

# HR HALL RESEARCH



## HR-4P Programmable Controller

UMA1164 Rev. NC

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This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of the Canadian Department of Communications.



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# 1. Introduction

## 1.1 General

The Model HR-4P is a programmable RS-232 device designed for control & automation of a Projector, LCD, or any other device with serial port and a compatible digital interface.

The unit has 4 configurable I/O lines that can sense dry contact closures or Voltage levels. It can detect "Low to High" or "High to Low" transitions as well as "High" or "Low" on Power-Up. The RTS (Output) and CTS (Input) lines in the RS232 DB9 connector can also be used to control an output or sense an input.

Each Input line state (high or low) can be configured to send RS232 commands at any baud rate; control Digital Outputs or to optionally send IR Remote Control Codes.

Hall Research provides a powerful Windows® based application (available on-line at <http://www.hallresearch.com> or on CD upon request) that is used to easily create complex control sequences that describe the desired actions and to then upload them into the HR-4P, via a user supplied Null Modem RS232 cable. The information is stored in non-volatile E2Prom which retains the information even if the power is lost. As your future needs change, the information can then be extracted from the HR-4P and modified as needed or copied into other HR-4P units.

The HR-4P has the ability to store up to 10 different command strings and can learn up to 32 different IR remote control codes for later playback.

## 1.2 Features

- ✓ Compact, Reliable, and Economical
- ✓ 10 user-programmable Command Strings
- ✓ 32 user-programmable IR Memory
- ✓ User configuration for up to 4 Inputs, 4 Outputs or any combination
- ✓ Optional IR Remote Control Learn and Playback
- ✓ Front panel LED Power indicator
- ✓ Windows™ GUI Software
- ✓ Made in USA

### 1.3 Block Diagram

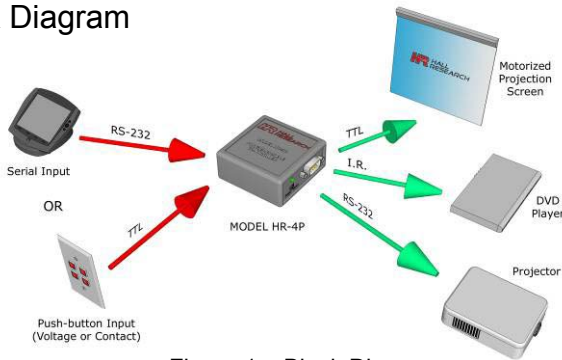


Figure 1 – Block Diagram



Figure 2 – Top Rear



Figure 3 – Top Front

## 2. Package Contents

One each of the following items:

- (1) 5 vDC , 2.6 ADC universal power supply (110 – 220 vAC 50/60 hZ) with power cord
- (1) Users Manual
- (1) HR-4P Controller

### NOTE

- The user needs to supply the appropriate RS232 cable (normally NULL MODEM) to connect the HR-4P to a PC in order to program the HR-4P.
- The user needs to supply the appropriate RS232 cable (could be straight or NULL MODEM) to connect the HR-4P to the Serial Device it will be controlling.

### 3. Getting Started

The HR-4P is a configurable Input/Output Controller device that for most installations is configured to detect either a dry contact closure or a DC voltage and then send a pre-programmed serial string to some device, typically a projector.

The unit comes from the factory setup with all 4 I/O lines configured for dry contact closures and no pre-programmed actions.

**You should be prepared with the necessary information and equipment to test your installation prior to being put into service.**

- If the HR-4P will be used to control a serial device, the required control codes for that device should be obtained. *For example, the code to turn on and off the Projector.*
- If the HR-4P will be used to interface to other electrical equipment such as contacts, compatible power sources or outputs, the supporting electrical information will be required. *For example, an electrical schematic or drawing that shows how the HR-4P to the other electrical equipment such as switches or relays.*
- A Windows™ compatible PC is required to program the HR-4P unit. Once programmed, the PC is no longer required except when testing and troubleshooting installations.
- Test the programmed units to ensure functionality before the final installation.

Select the desired interface for each of the I/O lines that will be used to control the HR-4P unit. These are set on the I/O Tab of the GUI and then uploaded into the HR-4P unit.

- Switches or Relay Contact Interface – Select the 'INPUT - CONTACT' type
- External DC Power Sources – Select the 'INPUT – VOLTAGE' type (9-28 vDC)
- Relay Coils – Select the 'OUTPUT' type (each output can provide 40 mADC of current)

**See examples of connection wiring at the end of this manual.**

The HR-4P unit must be programmed before being put into service to control something. The programming is accomplished using GUI software installed on the users PC. Follow the instructions below for installing the software GUI.

### 3.1 GUI Installation Overview

The HR-4P Programmer is a Windows Software GUI used to:

- Configure the input and output lines
- Upload and download configuration strings
- Learn or Enter Infra-Red Remote Control codes
- Create, Edit and Save unit configuration information

### 3.2 Installation Prerequisites

A compatible PC with Windows XP™ or later operating system is required.

- Microsoft™ .NET Framework 2.0 or later is required prior to installing the GUI.
- Most new PCs come with Microsoft™ .NET Framework 2.0 or later already installed.
- If .NET Framework 2.0 or later is not installed on your PC, it can be found on the Microsoft™ website.

### 3.3 Software GUI Installation

- If the software has been previously installed, you must UNINSTALL the program from the Add/Remove Programs selection of the control panel.
- The software is installed by running the SETUP.EXE program on the installation source.
- The typical user should be able accept all the default settings.



Once the HR-4P Programmer Software installation has completed, a desktop icon will appear as well as on the start menu under:

**Start->Programs->Hall Research->HR-4P Programmer**



### 3.4 Using the Software

- Double click the desktop icon or its program menu selection and the main screen will be displayed as shown below in Figure 4.

*Note: Certain items are disabled if the GUI is NOT in communication with the HR-4P unit.*



**Figure 4 – Main Screen**

### 3.5 Button Selection

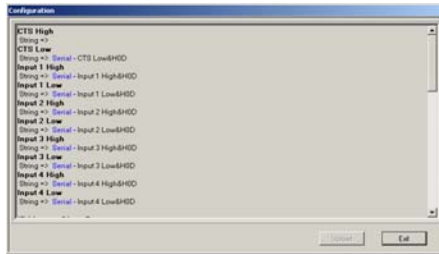
- The main screen has four buttons on the left side (titled **UPLOAD**, **DOWNLOAD**, **SHOW CONFIG** and **CONNECT**) and two buttons near the bottom right corner of the Main screen as shown in Figure 1, which allows users to quickly access the most commonly used functions.

### 3.6 Connect/Disconnect

- In order for the software to communicate with the HR-4P unit, it must be connected to serial port on the computer.
  - Click the **Communications** tab to verify or change the COM port selection. This setting will be remembered for future use.
  - To open a serial connection to the unit, click the Connect button on the left side of the screen to attempt a connection to the HR-4P. The button will automatically change and say Disconnect. There are also Connect and Disconnect buttons on the Communications tab that perform the same functions.
    - If a connection was established between the software and the unit, the GUI main screen will activate any previously disabled features. Note that the bottom lower left of the screen will always show the current connection status. This status bar will change color when the status changes to draw the user's attention.
  - To close the serial connection, click the Disconnect button on the left side of the screen, or click the Disconnect button in the Communications tab.

### 3.7 Show Config

- Click the **Show Config** button to display the current configuration present in the GUI. Figure 5 below shows an example of a unit's configuration. All INPUT Strings and IR Codes are available
- Configuration settings can be saved and loaded from disk by using the "FILE" menu at the top of the main screen.
- Configuration settings can be uploaded into the HR-4P unit by clicking the **Upload** button displayed on the left of the main screen.
- Configuration settings can be downloaded in the GUI by clicking the **Download** button displayed on the left of the main screen.



**Figure 5 – Sample Configuration Display**

### 3.8 Download

- Click the **Download** button on the left of the Main screen to retrieve the current configuration strings stored in a HR-4P unit and into the GUI software.
- As the configuration screens are downloaded, the GUI interface will update with the retrieved settings.
- If the configuration string for a specific condition needs to be viewed or modified, you can click the **Download Single** button to the right of the configuration text box as shown.



### Note

Downloading or uploading user configuration strings is **ONLY** allowed when the HR-4P unit is in the program mode (The power led is blinking).

### 3.9 Upload

- Click the **Upload** button on the left of the Main screen to store the current configuration strings in a HR-4P unit from the GUI software. All information stored in the HR-4P will be overwritten.
- If the configuration string for a specific condition needs to be uploaded, you can click the **Upload Single** button to the right of the configuration text box as shown.



### 3.10 Main Screen Tabs

- The HR-4P Programmer consists of four different pages in a tabular format. Each Tab has a specific function suited to a particular task.

#### *Configuration*

- The **Configuration** tab page as seen in Figure 6 is the default tab shown at software startup.
  - This tab allows the user to build configuration strings.
  - A configuration string can be created to perform one or more specific actions based on a particular condition.
  - A configuration string can be up to 250 bytes long, and it can be any combination of serial, time delays, IR codes, outputs, and pulses actions. Each type of command; Serial, Time Delay, IR, Output and Pulse each use a few bytes for identifying the desired action. For example, a Serial Commands uses XX+2 bytes where XX is the number of bytes the user defines. So... “Hello” uses 4 bytes + 2 bytes for the serial command.
- **Condition** – consists of 5 different real-world discrete inputs
  - CTS, Input 1, Input 2, Input 3, and Input 4.
  - Their state can be high or low.
- **Action**
  - **Serial** is used to send specific serial characters to a device
  - **IR** is used to send an IR code to an IR receiver
  - **Delay** is used to add a time delay
  - **Output** is used to toggle a specific output on and off
  - **Pulse** is used to send timed on/off/on or off/on/off to a output



Figure 6 – Configuration Tab

### 3.11 Serial Commands

- A serial command can send data to any standard serial device with selectable baud rate and parity. When sending serial commands, you can also specify a delay between characters to meet varying requirements.
- Serial commands can be mixed with other actions for the same input. For example, you may have a projector configuration string like “PWR\_ON” followed by a **DELAY** followed by an **OUTPUT**. There is no limit to the number of actions that can be added as long as the 250 character limit is observed.
- Hexadecimal characters may be entered by using **&H** in front of the 2 digit Hexadecimal character.
- Select the desired **Condition** and change **Action** to **Serial**. Commands are entered in the **Command** text box. When done, the user clicks the **Add** button to append the command to the existing user string as shown in Figure 7.

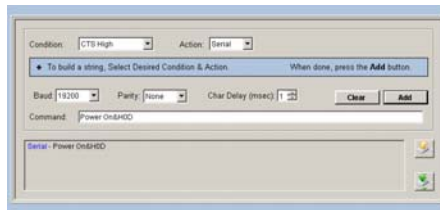
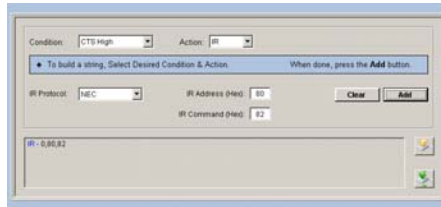


Figure 7 – Serial Commands

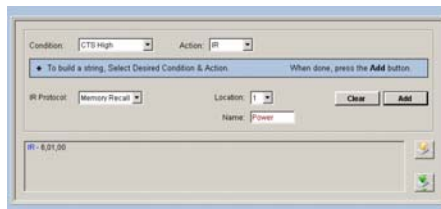
### 3.12 IR Codes

- IR code's can be part of the configuration string. Supported IR formats are available for sending known IR Addresses and Commands. Ensure that the IR Protocol, Address and Commands have been tested to ensure proper response from the controlled devices. A compatible IR Emitter is required to send IR Codes.
- Select the desired **Condition** and change **Action** to **IR**. When done, the user clicks the **Add** button to append the command to the existing user string as shown in Figure 8.



**Figure 8 – IR Codes**

- Up to 32 IR Codes that have been ‘learned’ can be transmitted from the unit. A compatible IR detector is required to LEARN IR Codes. A compatible IR Emitter is required to send IR Codes.
- Select the desired **Condition**, change **Action** to **IR**, change **IR Protocol** to **Memory Recall** and select the desired **location** that the IR code was saved into.
- When done, the user clicks the **Add** button to append the command to the existing user string as shown in Figure 9.



**Figure 9 – IR Memory Recall**

### 3.13 Time Delay

- Time delay's can be added to configuration strings as needed. Delay's can from milliseconds to 255 minutes. Multiple delays can be entered if longer times are required. Each of the minutes, seconds and milliseconds fields is limited to 0 to 255.
- When done, the user clicks the **Add** button to append the command to the existing user string to the existing user string as shown in Figure 10.

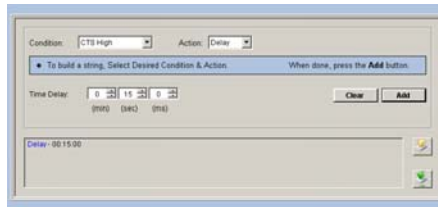


Figure 10 – Time Delay

### 3.14 Output

- If any of the units I/O is configured as an output, you can control that output based on a specific input condition.
- Select the **Output** from the **Action** drop-down menu and pick a desired output **channel** state, either ON or OFF.
- When done, the user clicks the **Add** button to append the command to the existing user string as shown in Figure 11.

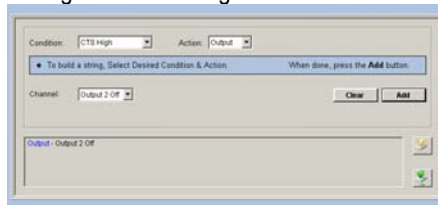
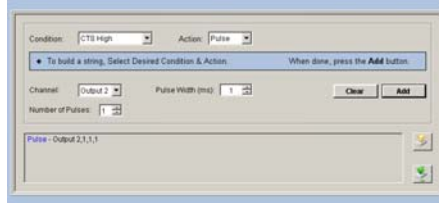


Figure 11 – Output



### 3.15 Pulse

- If any of the units I/O is configured as an output, you can pulse that output one or more times based on a specific input condition. The Pulse Width and Delay between Pulses is selectable in milliseconds. The delay is only required when more than one pulse is being sent.
- Select the **Pulse** from the **Action** drop-down menu and pick a desired output **channel**, the **Number of Pulses** and the **Pulse Width**.
- When done, the user clicks the **Add** button to append the command to the existing user string as shown in Figure 12.

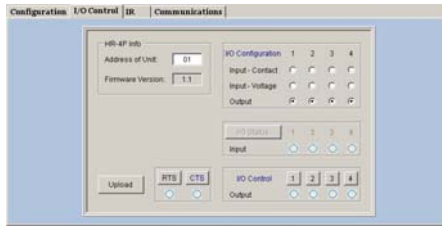


**Figure 12 – Pulse**

### 3.16 I/O Control

- The **I/O Control** tab as shown in figure 13 allows the user to configure any or all four discrete I/O as inputs or outputs.
  - An input can be as **Input-Contact**, which is for normal ‘dry-contact’ type devices or **Input-Voltage** which can be a DC voltage from 9-28 vDC.
  - Any I/O configured as inputs may have the current status read by clicking the **I/O Status** button.
  - Any I/O configured as outputs may have the output state set by selecting the appropriate control button.
- 
  

- RTS is an OUTPUT, CTS is an INPUT. Action based configuration strings can be created for the CTS Input only.
  - The HR-4P unit can be assigned a unique address value from 01 to 99. This is used as part of the “Long Command Format” mode when serially communicating with the unit. Only the HR-4P unit with that unique address will respond to RS232 commands. **All HR-4P unit addresses receiving the serial information must be unique otherwise incorrect operation will occur!**
  - All HR-4P units will respond to address 00. If multiple devices are connected together serially, all devices will respond resulting in garbled RS232 transmissions.
    - Long serial command format: **HRTxxADR?** where xx = 00 to 99
    - Short serial command format: **ADR?**
  - After using the **Connect** button and establishing communication with a HR-4P unit, this tab will show the units **Firmware Version** Number as well as its programmed **Address**.

- The **Upload** button is used to store this information in the HR-4P unit.



**Figure 13 – I/O Control**

### 3.17 IR

- The **IR** tab is used to configure the IR capabilities of the HR-4P unit. A compatible IR Detector and Emitter are required to fully utilize the IR features.
- When the IR is configured as an **Input**, the HR-4P unit can learn any supported IR codes from the user's remote control. These IR codes can be stored into 1 of 32 IR Memory locations in the unit.
- IR codes stored in memory can an 8 character name associated with it, making it easier to be identified later.
  - Check the **IR Enabled** box
  - To LEARN IR Codes
    - Select the **Input** radio button and click **Upload**
    - Install IR Detector on HR-4P Unit
    - Click the **LEARN** button
    - Press IR Remote Control button while pointing at IR Detector
    - Store code learned into IR Memory Location with name if desired
  - To SEND IR Codes
    - Select the Output radio button and click Upload
    - Install IR Emitter
    - Recall IR memory location
    - Click the SEND button to play the remote code from the HR-4P unit

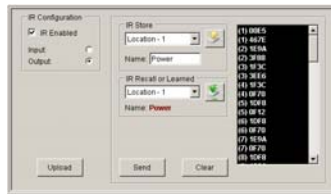


## Note

Storing and Recalling IR codes from memory locations are **ONLY** allowed when the HR-4P unit is in the program mode. (The LED is BLINKING)



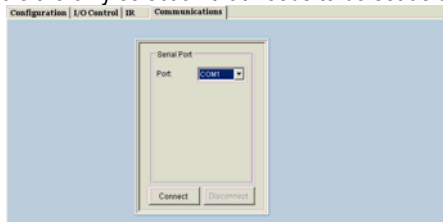
**Figure 14 – IR Learn**



**Figure 15 – IR Send**

### 3.18 Communications

- The **Communications** tab page can be used to select a COM port of your PC to talk to the HR-4P unit. Once, the preferred COM port is selected, pressing the **Connect** button either in this tab page or on the left of the Main screen to make a serial connection.
- Since the HR-4P's serial port communicates at a fix baud rate of 19200, no parity, 1 stop bit, and 8 data bits, those drop-down selections will be disabled. The COM port is the only selection that needs to be set as shown in Figure 16.



**Figure 16 – Communications**

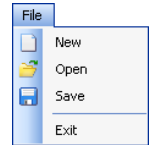
### 3.19 Menu System

The HR-4P Programmer consists of three menus which allow you to easily perform more specific tasks.

### 3.20 File

The **File** menu consists of the following menu items as shown in Figure 17.

- **New** – Erase all the user configuration strings and IR codes and start with a blank configuration.
- **Open** – Open a previously saved configuration file.
- **Save** – Saves a configuration file with the user specified filename.
- **Exit** – Exit the HR-4P Programmer Software.
- **Exit** – Exit the HR-4P Programmer.



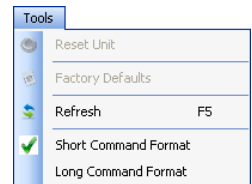
**Figure 17 – File Menu**

### 3.21 Tools

The **Tools** menu consists of the following menu items as shown in Figure 18.

*Note that certain items are disabled (grayed out) if the GUI is NOT in communication with the HR-4P unit.*

- **Reset Unit** – Reset your HR-4P unit after a new I/O configuration or IR configuration.
- **Factory Defaults** – Clears all information stored in HR-4P unit and resets it to the factory shipped configuration.
- **Refresh** – Refreshes the tab page.
- **Short Command Format** – Set unit to short command format.
- **Long Command Format** – Set unit to long command format.

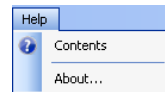


**Figure 18 – File Menu**

### 3.22 Help

The **Help** menu consists of the following menu items as shown in Figure 19.

- **Contents** – Display the help file contents. A previously installed PDF reader is required in order to view the document.
- **About...** – Display the Version and Support information for the GUI software.



**Figure 19 – Help Menu**

### 3.23 RS232 Command Summary

The HR-4P uses a simple command protocol that can be used by other software in order to control and/or configure the unit.

- The unit uses a baud rate of 19200, 8 Data bits, 1 Stop bit and No Parity for all communications and from the device when it is **RUN MODE** (Power Led is NOT blinking)
- The HR-4P supports both a short and long command format style.
  - Long command format have the sequence **HRTxx** before the actual command.
    - The **xx** is a numeric value from 00 to 99 which sets the units address
    - All HR-4P units will listen to address 00 (for example **HRT00VER?**)
    - Only units with the correct address that matches the **xx** address value will respond or execute the commands received.
  - Short command format uses only the command portion listed in the table
  - `<cr><lf>` in the table below denote the CARRIAGE RETURN (0x0D) and LINEFEED (0x0A) Characters
  - Each command is terminated by a single CARRIAGE RETURN `<cr>`

Command	Function	Response
VER? <code>&lt;cr&gt;</code>	Read Firmware version	Version x.y <code>&lt;cr&gt;&lt;lf&gt;</code> where X.Y is the firmware version
ADR? <code>&lt;cr&gt;</code>	Read Address of Unit	Device address = nn <code>&lt;cr&gt;&lt;lf&gt;</code>
ADnn <code>&lt;cr&gt;</code>	Set an address of the unit to nn <input type="checkbox"/> nn = 00 to 99	Set device address (01-99)nn <code>&lt;cr&gt;&lt;lf&gt;</code>
CLnm <code>&lt;cr&gt;</code>	Configure I/O line n to m <input type="checkbox"/> n = 1 to 4 <input type="checkbox"/> m = 1 : 2 : 3 : ? = contact input : voltage input : output : status	Nothing except Status Reads return: CLX1 = I/O line X configured as contact type input <code>&lt;cr&gt;&lt;lf&gt;</code> CLX2 = I/O line X configured as voltage type input <code>&lt;cr&gt;&lt;lf&gt;</code> CLX3 = I/O line X configured as output <code>&lt;cr&gt;&lt;lf&gt;</code>
IOnm <code>&lt;cr&gt;</code>	Set or Read State of I/O line n to m <input type="checkbox"/> n = 1 to 4 = output <input type="checkbox"/> m = 0 : 1 : ? = low : high : status	Input X = 1 or 0 <code>&lt;cr&gt;&lt;lf&gt;</code> Output X = 1 or 0 <code>&lt;cr&gt;&lt;lf&gt;</code>
TOGn <code>&lt;cr&gt;</code>	Toggle the state of I/O line n <input type="checkbox"/> n = 1 to 4	Input X = 1 or 0 <code>&lt;cr&gt;&lt;lf&gt;</code> Output X = 1 or 0 <code>&lt;cr&gt;&lt;lf&gt;</code>
IRCN <code>&lt;cr&gt;</code>	Set or inquire IR <input type="checkbox"/> n = 0 : 1 : ? = input : output : status	IRC0 = IR configured as Rxd <code>&lt;cr&gt;&lt;lf&gt;</code> IRC1 = IR configured as Txd <code>&lt;cr&gt;&lt;lf&gt;</code>
IRSn,m <code>&lt;cr&gt;</code>	Send IR code stored in 1 of 32 IR memory locations <input type="checkbox"/> n = 6 (Learned IR) <input type="checkbox"/> m = 1 – 32 (Memory Location)	Nothing

## Model HR-4P

Command	Function	Response
IRSn,m,k<cr>	Send IR code with a specified IR protocol, IR address, and IR command <input type="checkbox"/> n = 0 - 5 (NEC, JVC, Sharp, RCA, RC5, and Sony-sirc) <input type="checkbox"/> m = 0 - 255 = IR address in DECIMAL <input type="checkbox"/> k = 0 - 255 = IR command in DECIMAL	Nothing
IRPn<cr>	Set or Read Current IR protocol State <input type="checkbox"/> n = 0 - 5 (NEC, JVC, Sharp, RCA, RC5, and Sony-sirc) <input type="checkbox"/> n = ? = status	IRP0 = Current IR protocol = NEC<cr><lf> IRP1 = Current IR protocol = JVC<cr><lf> IRP2 = ... and so on
RTSn<cr>	Set or Read State of RTS line <input type="checkbox"/> n = 0 : 1 : T : ? = low : high : toggle : status	Nothing except Status Reads return: RTS? = RTS0<cr><lf> or RTS1<cr><lf>
CTSn<cr>	Read State of CTS line <input type="checkbox"/> n = ? = status	CTS? = CTS0<cr><lf> or CTS1<cr><lf>
FDFT<cr>	Factory default	Are you sure (Y,N)? User must send CAPITOL "Y" before 8 Second Timeout
RST<cr>	Unit Reset/Restart	
CMDn<cr>	Set serial command format <input type="checkbox"/> n = S : L : ? = short : long : status	<ACK> Character CMD? Returns: Short command format or Long command format
MODE<cr>	Return current mode status <input type="checkbox"/> 00 = Run mode <input type="checkbox"/> 01 = Program mode	00 or 01<cr><lf>
RE<cr> or re<cr>	Reserved – Active only in PROGRAM MODE	Factory use only
WE<cr> or we<cr>	Reserved – Active only in PROGRAM MODE	Factory use only
RDIO<cr>	Reserved – Active only in PROGRAM MODE	Factory use Only
RDIN<cr>	Reserved – Active only in PROGRAM MODE	Factory use Only

## 4. Final Installation

### 4.1 Connections

- Connect the following items to the **programmed** HR-4P unit:
- External wiring to Terminal Board
- RS232 cable to serial device to be controlled
- Ensure switch in RUN position.
- Power Supply

## 5. Troubleshooting

There are no field serviceable parts or circuits inside the device. If you think that the device is malfunctioning (or you have no picture output), please confirm that the unit contains the proper user programmed information and that the switch is in the RUN position.

If you are having trouble configuring or communicating with the HR-4P unit, check:

<b>UNIT SEEMS DEAD</b>	
Check that the unit is powered with the supplied power supply and operating normally.	With SWITCH in RUN Position the LED should be on SOLID With SWITCH in PRG Position the LED should be BLINKING
<b>GUI WONT RUN</b>	
Verify that program installs without errors and the OS is fully patched and up to date	
Verify that the .NET Framework 2.0 minimum has been installed	
<b>COMMUNICATIONS PROBLEMS WITH GUI</b>	
Set switch to PRG position when using the GUI	The LED should be BLINKING
Ensure RS232 cable used is compatible with the PC being used	This is normally a NULL-MODEM cable with pins 2 & 3 crossed. Only Pins 2, 3 and 5 are used for serial communication
Ensure PC COM port is set correctly on the <b>COMMUNICATIONS TAB</b>	
Ensure that the GUI Command Format matches the actual units setting	Check GUI Setting on TOOLS Menu. Factory Default is LONG COMMAND FORMAT
<b>UNIT DOESN'T CONTROL SERIAL DEVICE</b>	
Verify unit and Serial Device have proper serial interconnect cabling	Straight Cable or Null-Modem
Verify via PC and HyperTerminal that unit outputs proper characters at proper baud rate when the appropriate event occurs.	
Verify serial device can be controlled via HyperTerminal or similar program	
Set switch to RUN position when unit is put into service	The LED should be on solid

## 5.1 Contacting Hall Research

If you determine that your HR-4P is malfunctioning, do not attempt to repair the unit. Contact the Hall Research Technical Support department at 714-641-6607.

Before you do, make a record of the history of the problem. We will be able to provide more efficient and accurate assistance if you have a complete description.

## 5.2 Shipping and Packaging

If you need to transport or ship your unit:

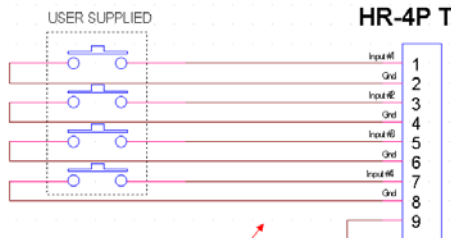
- Package it carefully. We recommend that you use the original container.
- Before you ship the units back to Hall Research for repair or return, contact us to get a Return Authorization (RMA) number.

# 6. Specifications

## 6.1 General

Power Supply	5V/2.6A DC (CE/FCC/UL certified) 2.1mm
Dimensions	2.607 inch (W) x 2.647 inch (D) x 1.10 inch (H) (66.22mm) x (67.22mm) x (28mm)
Weight	1 Lb (0.453kg)
Chassis	Black Plastic ABS-94VO UL File#56070
Operating Temp	32 to 122 DegF (0 to 50 DegC)

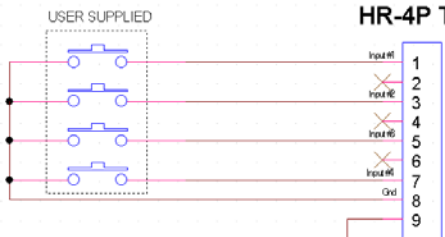
### HR-4P TB



**EITHER CONNECTION METHOD ACCEPTABLE**

+5 vDC  
160 mADC Maximum

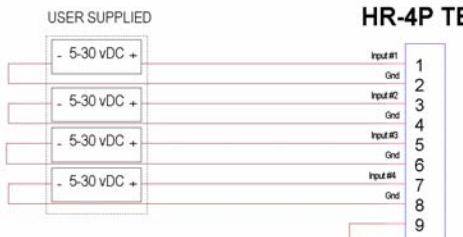
### HR-4P TB



**CONTACT INPUT EXAMPLE**

+5 vDC  
160 mADC Maximum

### HR-4P TB



**VOLTAGE INPUT EXAMPLE**

+5 vDC  
160 mADC Maximum

### HR-4P TB



+5 vDC  
**OUTPUT EXAMPLE** 160 mADC Maximum



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CUSTOMER  
SUPPORT  
INFORMATION

Order toll-free in the U.S. 800-959-6439  
FREE technical support, Call **714-641-6607** or fax **714-641-6698**  
Mail order: **Hall Research**, 1163 Warner Ave. Tustin, CA 92780  
Web site: [www.hallresearch.com](http://www.hallresearch.com) E-mail: [info@hallresearch.com](mailto:info@hallresearch.com)