HP E1534
Eight-Bit Frequency/Totalize/PWM Signal Conditioning Plug-on

User's Manual

Enclosed is the User's Manual for the HP E1534 Signal Conditioning Plug-on. Insert this manual in your VXI Module's User's Manual behind the "Signal Conditionining Plug-ons" divider.

APPLICABILITY
This SCP is used with the HP E1415.

E1534-90001

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Eight-Channel Frequency/Totalize/PWM Signal Conditioning Plug-on

About this Manual

This manual shows you how to configure the Signal Conditioning Plug-on (SCP) using SCPI commands and explains the capabilities of this SCP. The contents of this manual are:

Introduction

The HP E1534 provides eight TTL compatible channels of digital I/O. Channels can be individually configured to perform any one of the following functions:

- Input;
  - Static digital state
  - Frequency measurement
  - Totalize positive or negative digital transitions
- Output (configurable as active TTL or passive pull-up);
  - Static digital state
  - Single controlled width pulse per module trigger. With continuous algorithm execution, this becomes a pulse train who's frequency is the same as the algorithm execution rate (trigger rate).

- Free-running pulse train with pre-configured frequency and algorithm controlled pulse width. This is Pulse Width Modulation.

- Free-running pulse train with pre-configured pulse width and algorithm controlled frequency. Form 1 of Frequency Modulation.

- Free-running pulse train with 50% duty cycle and algorithm controlled frequency. Form 2 of Frequency Modulation.

Further, the logical sense of input and output channels can be configured as inverted or normal.

Installation

Installation for this Plug-on is common to several others and is covered in Chapter 1 of your VXI Module User's Manual.

Identifying the Plug-on

You'll find the HP part number on the connector side of the SCP to the left of the serial number bar code. For the HP E1534, the part number is : E1534-66501

Field Wiring

Since this Digital I/O SCP is NOT ISOLATED, it is extremely important not to introduce ground current-loops in the digital ground wires. Use of isolators in your system is highly recommended. For specific channel to terminal mapping, see the Terminal Module signal locating labels that are supplied with the HP E1534.

The following table maps SCP channels to Terminal Module terminal names. Also see the Terminal Module labels supplied with your HP E1531.

SCP's Channel	SCP 0 channels	SCP 1 channels	SCP 2 channels	SCP3 channels	SCP 4 channels	SCP 5 channels	SCP 6 channels	SCP 7 channels
0 H & G	0 H & L	8 H & L	16 H & L	24 H & L	32 H & L	40 H & L	48 H & L	56 H & L
1 H & G	1 H & L	9 H & L	17 H & L	25 H & L	33 H & L	41 H & L	49 H & L	57 H & L
2 H & G	2 H & L	10 H & L	18 H & L	26 H & L	34 H & L	42 H & L	50 H & L	58 H & L
3 H & G	3 H & L	11 H & L	19 H & L	27 H & L	35 H & L	43 H & L	51 H & L	59 H & L
4 H & G	4 H & L	12 H & L	20 H & L	28 H & L	36 H & L	44 H & L	52 H & L	60 H & L
5 H & G	5 H & L	13 H & L	21 H & L	29 H & L	37 H & L	45 H & L	53 H & L	61 H & L
6 H & G	6 H & L	14 H & L	22 H & L	30 H & L	38 H & L	46 H & L	54 H & L	62 H & L
7 H & G	7 H & L	15 H & L	23 H & L	31 H & L	39 H & L	47 H & L	55 H & L	63 H & L

Programming With SCPI Commands

The SCPI commands shown here query the SCP's identification string, and configure the eight digital channels. The HP E1415 doesn't provide SCPI commands to read an input channel or control an output channel. See the following section for a digital input/output examples.

Command Syntax	Page Discussed
INPut:POLarity NORM | INV,(@<*ch_list*>)	7
INPut:POLarity? (@<*ch_list*>)	
OUTPut:POLarity NORM | INV,(@<*ch_list*>)	7
OUTPut:POLarity? (@<*channel*>)	
OUTPut:TYPE ACTive | PASSive,(@<*ch_list*>)	7
OUTPut:TYPE? (@<*channel*>)	
SENSe:FREQuency:APERture <*gate_time*>,(@<*ch_list*>)	7
SENSe:FREQuency:APERture? (@<*channel*>)	
[SENSe:]FUNCtion:CONDition (@<*ch_list*>)	6
[SENSe:]FUNCtion:FREQuency (@<*ch_list*>)	7
[SENSe:]FUNCtion:TOTalize (@<*ch_list*>)	6
[SENSe:]TOTalize:RESet:MODE INIT | TRIG,(@<*ch_list*>)	6
[SENSe:]TOTalize:RESet:MODE? (@<*channel*>)	
SOURce:FM[:STATe] ON | OFF,(@<*ch_list*>)	8
SOURce:FM[:STATe]? (@<*channel*>)	
SOURce:FUNCtion[:SHAPe]:CONDition (@<*ch_list*>)	7
SOURce:FUNCtion[:SHAPe]:PULSe (@<*ch_list*>)	8
SOURce:FUNCtion[:SHAPe]:SQUare (@<*ch_list*>)	9
SOURce:PULM[:STATe] <*enable*>,(@<*ch_list*>)	8
SOURce:PULM[:STATe]? (@<*channel*>)	
SOURce:PULSe:PERiod <*period*>,(@<*ch_list*>)	8
SOURce:PULSe:PERiod? (@<*channel*>)	
SOURce:PULSe:WIDTh <*width*>,(@<*ch_list*>)	9
SOURce:PULSe:WIDTh? (@<*channel*>)	
SYStem:CTYPe? (@<*channel*>)	5

Checking the ID of the SCP

To verify the SCP type(s) installed on your VXI module, use the SYSTem:CTYPe? (@<*channel*>) command.

- The *channel* parameter specifies a single channel in the channel range covered by the SCP of interest. The first channel number for each of the eight SCP positions are; 0,8,16,24,32,40,48, and 56.

The value returned for the HP E1534 SCP is:
HEWLETT-PACKARD,E1534A Frequency/Totalize/PWM SCP,0,0

To determine the type of SCP installed on channels 0 through 7 send

```
SYST:CTYPE?  (@100)          query SCP type @ ch 0
enter statement here         enter response string
```

Configuring the Channels

The HP E1534 has eight digital channels. The Power-on and *RST state is all eight channels configured for input of digital states and logical sense is normal (SENS:FUNC:COND, and INP:POL NORM).

Configuring for Input

To configure channels as inputs you send one of the [SENSe:]FUNCtion:... commands. Any digital function from the SCPI SENSe subsystem configures the specified channels as inputs.

Static Digital State

Use [SENSe:]FUNCtion:CONDition (@<*ch_list*>).

To set channels 40 through 43 to input digital states

```
SENS:FUNC:COND  (@140:143)
```

Totalize Positive or Negative Edge State Changes

Use [SENSe:]TOTalize:RESet:MODe INIT | TRIG,(@<*ch_list*>) to configure the totalize channel to reset its count once each trigger event or only when module is INITiate. Use INP:POL INV to sense negative edges.

Use [SENSe:]FUNCtion:TOTalize (@<*ch_list*>) to configure channels to totalize.

To totalize state changes at channel 44 starting from INITiate time

```
SENS:TOT:RES:MOD  INIT,(@144)    ch 44 totalize reset at INIT
SENS:FUNC:TOT  (@144)            ch 44 is totalize input
```

Measure Frequency

The HP E1534 determines frequency by measuring the input signal's period. The gate time is the time allowed for the SCP to repeat this measurement. Up to a point, more measurements means a more accurate frequency value. Of course longer gate time means that the measurement returned contains more latency (is "older" in relation to the signals current frequency). To

track fast changing frequency, you have to trade-off some accuracy with a shorter gate time.

Use [SENSe:]FREQuency:APERture *<gate_time>*,(@*<ch_list>*) to configure the frequency counter channels' gate time.

Use [SENSe:]FUNCtion:FREQuency (@*<ch_list>*) to configure channels as frequency counters.

To measure frequency at channel 45 with gate time or 1 second

```
SENS:FREQ:APER  1,(@145)        ch 45 aperture is 1 sec
SENS:FUNC:FREQ  (@145)          ch 45 is frequency counter
```

Set Input Logic Sense

Use INPut:POLarity NORMal | INVerted,(@*<ch_list>*) to configure digital channels to sense either +=true (NORM) or 0=true (INV)

To configure channels 40 to 43 to sense 0 as true

```
INP:POL  INV,(@140:143)
```

Configuring for Output

To configure channels as outputs you send one of the SOURce:FUNCtion:... commands. Any digital function from the SCPI SOURce subsystem configures the specified channels as outputs.

Controlling Output Drive Characteristics

Use OUTPut:TYPE PASSive | ACTive,(@*<ch_list>*)

To configure channels 44 through 47 to passive pull-up outputs

```
OUTP:TYPE  PASS,(@144:147)
```

To configure channels 44 through 47 to active (source and sink current)

```
OUTP:TYPE  ACT,(@144:147)
```

Controlling Output Polarity

Use OUTPut:POLarity NORMal | INVerted,(@*<ch_list>*)

To set output polarity of channels 40 through 43 to 0 = true

```
OUTP:POL  INV,(@140:143)
```

Static Digital State

Use SOURce:FUNCtion[:SHAPe]:CONDition (@<*ch_list*>)

To configure channels 40 through 43 as static digital outputs

```
SOUR:FUNC:COND (@140:143)
```

Variable Width Pulse Per Trigger

Use SOURce:FUNCtion:PULSe (@<*ch_list*>) to enable pulse generation.

Use SOURce:FM[:STATe] OFF,(@<*ch_list*>) to disable continuous FM pulse trains.

Use SOURce:PULM[:STATe] OFF,(@<*ch_list*>) to disable continuous PWM pulse trains.

To configure channel 44 to output a single controlled width pulse per trigger

```
SOUR:FUNC:PULS (@144)          channel sources pulses...
SOUR:FM OFF,(@144)             but not continuous FM trains
SOUR:PULM OFF,(@144)           and not continuous PWM trains
```

The algorithm can now output a pulse width value to channel 44 each time it executes:

```
O144 = .5E-3   /* channel 44 pulse width will be .5 msec  */
```

Variable Width Continuous Pulse Train (PWM)

Use SOURce:FUNCtion[:SHAPe]:PULSe (@<*ch_list*>) to enable pulse generation.

Use SOURce:PULM[:STATe] ON,(@<*ch_list*>) to disable FM and enable continuous PWM pulse trains.

Use SOURce:PULSe:PERiod <*period*>,(@<*ch_list*>) to set the pulse repetition period (1/frequency).

To configure channel 45 to output variable pulse width continuous train

```
SOUR:FUNC:PULS (@145)          channel sources pulses...
SOUR:PULM ON,(@145)            and continuous PWM train
SOUR:PULS:PER .0005,(@145)     .5 msec period (2KHz freq)
```

The algorithm can now output a pulse width value to channel 45 to control pulse width:

```
O145 = 333E-6   /* channel 45 pulse width will be 333 µsec  */
```

Variable Frequency Fixed Width Continuous Pulse Train (FM)

Use SOURce:FUNCtion:PULSe (@<*ch_list*>) to enable pulse generation.

Use SOURce:FM[:STATe] ON,(@<*ch_list*>) to disable PWM and enable continuous FM pulse trains.

Use SOURce:PULSe:WIDTh <*width*>,(@<*ch_list*>) to pre-set the pulse width.

To configure channel 45 to output variable frequency continuous train with fixed pulse width

```
SOUR:FUNC:PULS  (@145)          channel sources pulses...
SOUR:FM  ON,(@145)              and continuous pulse train
SOUR:PULS:WIDT .001,(@145)      1 msec fixed pulse width
```

The algorithm can now output a frequency value to channel 45:

```
O145 = 250   /* channel 45 will source 250 Hz pulse train  */
```

Variable Frequency Square-Wave Continuous Pulse Train (FM)

Use SOURce:FUNCtion:SQUare (@<*ch_list*>) to enable square-wave generation.

Use SOURce:FM[:STATe] ON,(@<*ch_list*>) to disable PWM and enable continuous FM pulse trains.

To configure channel 45 to output variable frequency continuous train with 50% duty cycle (square wave)

```
SOUR:FUNC:SQUARE  (@145)        channel sources square wave...
SOUR:FM  ON,(@145)              and continuous PWM train
```

The algorithm can now output a frequency value to channel 45:

```
O145 = 2000   /* channel 45 will source 2 KHz square wave  */
```

*RST and *TST (important!)

The electrical model of a HP E1534 input is essentially a 1.2KΩ resistor in series with 3 volts DC. This circuit will look like a high logic level to a another TTL compatible digital input. When *RST or *TST? is executed, HP E1534 channels configured as outputs return to their default settings as inputs. The *RST condition for channel POLarity returns to NORM as well. You should keep this behavior in mind when applying the HP E1415 to your system. It is best to have your system digital inputs use a high input as their quiescent or safe state.

Over-Voltage Protection

The HP E1534 can sense an over-voltage condition on any of its channels. This is to protect the SCP and the module it is installed on from damaging voltage levels applied to its channels. If greater than approximately 5 volts, or less than 0 volts is applied to a channel, the SCP will signal the VXI module to open all of its Calibration/Protection relays. The module will then generate an error message in its error queue (read by SYST:ERR?), and set a status bit in its STAT:QUES:COND register.

Note The over-voltage protect condition can only be reset by issuing the command *RST, or by cycling power to the module.

Specifications

These specifications for the HP E1534 reflect its performance while installed on your VXI module.

General Specifications

Output Characteristics

Characteristic	OUTPut:TYPE ACTive	OUTPut:TYPE PASSive
current source (logic 1)	5 mA	0
current sink (logic 0)	48 mA	48 mA
Voltage (logic 1)	2.5V Min @ 5mA load	NA
Voltage (logic 0)	.5 Max @ 48mA load	.5 Max @ 48mA load

Input Characteristics

Characteristic	
Equivalent circuit	1.2 KΩ connected to 3 Volts
Maximum input low	0.8 Volts
Minimum input high	2 Volts

Maximum voltage applied to any input/output terminal

inputs clamped at +5.5 and -.5V (must limit -current)

For detailed information on I/O characteristics, refer to a data sheet for the 75ALS160 Interface Bus Transceiver

Totalizer

Capacity	24 bits or 16,777,215 counts
Minimum Pulse Width	500 nS
Frequency Range	0 - 100 KHz

Frequency Counter	Gate Time ($t_{aperture}$)	1 msec to 1 second, resolution $\frac{1}{f_{in}}$
	Range	$\frac{1}{t_{aperture}}$ to 100 Khz
	Accuracy	.1%
	Resolution	$\frac{f_{input}}{t_{aperture} \times 4.194\ MHz}$
	Minimum Pulse Width	500 nS
Frequency Source	Range	64 Hz to 40 KHz Square Wave 128 Hz to 40 KHz Other Shapes
	Accuracy	.1 %
	Resolution	$\frac{f^2_{out}}{4.194\ MHz}$
Pulse Source	Range	7.87 µsec to 1/f -7.87µsec Sqaure Wave 7.87 µsec to 7.812 msec Pulse per Trig
	Accuracy	.1 %
	Resolution	238.4 nsec