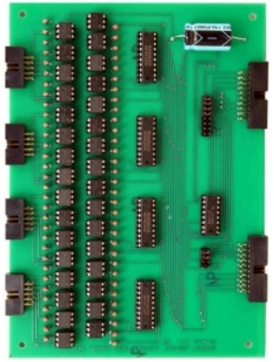
ST-32
DIGITAL INPUT EXPANSION CARD

(for use with the AR-8X, ADC-4, ADC-8, ADC-16, STA-8 & STA-16)



TECHNICAL REFERENCE

Click to see photo: www.eeci.com/st-32p.htm

PHONE..... (937) 349-6000
ORDERS..... (800) 842-7714
TECH SUPPORT... (937) 349-6000
E-mail..... sales@eeci.com

www.eeci.com
Click for Website

TABLE OF CONTENTS

SPECIFICATIONS

Power Supply.....	5 volts DC (powered through the ribbon cable from the ADC-16 or STA-16)
Status Inputs.....	32
Expansion Capability.....	up to 144 status inputs with the STA-16 (with (4) ST-32 expansion cards) up to 128 status inputs with the ADC-4(8)(16) (with (4) ST-32 expansion cards) up to 128 status inputs with the AR-8X (with (4) ST-32 expansion cards)
Weight.....	4 ounces
Size.....	7 inches by 5 inches
Options Available.....	AC opto isolators and opto isolator limiting resistors of various values

TECHNICAL SUPPORT

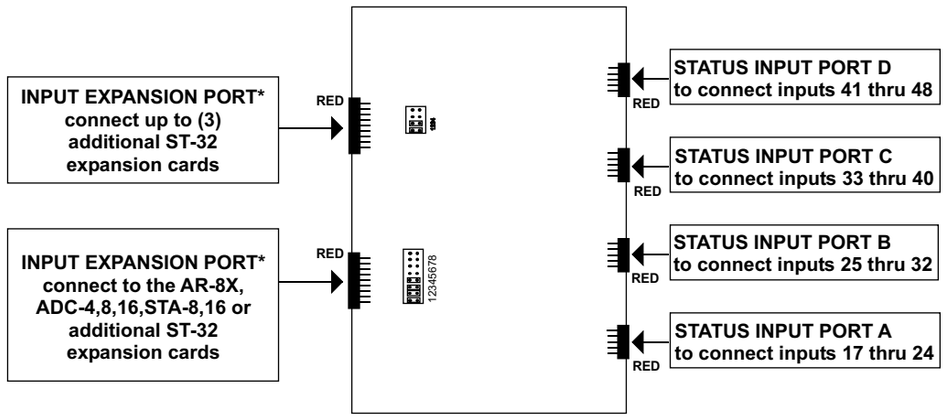
Technical support for our products is available by calling (937) 349-6000. If a technical adviser is not available, please leave your name, phone number and a time that you can be reached. Your call will be returned as soon as possible and within 24 hours. Before contacting technical support be sure that you have your PC and interface hardware powered up with a telephone at hand. The interfacing hardware (ADC-16, ST-32, etc.) should not be inside an enclosure and should be immediately accessible. A multimeter should be available for checking voltage levels.

WARRANTY AND CARE OF THE ST-32

The ST-32 Status Input Interface is warranted against factory defects for a period of 90 days from the date of purchase. The ST-32 has proven to be extremely reliable in actual operation during field tests. We recommend that the ST-32 and associated hardware be installed in a suitable enclosure (4 mounting holes are provided on the circuit board) and that reasonable precautions be taken to protect the circuit from static discharge. The most likely damage to occur is that caused by lightning discharge through the power supply or serial I/O lines. The best way to prevent this type of damage is to install a Power Protector (Part # SP-120 or Radio Shack #26-1395 or Surgebuster #120K15A) in the electrical outlet which supplies power to the hardware. Shielding the status input lines will provide additional protection. If further protection is desired, install a TransZorb across the power input to the interface card (part #SP-12K) and to the RS-232 lines (part #SP-232K).

CONNECTION DIAGRAM

ST-32 STATUS INPUT EXPANSION CARD



NOTE: The shunt settings shown above are set for inputs 17 thru 48 (ports 3 thru 6). Inputs 1 thru 16 are used for the STA-16 (ports 1 and 2). Connect all ribbon cables with the notch on the ribbon cable connecter pointing up. The red conductor should be positioned as shown above.

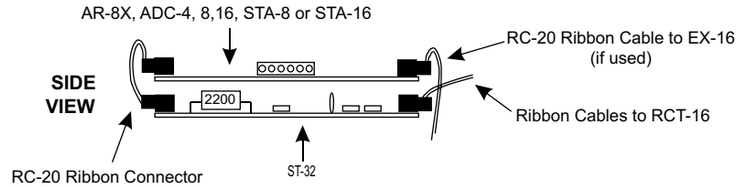
*All contacts on both input expansion ports are pin equivalent and may be connected to either the ADC-16, STA-16 or additional ST-32 cards.

CONNECTING THE ST-32

The ST-32 should be installed directly below the STA-16 or ADC-16 with it's 20 position input expansion port directly below the 20 position input port on the AR-8X, STA-8,16 or ADC-4,8,16 (both 20 position ports on the ST-32 are pin for pin equivalent and may be used for connection to the AR-8X, ADC-16, STA-16 or for connection to other ST-32 cards). The RC-20 ribbon cable should be connected as shown on the following page. Up to four ST-32 cards may be connected to the AR-8X, ADC-4,8,16 or STA-8,16 to provide up to 144 status inputs. Each additional ST-32 card should connect to the preceding ST-32 card using a 3" RC-20 ribbon cable and be located directly below the preceding ST-32 card. If EX-16 relay expansion cards are also connected to the ADC-16 or STA-16, the first EX-16 card should be located directly below all ST-32 cards and connected to the AR-8X, ADC-16 or STA-16 using an extended length RC-20 cable (allow an extra inch for each ST-32 card). The RC-20 should be kept as short as possible (to minimize possible noise induction) and should never be longer than 6 inches in length.

PLEASE NOTE: Your hardware has been carefully tested for proper operation just prior to shipment. If you follow the instructions listed on the following page and are using a cable and power supply that we provided, you should have little difficulty utilizing the ST-32. Please test and familiarize yourself with the ST-32 before installing the ST-32 inside your equipment or enclosure. This will prevent problems or confusion later on should trouble-shooting be required.

CABLE CONNECTIONS



SET-UP AND TESTING

Upon receiving your ST-32, you should connect and test the operation of the hardware to verify proper operation. Please set-up and test the ST-32 as follows (IBM and Compatibles):

(1) Plug the serial cable into COM 1 of your computer and connect the other end to the terminal block on the AR-8X, STA-8,16 or ADC-4,8,16 (as shown in it's technical reference). Care should be taken to prevent any static discharge on the ST-32 by touching a metal ground before handling the ST-32 and associated circuits. Use caution not to set the ST-32 or associated hardware on a metal surface or damage could result. Connect the ST-32 to the STA-16 or ADC-16 using the RC-20 ribbon cable as described on the preceding page. Power to the ST-32 will be supplied through the RC-20 ribbon cable.

(2) Connect the power supply (part # PS-GP-1) to the AR-8X, STA-16 or ADC-16. Be sure to observe the (+) and (-) connections (reversed polarity may cause damage). Connect two RCT-16 terminal blocks to ports #3, #4, #5 and #6 on the ST-32. When connecting the ribbon cable from the RCT-16 to the ST-32, the notch on the ribbon cable connector should point up. The ribbon cables for the RCT-16 should be folded over and routed underneath the ST-32 so that the RCT-16 is on the left side of the ST-32. If your ST-32 was not shipped with the opto isolators installed, the opto isolators should be installed before testing (the inputs will not function without the opto isolators).

(3) The AR-8X, STA-16 or ADC-16 is set to 9,600 baud at the factory. This is the proper setting for use with the test software which is provided on CD with your order. Use the test software provided for the AR-8X, ADC-4/8/16 or STA-8/16 for testing. Your screen should show two rows of sixteen numbers. The top rows of eight numbers represent the status inputs for ports #3 and #5 and the two lower rows of eight numbers represent the status inputs for ports #4 and #6.

(4) Test the inputs by applying 9 to 15 volts DC to each input (one at a time). Connect negative to the proper common terminal on the RCT-16 (pin #9 for inputs 1 thru 4 and pin #10 for inputs 5 thru 8 as shown on page 5). The PS-GP-1 power supply which is used to power the AR-8X, STA-16 or ADC-16 may be used to apply power to the inputs during testing. When positive is connected to the input (input on/voltage applied) the screen should display a "1" for that channel and a "0" should be displayed with no voltage applied to the input (input off).

(5)If operation of the inputs is normal, than testing is now complete and the ST-32 may be placed in service.

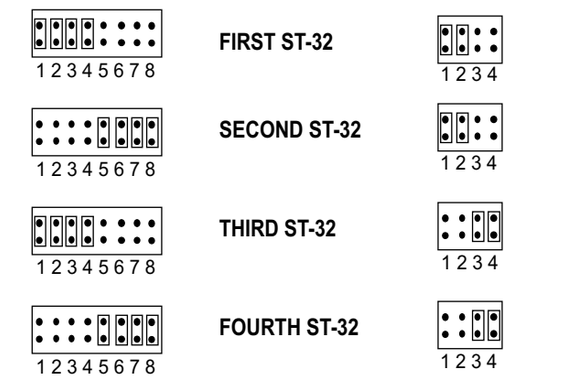
TROUBLE-SHOOTING THE ST-32

(1) Verify that the AR-8X, STA-16 or ADC-16 is set to the same baud rate as what appears on the test software screen. Test the AR-8X, the STA-16 or ADC-16 first and verify that this card is functioning properly. If the preceding card is not functioning properly, proceed to the troubleshooting section in it's technical reference and correct the problem before proceeding with these steps. Verify power to the ST-32 by checking for 5 volts DC on the 2200 mf capacitor (low voltage may indicate an overload, short or metal contact with the ST-32 circuit area). Also check for loose connections at all ribbon cables. Verify that the voltage being applied to the input is 9 to 15 volts and that the + is connected to the input channel and - is connected to terminals 9 and 10. If after checking thoroughly you are still unable to correct the problem, contact us at (937) 349-6000 for technical support.

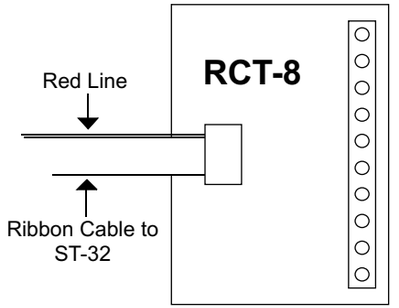
SHUNT BANK SETTINGS FOR THE ST-32

PORT SELECTION: The status input ports are selected using the two shunt banks on the ST-32. The diagram on page 2 shows the shunts positions for ports #3, #4, #5 & #6. The shunt positions for each card are shown below. The ports are as follows:

CARD	PORT A	PORT B	PORT C	PORT D
STA-16	#1	#2		
1st ST-32	#3	#4	#5	#6
2nd ST-32	#7	#8	#9	#10
3rd ST-32	#11	#12	#13	#14
4th ST-32	#15	#16	#17	#18



RCT-8 CONNECTION DIAGRAM



NOTE: The diagram for the RCT-16 is the same except the terminals on the lower block are for inputs 9 thru 16

USE OF AC (bipolar) OPTO ISOLATORS

The ST-32 may be ordered with AC opto isolators which will allow the inputs to be turned on in either direction and will allow for both a common anode (+ ground) or common cathode (-ground) configuration of the inputs (or a combination of both). The ST-32 may be ordered with AC opto isolators by specifying the AC option.

COMMERCIAL USE OF THE ST-32

When the ST-32 is to be used in a commercial/industrial environment, additional action must be taken to insure long term reliability and trouble free operation of the hardware. In general, the most serious threat to the hardware will be electrical transients (most often caused by electrical storm activity). The following steps are strongly encouraged to protect the hardware and are listed in the order of highest priority:

(1) Install a voltage surge/spike protector in the 120 volt AC outlet which supplies power to the ST-32 and to your hardware. Be sure that the electrical outlet has a third prong electrical ground and that it is correctly wired. Install TransZorbs on the power inputs to the AR-8, STA-16 or ADC-16 (specify part # SP-12K).

(2) Install the AR-8X, STA-16 or ADC-16 (and any expansion cards) in a metal enclosure and ground the enclosure to a reliable earth ground (an electrical system ground using the third prong on an electrical outlet will usually be sufficient). Install a Transzorb across the power input to the STA-16 (at the terminal block) and connect a Transzorb from the (-) terminal to the metal enclosure. An inline ½ amp fast-acting fuse should be installed prior to the transzorbs (the fuse will blow and prevent damage to the STA-16 in the event of a major electrical surge). When the installation site is at higher elevations, in areas that are subject to increased electrical storm activity, the installation of gas-tube discharge devices and other action may be necessary (contact technical support for more information).

(3) Order the EX-16 with the /C Opto Isolator option. The opto isolators significantly reduce the possibility of voltage transients back-feeding to the EX-16 through the relay output lines.

(4) Power the AR-8X, STA-16 or ADC-16 from a 9 volt power supply. A 9 volt power source will significantly reduce the heat produced by your hardware and will also reduce the energy consumption of the hardware. If your hardware is to be operated in elevated room temperatures (above 85° F), additional steps should be taken to reduce heating of the hardware. Install a larger heat sink on the AR-8X, STA-8,16 or ADC-4,8,16 regulator or increase air flow and install your hardware in a larger metal enclosure.

STATUS INPUTS

Status lines are connected to the ST-32 with one of the following ribbon cable adapters: RCT-8, RCT-16, RCS-8, RCP-8 or RCC-50. The ribbon cable adapters connect to the ST-32 status input ports. The terminal assignments are shown on page 5. The inputs are electrically isolated from the ST-32 with opto isolators. The ST-32 inputs are turned on by applying a small voltage to the LED inside the opto isolator. We recommend that an isolated power source be used for this purpose to prevent possible serial I/O errors or possible damage to the ST-32 which could occur as a result of lightning, voltage surges, EMI or other noise. A separate PS-GP-1 power supply may be used for this purpose (shown below). We recommend that the PS-GP-1 be fused to prevent damage in the event of a short circuit. Each status input port provides two isolated (-) commons so that two different input configurations can be utilized (see RCT-8 terminal connections, page 5). Wire connections between the switch or relay and the ST-32 may be up to several miles long if necessary (the only limiting factor is the voltage drop in the wire). Low cost communication cable is ideal for this purpose (24 gauge typical). The ST-32 is shipped with 1.8K limiting resistors installed in series with the opto isolator to provide a typical voltage input range of 9 to 15 volts DC. The limiting resistor may be replaced with different values to provide different voltage input ranges from 1.2 volts to hundreds of volts (for safety reasons, we recommend that a voltage dividing circuit be used for DC voltages over 50 volts, see diagram shown below). An isolation transformer should be used for AC voltages over 50 volts (see figure A). The ST-32 may be ordered without limiting resistors installed or with limiting resistors for different voltage ranges (specify when ordering).

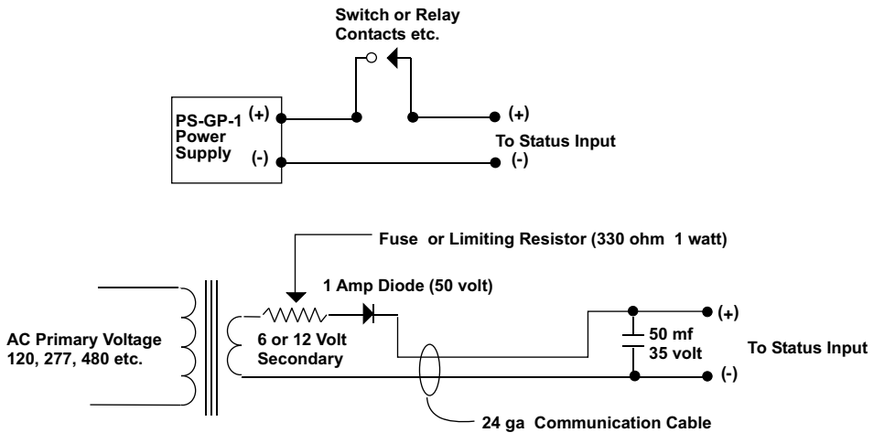


FIGURE A

HIGH VOLTAGE INTERFACING

CAUTION: When working with high voltages, the potential for fire, explosion, electrocution, eye injury or blindness and life threatening injurys exists. If you are not familiar with the precautions needed when working with high voltages, do not attempt to connect high voltage up to these circuits. When connecting the ST-32 to high voltage AC equipment (such as compressors, fans, hot water heaters, lights etc.) the method shown above in figure A is recommended.

The following method is used to divide a high DC voltage down to the range needed for input into the ST-32 (see figure B). This method involves the use of two resistors (R1 and R2) which together add up to Rt (total resistance). The total resistance is determined by using the Ohms Law to compute the resistance needed for a 10 milliamp current flow through the resistors. EXAMPLE: If the input voltage is 100 volts (R = E divided by I) 100 volts divided by

.01 amps =10,000 ohms (10K ohm) = total resistance. To determine the proper ratio of the resistors divide 12 volts (ST-32 input voltage) by 100 (high voltage input) = .12. The value of R2 = .12 times 10,000 ohms = 1,200 ohms. R1 is then equal to the difference between the total resistance (10,000 ohms) less R2 (1,200 ohms) = 8,800 ohms. To determine the power rating needed for the resistor, use the following formula: P = I squared times R. EXAMPLE: .01 squared = .0001 times R1 (8,800 ohms) = .88 watts. A 1 watt resistor would be sufficient. To prevent the danger of a high voltage feed back to the ST-32 and/or a fire/electrocution hazard caused by an open or short circuit, a 15 volt 5 watt zener diode and a 1/4 amp in-line fuse should be installed as shown in figure B.

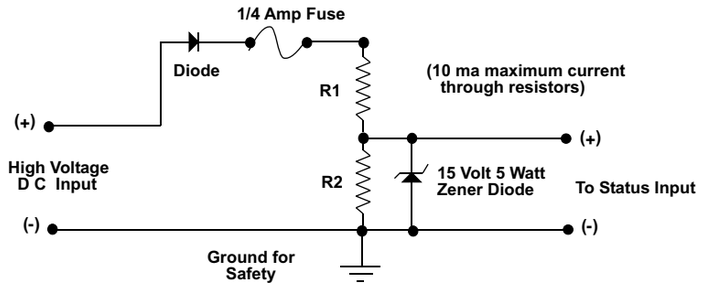


FIGURE B

CONTROL SOFTWARE

Program examples in GW BASIC, QUICKBASIC, VISUAL BASIC, TURBO C and TURBO ASSEMBLY are provided on the disk supplied with your order. The Status information is transmitted from the ST-32 (via the STA-16, ADC-4 or ADC-16) upon receipt of a status port code which must be transmitted by the computer. The status information on ports #1 and #2 (STA-16 only) are obtained by transmitting 0 and 1 to the STA-16 (for inputs 1 thru 8 and 9 thru 16). The status information on the ST-32 ports are obtained by transmitting the following codes to the AR-8X, STA-8, STA-16, ADC-4, ADC-8 or ADC-16:

PORT #	TRANSMITTED CODES	INPUTS
3, 4, 5, 6	16, 17, 18, 19	17-24, 25-32, 33-40, 41-48
7, 8, 9, 10	20, 21, 22, 23	49-54, 55-64, 65-72, 73-80
11, 12, 13, 14	24, 25, 26, 27	81-88, 89-96, 97-104, 105-112
15, 16, 17, 18	28, 29, 30, 31	113-120, 121-128, 129-136, 137-144

Upon receipt of the channel code, the AR-8X, STA-16 or ADC-16 will transmit back a single byte binary number. The single byte number will represent the status information in sequence using the LS bit as the lowest status input and the MS bit as the highest status input (0 = OFF, 1 = ON). The AR-8X, STA-16 or ADC-16 will only recognize codes 0 to 31. The AR-8X, STA-16 or ADC-16 passes all higher codes to the EX-16 or EX-32 (if connected) for relay control functions.

PROGRAMMING IN BASIC

The following program has been written for IBM or compatible computers using GW Basic or QuickBasic. The program will continuously display the status information for all 32 status inputs. The screen is continuously updated so that new status information is displayed at intervals only a few milliseconds apart. This program is intended to illustrate the fundamentals needed to develop your own software for specific applications. All values are decimal, the protocol is set as follows: 9600 baud, 8 data bits, 2 stop bits and no parity. To stop program execution, press Ctrl break. If the following program does not run on the first attempt, change the on error statement (line 30) to

ON ERROR GOTO 0 while trouble-shooting the software. NOTE: In the software example shown on the following page, we are using GW Basic/QuickBasic statements. If you are using another type of Basic, this software will still work in most cases, but minor changes may be necessary (consult your Basic manual and the sections concerning serial communications). All example programs may be loaded from disk using the test disk supplied with your order. An example of a Basic Program using an assembly language subroutine for IBM and compatibles (not shown) may be loaded and listed from GW Basic (file name ST-32S.BAS).

GW BASIC or QUICKBASIC PROGRAM EXAMPLE

```
10 CLS
20 DIM A(32)                                                    ' Specify array
30 ON ERROR GOTO 360                                            ' Continue if error
40 OPEN "COM1:9600,N,8,2,CS,DS,CD" FOR RANDOM AS #1             ' Set protocol
50 GOSUB 130                                                    ' Go to ST-32 subroutine
60 LOCATE 1, 1                                                  ' Position cursor
70 FOR X = 1 TO 16                                              ' Print status on screen
80 PRINT A(X), A(X + 16)                                ' (0 = off, 1 = on)
90 IF X = 8 THEN PRINT " "                                      ' Space
100 NEXT X
110 K$ = INKEY$: IF K$ <> "" THEN CLOSE #1: CLS : END           ' Exit program
120 GOTO 50                                                     ' Repeat
130 '**********************************ST-32 SUBROUTINE************************************
140 '******************RESULTS RETURNED AS A(1) THRU A(32)*********************
150 FOR X = 16 TO 19                                            ' Channel codes
160 Y = 0                                                       ' Clear wait count
170 PRINT #1, CHR$(X);                                          ' Transmit
180 IF Y > 25000 THEN 230                               ' Retry up to 25,000 times, quit if byte lost
190 IF EOF(1) = -1 THEN Y = Y + 1: GOTO 180                     ' Wait for byte
200 A$ = INPUT$(1, 1)                                           ' Receive
210 B(X - 16) = ASC(A$)                                         ' Store byte as a number
220 NEXT X
230 IF EOF(1) = -1 THEN 250                                     ' Check for byte in buffer
240 A$ = INPUT$(1, 1): CLOSE #1: GOTO 40                        ' Clear if error
250 FOR X = 0 TO 3
260 Z = 1
270 FOR Y = 1 TO 8
280 A = B(X) AND Z                                              ' Check bit
290 Z = Z * 2
300 IF A > 0 THEN A(Y + X * 8) = 1: GOTO 320                    ' Input on?
310 A(Y + X * 8) = 0                                            ' If not, input is off
320 NEXT Y
330 NEXT X
340 RETURN
350 '*******************************END OF SUBROUTINE*********************************
360 RESUME                              ' Start over if error (error subroutine can go here)
```

ERROR TRAPPING: The programs in these examples include an error trapping feature to prevent problems as a result of serial transmission errors which can occur when the program is left running for long periods of time. Serial errors may be created when fluctuations in power occur, if electro mechanical interference is encountered, when strong radio signals are nearby, if lightning is in the immediate area or if other types of noise are picked up on the serial transmission lines (much of the noise can be eliminated by using a shielded serial cable). It is important to stress, however, that serial I/O errors are fairly remote and may only occur once in every 20,000 hours of operation. If your application requires 24 hour operation, 365 days a year (such as in energy management) an error which could cause a computer lock-up is unacceptable.

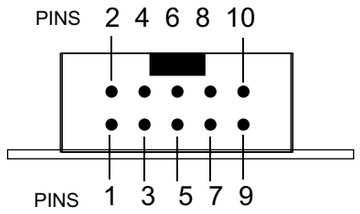
PROGRAMMING EXAMPLES IN ASSEMBLY OR C

To view the assembly listing or C listing for IBM and compatibles, insert the test disk in drive A and enter:
A> TYPE ST-32.ASM or ST-32.C To line print the listing, enter: A> PRINT ST-32.ASM or ST-32.C
NOTE: PRINT is an external DOS command. The assembly code was assembled and linked on an IBM XT using MS DOS 3.3 and TURBO ASSEMBLER (Borland in Scotts Valley, CA).

RACK MOUNTING

The ST-32 may be rack mounted with any of the 5" by 7" cards in the CH series card holder racks. The CH-2 will hold up to (2) of the 5" by 7" cards, the CH-4 will hold up to (4) of the 5" by 7" cards and the CH-8 will hold up to (8) of the 5" by 7" cards. The interface card (AR-8X, ADC-16 or STA-16) should be installed in the top slot of the card holder rack. The expansion cards (EX-16, EX-32, ST-32 or AD-16) should be installed in the slots below the interface card (see diagram page 3). All RC-20 cables are pin equivalent and may be used with the ST-32, EX-16, EX-32 or AD-16. The use of an extended length RC-20 ribbon cable will be necessary when the AD-16 or ST-32 expansion cards are used with the EX-16 or EX-32 expansion cards (add one inch for each AD-16 or ST-32 card).

INPUT HEADER PIN OUT



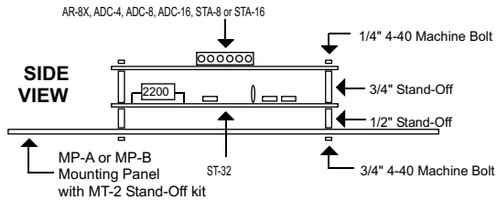
HEADER PIN-OUT FOR THE
STA-16 & ST-32.

NOTE: Key notch is on top.
View is looking into header pins.

PIN CONNECTIONS

(1) Input #1 +
(2) Input #2 +
(3) Input #3 +
(4) Input #4 +
(5) Input #5 +
(6) Input #6 +
(7) Input #7 +
(8) Input #8 +
(9) (-) Common (inputs 1 thru 4)
(10) (-) Common (inputs 5 thru 8)

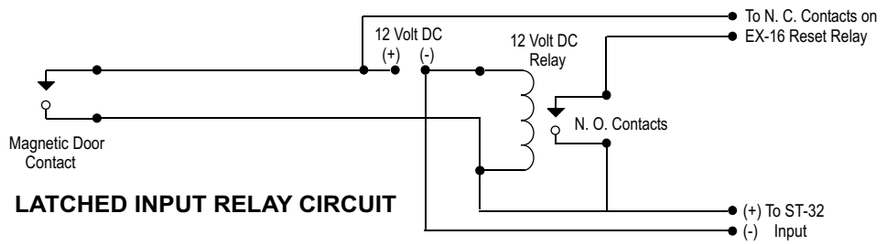
MOUNTING A STAND ALONE UNIT...A single interface card with the ST-32 may be mounted in an enclosure or on a metal mounting panel using the MT-2 stand-off mounting hardware. The STA-16/ST-32 will attach to the 4 stand-off spacers using 4-40 machine screws as shown below (4 mounting holes are provided on the STA-16 & ST-32). Contact technical support for more information on mounting panels and custom made distribution boards for use with the AR-8X, ADC-16, STA-16, EX-16, EX-32, AD-16 and ST-32.



USE OF THE ST-32 IN SECURITY SYSTEM APPLICATIONS

The ST-32 may be used as a security system interface to monitor door and window contacts, smoke detectors, motion detectors, entry keypads and other devices. The KY-12M keypad may be used to remotely enter door entry codes, log entry times and individuals, to arm and disarm the security system and for other functions. The EX-16 with relay card may be used to sound alarm sirens, light indicator lamps or to control other devices. The addition of a modem and a voice sound card will allow the security system to dial out with a message for police or fire protection or to call building owners in the event of an emergency. The modem will also allow incoming calls to download system status or to provide log information etc.

In applications where the information from the ST-32 is collected only periodically (such as once a minute), it may be desirable to latch inputs which are connected to magnetic contacts or to other types of intermittent signals. The easiest way to latch the input is with a small reed relay as shown in the circuit below. After the STA-16 transmits the input information, the latch may be reset using one of the outputs from the EX-16 or by using one of the RS-232 control lines with the AR-2 Relay Interface using DTR or RTS. A latched input relay card with 8 latched inputs is available for this purpose (specify part # LR-8). Please contact technical support for more information.



LATCHED INPUT RELAY CIRCUIT

REPAIR SERVICE

In the event that the ST-32 is damaged from an inadvertent short circuit or other mishap, repair service is available through us by shipping your ST-32 to the address on the rear cover of this manual. The charge for minor repair is $15.00 and takes about 3 business days (not including shipping).

CONTROL SYSTEM TECHNOLOGY

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