APROTEK

UNIVERSAL RS-232 INTERFACE

(USR-232) #5232

OPERATING MANUAL

APROTEK
1071-A AVENIDA ACASO
CAMARILLO, CA. 93010
805/987-2454

INTRODUCTION

Commodore decided to make products that operate from the serial port in a different way than the rest of the computer industry. Commodore home computer owners have, until now, had to use only equipment made specifically for connection to their computer and could not easily use equipment made to the more standard RS-232 protocol. This is why Aprotek decided to make this product. It will allow you to buy and use industry standard peripherals and accessories that adhere to the RS-232 standard. A whole new world of possibilities is opened and your Commodore computer system becomes much more usable with the addition of this interface. Before you begin, be sure to finish reading this manual completely. A little time spent here will pay you back many times over by allowing you to write or install programs that work correctly.

TO START

This Universal RS-232 Interface (USR-232) installs in the User Port on the left rear area of your Commodore. As with any device, you must be sure that your computer is off before plugging in this interface. When plugging it in be sure that the product label is facing up and that you correctly align the connector to the corresponding connector inside your computer. Then firmly push it into the connector. The interface should go about 1/4 inch into the computer after you feel the initial contact. If it is not correctly connected it will be damaged, so be sure to plug it in correctly and firmly.

DESCRIPTION

As you can see, the USR-232 has a connector that plugs into the computer, an extension of that same connector on its back end, and a cable with a DB-25 connector that extends from the right side. The DB-25 connector is what is connected to the RS-232 device. The connector on the DB-25 is of the male type which is standard for a cable. If your peripherals connector is not of the female type that would correctly mate, you can buy a 'gender changer' for conversion of your peripheral. It is something that most computer stores carry or you can contact us. If you need to get one, be sure to specify a female/female type. The extension of the User Port is exactly that, a duplication of the pins and their functions. Nothing was added or deleted from the User Port Extension. This allows you, when there is no conflict of function, to have more than one device at one time connected to your User Port. Some devices will not allow you to leave them connected. If that is the case, it will become obvious to you when the other device connected to the extender will not operate correctly. If this is the case, simply unplug the device causing a conflict. Please note that only one device at one time may be actively driven from the User Port.

SWITCH SETTINGS

Using the USR-232 will require that you know the product you are planning to use it with. If it is a printer or MODEM, the connection and switch settings should be fairly straightforward. There are some devices on the market that have a strange protocol but in all cases that we are aware of, they should be usable with this interface. If you are going to drive a modem, you would set the switches to Normal, Modem A and Modem B. If you are going to drive a printer, you would set the switches to Normal, Printer A and Printer B. If at any time the switch settings are incorrect for the unit attached to the RS-232 cable, there are a limited number (8) of possible switch settings. If you simply don't know how your interface should be configured, you may need to try each of them to find the right one. In virtually all cases the information to connect your device will be in the operating manual for that device.

RS-232 EXPLANATION

This section is for those users that want to know the inner workings of how RS-232 operates, or for troubleshooting problems. You may skip this if you do not have a need or desire to know. The RS-232 protocol is one that specifies that certain signal types and voltage levels be present on both ends of a transmission cable. The full specification is quite lengthy and involved and most equipment is a subset of the full specification. The subset used in USR-232 is a 10 wire subset that encompasses virtually all commonly used equipment. That is why it is a 'Universal' RS-232 Interface. RS-232 equipment is classified as one of two types. The first type is Data Terminal Equipment (DTE), the device that is acting as the host or driver piece of equipment, such as your computer. The second type is Data Communications Equipment (DCE), the device being driven such as a modem. In each case certain pins have certain functions. Here is a list of the pin assignments for the RS-232 standard:

PIN# - DTE FUNCTION	DCE FUNCTION
2 TRANSMIT DATA	RECEIVE DATA
3 RECEIVE DATA	TRANSMIT DATA
4 REQUEST TO SEND	REQUEST TO SEND
5 CLEAR TO SEND	CLEAR TO SEND
6 DATA SET READY	DATA SET READY
7 SIGNAL GROUND	SIGNAL GROUND
8 CARRIER DETECT	CARRIER DETECT
12 SEC. CARRIER DETECT *	SEC. CARRIER DETECT *
20 DATA TERMINAL READY	DATA TERMINAL READY
22 RING INDICATOR	RING INDICATOR

* Normally used for high speed indication.

The actual data transmitted by each device is done only on pins 2 and 3. All other pins are used for status and readiness indication which is commonly referred to as 'handshaking'. The Commodore computer supports two

types of RS-232 handshaking. The simplest configuration is called 3-line handshaking. 3-Line uses the absolute minimum of RS-232 lines to communicate, one for data being transmitted, one for data being received, and one line for the common ground. In 3-Line mode, the computer assumes that the modem is always ready to send data, and the modem assumes that the computer is always ready to receive data. In X-Line mode, a number of handshaking signal lines become available which can be used to control the data flow. For example, the computer and the modem can use the RS-232 DTR (Data Terminal Ready) and DSR (Data Set Ready) lines to inform each other about their readiness to send or receive data. Most Commodore modems and software use the simpler 3-Line handshaking mode.

A printer is the one exception to the rule that equipment being driven are DCE devices. A printer is normally a DTE device. The reason printers are DTE devices is because they evolved from teletypes. Most printers use only pins 3,7,20; and are considered a 'dumb' terminal, meaning that it can only listen. The control line on pin 20 simply shows that the printer isn't ready to accept more characters to print. We have included the other signals for those cases that use them. Essentially, what you are doing when you switch from modem to printer on the USR-232 is connecting the above lines from the DTE-DCE case to the DTE-DTE case.

WORDPROCESSORS AND RS-232 PRINTERS
In most cases, software written for the Commodore home computers is written to drive printers attached to the Commodore serial port (the 5 pin circular connector). In many cases though you can reinstall your software to drive a printer through the User Port. Popular software such as Paper Clip, Easy Script and Totl.Writer support driving an RS-232 printer through the User Port. If your printer attached to the USR-232 does not operate with your wordprocessor, check that the software is configured for the User Port first. Some software such as Speedscript and Multiplan do not operate with an RS-232 printer attached to the User port. Your only choice is to change printers or software, or to write a program which will redirect output from the Serial to the User port.

COMPATIBILITY
In order for devices to communicate through RS-232 they must have similar settings. The speed at which they communicate must be the same. This is called baud rate. If one device is set to 1200 baud, then the other must also be set at the same rate. The USR-232 will transmit any of the many different baud rates and does not determine the rate itself. Be sure that you set your computer through the driver program and the device you are driving to the same rate before trying to communicate. Please note that 2400 baud is the upper limit for the Commodore 64/128. This is a hardware limit due to the way that Commodore chose to do the RS-232 (UART) routines in software. It is not a limitation of the USR-232. Instructions for how to set your computer are contained later in this manual. Instructions for

4

the other device will be contained in its manual. If the other device is set by a switch, be sure to change it before turning it on. Unequal baud rates typically are obvious by communication taking place, but random characters (garbage) being transmitted. Other parameters such as word length, parity, and stop bits must also be the same. Word length can be from 5-8 bits, but is usually 7 or 8 bits long.

PROGRAMMING THE RS-232 PORT

The first thing you must do when programming the RS-232 port on the C-64/128 is to open a channel to the user port. On the C-64, this must be done before any variables are defined. This is due to an automatic CLR being performed when an RS-232 channel is opened. This does not apply to the C-128, due to the predefined RS-232 I/O buffers. To open the RS-232 channel, the following format is used:

OPEN LF,2,SA,CHR$(A)CHR$(B)CHR$(C)CHR$(D)

LF = Logical File number. This number must be in the range of 1-255 and is the computer's way of distinguishing between files. This is also the number that is used in GET#, PRINT#, and INPUT#. If the file number is greater than 127, a linefeed will be added to all carriage returns.

SA = Secondary Address. Again, must be in the range of 0-255. When opening the RS-232 port, the secondary address doesn't do anything; but it is required. Many programmers make this identical to the Logical File Number.

A = Control Register. This number controls the number of stop bits, word length, and baud rate.

B = Command Register. This number controls the parity, duplex, and the handshaking. (Optional)

C/D = Low Byte/High Byte format, these numbers are used to control the user-defined baud rate. Only used if the control register's lower 4 bits are all zero, indicating a user-defined baud rate.

Now that we know the format for opening the RS-232 channel, let's examine the actual registers. Each register is a single memory location in the Commodore computer, also known as a 'byte'. One byte contains eight bits of information. In the Decimal system of counting, the bit value counting from right to left are 1,10,100,1000, etc. Computer's however, can only count in Binary. The bit values are as follows:

```
Value -> 128  64  32  16  8  4  2  1
Bit   ->   7   6   5   4  3  2  1  0
```

The following charts will allow you to determine what values to put in place of the A,B,C, and D, as you open an RS-232 channel.

CONTROL REGISTER

The Control Register is sent a decimal number that, when converted to its binary equivalent, allows you to control the number of stop bits, word length, and baud rate.

STOP BITS						BAUD RATE
BIT 7	Bit	3	2	1	0	
0 = 1 Stop Bits		0	0	0	0	= USER RATE
1 = 2 Stop Bits		0	0	0	1	= 50
		0	0	1	0	= 75
		0	0	1	1	= 110
WORD LENGTH		0	1	0	0	= 134.5
BIT 6 5		0	1	0	1	= 150
0 0 = 8 Bits		0	1	1	0	= 300
0 1 = 7 Bits		0	1	1	1	= 600
1 0 = 6 Bits		1	0	0	0	= 1200
1 1 = 5 Bits		1	0	0	1	= 1800
		1	0	1	0	= 2400

(Baud rates above 2400 are not implemented)

Bit 4 is unused

COMMAND REGISTER

The Command Register is sent a decimal number that, when converted to its binary equivalent, allows you to control the parity, duplex, and handshake.

PARITY   DUPLEX
BITS 7 6 5   BIT 4
   X X 0 = NO PARITY   0 = FULL
   0 0 1 = ODD PARITY   1 = HALF
   0 1 1 = EVEN PARITY
   1 0 1 = MARK TRANSMITTED   HANDSHAKE MODE
           PARITY CHECK DISABLED   BIT 0
   1 1 1 = SPACE TRANSMITTED   0 = 3 LINE
           PARITY CHECK DISABLED   1 = X LINE

BIT LOCATIONS 3,2,1 ARE UNUSED

USER-DEFINED BAUD RATE

The formula for a user-defined baud rate is:
BAUD RATE=CLOCK FREQ/(2*(HIGH BYTE*256+LOW BYTE+100))
USA NTSC FREQUENCY = 1022727 Hz.
PAL EUROPEAN FREQ. = 985248 Hz.

EXAMPLE 1: You would like to communicate over a modem using 300 baud, 8 bit word length, no parity, one stop bit, full duplex, and 3-line handshake. Looking at the control register, first write down the binary number for the above choices...

Control Register	76543210	Command Register	76543210
One stop bit	- 0	No parity	- 000
8 bit word length -	00	Full duplex	- 0
300 Baud rate	- 0110	3-Line handshake -	0
	= 00000110		= 00000000

An easy way to convert binary to decimal is to pick out the 'ones'. Then, counting from right to left, add +1 +2 +4 +8 +16 +32 +64 +128 in the respective locations where there are ones. As you can see you can express any decimal number from 0-255 with this 8 bit binary number. In our example, the control register number is equal to 00000110, (2+4=6). The command register number is 00000000, which in decimal terms is still 0. We now know what numbers the computer needs: OPEN5,2,3,CHR$(6). Remember, the command register is optional, so since the value is zero, there is no need to put it in the OPEN statement.

EXAMPLE 2: You would like to use 1200 baud, 7 bit word length, even parity, one stop bit, full duplex, and 3-line handshake. Looking at the control register, first write down the binary number for the above choices...

Control Register	76543210	Command Register	76543210
One stop bit	- 0	Even parity	- 011
7 bit word length -	01	Full duplex	- 0
1200 Baud rate	- 1000	3-Line handshake -	0
	= 00101000		= 01100000

The control register number is equal to 00101000, (8+32=40). The command register number is 01100000, (32+64=96). We now know what numbers the computer needs: OPEN5,2,3,CHR$(40)CHR$(96).

EXAMPLE 3: Re-arranging the terms of the formula for user-defined baud rates, we have X=(Clock Freq/Baud)/2-100. To come up with 1000 baud for example: first divide the system frequency by the baud rate - 1022727/1000= 1022.727. Second, divide that result by 2 - 1022.727/2= 511.3635. Third, subtract 100 and round off - 511.3635-100= 411. Now convert this number to low byte/high byte format - 411/256=1, 411-1*256=155. Now that we have all the values that we need; we can open the channel as follows:
OPEN5,2,3,CHR$(32)CHR$(32)CHR$(155)CHR$(1) - This will give us a 1000 baud, 7-bit word length, odd parity, one stop bit, full duplex, and 3-Line mode. It is by using this method that many Commodore BBS's offer 450 Baud speed for 300 Baud modem users.

A simple example of a User I/O Port driver program that you can type in and
save is listed here so you don't have to develop one yourself. This program
will work in both the C64 and C128. Other public domain programs are also
available in other Commodore literature and periodicals. The most valuable
single source for technical information is the "Programmers Reference Guide"
for your computer, available at your Commodore dealer or local bookstore. We
also have the following listings as well as our popular terminal program
'Multiterm' available on disk for only $15.95 postage included. Call or
write for order # 5232-PROG.

```
10 REM OPEN PORT & ASSIGN VARIABLES
20 OPEN5,2,3,CHR$(6)+CHR$(0)
30 DIMF%(255),T%(255):CR$=CHR$(13)
40 FORJ=32TO64:T%(J)=J:NEXT
50 T%(13)=13:T%(20)=8:RV=18:CT=0
60 FORJ=65TO90:K=J+32:T%(J)=K:NEXT
70 FORJ=91TO95:T%(J)=J:NEXT
80 FORJ=193TO218:K=J-128:T%(J)=K:NEXT
90 T%(146)=16:T%(133)=16
100 T%(137)=3:T%(134)=17:T%(138)=19
110 FORJ=0TO255:K=T%(J)
120 IFK<>0THENF%(K)=J:F%(K+128)=J
130 NEXT
150 REM MAIN PROGRAM
160 PRINTCHR$(14)" "CHR$(147)
170 GET#5,A$:IFA$=""ORST<>0THEN210
180 PRINT" "CHR$(157);CHR$(F%(ASC(A$)));
190 IFF%(ASC(A$))=34THENPOKE212,0
200 GOTO170
210 PRINTCHR$(RV)" "CHR$(157);CHR$(146)';GETA$
230 IFA$<>""THENPRINT#5,CHR$(T%(ASC(A$)));
240 CT=CT+1:IFCT=8THENCT=0:RV=164-RV
250 GOTO170
```

Be sure to type it exactly as shown and save it before using. Be careful to
distinguish between the letter '0' and zero as you type it in. By using
this basic terminal program you can drive the User port and control any
modem connected to it. Of course you can elaborate on this program and do
many other things such as include an autodial phone number subroutine.

By using the Control and Command Registers, and with a good understanding of
Commodore Basic, you can drive just about any RS-232 device with any
protocol imaginable.

8

The program following is an autodial subroutine for the Aprotek Minimodem-H, (or any Hayes compatible modem). If used with the previous terminal program, it must be entered with exactly the same line numbers to be incorporated into the previous program. The phone number list is accessed by pressing the '#' key.

```
140 READNP:FORZ=1TONP:READPH$(Z):NEXTZ
220 IFA$=CHR$(35)THEN260
260 PRINTCHR$(147)"PHONE LOG":PRINT
270 FORZ=1TONP:PRINTZ;PH$(Z):NEXTZ:PRINT
280 INPUT"SELECTION";A$:PH=VAL(A$)
290 IF PH=0 OR PH>NP THEN 170
300 REM CHANGE 'ATDT' TO 'ATDP' IF YOU HAVE ROTARY PHONES
310 PRINTCHR$(147):TP$=CR$+"ATDT"+PH$(PH)
320 PRINT#5,TP$:GOTO170
330 REM THE FIRST NUMBER IN THIS DATA STATEMENT IS THE
    NUMBER OF PHONE NUMBERS LISTED
340 REM THE NUMBERS BETWEEN COMMAS ARE THE PHONE
    NUMBERS YOU WISH TO SELECT FROM
350 DATA 4,5551212,18059862454,NNNNNNN,NNNNNNNN
```

While it is beyond the resources of this booklet to teach the art of programming, this short routine may be used and expanded upon for auto-answering capability:

```
10 REM HAYES AUTO-ANSWER SUBROUTINE
20 POKE 56579,38:REM 00100110  INITIALIZE I/O LINES
30 IF (PEEK (56577) AND 8)=0 THEN 30:REM WAIT FOR RING
40 TI$="000000":REM SET TIMER TO ZERO
50 IF (PEEK (56577) AND 16)=16 THEN 80:REM CHECK FOR CARRIER
60 IF TI<1000 THEN 50:REM HAS TIME RUN OUT?
70 GOTO 20:REM TIME RAN OUT
80 REM MAIN PROGRAM FOLLOWS, CARRIER FOUND IN LINE 50
```

By examining the this program, you will notice there are two very important memory locations used. The first one is the Data Direction Register (DDR), located at 56579. This memory location defines which RS-232 lines are input or output. If the bit in the DDR is set to one, the corresponding bit in 56577 is defined as an output. If the bit in the DDR is set to zero, the corresponding bit in 56577 is an input line. Data Port B (Memory location 56577) is the 'gate' between the computer and the RS-232 device. This is the location where the program will find various handshaking signals. More information on these memory locations can be found in the "Programmer's Reference Guide".

Since the two primary devices to be used through the User port are a modem and printer, and since we have discussed modems, we will now discuss printers. There are quite a few similarities between modems and printers. A printer must have the correct baud rate set, as well as word length, parity, etc. Most printers will have a set of switches to allow you to select various parameters. If you have a selection, set a baud rate that is neither too slow or too fast, such as 1200 or 2400 baud. The higher the baud rate is, the more likely that a bit or bits may not be transmitted correctly. Experimentation will tell you how fast a baud rate you can use, and you must remember to set both the printer and Control Register at the same rate. Usually the only return signal a printer will send back to the computer is one that tells the computer not to send any more data until the printer catches up. This is the Busy signal and it is usually found on pin 20 of the RS-232 connector. The busy signal is high (has a plus voltage) when the printer is ready and a low (minus voltage) when the printer is busy. If these signals are reversed, you can adjust for it by switching from NORMAL to INVERTED on the USR-232 front panel switch. There are also a very few printers that have the handshaking signals on pin 4 rather than pin 20. If you are positive that you have this type, you will need to make two cuts and two jumpers on the USR-232 PC board or have us do it. Call us for the instructions only if you are positive that you have that type of printer and want to use it. If you implement this change it will make the USR-232 non-returnable.

PRINTER SOFTWARE COMMANDS

You can drive your printer in the same way as described in the terminal program. If you have existing software that you can modify, you can simply change the OPEN command to reflect a device # 2 instead of # 4. You must also set the correct Control and Command registers. You may also use the User port directly to list a program in memory. An example of how to do this would be:

```
OPEN2,2,3,CHR$(8)+CHR$(1)
CMD2
LIST
```

This, is for a printer at 1200 baud, no parity, 8 bit word length, with X-Line handshaking. If your switches on the printer and USR-232 are set correctly you should start printing out the program listing. When done, close the port by typing:

```
PRINT#2:CLOSE2
```

This manual contains all the basics of how to use your USR-232 and the devices connected to it. Please remember that the USR-232 is an interface and as such will not program itself. That is left to you the user. Using your computer for new and interesting things is what computing is all about...HAVE FUN.

RS-232 USER PORT AND DATA PORT CHART

Pin ID	I/O Port ID	DESCRIPTION	ABV	IN/ OUT	MODES	DATA PORT B (56577) BIT	VALUE
A	GND	Protective Ground	GND	-	1,2		
B	FLAG2	Received Data	RXD	IN	1,2		
C	PB0	Received Data	RXD	IN	1,2	0	1
D	PB1	Request to Send	RTS	OUT	1*,2	1	2
E	PB2	Data Terminal Ready	DTR	OUT	1*,2	2	4
F	PB3	Ring Indicator	RI	IN	3	3	8
H	PB4	Carrier Detect	DCD	IN	2	4	16
J	PB5	Unassigned	-	IN	3,4	5	32
K	PB6	Clear to Send	CTS	IN	2	6	64
L	PB7	Data Set Ready	DSR	IN	2	7	128
M	PA2	Transmitted Data	TXD	OUT	1,2		
N	GND	Signal Ground	GND	-	1,2		

Modes: 1. 3-Line Handshake (TXD,RXD,GND)
      2. X-Line Handshake
      3. User Programmed (Unused/Unimplemented in ROM code)
      4. Modems commonly use this for High Speed Detect
      * These lines held high in 3-Line mode.

ONE YEAR LIMITED WARRANTY

Aprotek warrants equipment manufactured and sold by it to be free from defects in material and workmanship and to meet applicable specifications under normal use and service for a period of one (1) year after sale to the original owner. If any equipment or part not covered by another manufacturer's warranty are deemed by Aprotek to have been defective originally, or if these parts or equipment are found to have become defective under normal usage rather than misuse, negligence or accident, Aprotek will repair or replace without charge.

This warranty shall not apply to equipment or parts which are normally consumed in operation, nor to equipment which, in the opinion of Aprotek, has been repaired or altered in any way that would affect its reliability or stability. Also not covered is equipment subjected to misuse, negligence or accident, or which has been altered, defaced, or has had the serial number removed.

Aprotek does not assume any liabilities for consequential damages and, in any event, the company's liable shall not exceed the purchase price.

If you are in need of service assistance please contact our service department at (805)987-2454, 8 a.m. to 5 p.m. Pacific time, weekdays.

<u>**Unapproved returns will not be accepted.**</u>

Vers. C
USR-232.man