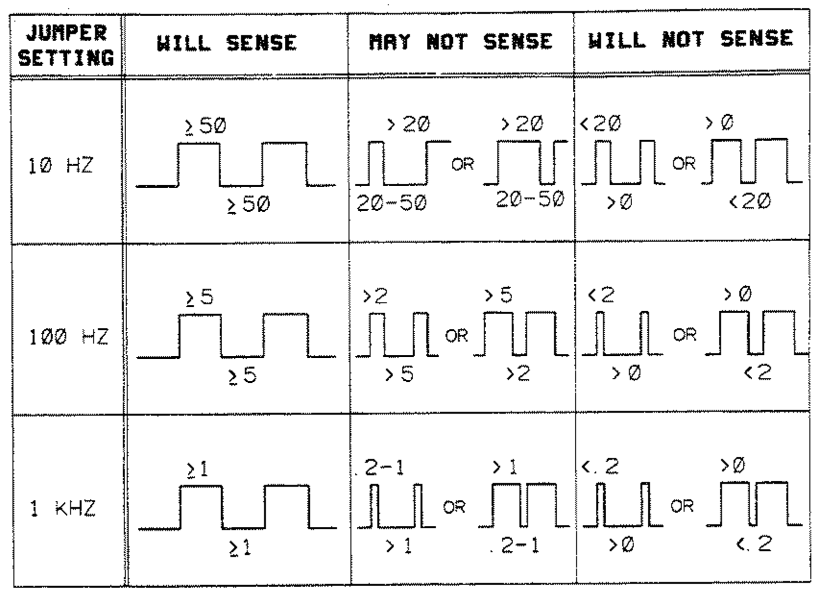


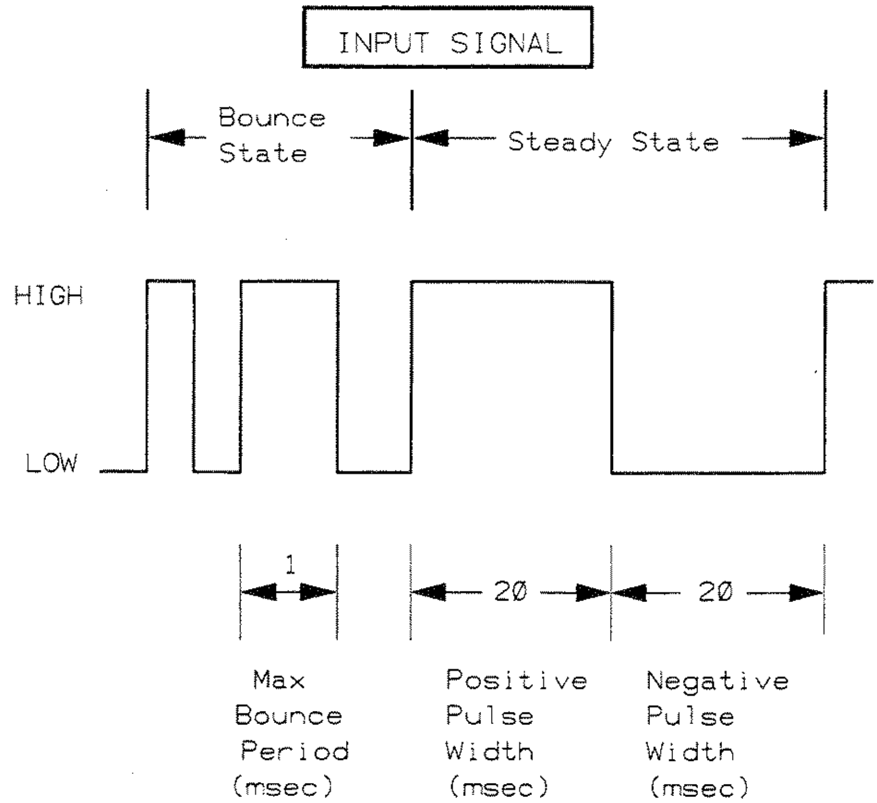
Figure 2-5. Input Pulse Width Requirements

Example: Selecting Debounce Jumper Setting

You want to set the debounce jumper for a 25 Hz square-wave input with Max Bounce Period = 1 msec and Positive Pulse Widths = Negative Pulse Widths = 20 msec (see Figure 2-6). For proper debounce jumper setting, Max Bounce Period of the input must be ≤ Maximum Bounce Period Ignored and the Positive and Negative Pulse Widths must both be ≥ Minimum Pulse Width to Sense.

From Figure 2-6, the 10 Hz setting cannot be used since the input pulse widths (20 msec) are < Min Pulse Width to Sense (50 msec). Also, the 1 kHz setting cannot be used since the Max Bounce Period (1 msec) > Maximum Bounce Period Ignored (0.2 msec).

Therefore, for this input use the 100 Hz setting since the Max Bounce Period (1 msec) < Max Bounce Period Ignored (2 msec) and both the Positive and Negative Pulse Widths (20 msec) > Minimum Pulse Width to Sense (5 msec). In addition, the input frequency of 25 Hz is well within the specified frequency range of 0 - 100 Hz.



INPUT PARAMETERS VS. DEBOUNCE JUMPER RATINGS

SETTING	BOUNCE STATE		STEADY STATE		COMMENTS
	MAX BOUNCE PERIOD	MAX * BOUNCE PERIOD IGNORED	INPUT SIGNAL PULSE WIDTHS	MIN * PULSE WIDTH TO SENSE	
10 Hz	1 msec	20 msec	20 msec	50 msec	can't use : positive and negative pulse widths < min pulse width to sense.
100 Hz	1 msec	2 msec	20 msec	5 msec	use this setting : max bounce period < max bounce period ignored and positive and negative pulse widths > min pulse width to sense.
1 KHz	1 msec	0.2 msec	20 msec	1 msec	can't use : max bounce period > max bounce period ignored.

38852P:A21.2.6

Figure 2-6. Example: Setting Debounce Jumper

Connecting Field Wiring

When you have set the attenuator jumpers and the debounce jumper, connect field wiring from your devices to the appropriate terminals on the terminal module. Each channel of the 16-channel terminal module has a POS and NEG terminal. Two +5V connectors (on the POS terminal) and two GND connectors (on the NEG terminal) are provided for dry contact inputs. See Figure 2-1 for jumper and terminal locations.

When connecting field wiring, route the field wires under the strain relief clamp and tighten the clamp screw to reduce the chance of wires being pulled out of the terminal connectors. When you have connected field wiring, replace the terminal module cover. Three example configurations follow.

Example: Connecting DC Input

A +9 VDC source and switch are connected to channel 5 as shown in Figure 2-7. The switch is opened and closed at a 5 Hz rate (100 msec pulse widths) and Max Bounce Period = 10 msec. To set the channel attenuator jumper (J105), select the setting with the best positive noise margin.

From Table 2-1, the noise margin for the 5V setting = min [(9-4), (1-0)] = min (5,1) = 1, while the 12V, 24V and 48V settings all have negative noise margins. Therefore, set J105 to the 5V setting since this is the only setting with a positive noise margin.

Any setting for the debounce jumper (J2) satisfies the condition that Pulse Widths > Min Pulse Width to Sense (refer to Table 2-2). However, set the debounce jumper to 10 Hz since this is the only setting with Maximum Bounce Period (10 msec) < Max Bounce Period Ignored (20 msec). When the jumpers have been set, route the field wires as shown in Figure 2-7.

Example: Using +5V Supply

Three ganged switches are connected to channels 2, 3, and 4 as shown in Figure 2-8 and are switched at a 5 Hz rate. For this input, set the attenuator jumpers for channel 2 (J102), channel 3 (J103), and channel 4 (J104) to 5V. For the switching rate of 5 Hz (100 msec pulse widths), set the debounce jumper to 10 Hz. (Refer to the previous example, "Connecting DC Inputs" for details to set the jumpers. When you have set the jumpers, route the field wires as shown in Figure 2-8.

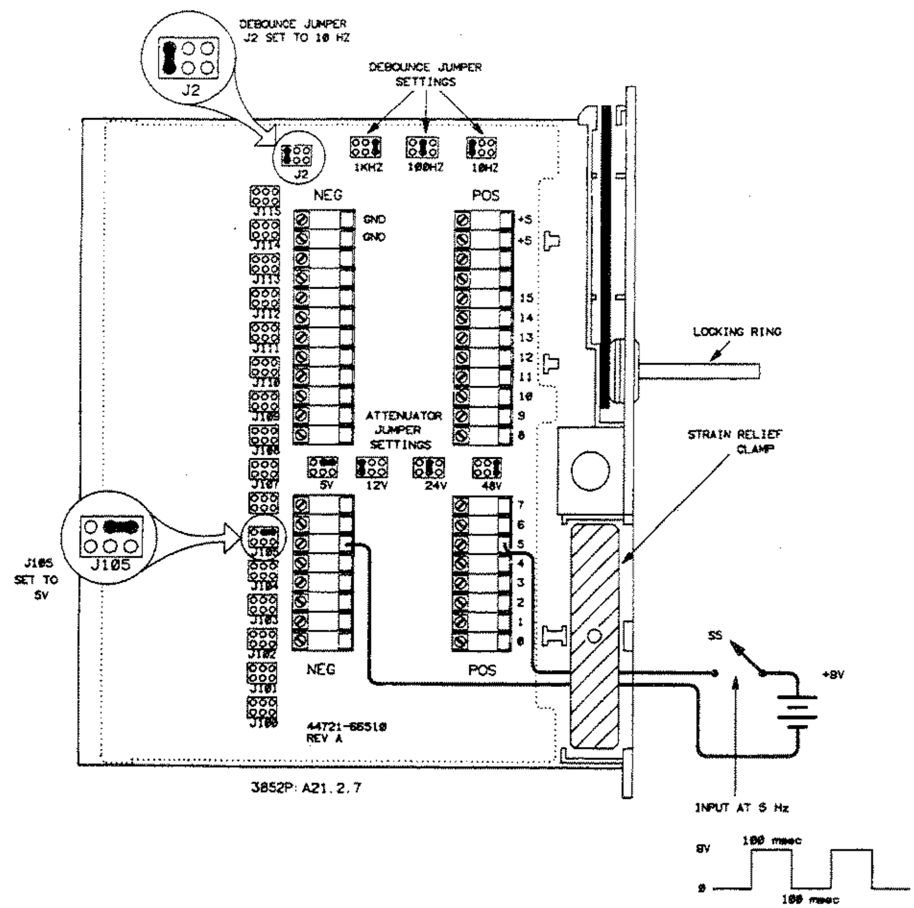


Figure 2-7. Example: Connecting DC Input

NOTE

When the +5 VDC supply on the terminal module is used, the input is NOT isolated from the mainframe. Either of the +5V and GND terminals may be used to connect field wiring.

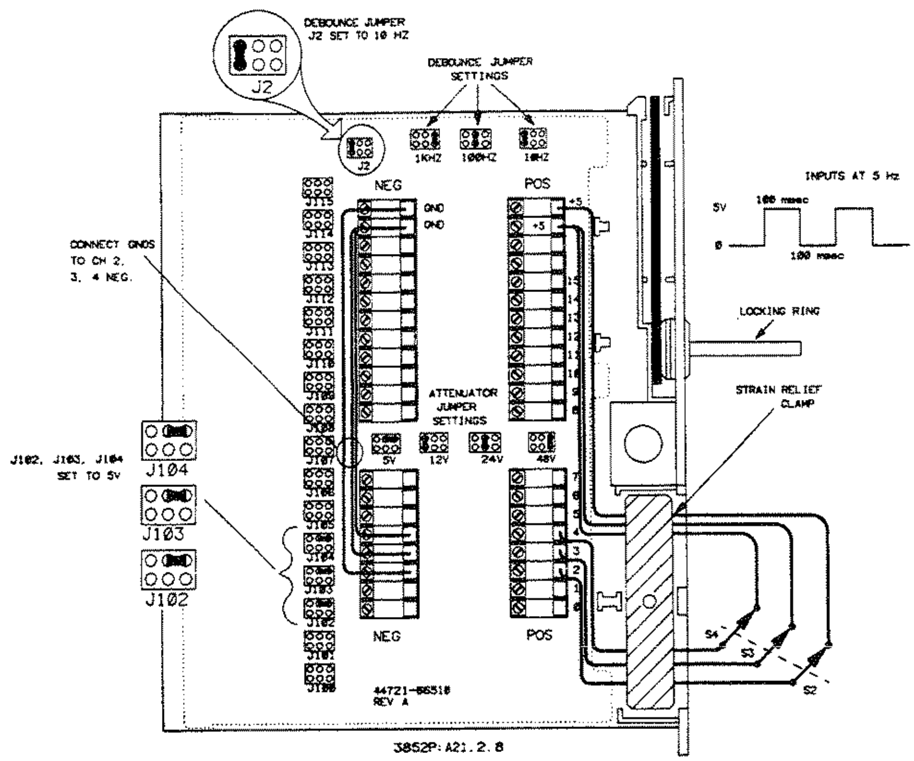


Figure 2-8. Example: Using +5V Supply

Example: Connecting TTL/CMOS Inputs

TTL and CMOS logic can also be connected to the 16-channel digital input, as shown in Figure 2-9. For TTL or CMOS inputs, set the attenuator jumper for each channel used to the 5V or 12V range, as required, and set the debounce jumper to a range appropriate for the switching rate. When you have set the jumpers, route the field wires as shown in Figure 2-9.

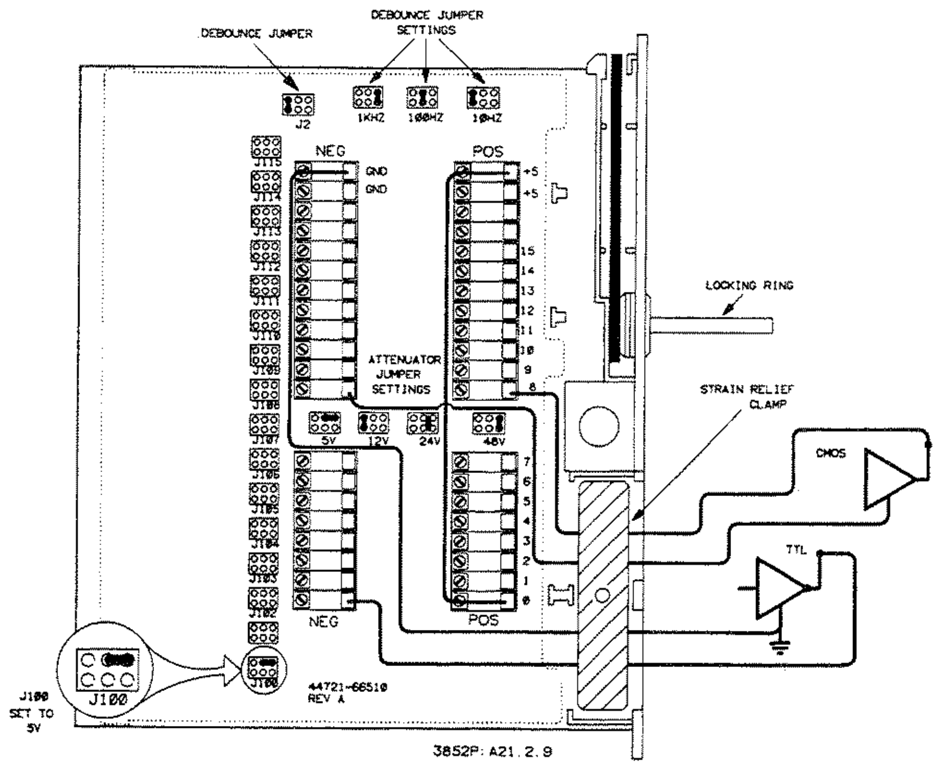


Figure 2-9. Example: Connecting TTL/CMOS Inputs

Installation and Checkout

When the attenuator jumpers and debounce jumper have been set and field wiring connected, connect the terminal module to the digital input component module and install the accessory in a desired slot. Refer to the HP 3852A Mainframe Configuration and Programming Manual to connect the modules and to install the accessory.

When the accessory input is installed, enter the ID? slot command from the front panel to check the accessory ID. At power-on, a 16-channel digital input returns 44721A, while a 16-channel digital input module only (no terminal module attached) returns 447XXX. (Note that if the terminal module is removed after power-on, the ID? command still returns 44721A for a 16-channel digital input).

If the 16-channel digital input does not return 44721A, be sure you have addressed the correct slot and the terminal module is attached. If the slot number is correct and terminal module is installed, but the correct code is not returned, refer to the HP 3852A Assembly Level Service Manual for service procedures.

This completes hardware configuration for the 16-channel digital input. Refer to Chapter 4 - Programming the Digital Inputs to program the accessory for your application.

Chapter 3
Configuring the 8-Channel Digital Input

Contents

Chapter 3

Configuring the 8-Channel Digital Input

Introduction

This chapter shows how to hardware configure the 8-channel digital input. It includes guidelines to set the attenuator jumpers on the terminal module, shows typical field wiring connections, and shows how to install and initially check the accessory.

Chapter Contents

This chapter has three sections:

- **Introduction** includes a chapter overview and lists WARNINGS, CAUTIONS, and NOTES which apply to the 8-channel digital input.

- **Terminal Module Configuration** shows how to set the attenuator jumpers and how to connect field wiring to the terminal module.

- **Installation and Checkout** shows how to install and initially check the 8-channel digital input.

Warnings, Cautions, and Notes

This section summarizes WARNINGS, CAUTIONS, and NOTES which apply to the 8-channel digital input accessory. You should review the WARNINGS and CAUTIONS shown before handling or configuring the accessory.

WARNING

⚠ 1 *SHOCK HAZARD. Only qualified, service-trained personnel who are aware of the hazards involved should install, remove, or configure any accessory. Before touching any installed accessory, turn off all power to the mainframe, extenders, and to all external devices connected to the mainframe, extenders, or accessories.*

⚠ 2

WARNING

POSSIBLE OPERATOR INJURY. For safety, consider all accessory channels to be at the highest potential applied to any channel.

CAUTION

MAXIMUM VOLTAGE/POWER LIMITATIONS. Absolute maximum voltage input to a channel depends on the attenuator jumper setting for the channel: 80 volts for the 24V setting; 200 volts for the 120V setting; or 250 volts for the 240V setting, where volts = VDC or VAC rms. If combined inputs to the terminal module exceed six watts, operation of other accessories installed in the box may be affected due to excessive power dissipation.

CAUTION

STATIC SENSITIVE. Use clean-handling techniques when handling the accessory. Do not install an accessory without the metal covers attached.

NOTE

HP-IB ADDRESS. The example programs in this manual use "709" as the HP-IB address for the HP 3852A. Specific slot and channel numbers are also used. Program syntax and data return formats apply to HP Series 200/300 controllers. Modify slot and channel numbers and program syntax as required.

Terminal Module Configuration

This section shows how to set the attenuator jumpers and how to connect field wiring to the 8-channel digital input terminal module.

Setting Attenuator Jumpers

To begin terminal module configuration, remove the terminal module cover. (If the accessory is installed in the mainframe or an extender, refer to the HP 3852A Mainframe Configuration and Programming Manual to remove the terminal module.)

Terminal Module Description

Figure 3-1 shows the 8-channel terminal module with the cover removed. The terminal module has 8 attenuator jumpers (J100 through J107), one for each channel. J100 sets channel 0, J101 sets channel 1,. . ., J107 sets channel 7. Each jumper can be set to 24V, 120V, or 240V. However, to properly set the attenuator jumper, we will first need to define some terms.

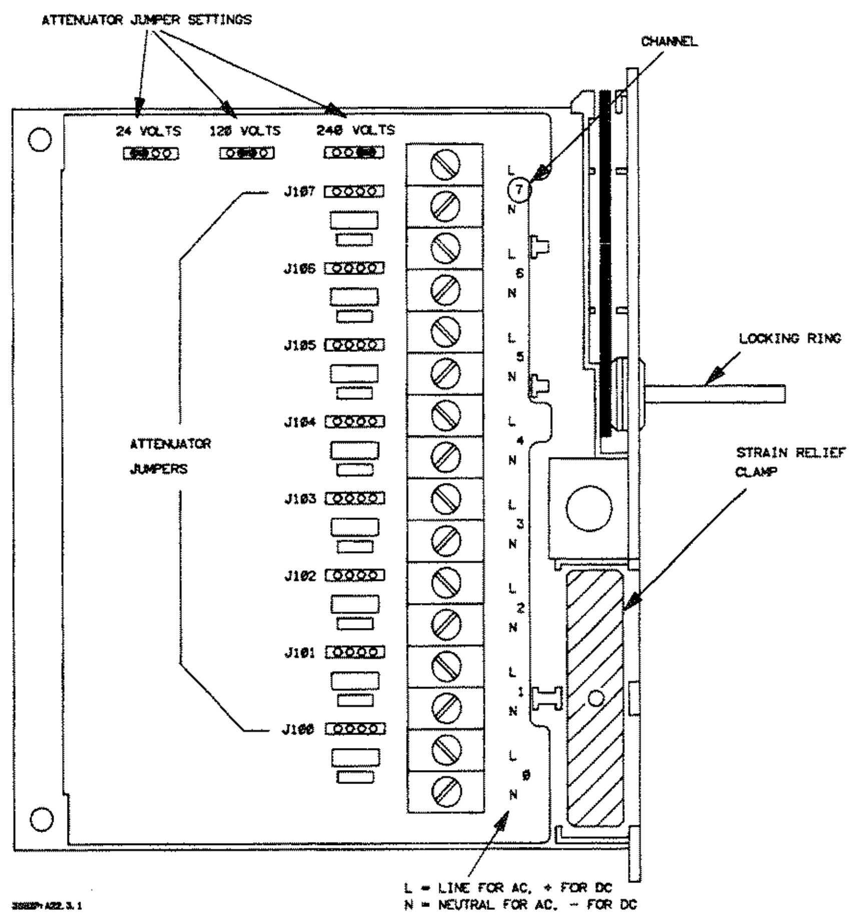
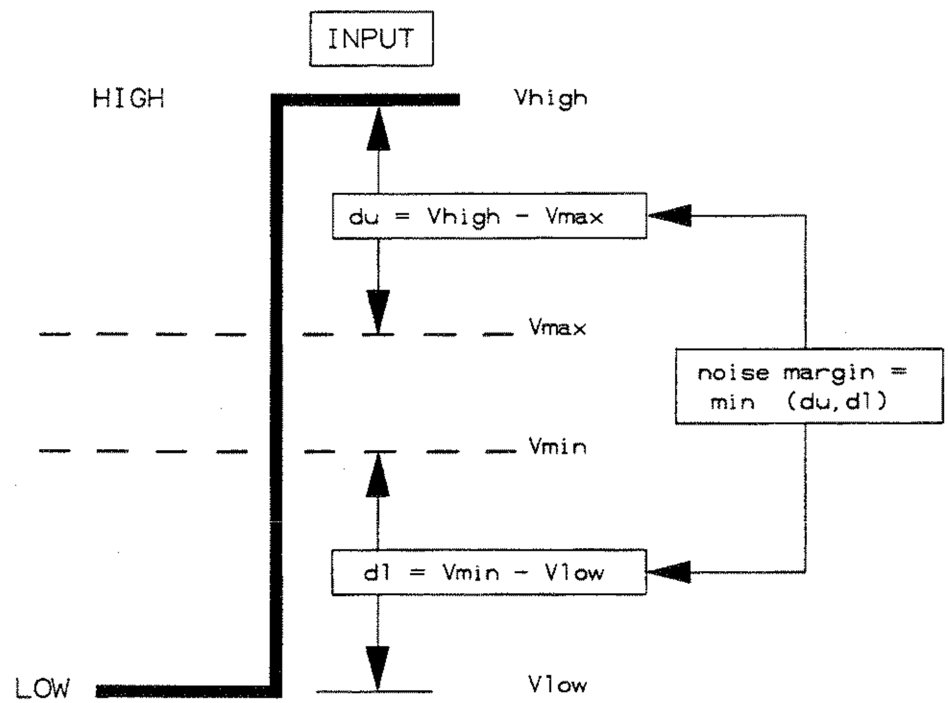


Figure 3-1. HP 44722A Terminal Module

Determining Jumper Setting

Figure 3-2 shows guidelines to select the proper attenuator jumper setting for a typical DC input, where Vhigh is the MINIMUM value of the input HIGH state and Vlow is the MAXIMUM value of input LOW state. Vmax and Vmin are the Threshold Voltages shown in Table 3-1.



ATTENUATOR JUMPER SETTINGS - GUIDELINES

1. Vmax ≤ = Vhigh AND Vmin ≥ = Vlow.
2. Set jumper for best POSITIVE noise margin.

3852P:A22.3.2

Figure 3-2. Attenuator Jumper Setting Guidelines

To determine the appropriate jumper settings, use the setting (24V, 120V, or 240V) which has the best POSITIVE noise margin, where noise margin = min (du, dl) = min (Vhigh - Vmax, Vmin - Vlow).

Table 3-1. Threshold Voltages

Attenuator Jumper Settings	Threshold Voltages		Nominal Current for Setting
	Vmin	Vmax	
24 V	5.5	16.5	1.7 mA
120 V	30.0	90.0	1.1 mA
240 V	65.0	185.0	1.1 mA

Example: Selecting Attenuator Jumper Setting

You want to select the best attenuator jumper setting for a DC input with Vlow = 25 VDC and Vhigh = 195 VDC (or Vlow = 25 VAC rms and Vhigh = 195 VAC rms). The first step is to compute the noise margin for each jumper range, as shown in Figure 3-3. For example, the noise margin on the 24V range = min [(195 - 16.5), (5.5 - 25)] = min (178.5, -19.5) = -19.5.

Thus, the 24V setting cannot be used, since the noise margin (-19.5) is negative. Both the 120V and 240V settings have positive noise margins. However, since the noise margin for the 240V setting (+10.0) is better than the noise margin for the 120V setting (+5.0), use the 240 V setting.

Connecting Field Wiring

When you have set the channel attenuator jumpers, connect field wiring from your inputs to the 8-channel terminal module. Each channel of the 8-channel terminal module has an L and an N terminal, where L = the HIGH (+) input for DC or the LINE input for AC and N = the LOW (−) input for DC or the NEUTRAL input for AC. See Figure 3-1 for jumper and terminal locations.

NOTE

The maximum frequency which can be counted by the HP 44722A is 10 Hz for either DC or AC inputs. Recall that the AC input state is sensed as AC OFF or AC ON and the HP 44722A does NOT change state with each cycle of the input. Thus, for any acceptable range of the AC input (47 Hz - 470 Hz), the maximum rate at which input state changes (AC OFF to AC ON or AC OFF to AC ON) can be counted is 10 changes/second.

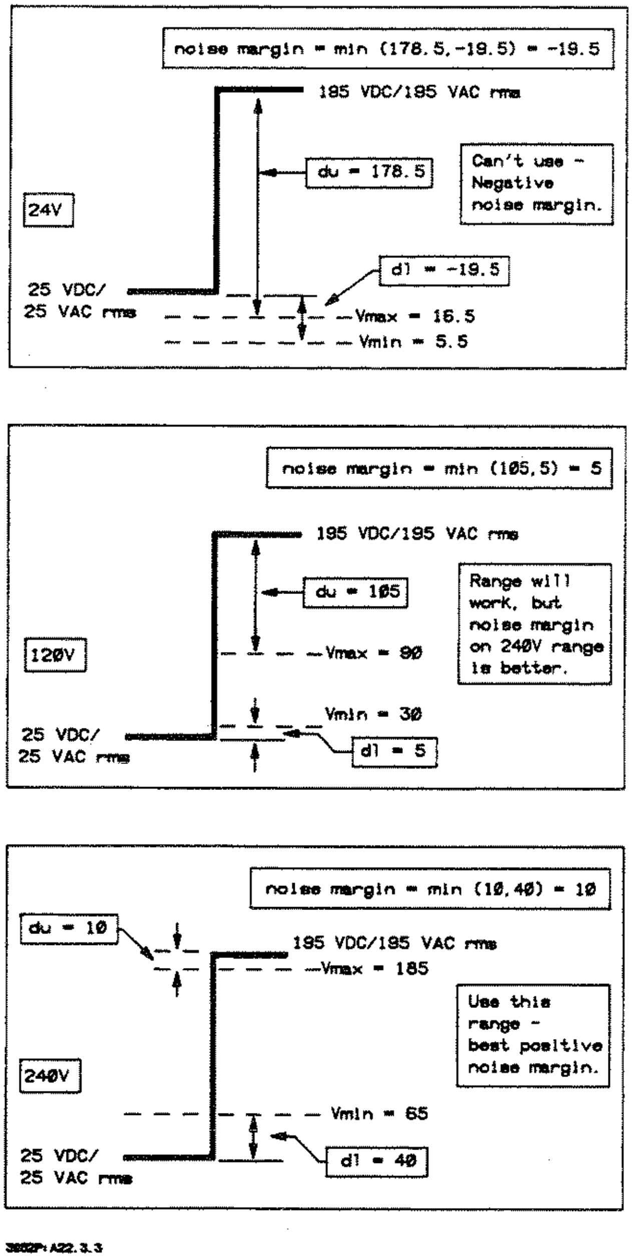


Figure 3-3. Example: Setting Attenuator Jumper

When connecting field wiring, route the field wires under the strain relief clamp and tighten the clamp screw to reduce the chance of wires being pulled out of the terminal connectors. After you have connected field wiring, replace the terminal assembly cover. Two example configurations follow.

Example: Connecting DC Input

A 100 VDC source is connected through switch S1 to channel 1 of an 8-channel digital input as shown in Figure 3-4. To set the channel attenuator jumper (J101) for this input, select the setting with the best positive noise margin.

From Table 3-1, the noise margin for the 24V setting = min [(100-16.5), (5.5-0)] = min [(83.5,5.5)] = 5.5, while the noise margin for the 120V setting = min [(10,30)] = 10. The 240V setting cannot be used since it has a negative noise margin [min (-85,65) = -85]. Therefore, set J101 to 120V since this setting has the best positive noise margin. After setting J101, connect field wires as shown in Figure 3-4.

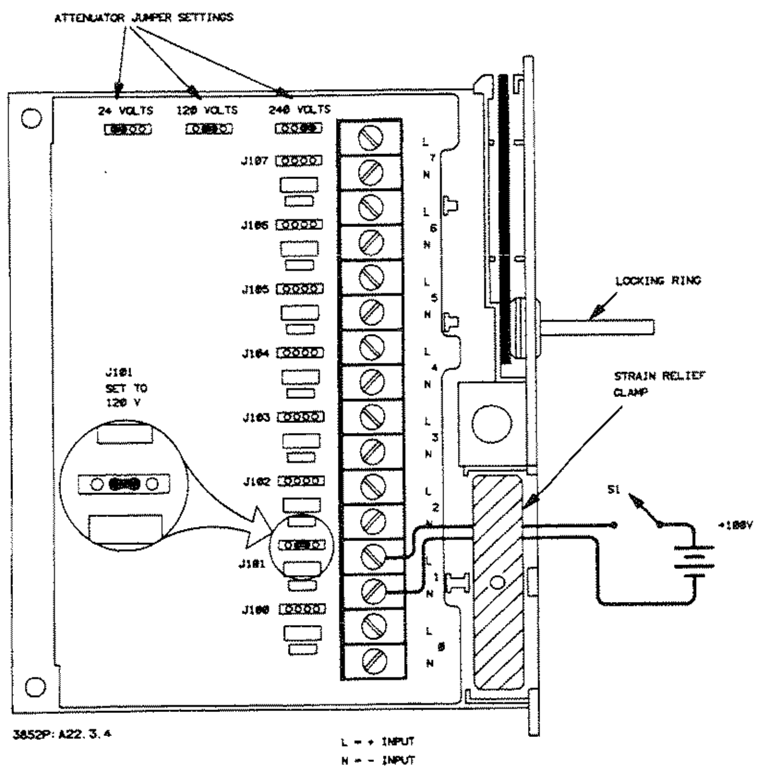


Figure 3-4. Example: Connecting DC Input

Example: Connecting AC Input

A 120 VAC rms, 60 Hz source is connected through switch S0 to channel 0 of an 8-channel digital input as shown in Figure 3-5. To set the attenuator jumper J100 for this input, select the setting with the best positive noise margin.

The noise margin for the 24V setting = min [(103.5,5.5)] = 5.5, while the noise margin for the 120V setting = min [(30,30)] = 30. The 240V setting cannot be used since it has a negative noise margin [min (-65,65) = -65]. Therefore, set J100 to 120V since this setting has the best positive noise margin. After setting J100, connect field wires as shown in Figure 3-5.

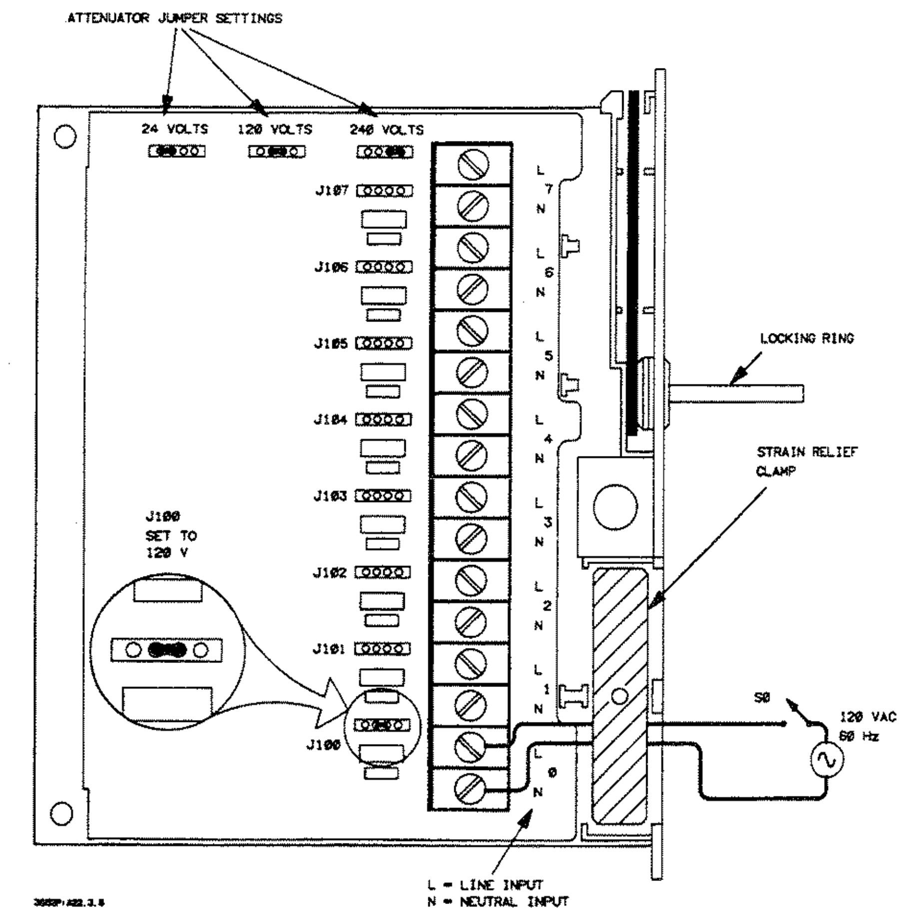


Figure 3-5. Example: Connecting AC Input

Installation and Checkout

When the attenuator jumpers have been set and field wiring connected, connect the terminal module to the digital input component module and install the accessory in a desired slot. Refer to the HP 3852A Mainframe Configuration and Programming Manual to connect the modules and to install the accessory.

When the accessory input is installed, send the ID? slot command from the front panel to check the accessory ID. At power-on, an 8-channel digital input returns 44722A, while an 8-channel digital input module only (no terminal module attached) returns 447XXX. (Note that if the terminal module is removed after power-on, the ID? command still returns 44722A for an 8-channel digital input).

If the 8-channel digital input does not return 44722A, be sure you have addressed the correct slot and the terminal module is attached. If the slot number is correct and terminal module is installed, but the correct code is not returned, refer to the HP 3852A Assembly Level Service Manual for service procedures.

This completes hardware configuration for the 8-channel digital input. Refer to Chapter 4 - Programming the Digital Inputs to program the accessory for your application.

Chapter 4
Programming the Digital Inputs

Contents

Chapter 4

Programming the Digital Inputs

Introduction

This chapter shows how to program the 16-channel and 8-channel digital inputs. The chapter has three sections:

- **Introduction** summarizes chapter contents, lists example program titles, and shows how to determine the mainframe firmware revision number.

- **Programming Overview** summarizes commands vs. logical channel numbers, gives an overview of binary-to-decimal conversions, and provides an alphabetical summary of commands.

- **Programming Digital Input Channels** shows how to program digital input channels for four functions: detecting input states; counting input edges; generating event interrupts; and generating counter interrupts.

Example Program Titles

Table 4-1 lists the titles of the example programs in this chapter.

Table 4-1. Example Program Titles

Title	Description	Commands
Detecting Input States		
Reading* DC Input State	Read the state of two channels to determine if the channel switch is open or closed.	CHREADM
Reading AC Input State	Read the state of all channels in a slot to determine the AC ON/OFF status.	READ
Counting Input Edges		
Counting DC Input Edges	Set a channel to count switch openings and closures. Read the number of openings and closures.	EDGE, CHREAD
Counting AC Input Edges	Read the number of times an AC input is ON and then zero the count.	EDGE, CHREADZ
Generating Event Interrupts		
Enable Event Interrupt - Single Channel	Enable a channel to generate an event interrupt on the first edge of a burst. Read the number of pulses in the burst.	EDGE, CHREAD, ENABLE INTR
Enable* Event Interrupt - Any Channel	Enable the accessory to generate an event interrupt on an LH edge into any channel. Read the interrupt time and channel states at the time of interrupt.	EDGE, CHREAD, ENABLE INTR
Generating Counter Interrupts		
Enable Counter Interrupt - Single Channel	Enable a channel to generate a counter interrupt after five switch closures. Read the interrupt time and number of closures after the interrupt.	EDGE, CNTSET, CHREAD, ENABLE INTR
Enable* Counter Interrupt - Any Channel	Enable any channel to generate a counter interrupt after three switch closures. Read Interrupt time and channel which generated the interrupt.	EDGE, CNTSET, CHREADM, ENABLE INTR

* = Program requires mainframe firmware revision 3.0 or greater.

Mainframe Firmware Revision

Since some commands for the HP 44721A/44722A require mainframe firmware revision 3.0 or greater (refer to the Command Summary in Table 4-5), you may want to check the revision number for your mainframe to ensure that the accessory commands will be accepted. The following example program uses the IDN? command to check the mainframe ID, including the firmware revision number.

```
10 DIM Identity$(1:4)[17]              !Dimension controller array
20 OUTPUT 709;"IDN?"                   !Query HP 3852A identity
30 ENTER 709;Identity$(*)              !Enter identity
40 PRINT USING "K,/";Identity$(*)      !Display identity
50 END
```

A typical return for firmware revision 3.0 follows.

```
HEWLETT PACKARD   (Company name)
3852A             (Model number)
0                 (Mainframe serial number unknown)
3.0               (Firmware revision 3.0)
```

Programming Overview

This section provides an overview of programming for the 16-channel and 8-channel digital inputs. It includes a summary of commands vs. logical channel numbers, an overview of binary to decimal conversions, and an alphabetical command summary.

Commands vs. Channel Numbers

As noted, each digital input channel has a physical channel number and two associated logical channel numbers. The 16-channel digital input has physical channel numbers 0 through 15, while the 8-channel digital input has physical channel numbers 0 through 7.

However, digital input commands use logical channel numbers rather than physical channel numbers. Logical channel numbers define both the channel to be addressed and the function the channel is to perform. The channel function depends on the command sent.

Table 4-2 defines the functions set by the USE *ch* command or parameter for commands used with the 16-channel digital input. Table 4-3 defines the same functions for the 8-channel digital input.

For example, as shown in Table 4-2, CHREAD 0 reads the number of counts on a 16-channel digital input in slot 0 of the mainframe while CHREAD 16 reads the channel state. Or, as shown in Table 4-3, ENABLE INTR USE 0 enables a counter interrupt on channel 0 of an 8-channel digital input while ENABLE INTR USE 8 enables an event interrupt on this channel.

Table 4-2. Commands vs. Channel Numbers - 16-Channel

Command	Logical Channel Number				Note
	ES00-ES15	ES16-ES31	ES90	ES91	[1]
CHREAD	Read count on specified channel.	Read state of specified channel.	N/A	N/A	
CHREADM	Read count on specified channel(s).	Read state of specified channel(s).	N/A	N/A	
CHREADZ	Read/zero count on specified channel.	N/A	N/A	N/A	
CNTSET	Preset count on specified channel.	N/A	N/A	N/A	
DISABLE INTR	Disable counter interrupt on specified channel.	Disable event interrupt on specified channel.	Disable counter interrupt on all channels in range ES00-ES15.	Disable event interrupt on all channels in range ES16-ES31.	
EDGE	Set edge to be counted on specified channel.	Set edge to generate event interrupt on specified channel when enabled.	Set edge to be counted on all channels in range ES00-ES15.	Set edge for event interrupt on any channel in range ES16-ES31.	[2]
ENABLE INTR	Enable counter interrupt on on specified channel.	Enable event interrupt on specified channel.	Enable counter interrupt on all channels in range ES00-ES15.	Enable event interrupt on all channels in range ES16-ES31.	
READ	N/A	Read state of specified slot.	N/A	N/A	[3]
READM	N/A	Read state of specified slot(s).	N/A	N/A	[3]

Notes:

[1] = Physical channel numbers for ES16-ES31 are ES00-ES15. ES90 and ES91 require mainframe firmware revision 3.0 or greater.

[2] = EDGE sets the edge for BOTH the counting function and for interrupt transitions on a channel (e.g., EDGE LH, USE 105 sets LH edges for both counting and event interrupts on channel 105). The EDGE BOTH parameter requires mainframe firmware revision 3.0 or greater plus HP 44721A with serial number 2711A01765 or greater.

[3] = READ [number] parameter and READM require mainframe firmware revision 3.0 or greater.

Table 4-3. Commands vs. Channel Numbers - 8-Channel

Command	Logical Channel Number				Note
	ES00-ES07	ES08-ES15	ES90	ES91	[1]
CHREAD	Read count on specified channel.	Read state of specified channel.	N/A	N/A	
CHREADM	Read count on specified channel(s).	Read state of specified channel(s).	N/A	N/A	
CHREADZ	Read/zero count on specified channel.	N/A	N/A	N/A	
CNTSET	Preset count on specified channel.	N/A	N/A	N/A	
DISABLE INTR	Disable counter interrupt on specified channel.	Disable event interrupt on specified channel.	Disable counter interrupt on all channels in range ES00-ES07.	Disable event interrupt on all channels in range ES08-ES15.	
EDGE	Set edge to be counted on specified channel.	Set edge to generate event interrupt on specified channel when enabled.	Set edge to be counted on all channels in range ES00-ES07.	Set edge for event interrupt on any channel in range ES08-ES15.	[2]
ENABLE INTR	Enable counter interrupt on on specified channel.	Enable event interrupt on specified channel.	Enable counter interrupt on all channels in range ES00-ES07.	Enable event interrupt on all channels in range ES08-ES15.	
READ	N/A	Read state of specified slot.	N/A	N/A	[3]
READM	N/A	Read state of specified slot(s).	N/A	N/A	[3]

Notes:

[1] = Physical channel numbers for ES08-ES15 are ES00-ES07. ES90 and ES91 require mainframe firmware revision 3.0 or greater.

[2] = EDGE sets the edge for BOTH the counting function and for interrupt transitions on a channel (e.g., EDGE LH, USE 105 sets LH edges for both counting and event interrupts on channel 105). The EDGE BOTH parameter requires mainframe firmware revision 3.0 or greater plus HP 44722A with serial number 2711A00178 or greater.

[3] = READ [number] parameter and READM require mainframe firmware revision 3.0 or greater.

Data Conversion

For HP 9000 Series 200/300 controllers (and equivalent), data inputs and returns must be in decimal format. For the digital input accessories, the READ or READM command returns the decimal equivalent of the state of each of the channels, where channel state "0" = AC OFF or DC LOW and channel state "1" = AC ON or DC HIGH. The range of the READ and READM commands is -32768 to +32767.

This section shows how to compute decimal values for desired channel bit patterns and how to determine the bit pattern for a given decimal value. Table 4-4 shows the associated weighted decimal value for each channel. For example, channel 0 has weighted decimal value 1, channel 5 has weighted decimal value 32, etc.

To compute the decimal value for any channel bit pattern, add the weighted decimal values of the "1" bits in the channel bit pattern, where "1" = AC ON or DC HIGH and "0" = AC OFF or DC LOW. Examples follow to show how to compute the decimal value for a given bit pattern or to determine the bit pattern for a given decimal value.

Table 4-4. Decimal Values vs. Channel Numbers

Channel Number	Weighted Decimal Value	Channel Number	Weighted Decimal Value
0	1	8	256
1	2	9	512
2	4	10	1024
3	8	11	2048
4	16	12	4096
5	32	13	8192
6	64	14	16384
7	128	15	-32768

Example: Finding Positive Decimal Value of Bit Pattern

To compute the positive decimal value of a bit pattern with channel 15 state = 0 (AC OFF or DC LOW), add the weighted decimal values for the "1"s in the bit pattern. For example, for a 16-channel digital input with channel 2, 4, 6, and 9 states = 1, the channel bit pattern is 0000 0010 0101 0100 and the decimal value is 596.

1. Channel Bit Pattern: 0000 0010 0101 0100 = ?
2. Decimal Value: 512 + 64 + 16 + 4 = 596

Example: Finding Negative Decimal Value of Bit Pattern

There are two ways to find the decimal value of a bit pattern when the channel 15 state = 1. The first way is to add the weighted decimal values of the "1" bits, the same as for a positive decimal value. For example, for bit pattern 1000 0000 0010 1110 (channel 1, 2, 3, 5, and 15 states = 1), the decimal value = -32722.

1. Channel Bit Pattern:	1000 0000 0010 1110
2. Decimal Value:	−32768 + 32 + 8 + 4 + 2 = −32722

The second way to compute the decimal value of a bit pattern with channel 15 state = 1 is to find the 2's complement of the bit pattern, calculate the decimal equivalent, and use the negative of this number. For example, with channels 1, 2, 3, 5, and 15 states = 1, the bit pattern is 1000 0000 0010 1110. Use the following steps to calculate the decimal value of this pattern using the 2's complement method.

1. Channel Bit Pattern:	1000 0000 0010 1110 = ?
2. 2's Complement:	0111 1111 1101 0010
3. Decimal Equivalent of 2's Complement:	16384+8192+4096+2048 +1024+512+256+128+64 +16+2 = 32722
4. Decimal Value:	1000 0000 0010 1110 = −32722

Example: Finding Bit Pattern for Positive Decimal Value

To find the channel bit pattern for a positive decimal value (0 to 32767), compute the binary equivalent of the number by doing a decimal to binary conversion. For example, the channel bit pattern for decimal 40 is:

```
Bit Pattern for +40:       40 = 32 + 8 = 0000 0000 0010 1000
                                                  /  \
                                                 32 + 8
```

Example: Finding Bit Pattern for Negative Decimal Value

To find the channel bit pattern for a negative decimal value (−32768 to −1), first determine the bit pattern for the positive decimal value. The 2's complement of this pattern is the bit pattern for the negative number. For example, the bit pattern for decimal −483 is computed as follows:

1. Decimal Value:	−483	=	?
2. Bit Pattern for +483:	483	=	0000 0001 1110 0011
3. 2's Complement of +483:		=	1111 1110 0001 1101
4. Bit Pattern for −483:	−483	=	1111 1110 0001 1101

Command Summary

Table 4-5 is an alphabetical summary of commands which apply to the digital inputs. Refer to the HP 3852A Command Reference Manual for a complete description of these commands.

Table 4-5. Command Summary

CHREAD *ch* [INTO *name*] or [*fmt*]

For *ch* = ES00-ES15 (ES00-ES07 for 8-channel), returns the count on the channel. For *ch* = ES16-ES31 (ES08-ES15 for 8-channel), returns the state of the channel.

CHREADM *ch_list* [INTO *name*] or [*fmt*]

For USE *ch* = ES00-ES15 (ES00-ES07 for 8-channel), returns the count on the channel(s) specified by *ch_list*. For USE *ch* = ES16-ES31 (ES08-ES15 for 8-channel), returns the state of the channel(s) specified by *ch_list.*

CHREADZ *ch* [INTO *name*] or [*fmt*]

For USE *ch* = ES00-ES15 (ES00-ES07 for 8-channel), read and zero the channel count on the channel specified by *ch.*

CNTSET [*number*] [USE *ch*]

For the channel specified by USE *ch*, presets the channel counter to begin counting from the number of counts set by *number* OR to rollover after the number of counts set by *number*. Range of *number* = -2147483648 to +2147483647.

CONF *function* [USE *ch*]

Configure the digital input to sense the input level or to totalize counts. CONF LVL configures the specified channel to sense the input level. CONF TOTAL configures the specified channel to totalize inputs on the channel.

For CONF TOTAL, the *ch* range = ES00-ES15 (ES00-ES08 for the HP 44722A) and the channel totalizes counts. For CONF LVL, the *ch* range = ES16-ES31 (ES08-ES15 for the HP 44722A) and the channel senses the input level (LOW [0] or HIGH [1] for DC input; OFF [0] or ON [1] for AC input).

CONF sets DISABLE INTR, EDGE LH, and CNTSET 0 on the specified channel. CONF clears and disables all interrupts enabled on the channel.

DISABLE INTR [USE *ch*]

Prevents enabled channel(s) from generating event or counter interrupts. Type of interrupt disabled is specified by USE *ch.*

EDGE *trans* [USE *ch*]

For channel specified by USE *ch* command, *trans* sets edge (positive, negative, or either) which will be counted AND sets the edge transition which will cause an event interupt when enabled.

Table 4-5. Command Summary (Cont'd)

ENABLE INTR [USE *ch*]

Enables channel(s) specified by USE *ch* to generate event or counter interrupts. For USE *ch* = ES00-ES15 (ES00-ES07 for 8-channel), enables channel specified by *ch* to interrupt on counter overflow (counter interrupt). For USE *ch* = ES16-ES31 (ES08-ES15 for 8-channel), enables channel specified by *ch* to interrupt when the edge specified by EDGE occurs (event interrupt).

For USE *ch* = ES90, enables counter interrupt when counter overflow occurs on any channel in range ES00-ES15 (ES00-ES07 for 8-channel). For USE *ch* = ES91, enables event interrupt when the edge(s) specified by EDGE occurs on any channel in range ES16-ES31 (ES08-ES15 for 8-channel). ENABLE INTR USE ES90 or ES91 requires mainframe firmware revision 3.0 or greater.

ID? *slot*

Reads identity of digital input in slot specified by *slot*. An HP 44721A returns 44721A, while an HP 44722A returns 44722A.

READ *slot* [*number*] [INTO *name*] or [*fmt*]

Reads the state of all channels in the slot specified by *slot* and returns the equivalent decimal value of the bit pattern (0 = AC OFF or DC LOW, 1 = AC ON or DC HIGH). Range is -32768 to 32767, where the LSB = channel ES00 state and the MSB = channel ES15 state (channel ES07 state for the HP 44722A). *number* reads the slot the specified number of times. The *number* parameter requires mainframe firmware revision 3.0 or greater.

READM *slot_list* [INTO *name*] or [*fmt*]

Reads the state of all channels in the slot(s) specified by *slot_list* and returns the equivalent decimal value of the bit pattern(s) (0 = AC OFF or DC LOW, 1 = AC ON or DC HIGH). Range is -32768 to 32767, where the LSB = channel ES00 state and the MSB = channel ES15 state (channel ES07 state for the HP 44722A). One value is returned for each slot read.

RST *slot*

Resets digital input in slot specified by *slot* to power-on state.

USE *ch*

Use channel specified by *ch* in commands to follow (unless USE parameter is given) where *ch* specifies logical channel number and function.

XRDGS *ch* [*number*] [INTO *name*] or [*fmt*]

For the channel specified by the *ch* parameter or by the USE *ch* command, XRDGS transfers the number of readings specified by *number* from a digital input channel to the mainframe. XRDGS transfers each reading as it becomes available without disturbing the counting or state sensing function. Range of *number* is 1 to 2147483647. Default *number* = 1.

Programming Digital Input Channels

This section shows how to program the 16-channel and 8-channel digital input channels for four functions:

- Detecting Input States
- Counting Input Edges
- Generating Event Interrupts
- Generating Counter Interrupts

Detecting Input States

One of the programming functions for the digital inputs is to detect (read) the state of an input. When the channel input is DC HIGH or AC ON, the channel is set to the "1" state. When the input is DC LOW or AC OFF, the channel is set to the "0" state. Figure 4-1 summarizes commands and operation for this function.

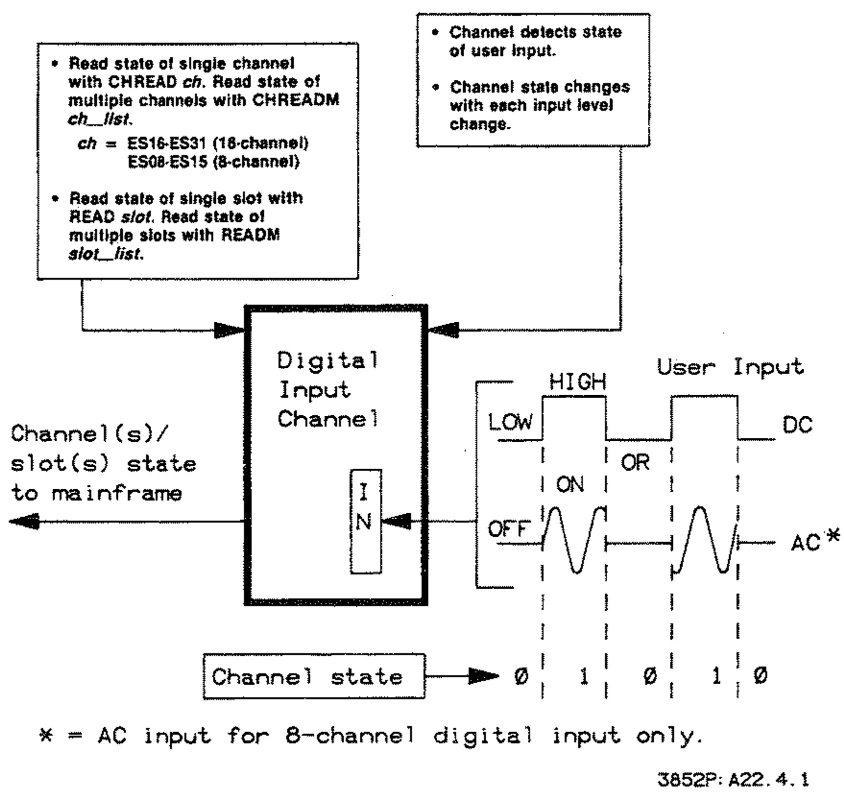


Figure 4-1. Detecting Input States

Reading Channel States

CHREAD and CHREADM read the state of individual digital input channels. For USE *ch* = ES16-ES31 (ES08-ES15 for the HP 44722A), use CHREAD *ch* to read the state of the channel specified by *ch*. (You can also use the XRDGS *ch* command which acts as a multiple CHREAD command).

Use CHREADM *ch_list* to read the state of the channel(s) specified by *ch_list*. (CHREADM requires mainframe firmware revision 3.0 or greater.) For example, use CHREAD 220 to read the state of channel 204 of an HP 44721A in slot 2 of the mainframe. Or, use CHREADM 220-230 to read the state of channels 204 through 214.

Reading Slot States

READ and READM read the state of all channels in a slot or slots. Use READ *slot* to read the state of all channels in the slot specified by *slot*. For mainframe firmware revision 3.0 or greater, use READ *slot* [*number*] to read the specified slot the number of times specified by [*number*] or use READM *slot_list* to read the state of all channels in the slot(s) specified by *slot_list*.

For example, use READ 100,3 to read the state of all channels of an HP 44721A or HP 4472A in slot 1 of the mainframe three times. Or, use READM 100,200,300-500 to read the state of slots 100, 200, and 300 through 500.

NOTE

READ and READM read the state of the specified slot(s) but do not read the number of counts on the channels in these slot(s).

Example: Reading DC Input State

This program determines if switches S1 and S8 are open or closed by reading the state of channels 401 and 408 of a 16-channel digital input in slot 4 of the mainframe. See Figure 4-2 for typical connections to the terminal module.

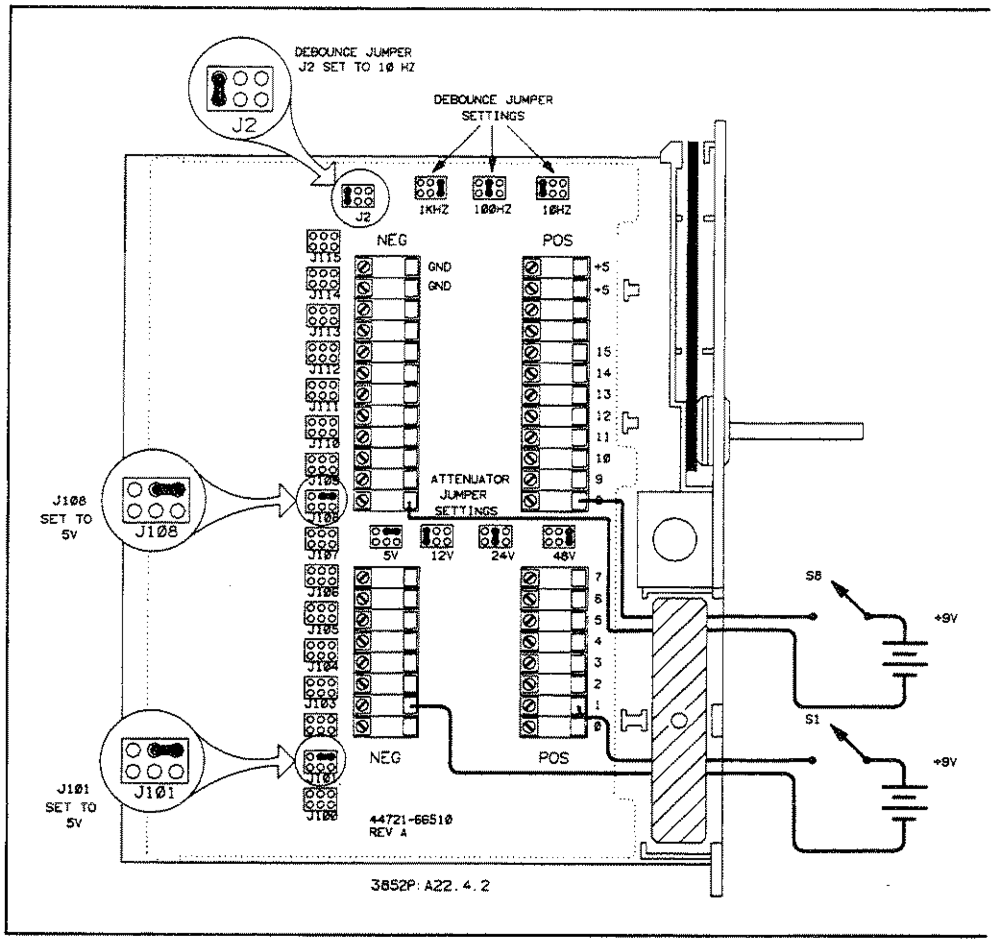


Figure 4-2. Example: Reading DC Input State

An example program using CHREADM follows. Note that mainframe firmware revision 3.0 or greater is required.

```
10 INTEGER A(0:1)
20 OUTPUT 709;"CHREADM 417,424"     !Read channel 401, 408 states
30 ENTER 709;A(*)                   !Enter channel 401, 408 states
40 PRINT "S1 state = ";A(0)         !Display channel 401 state
50 PRINT "S8 state = ";A(1)         !Display channel 408 state
60 END
```

If S1 is open and S8 is closed when CHREADM is executed, a typical return is:

```
S1 state = 0
S8 state = 1
```

Example: Reading AC Input State

This program determines the ON/OFF status of eight AC inputs to an 8-channel digital input in slot 3 of the mainframe. Inputs are connected to the channels through switches S0 through S7. When a channel switch is closed, AC is present on the channel (AC ON). When a channel switch is open, AC is absent (AC OFF). See Figure 4-3 for typical connections to the terminal module.

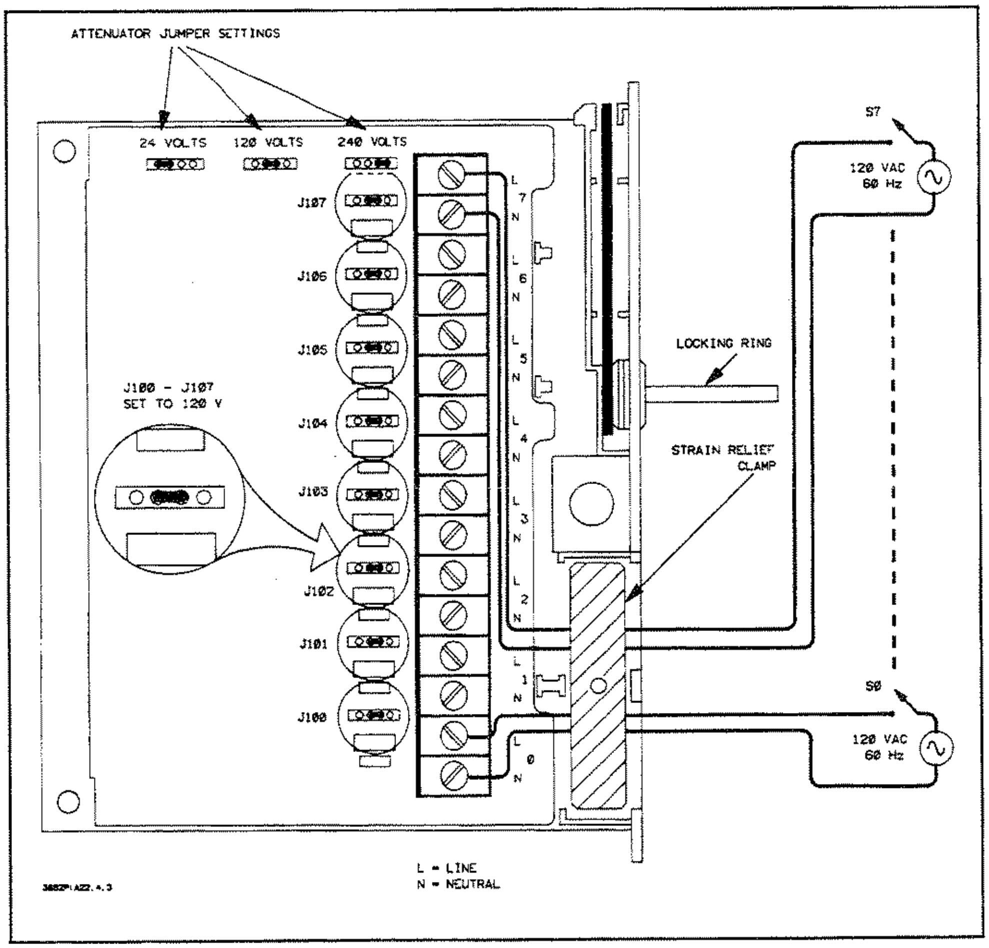


Figure 4-3. Example: Reading AC Input State

This program determines the status of all AC inputs in slot 300 by using the READ *slot* command. The data returned is the decimal value of the current channel states where 1 = switch closed (AC ON) for the channel and 0 = switch open (AC OFF) for the channel.

```
10 OUTPUT 709;"READ 300"          !Read state of slot 300
20 ENTER 709;A                    !Enter decimal equiv of state
30 PRINT "Switch States =.";A     !Display decimal equiv
40 END
```

For example, with switches S0, S1, S4, and S6 closed (AC ON for channels 300, 301, 304 and 306; AC OFF for channels 302, 303, 305, and 307), READ returns 83, where 83 = the decimal value of channel bit pattern 0101 0011. A typical return is:

```
Switch States = 83
```

Counting Input Edges

A second programming function for the digital inputs is to count specified input edges. The edges to be counted are set with the EDGE command. The count can be set to start at zero or at a programmable point with the CNTSET command. Figure 4-4 summarizes commands and operation for the counting function.

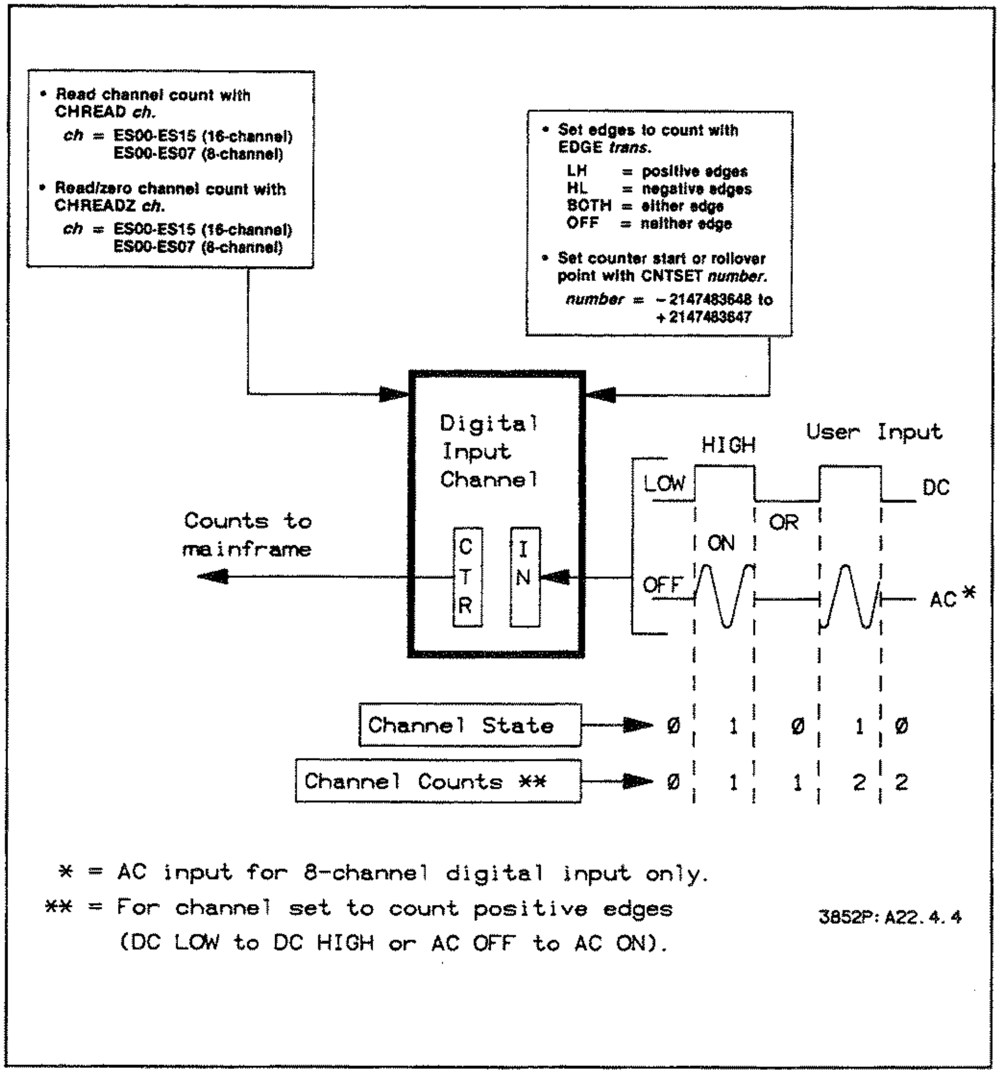


Figure 4-4. Counting Input Edges

Enabling Channel to Count Edges (EDGE)

Although a digital input channel automatically detects all input edges, the channel must be enabled to count programmed input edges. To enable a channel to count edges, use EDGE *trans* [USE *ch*] where *trans* = LH, HL, BOTH, or OFF defines the edges to be counted and USE *ch* = ES00-ES15 (ES00-ES07 for the 8-channel) sets the channel to count the programmed edges. (The EDGE BOTH parameter requires mainframe firmware revision 3.0 or greater plus an HP 44721A with serial number 2711A01765 or greater or an HP 44722A with serial number 2711A00178 or greater.)

For USE *ch* = ES00-ES15 (ES00-ES07 for the 8-channel), EDGE LH sets the channel to count positive edges, EDGE HL sets the channel to count negative edges, EDGE BOTH sets the channel to count both edges, and EDGE OFF sets the channel to idle (does not count either edge).

For USE *ch* = ES00-ES15 (ES00-ES07 for the 8-channel), you can use CHREAD *ch* to read accumulated counts on the channel specified by *ch*. Or, you can use CHREADZ *ch* to read and zero the counts on the channel specified by *ch*. (CHREADM cannot be used to read channel counts.)

For example, Figure 4-4 shows a digital input channel enabled to count positive edges (with EDGE LH). Although the channel state changes from "0" to "1" and back to "0" with each input change, the channel count totalizes with each positive edge.

NOTE

1. At power-on or after a RST or RST slot command, EDGE OFF is set and all channels are disabled from counting edges.

2. EDGE is NOT independently selectable for counts and interrupts. For example, setting EDGE LH USE 300 also sets EDGE LH USE 316 (16-channel) or sets EDGE LH USE 308 (8-channel).

3. For USE ch = ES91, when enabled with ENABLE INTR, an event interrupt is generated when the edge specified by EDGE occurs on any channel in the range ES16-ES31 (ES08-ES15 for the 8-channel). Refer to "Generating Event Interrupts" for details.

Setting Counter Presets/Rollovers (CNTSET)

Each channel has a separate counter with range from -2147483648 to +2147483647 counts. For DC inputs, the counter registers one count for each programmed edge detected (positive, negative, or both). For AC inputs (8-channel digital input only), the counter registers one count for each transition from AC OFF to AC ON and/or from AC ON to AC OFF, as programmed.

Each channel counter can be preset to begin counting from a specified number of counts or to rollover after a specified number of counts with the CNTSET [*number*] command. The *number* parameter specifies the number of counts at which the channel starts counting OR specifies the number of counts required to cause the counter to rollover.

As shown in Figure 4-5, the counter sequence is from 0 or from the preset value up to 2147483647 then to -2147483648 to -1 to 0. When the counter goes from -1 to 0, counter rollover occurs. Note that the count range is from 0 to 4294967296, while the CNTSET [*number*] range is from -2147483648 to 2147483647. Default [*number*] = 0.

The value to use for CNTSET [*number*] depends on the number of counts specified, as shown in Figure 4-5 where the decision point is counts = 2147483648. For example, with 1000 counts, since 1000 is <2147483648, CNTSET 1000 presets the counter to start counting at 1000 counts, while CNTSET -1000 causes the counter to rollover after 1000 counts.

However, for 3,000,000,000 counts, since 3000000000 is ≥ 2147483648, CNTSET -1294967296 (counts - 4294967296) presets the counter to start counting at 3,000,000,000 counts while CNTSET 1294967296 (4294967296 - counts) causes the counter to rollover after 3,000,000,000 counts.

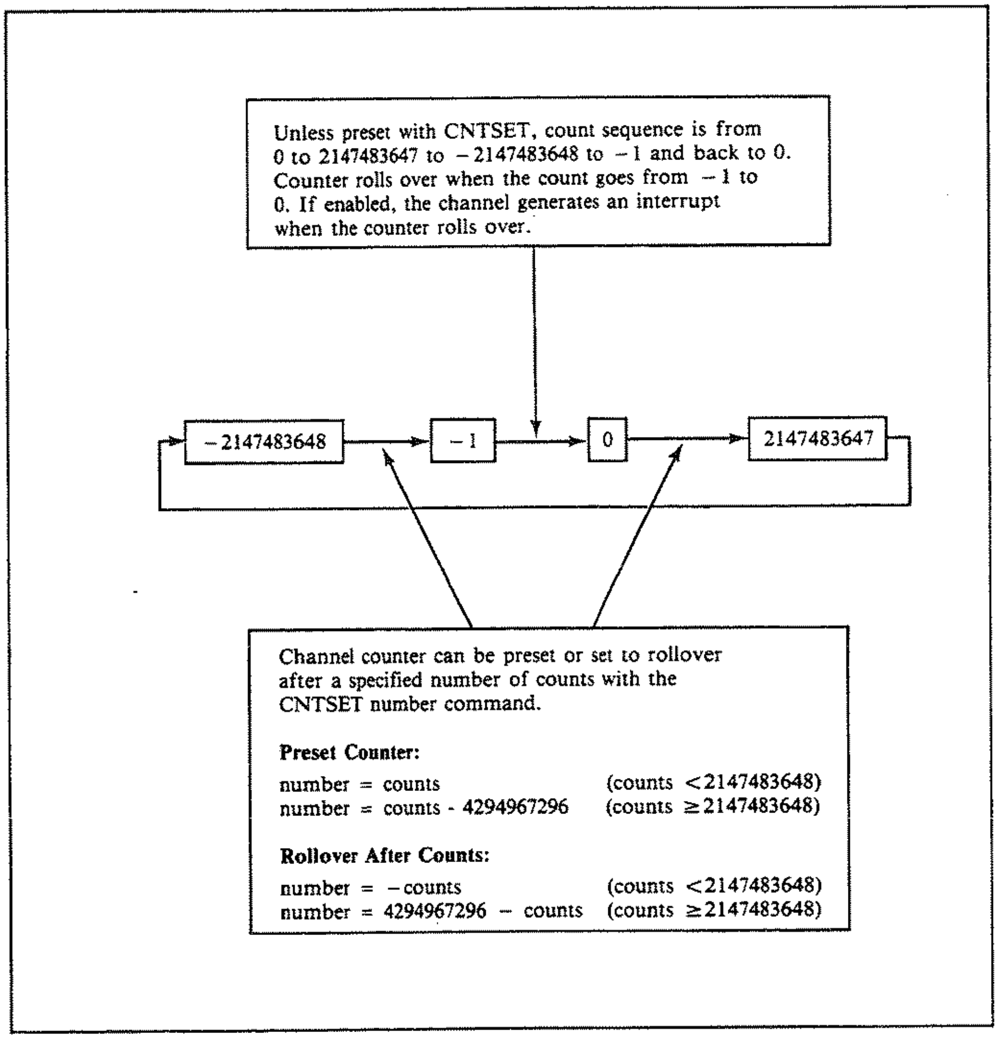


Figure 4-5. Channel Counter - Count Sequence

Example: Counting DC Input Edges

This program counts the total number of switch (S0) openings and closures during a ten-second interval by counting both edges on channel 100. See Figure 4-6 for typical connections to channel 100 of a 16-channel digital input in slot 1 of the mainframe. This program requires mainframe firmware revision 3.0 or greater.

The program sets channel 100 of a 16-channel digital input to count both edges, waits 10 seconds, and then reads the count.

```
10 OUTPUT 709;"RST"                   !Reset HP 3852A
20 OUTPUT 709;"USE 100"               !Use ch is 100
30 OUTPUT 709;"EDGE BOTH"             !Count both edges on ch 100
40 WAIT 10                            !Wait 10 seconds
50 OUTPUT 709;"CHREAD 100"            !Read counts on ch 100
60 ENTER 709;A                        !Enter ch 100 counts
70 PRINT "S0 Opens/Closes = ";A       !Display ch 100 counts
80 END
```

For a total of five switch openings and closures during the 10 seconds, a typical return is:

```
S0 Opens/Closes = 5
```

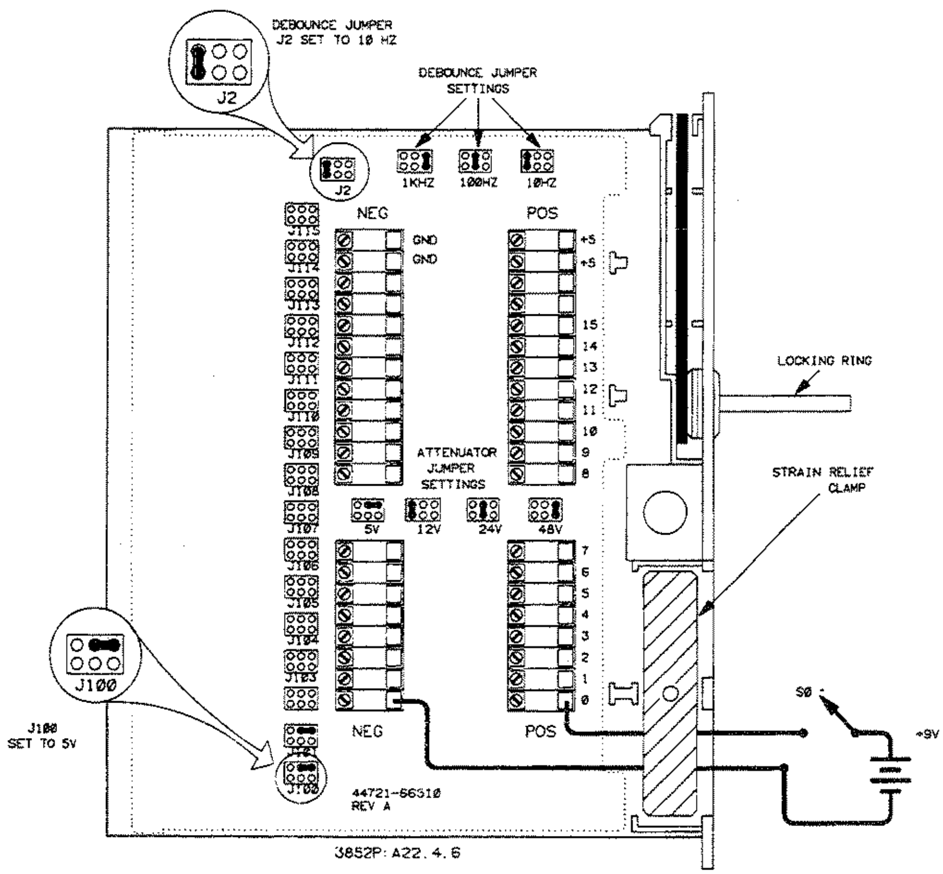


Figure 4-6. Example: Counting DC Input Edges

Example: Counting AC Input Edges

This program counts the number of times an AC input was switched ON during a one-minute interval and then zeroes the count. See Figure 4-7 for typical connections to channel 304 of a 16-channel digital input in slot 3 of the mainframe.

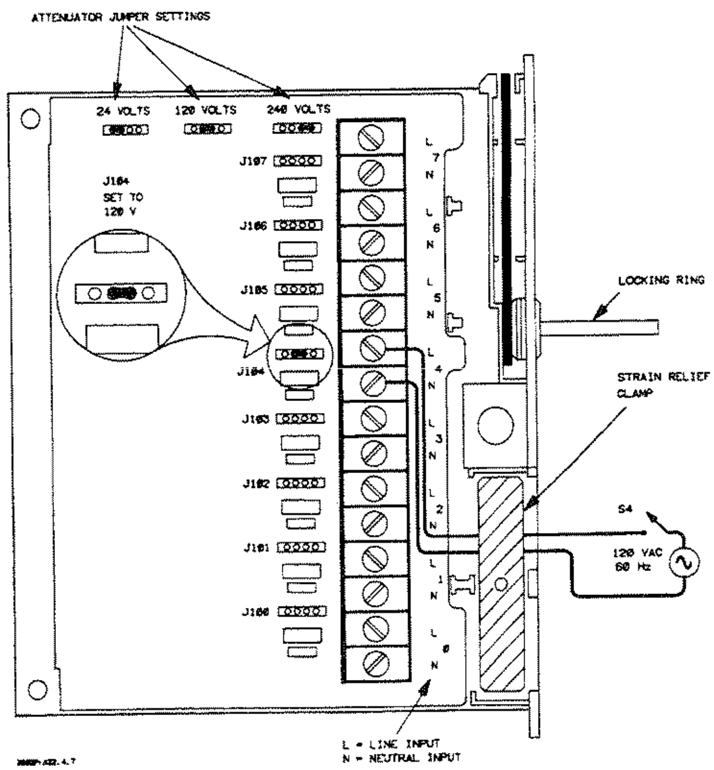


Figure 4-7. Example: Counting AC Input Edges

This program sets channel 304 to count positive edges, waits 60 seconds, and then reads and zeroes the count on channel 304. The number of positive edges counted = the number of times S4 was closed during the one-minute interval = the number of AC ON states during this time.

```
10 OUTPUT 709;"EDGE LH,USE 304"       !Count pos edges on ch 304
20 WAIT 60                            !Wait 60 seconds
30 OUTPUT 709;"CHREADZ 304"           !Read/zero count on ch 304
40 ENTER 709;A                        !Enter count
50 PRINT "Channel 304 AC ON = ";A     !Display count
60 END
```

For five switch closures, a typical return is:

```
Channel 304 AC ON = 5
```

Generating Event Interrupts

A third programming function for the digital inputs is to generate event interrupts. Each channel can be independently enabled to generate an interrupt when a programmed edge is detected. This is called an event interrupt. Enabled channels can be disabled from generating an event interrupt. Figure 4-8 summarizes commands and operation for event interrupts.

Enabling Event Interrupts

Two commands are required to enable a channel for an event interrupt: EDGE and ENABLE INTR. EDGE sets the edge (positive, negative, or either) on which to interrupt. EDGE LH sets positive edges, EDGE HL sets negative edges, and EDGE BOTH sets either edge. (EDGE BOTH requires mainframe firmware revision 3.0 or greater plus an HP 44721A with serial number 2711A01765 or greater or an HP 44722A with serial number 2711A00178 or greater.)

For USE *ch* = ES16-ES31 (ES08-ES15 for the 8-channel), ENABLE INTR [USE *ch*] enables the channel specified by *ch* to generate an event interrupt when the edge specified by EDGE occurs on the channel.

For USE *ch* = ES91, ENABLE INTR USE ES91 enables the accessory to generate an event interrupt when the edge specified by EDGE occurs on any channel in range ES16-ES31 (ES08-ES15 for the 8-channel). (USE ES91 is valid only for mainframe firmware revision 3.0 and greater.)

For example, to enable channel 100 of a 16-channel digital input to interrupt on a positive edge, EDGE LH USE 116 sets the channel to detect positive edges and ENABLE INTR USE 116 enables channel 100 to generate an event interrupt on the first positive edge. (To enable channel 100 of an 8-channel digital input in this slot, use EDGE LH USE 208 and ENABLE INTR USE 208).

For mainframe firmware revision 3.0 and greater, EDGE BOTH USE 191 plus ENABLE INTR USE 191 enables a 16-channel digital input in mainframe slot 1 to generate an event interrupt on the first edge (positive or negative) received on any channel in range ES16-ES31.

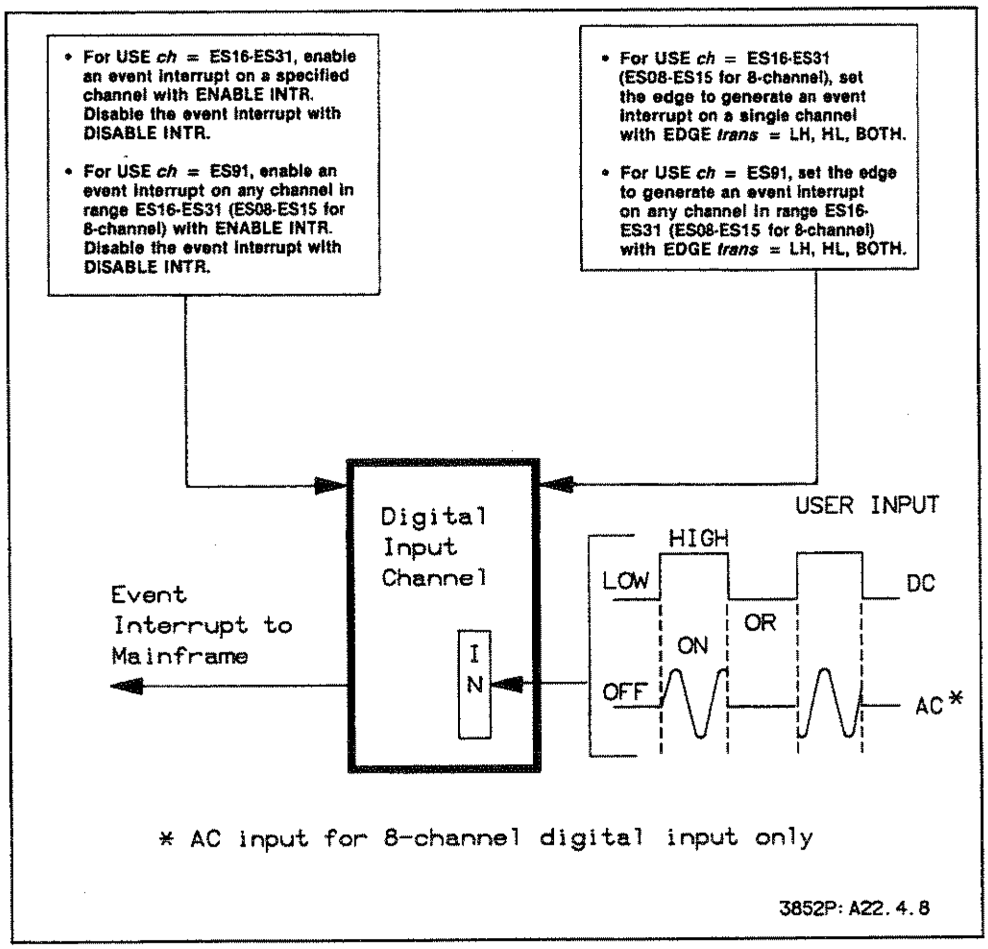


Figure 4-8. Generating Event Interrupts

Disabling Event Interrupts

A channel which has been enabled for event interrupts can be disabled from sending an event interrupt with DISABLE INTR [USE *ch*], where *ch* = ES16-ES31 (ES08-ES15 for the 8-channel). Also, for mainframe firmware revision 3.0 and greater, DISABLE INTR USE ES91 disables event interrupts on all channels in range ES16-ES31 (ES08-ES15 for the 8-channel).

NOTE

Since a channel can be enabled for event and counter interrupts, disabling event interrupts does NOT disable counter interrupts set on the channel(s) and vice-versa.

Servicing Event Interrupts

Whether or not DISABLE INTR is used, an event interrupt which is serviced by the mainframe is automatically cleared and disabled. This means that any programmed edges after the first programmed edge will not generate an interrupt unless the channel is first reenabled with another ENABLE INTR command.

For example, if the channel in Figure 4-9 is set to detect positive edges (EDGE LH) and enabled for event interrupts (ENABLE INTR), edge 1 will generate an event interrupt. However, edge 2 (and any following programmed edges) will not generate an interrupt unless another ENABLE INTR command is sent before edge 2 occurs AND the mainframe has serviced the interrupt from edge 1.

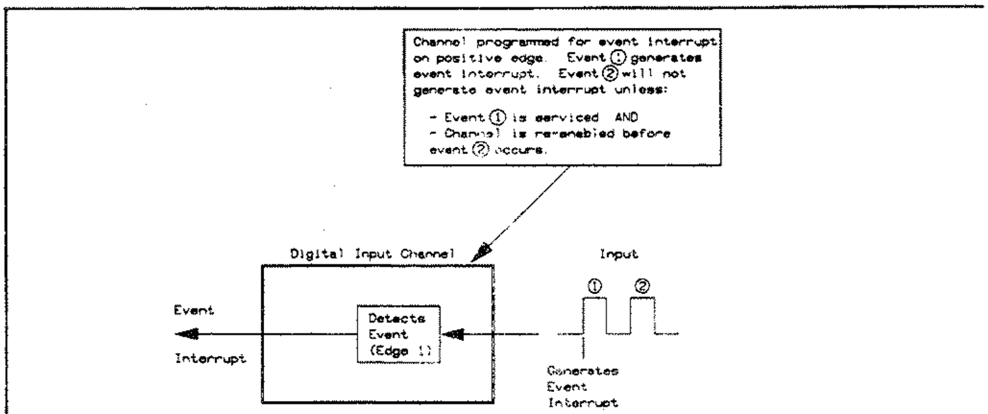


Figure 4-9. Servicing Event Interrupts

Event Interrupt Priorities

A channel can be enabled for event interrupts, counter interrupts, or both. Refer to "Generating Counter Interrupts" to program a channel for counter interrupts. At power-on or after a RST or RST *slot* (reset) command, all channels are disabled from generating event interrupts and/or counter interrupts.

If a channel generates an event interrupt and a counter interrupt, the counter interrupt is serviced first, then the event interrupt. Each interrupting channel is automatically cleared and disabled when serviced.

If more than one channel generates an interrupt, the mainframe services the lowest-numbered channel first, then the next lowest-numbered channel, and so on. The digital input keeps track of the interrupts which have not been serviced.

Event Interrupt Delay Times

Interrupt delay time for the 16-channel digital input varies, depending on the debounce jumper setting, as shown in Table 4-6. Total SYSTEM delay time, in turn, depends on the application program response time which is a function of the user program.

The delay times shown in Table 4-6 are accessory response times only. You must add the application program response time to get the total delay. That is, system interrupt delay time = (application program response time) + (interrupt delay time from Table 4-6).

For example, with the debounce jumper set for 100 Hz, minimum accessory interrupt delay time is 2 msec and maximum delay is 6.5 msec which must be added to the application program response time to get total system interrupt delay time.

NOTE

Maximum interrupt delay time for the 8-channel digital input is 50 msec. Add this delay to the application program response time to get total system interrupt delay time.

Table 4-6. Accessory Interrupt Delay Times

Debounce Jumper Setting	Accessory Response Time (msec)		Debounce Response Time (msec)		Interrupt* Delay Time (msec)	
	Min	Max	Min	Max	Min	Max
10 Hz	0	1.5	20	50	20	51.5
100 Hz	0	1.5	2	5	2	6.5
1 kHz	0	1.5	0.2	1	0.2	2.5

* = Interrupt Delay Time = Accessory Response Time + Debounce Response Time.

Example: Enable Event Interrupt - Single Channel

For this example, we will monitor a digital channel which has LOW state = 0 volts and HIGH state = 1 volt, but is prone to bursts of noise. The noise bursts are typically 5 volt positive pulses at about 5 Hz and bursts generally last about 1 to 2 seconds.

To detect the noise bursts, we will generate an event interrupt when the burst begins (first positive pulse) and then count the pulses for 5 seconds following the interrupt. (We will assume any burst lasts less than 5 seconds). See Figure 4-10 for typical connections to channel 105 of a 16-channel digital input in slot 1 of the mainframe.

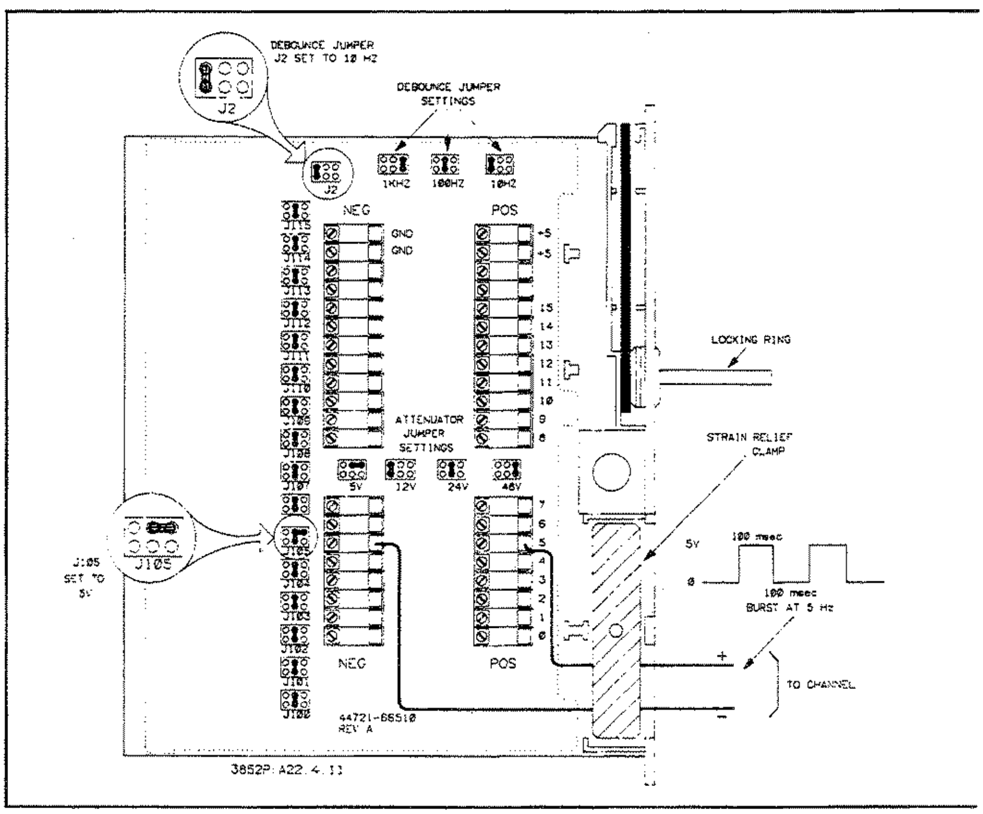


Figure 4-10. Example: Enable Event Interrupt - Single Channel

```
10    ON INTR 7 GOTO Results              !Call sub Results on interrupt
20    ENABLE INTR 7;2                     !Enable controller intr on SRQ
30    OUTPUT 709;"RST"                    !Reset HP 3852A
40    OUTPUT 709;"RQS ON;RQS INTR"        !Enable interrupt on SRQ
50    OUTPUT 709;"USE 121"                !Physical channel is 105
60    OUTPUT 709;"EDGE LH"                !Detect positive edges
70    OUTPUT 709;"ENABLE INTR SYS"        !Enable mainframe intr capability
80    OUTPUT 709;"ENABLE INTR"            !Enable ch to intr on neg edge
90  Idle:GOTO Idle                        !Loop until interrupt occurs
100   !
110 Results: !                            !Start controller subroutine
120   OUTPUT 709;"TIME"                   !Query time of day
130   ENTER 709;T                         !Enter time of day
140   PRINT "Ch 105 intr @ ";TIME$(T)     !Print intr time/message
150   WAIT 5                              !Wait 5 seconds
160   OUTPUT 709;"CHREAD 105"             !Read channel 105 counts
170   ENTER 709;B                         !Enter counts
180   PRINT "Ch 105 counts = ";B          !Display counts/message
190   A=SPOLL(709)                        !Read/clear SRQ bit
200   STOP                                !End controller subroutine
210   END
```

When the first positive edge is detected on channel 105, an event interrupt is generated. If the burst following the interrupt has 3 pulses (3 positive edges), a typical return is as follows. Note that the number of counts (4) includes the 3 edges in the burst plus the edge which caused the event interrupt.

```
Ch 105 intr @ 02:02:04
Ch 105 counts = 4
```

Example: Enable Event Interrupt - Any Channel

This program generates an event interrupt when the switch connected to any channel of a 16-channel digital input is closed. (See Figure 4-11 for typical connections.) The program requires mainframe firmware revision 3.0 or greater.

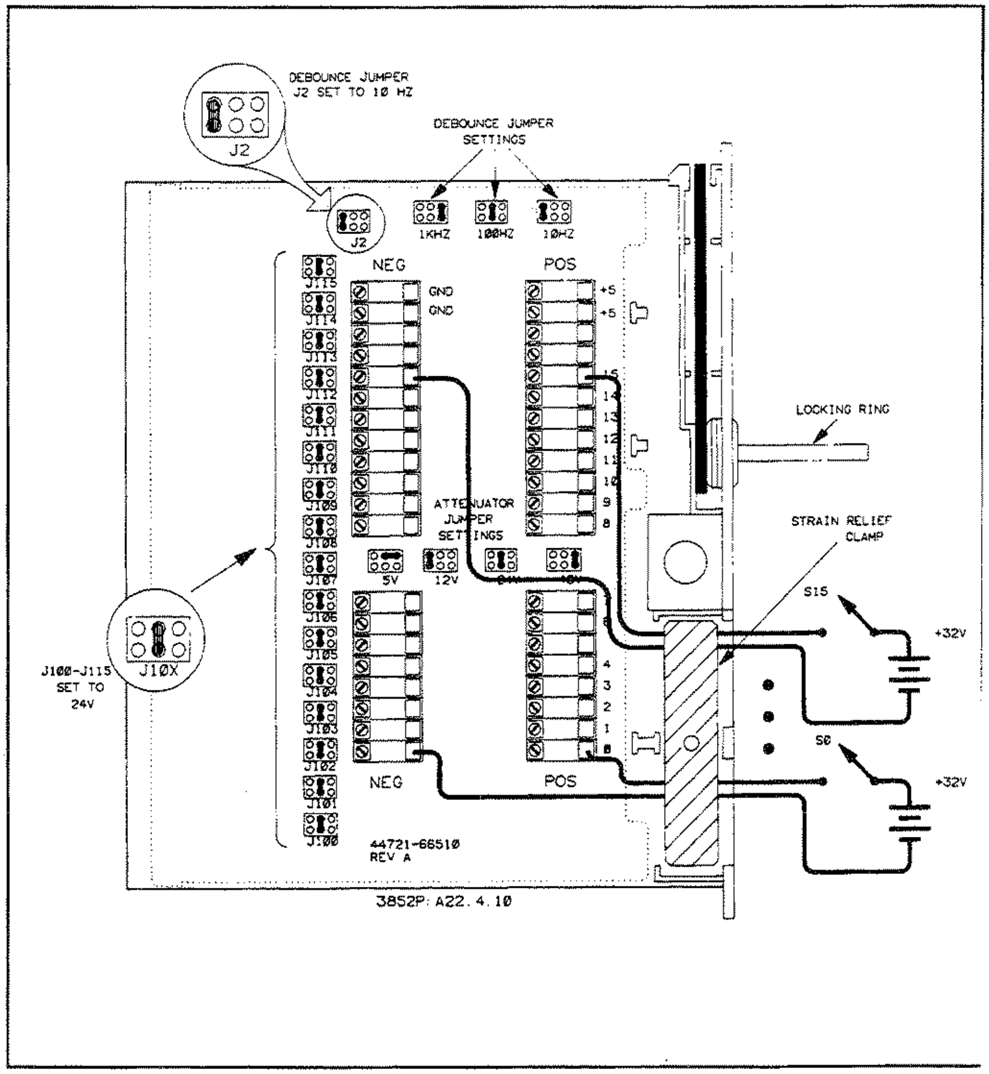


Figure 4-11. Example: Enable Event Interrupt - Any Channel

```
10    !
20    !Initial setup
30    !
40    INTEGER B(0:15)                      !Define controller array
50    ON INTR 7 GOTO Results               !Call sub Results on interrupt
60    ENABLE INTR 7;2                      !Enable controller intr on SRQ
70    OUTPUT 709;"RST"                     !Reset HP 3852A
80    OUTPUT 709;"RQS ON;RQS INTR"         !Enable interrupt on SRQ
90    !
100   !Enable event interrupt
110   !
120   OUTPUT 709;"EDGE LH USE 191"         !Detect LH edges on all channels
130   OUTPUT 709;"ENABLE INTR SYS"         !Enable mainframe intr capability
140   OUTPUT 709;"ENABLE INTR USE 191"     !Enable event intr on all chs
```

```
150  Idle:GOTO Idle                         !Loop until interrupt occurs
160    !
170  Results: !                             !Start controller subroutine
180    OUTPUT 709;"TIME"                    !Query time of day
190    ENTER 709;T                          !Enter time of day
200    !
210    !Read/display channel states
220    !
230    OUTPUT 709;"CHREADM 116-131"         !Read state of all channels
240    ENTER 709;B(*)                       !Enter channel states
250    PRINT "Slot 100 intr @ ";TIME$(T)    !Print intr time/message
260    PRINT "Channel states:"              !Print header
270    PRINT B(*)                           !Print channel states
280    A=SPOLL(709)                         !Read/clear SRQ bit
290    STOP                                 !End controller subroutine
300    END
```

For example, when the switch connected to channel 108 (S8) is closed, an event interrupt occurs. A typical return follows, if the switches for all other channels are open when the interrupt occurs.

```
Slot 100 intr @ 02:02:04
Channel states:
0    0    0    0    0    0    0    0
1    0    0    0    0    0    0    0
```

Generating Counter Interrupts

A fourth programming function for the digital inputs is to generate counter interrupts. Each channel can be independently enabled to generate an interrupt when the channel counter rolls over from -1 to 0. This is called a counter interrupt. In addition, a channel enabled for counter interrupts can be disabled from generating the interrupt. Figure 4-12 summarizes commands and operation for counter interrupts.

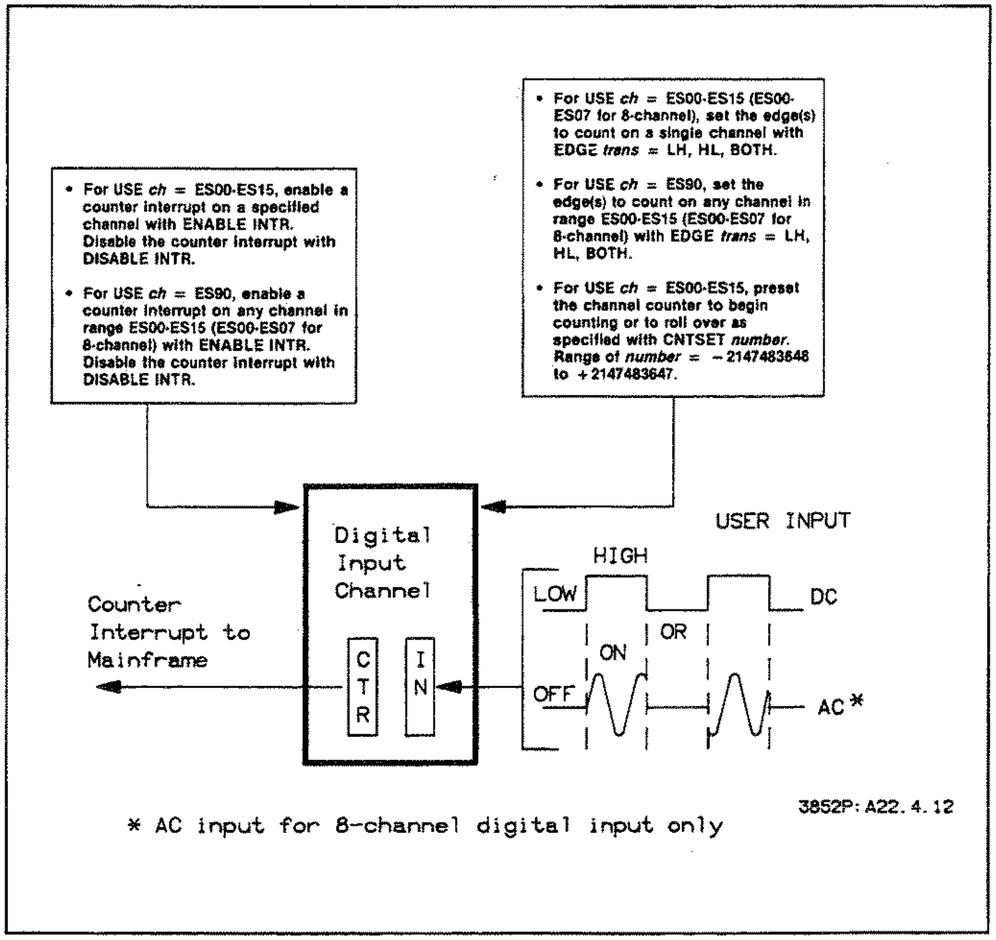


Figure 4-12. Generating Counter Interrupts

Enabling Counter Interrupts

Each channel of a digital input can be enabled to send a counter interrupt when the channel counter rolls over from -1 to 0. Two commands are required to enable a channel for counter interrupt: EDGE and ENABLE INTR. In addition, CNTSET can be used to preset the counter or to set the number of counts to cause rollover.

For USE *ch* with *ch* = ES00-ES15 (ES00-ES07 for the 8-channel), EDGE *trans* sets the channel to count positive, negative, or either edge. EDGE LH sets positive edges, EDGE HL sets negative edges, and EDGE BOTH sets either edge. (EDGE BOTH is valid only for mainframe firmware revision 3.0 and greater.)

For USE *ch* = ES00-ES15 (ES00-ES07 for the 8-channel), ENABLE INTR [USE *ch*] enables the channel specified by *ch* to generate a counter interrupt when the channel counter rolls over (from -1 to 0). For USE *ch* = ES90, ENABLE INTR USE ES90 enables a counter interrupt when counter overflow occurs on any channel in range ES00-ES15 (ES00-ES07 for the 8-channel). (ENABLE INTR USE ES90 is valid only for mainframe firmware revision 3.0 and greater.)

For example, to enable channel 100 of a 16-channel digital input in slot 1 of the mainframe to interrupt on counter rollover, use EDGE LH USE 100 to count positive edges and use ENABLE INTR USE 100 to enable the channel for counter interrupt. Or, to count either edge of inputs and enable counter interrupt for counter overflow on any channel, use EDGE BOTH USE 100 and ENABLE INTR USE 190.

Presetting the Channel Counter

Use CNTSET [*number*] to preset the counter so that a counter interrupt can be generated after a specified number of counts. The range of CNTSET [*number*] is from -2147483648 to +2147483647, with default [*number*] value = 0.

Without a preset value, the count sequence starts from 0 and goes to 2147483647 counts to -2147483648 counts to -1 and back to 0 (see Figure 4-5). When the counter rolls over to 0, the channel (if enabled) generates a counter interrupt. Without a preset, 4294967296 counts are needed to generate a counter interrupt.

However, you can preset a channel to interrupt after a desired number of counts with the CNTSET [*number*] command. To do this, first decide how many counts are required to generate counter rollover. Then, compute CNTSET *number* from Figure 4-5, where count = desired number of counts to cause counter rollover.

For example, to cause counter rollover after 1000 counts, since count = 1000 is ≤ 2147483648, *number* = -counts = -1000. Or, to cause counter rollover after 3,000,000,000 counts, *number* = 4294967296 - 3000000000 = 1294967296.

Disabling Counter Interrupts

You can prevent a channel enabled for counter interrupts from generating a counter interrupt by using DISABLE INTR [USE *ch*] with *ch* = ES00-ES15 (ES00-ES07 for the 8-channel). Or, for mainframe firmware revision 3.0 and greater, use DISABLE INTR USE ES90 to disable counter interrupts on all channels in range ES00-ES15 (ES00-ES07 for the 8-channel).

NOTE

Since a channel can be enabled for both event and counter interrupts, disabling a counter interrupt does NOT disable an event interrupt set on the channel(s) and vice-versa.

Servicing Counter Interrupts

Whether or not DISABLE INTR has been sent to the channel, when a counter interrupt has been serviced by the mainframe, the interrupt is automatically cleared and disabled. This means that any programmed edges after the edge which causes counter rollover will not generate another interrupt unless the channel is reenabled with another ENABLE INTR command.

For example, assume the channel in Figure 4-13 is programmed to count positive edges and is enabled for counter interrupts. Also, assume that edge 1 causes the channel counter to rollover to zero and to generate a counter interrupt.

When the interrupt has been serviced, the interrupt is cleared and disabled. Therefore, edge 2 will not generate an interrupt unless another ENABLE INTR command is sent before edge 2 occurs AND the counter is set to -1. However, all positive edges will continue to be counted by the channel counter, with edge 2 = count 1, etc. Also, note that edges 2 through n will not generate an interrupt if the mainframe has not serviced the interrupt from edge 1.

Interrupt Priorities

As noted, a channel can be enabled for event interrupts, counter interrupts, or both. Refer to "Generating Event Interrupts" to program a channel for event interrupts. At power-on or after a RST or RST *slot* (reset) command, all channels are disabled from generating event interrupts and/or counter interrupts.

If a channel generates an event interrupt and a counter interrupt, the counter interrupt is serviced first, then the event interrupt. Each interrupting channel is automatically cleared and disabled when serviced.

If more than one channel generates an interrupt, the mainframe services the lowest-numbered channel first, then the next lowest-numbered channel, and so on. The digital input keeps track of the interrupts which have not been serviced.

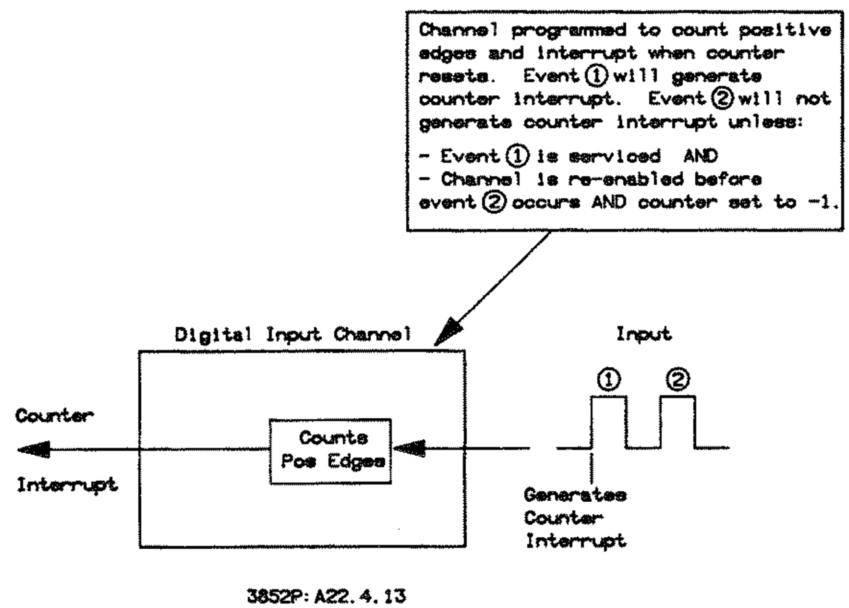


Figure 4-13. Servicing Counter Interrupts

Interrupt Delay Times

Interrupt delay times for the 16-channel digital input vary, depending on the debounce jumper setting. For the 8-channel digital input, maximum accessory interrupt delay time is 50 msec. Refer to "Generating Event Interrupts" for a discussion of interrupt delay times.

Example: Enable Counter Interrupt - Single Channel

This program sends a counter interrupt after a switch (S2) connected to channel 102 of a 16-channel digital input has closed five times. See Figure 4-14 for typical connections.

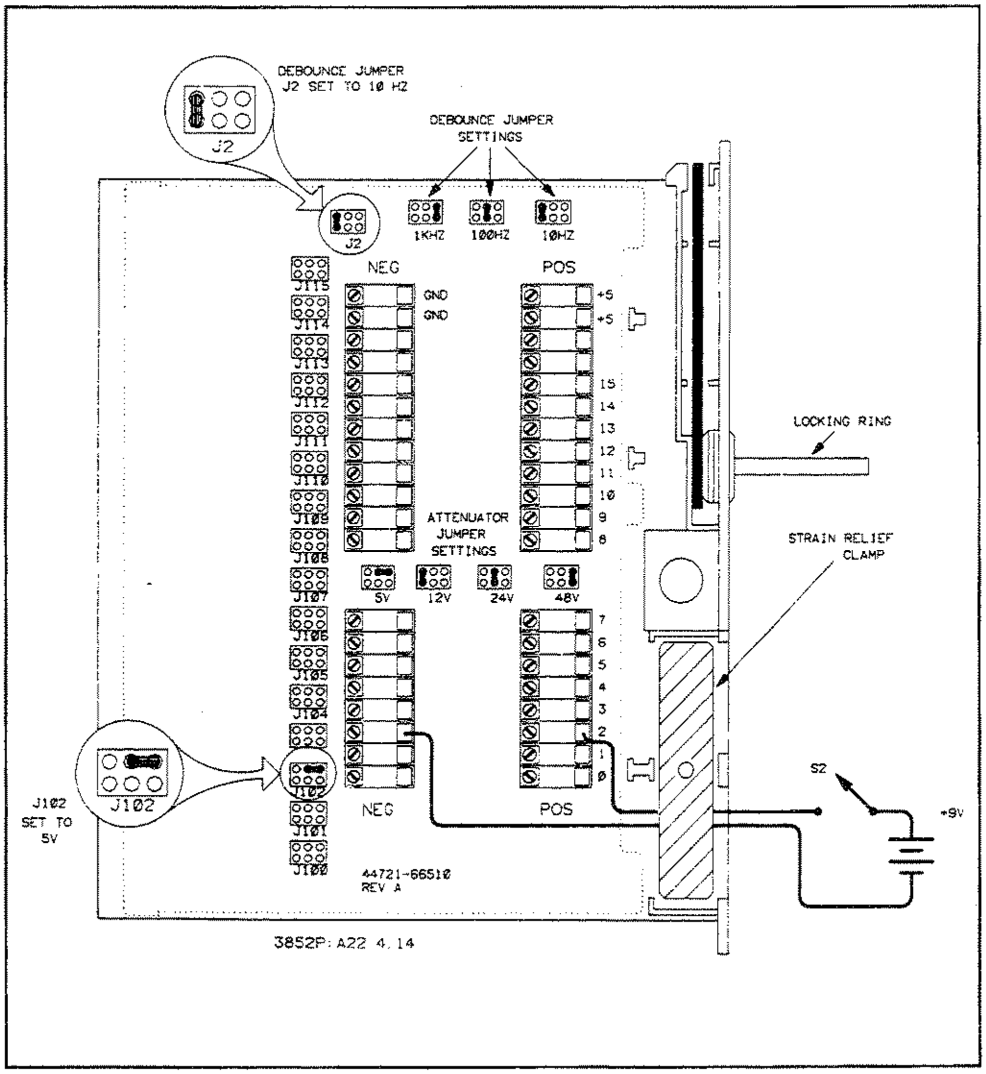


Figure 4-14. Example: Enable Counter Interrupt - Single Channel

The program enables channel 102 of a 16-channel digital input in slot 1 of the mainframe to count positive edges (switch closures) and enables the channel for counter interrupt. CNTSET -5 presets the channel counter so that it will roll over after five counts (five switch closures). After a 10 second wait, CHREAD reads the number of times S2 was closed after the counter roll over (does NOT include the edge which caused the roll over).

```
10   ON INTR 7 GOTO Results              !Call sub Results on interrupt
20   ENABLE INTR 7;2                     !Enable controller intr on SRQ
30   OUTPUT 709;"RST"                    !Reset HP 3852A
40   OUTPUT 709;"RQS ON;RQS INTR"        !Enable interrupt on SRQ
50   OUTPUT 709;"USE 102"                !Use ch is 102
60   OUTPUT 709;"CNTSET -5"              !Set roll over after 5 counts
70   OUTPUT 709;"EDGE LH"                !Detect positive edges
80   OUTPUT 709;"ENABLE INTR SYS"        !Enable mainframe intr capability
90   OUTPUT 709;"ENABLE INTR"            !Enable ch to intr on neg edge
```

```
100  Idle:GOTO Idle                          !Loop until interrupt occurs
110    !
120  Results: !                              !Start controller subroutine
130    OUTPUT 709;"TIME"                     !Query time of day
140    ENTER 709;T                           !Enter time of day
150    PRINT "Ch 102 intr @ ";TIME$(T)       !Print intr time/message
160    WAIT 10                               !Wait 10 seconds
170    OUTPUT 709;"CHREAD 102"               !Read channel 102 counts
180    ENTER 709;B                           !Enter counts
190    PRINT "Ch 102 counts = ";B            !Display counts/message
200    A=SPOLL(709)                          !Read/clear SRQ bit
210    STOP                                  !End controller subroutine
220    END
```

When switch S2 has been closed five times, a counter interrupt is generated. If S2 is closed four times within the 10 seconds after the interrupt, a typical return is as shown. Note that the number of counts (4) does NOT include the edge which caused the interrupt.

```
Ch 102 Intr @ 02:02:04
Ch 102 Counts = 4
```

Example: Enable Counter Interrupt - Any Channel

This program generates a counter interrupt after three closures of a switch connected to any channel of a 16-channel digital input. (See Figure 4-15 for typical connections.) Note that the program requires mainframe firmware revision 3.0 or greater.

```
10    !
20    !Initial setup
30    !
40    INTEGER B(0:15)                        !Define controller array
50    ON INTR 7 GOTO Results                 !Call sub Results on interrupt
60    ENABLE INTR 7;2                        !Enable controller intr on SRQ
70    OUTPUT 709;"RST"                       !Reset HP 3852A
80    OUTPUT 709;"INTEGER A(15),I,J"         !Define HP 3852A array, variables
90    OUTPUT 709;"RQS ON;RQS INTR"           !Enable interrupt on SRQ
100   OUTPUT 709;"EDGE LH USE 190"           !Set LH edges on all channels
110   !
120   !Preset channel counters
130   !
140   OUTPUT 709;"SUB Cntst"                 !Start Cntset subroutine
150   OUTPUT 709;" FOR J=0 TO 15"            !Start counter set loop
160   OUTPUT 709;"   CNTSET -3 USE (J+100)"    !Set ctr to -3 on each ch
170   OUTPUT 709;" NEXT J"                   !Increment counter set loop
180   OUTPUT 709;"SUBEND"                    !End Cntst subroutine
190   OUTPUT 709;"CALL Cntst"                !Call Cntst subroutine
200   !
```

```
210     !Read channel counters
220     !
230     OUTPUT 709;"SUB Dta"                  !Start Dta subroutine
240     OUTPUT 709;" FOR I=0 TO 15"           !Start read loop
250     OUTPUT 709;"  CHREAD (100+I) INTO A(I)"     !Read count on each ch
260     OUTPUT 709;" NEXT I"                  !Increment read loop
270     OUTPUT 709;"SUBEND"                   !End Dta subroutine
280     !
290     !Enable counter interrrupt
300     !
310     OUTPUT 709;"ENABLE INTR SYS"          !Enable mainframe intr capability
320     OUTPUT 709;"ENABLE INTR USE 190"      !Enable any ch for ctr interrupt
330   Idle:GOTO Idle                          !Loop until interrupt occurs
340     !
350   Results: !                              !Start controller subroutine
360     OUTPUT 709;"TIME"                     !Query time of day
370     ENTER 709;T                           !Enter time of day
380     OUTPUT 709;"CALL Dta"                 !Call Dta subroutine
390     !
400     !Enter channel count
410     !
420     OUTPUT 709;"VREAD A"                  !Trans ch counts to out buffer
430     ENTER 709;B(*)                        !Enter ch counts
440     !
450     !Display interrupt message
460     !
470     FOR I=0 TO 15                         !Start print loop
480       IF B(I)=0 THEN                      !Decision point
490         PRINT "Ch";I+100;"intr @ ";TIME$(T)     !Print intr time/message
500       END IF                              !End decision point
510     NEXT I                                !Increment print loop
520     A=SPOLL(709)                          !Read/clear SRQ bit
530     STOP                                  !End controller subroutine
540     END
```

For example, if the switch connected to channel 108 (S8) is the first switch to be closed three times after the program executes, the counter in channel 108 rolls over to 0 and a counter interrupt occurs. A typical return follows.

```
Ch 108 intr @ 02:02:04
```

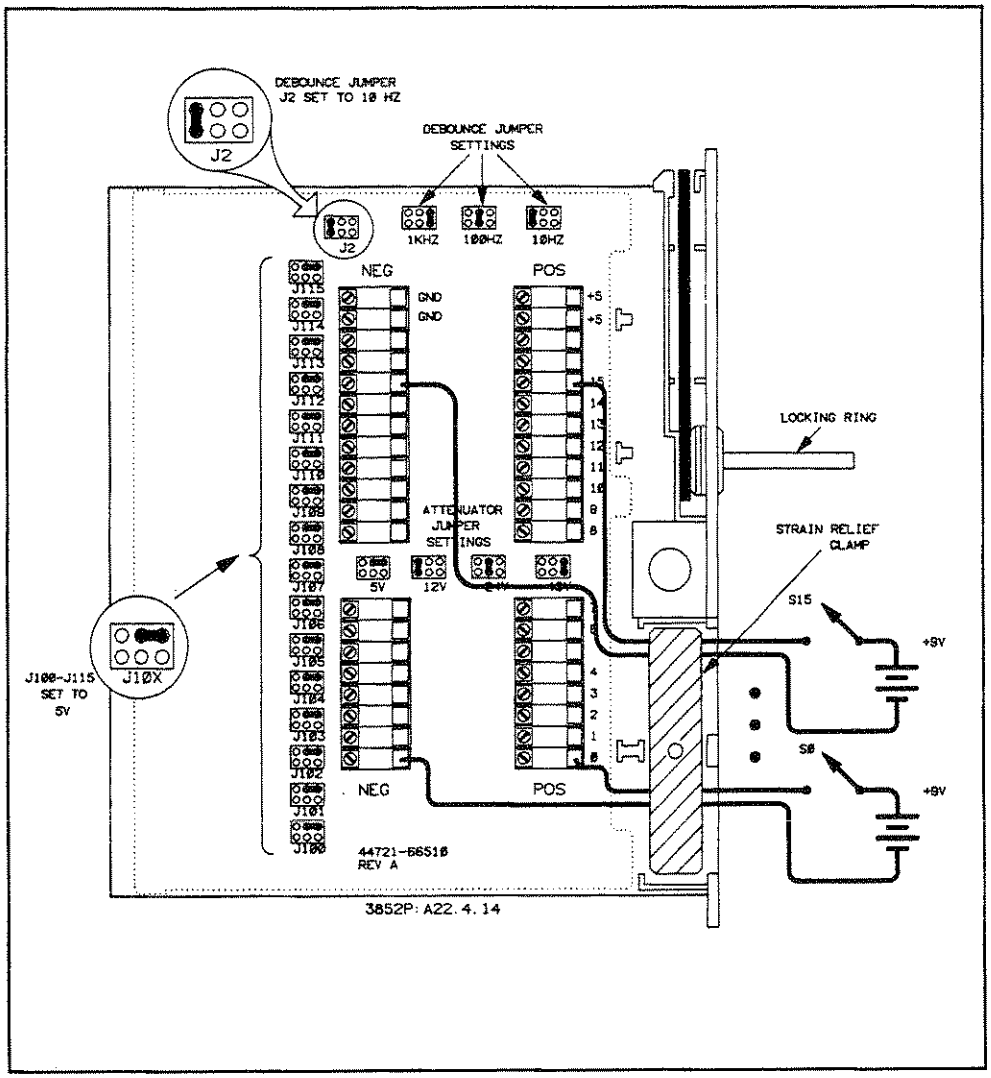


Figure 4-15. Example: Enable Counter Interrupt - Any Channel

Index

Contents

Index

Reorder No. or
Manual Part No.
44721-90002-E1088