

Using RS-422/RS-485

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Note: This application note is for reference purposes only.

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INTRODUCTION

This application note is dedicated to exploring the use of the RS-422/RS-485 option of the TEKNOR TEK-AT, VIPer and PCI boards. In the first section, we will look at RS-422 operation and the second will cover RS-485.

This text is not intended to explore the RS-422 or RS-485 standard in detail. Such documentation is available from IEEE¹. We will look at the general principles involved in implementing Teknor TEK-AT, VIPer and PCI cards with RS-422/RS-485.

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USING RS-422

In serial communications, there are many different hardware drivers, protocols and user implementations. In this brief text, we will explore one common implementation using differential drivers¹.

Basic principles

The use of RS-422 drivers is gaining more and more popularity. These hardware drivers transmit and receive differential signals. Therefore, a pair of wires is required for transmit and a pair is required for receive. For better noise rejection, the use of twisted pair cable is highly recommended. RS-422 drivers are being used in more applications everyday. This gain in popularity is due to the high noise rejection which enables faster serial transmissions over greater distances than with the more common RS-232 drivers.

The diagram on the following page depicts a typical RS-422 setup between 2 computers.

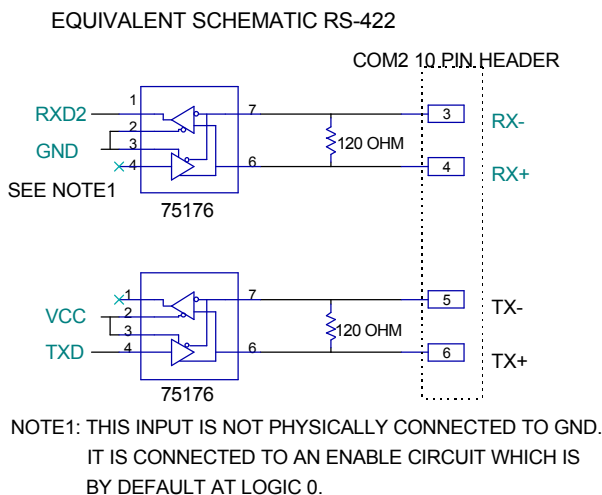
This setup offers some advantages such as increased speed over longer distances, improved reliability over similar RS-232 setups, no need for complex multi-station communication protocols, etc.

Disadvantages include more expensive twisted pair wiring required, handshake lines (RTS, CTS, DSR, DTR) not available for COM2 on TEKNOR TEK-AT, VIPer and PCI cards, extra hardware needed for implementing multi-station communications, etc.

Connecting hardware

Because the RS-422/RS-485 option requires different drivers than the usual RS-232 drivers, these must be installed directly at the factory on TEK-AT1, TEK-AT2 and TEK-AT3. Some simple jumper changes are required for the TEK-AT3L, TEK-AT4, TEK-AT4L, VIPer 800, 801, 803, 804, 805, 806, 807, 820, 880, PCI 930, 932, 933 and 935. In the latter case these can be performed by the user, please refer to the appropriate hardware reference manuals for more details.

The following diagram gives the schematic layout of the RS-422 drivers on the TEKNOR boards.



¹ Please note only COM2 is available with RS-422/RS-485 drivers. The pins given are those of COM2's 10 pin header. These pin numbers are not the same ones as a DB-9 connector. If you are using a DB-10 to DB-9 cable (direct with pin 1 aligned), please refer to the translate table in annex C.

Use the signals marked TX- and TX+ for the outgoing transmit signal and use RX- and RX+ for the incoming receive signal. Please note a 120 ohm termination resistor is installed on both pairs on the TEKNOR cards. Another termination resistor should be installed at the other end of each pair.

USING RS-422(continued)

Implementing software

Software for RS-422 is quite straight forward. There are no special requirements except that software must not attempt to use the handshake lines (because they are not connected). Therefore software handshaking can be used (XON-XOFF).

The actual COM2 port architecture is identical to that of a standard IBM RS-232 communications port without handshake lines. Only the hardware drivers are changed from $\pm 12\text{v}$ RS-232 to differential RS-422 drivers.

By default the address of the RS-422 port is COM2 (2f8h)². However, if your application requires the address of the RS-422 port to be 3f8h (COM1), this can be done by writing to a special configuration port (FOR TEK-AT MODELS ONLY!!!). If you want to swap the addresses for the ports on a VIPer 800, 801, 803, 804, 880, you should do it in the VIP-UP program (at startup), for other VIPer and PCI models, it can be done in the AMI BIOS setup. (please refer to annex A)³

² COM1 being an RS-232 port.

³ In this case, the RS-232 port is moved to COM2

Error! Bookmark not defined. USING RS-485

RS-485 is another interesting application of differential drivers for serial communications. You will find many similarities between RS-422 and RS-485.

Basic principles

RS-485 employs differential drivers like those used in RS-422. Therefore the advantages such as noise immunity and higher transfer speeds are also prevalent.

In addition, RS-485 also offers the ability to transmit and receive over the same pair of wires. Rather than use a separate pair of wires to transmit and to receive, the same pair of wires is used to do both. This offers a reduction in cabling. This also allows sharing of the communication line by multiple stations.

The diagram on the following page depicts a typical RS-485 setup between 3 or more computers.

Notice such a setup requires 1 computer as the master and the other systems are identified as slaves. This is to ensure only 1 system takes control of the communication line at a time. If this were not in place, more than 1 system could attempt to transmit at the same time causing transmission line contention and possible data loss.

This setup offers some advantages such as increased speed over longer distances, improved reliability over similar RS-232 setups, ability to share the transmission lines, less cabling required than RS-422, etc.

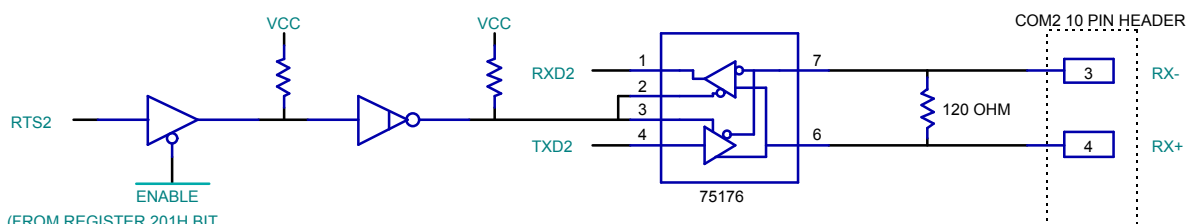
Disadvantages include more expensive twisted pair wiring required, handshake lines (RTS, CTS, DSR, DTR) not available for COM2 on TEKNOR cards, extra software needed for implementing multi-station communications protocol (master-slave), etc.

Connecting hardware

Because the RS-422/RS-485 option requires different drivers than the usual RS-232 drivers, these must be installed directly at the factory on TEK-AT1, TEK-AT2 and TEK-AT3. Some simple jumper changes are required for the TEK-AT3L, TEK-AT4 and TEK-AT4L, VIPer 800, 801, 803, 804, 805, 806, 807, 820, 880, PCI 930, 932, 933 and 935. In the latter case these can be performed by the user, please refer to the appropriate hardware reference manuals for more details.

The following diagram gives the schematic layout of the RS-485 drivers on the TEKNOR boards.

EQUIVALENT SCHEMATIC RS-485 OPERATION



Please note only COM2 is available with RS-422/RS-485 drivers. The pins given are those of COM2's 10 pin header. These pin numbers are not the same ones as a DB-9 connector. If you are using a DB-10 to DB-9 cable (direct with pin 1 aligned), please refer to the translate table in annex C.

Use the signals marked **RX-** and **RX+** to interconnect the transmission lines. In order to change the direction of the RS-485 buffer, the **RTS** line of port COM2 is used. This line is disabled at bootup until the enable bit has not first been initialized to 1. At bootup, the enable bit is not active, making the port RS-422. Therefore, the first thing to do when initializing the TEKNOR for RS-485 mode is to make the RS-485 buffer input. Then enable the RS-485 direction by writing high (1) to address 201h bit 3.

USING RS-485(continued)

Connecting hardware(continued)

In RS-485, a termination resistor should be installed at both extremities of the communication line. This 120 ohms resistor is already present on all Teknor boards. So, the boards that are not at one extreme of the communication line should have their termination resistor removed ⁴. Because the master may not be at an extremity of the communication line, the master may or may not have a termination resistor.

Because all drivers in this circuit can be tri-stated at any point in time, the line could float and cause false start bit detection. It is therefore advisable to use a pull up and a pull down on the line to ensure a "high" state of the RS-485 line. Therefore, a pull up resistor of approximately 10K ohms should be added to the RX+ line and a 10K ohms pull down should be added to RX-.

Implementing software

In party line operation, several software schemes can be used to control the flow of data. Because there are no hardware handshake lines available, a software scheme must be used to control the flow of data back and forth without contention.

One such scheme involves the use of a master system and slave systems. The master system is the only one to initiate communication. Therefore, while idling, all systems have their RS-485 buffer as an input. The master system can then decide to request a response from one of the slave systems. The protocol should then include an address field. This address field identifies the slave system which must respond to the request. Each slave system must have a different address. When the designated slave system has completed its response, the communication line is released and all RS-485 buffers are again inputs.

The actual COM2 port architecture is identical to that of a standard IBM RS-232 communications port without handshake lines. Only the hardware drivers are changed from $\pm 12v$ RS-232 to bi-directional differential RS-485 drivers.

By default the address of the RS-485 port is COM2 (2f8h). However, if your application requires the address of the RS-485 port to be 3f8h (COM1), this can be done by writing to a special configuration port (FOR TEK-AT MODELS ONLY!!!). If you want to swap the addresses for the ports on a VIPer 800, 801, 803, 804, 880, you should do it in the VIP-UP program (at startup), for other VIPer and PCI models, it can be done in the AMI BIOS setup. (please refer to annex A)

⁴ The location of the termination resistor is not the same for all boards. Contact Teknor's Filed Application Group in order to know the exact location for the board you are using.

Controlling the direction of the RS-485 buffers

To control the direction of the RS-485 buffers, the RTS line is used. To avoid the RS-485 lines from glitching active at initialization, the direction should first be directed to input before initializing address 201h bit 3 (FOR TEK-AT SERIES ONLY). On the VIPer and PCI series, this address is 190h, 290h or 380h, depending on the jumper settings.

Set RS-485 buffer to transmit (output) : Write "03" to base I/O + 4

Set RS-485 buffer to receive (input) : Write "01" to base I/O + 4

ANNEXE A

Swapping COM1/COM2 addresses (FOR TEK-AT MODELS)

It is possible to swap the addresses used for COM1 (3f8h) with the addresses used for COM2 (2f8h). The result is the port who's connector is located on the front plate will become addressed at 2f8h and the port who's connector is the 10 pin header will become addressed at 3f8h.

Simply execute the following code:

```
MOV  DX,3F3h    ;Write to special port 3f3h twice to
MOV  AL,10h     ;reconfigure the communication ports
OUT  DX,AL      ;Swap COM1's / COM2's address & vice-versa
OUT  DX,AL
```

It is important the 2 "OUT" statements be consecutive. They can be done in C language, PASCAL, Assembler, Basic, etc. But this code cannot be performed manually using a debugger as this would be too slow.

Swapping COM1/COM2 addresses (FOR VIPer & PCI MODELS)

On theses models, swapping the serial ports is more simple;

For the VIPer 800, 801, 803, 804, 880 models

- Go in the VIPer Setup menu (Press CTRL-V at startup when system prompt for it).
- Change the UART 1 & UART 2 addresses.
- Press F10 (for update)

For the other VIPer & PCI models

- Go in the AMI BIOS setup (press DEL key at startup).
- In the setup window, select peripherals.
- Select the "Onboard serial port 1 or 2" by pressing Enter.
- Select the correct address you need for your serial port.
- Save and exit.

ANNEXE B

Disabling COM1 and/or COM2 (FOR TEK-AT MODELS)

Either or both communication ports (COM1 and/or COM2) can be disabled by issuing the following commands:

```
MOV DX,3F3h    ;This code will disable COM1 and free
MOV AL,04      ;addresses 2f8h-2ffh
OUT DX,AL
OUT DX,AL

MOV DX,3F3h    ;This code will disable COM2 and free
MOV AL,08      ;addresses 3f8h-3ffh
OUT DX,AL
OUT DX,AL

MOV DX,3F3h    ;This code will disable COM1 and COM2
MOV AL,0Ch      ;and free addresses 2f8h-2ffh + 3f8h-3ffh
OUT DX,AL
OUT DX,AL
```

Disabling COM1 and/or COM2 (FOR VIPer & PCI MODELS)

On these models, disabling the serial ports is more simple;

For the VIPer 800, 801, 803, 804, 880 models

- Go in the VIPer Setup menu (Press CTRL-V at startup when system prompt for it).
- Change the UART 1 interface or UART 2 interface to DISABLE.
- Press F10 (for update)

For the other VIPer & PCI models

- Go in the AMIBIOS setup (press DEL key at startup).
- In the setup window, select peripherals.
- Select the "Onboard serial port 1 or 2" by pressing Enter.
- Select the DISABLE option.
- Save and exit.

ANNEXE C

10 pin header to 9 pin DSUB cross-reference

Signal name	10 pin header	9 pin DSUB
Reserved	1	1
NC	2	6
RXD (-)	3	2
RXD (+)	4	7
TXD (-)	5	3
TXD (+)	6	8
NC	7	4
NC	8	9
GND	9	5

On TEKNOR TEK-AT boards, the COM1 port is output on a 9 pin DSUB connector on the front plate. This 9 pin DSUB is compatible with the IBM AT standard. The COM2 port is output on a 10 pin header located in the top right hand corner of the board. This 10 pin header can be changed into an IBM AT standard 9 pin DSUB with a simple adapter cable as described below.

On TEKNOR VIPer boards, the COM1 port is output on a 10 pin header located in the top right hand corner of the board. COM2 is just beside it, output on another 10 pin header. These 10 pin headers can be changed into an IBM AT standard 9 pin DSUB as described below. *** Special mention for VIPer 804 and 805 COM1 is also output on a 9 pin DSUB on the front plate (in parallel).

On the TEKNOR PCI boards, the COM2 port is output on a 10 pin header located in the top right hand corner of the board. COM1 is just aside it, (at left), output on another 10 pin header. These 10 pin headers can be changed into an IBM AT standard 9 pin DSUB as described below.

*****NOTE:** This cable can easily be made with a 10 pin flat cable crimp header and a 9 pin DSUB flat cable crimp header. Crimp both connectors to the cable keeping the pin 1 aligned with wire 1 of the cable. The end result must have continuity on pin 1 of both connectors. The above table can then be checked with a continuity tester. (TEKNOR OPT-402)