

## **Communication with IAI Controller**

### **Overview**

This document explains how to set-up communications between the DVT 600 Series and the IAI Super SEL controller type G. Some known confusion points and hardware problems are discussed and several solutions are presented. A very simple communications example is described to illustrate the necessary commands used in SEL language and the steps required to configure DataLink. The purpose of this document is to address communication issues, for a more elaborate example involving vision and motion control the reader is referred to the documents under Motion Control Notes.

### **Hardware**

The DVT 600 Series can communicate inspection results through a serial RS-422/485 connection or via Ethernet TCP/IP. The IAI controller communicates with external devices using a serial RS-232 connection called a SELNET port. Therefore, serial communications need to be established between the two systems. Both devices can send and receive data as ASCII characters without an additional serial protocol.

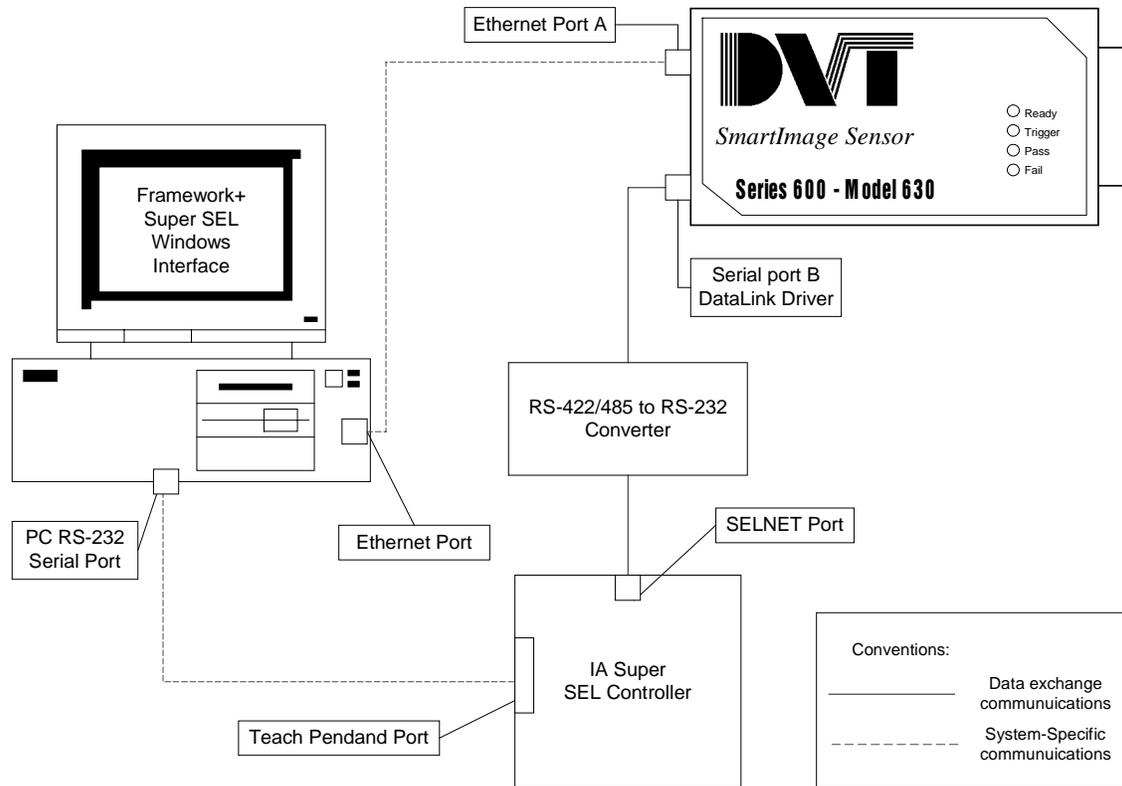
Confusion Point: System-specific communications must not be confused with data exchange communications.

Both the IAI controller and the DVT 600 have a command list composed of system-specific functions. The IAI controller system commands are used to communicate between the windows user interface (or the teaching pendant) and the firmware in the controller. IAI System Commands are ASCII characters preceded by either '!', '#', or '%'. For a complete list of commands refer to IAI Serial Communications Protocol publication #IAI-039C.

The DVT 600 system commands are used to communicate from the Framework User Interface to the firmware in the SmartImage Sensor. These system commands are also ASCII characters and are preceded by a '#' or a '\*'. For instance, the command to trigger an inspection is '#YI'. For a complete list of commands refer to link.

For the IAI controller, the system commands are received and interpreted over the teaching pendant port. Data is exchanged with external devices and other controllers via the SELNET port. Although it is possible to use a IAI command to send information through the teaching pendant port it is more convenient use the SELNET port because this allows the windows interface to run while debugging communications. (see **Error! Reference source not found.**)

In the DVT 600, system commands and data can be sent over the serial port or over the Ethernet port. Since the same physical connection can be used for both types of information, a distinction is made by selecting the System driver or the DataLink driver under the **Image Sensor Communications** dialog box in the **Communications** menu. **Error! Reference source not found.** shows a schematic of the basic connections, the ports used are indicated as well as the type of data that flows over the different lines.



**Figure 1: Schematic of Connections**

The configuration shown above is useful for testing because it allows the user to simultaneously interface with the image sensor and with the controller using the corresponding Window's GUIs. Assuming that both system communications are running normally let us describe in detail the data exchange connection.

To go from the DVT system to the IAI controller, the converter block in figure 2 must perform two functions: change standards from RS-422/485 to RS-232 and provide the proper connectors to the SELNET and DVT cables. The serial connection on the DVT 600 is an RS-422/485 port with a RJ-11 connector plug. A shielded RJ-11 cable is offered as an option with the DVT 600 system. The serial connection on the IAI controller is an RS-232 port with a plug for a 6 pin plastic connector as illustrated in **Error! Reference source not found..** There are several options for the SELNET port cable. IAI offers the following cables:

SELNET connector to SELNET connector - part # N/A

SELNET connector to 9 pin female D connector - part # IA-H201-IBM

SELNET connector to 25 pin female D connector - part # N/A

Only cable #1 above is shipped with the Super-SEL EG controller, the other options need to be ordered separately. However it is possible to cut the SELNET-SELNET cable and, using the given pin outs, connect the necessary 9 or 25 pin D connector with convenient gender ( see **Error! Reference source not found..** **Error! Reference source not found.** shows the pin outs of the connectors on each system. Remember that an interface converter is needed.

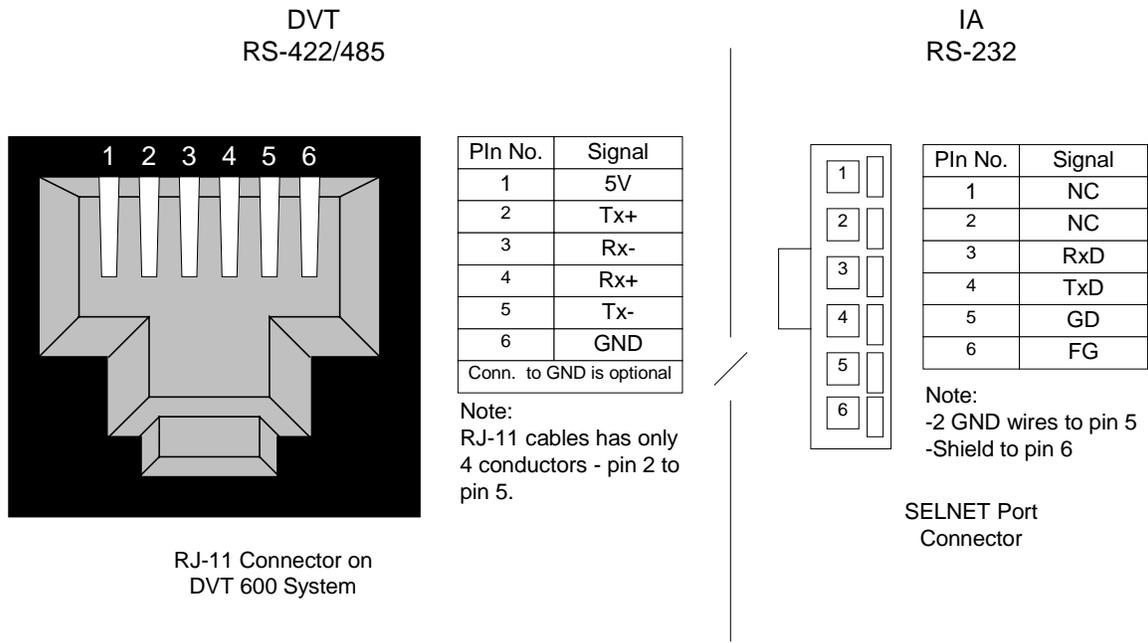


Figure 2 Serial Stds. And Connectors on Both Systems

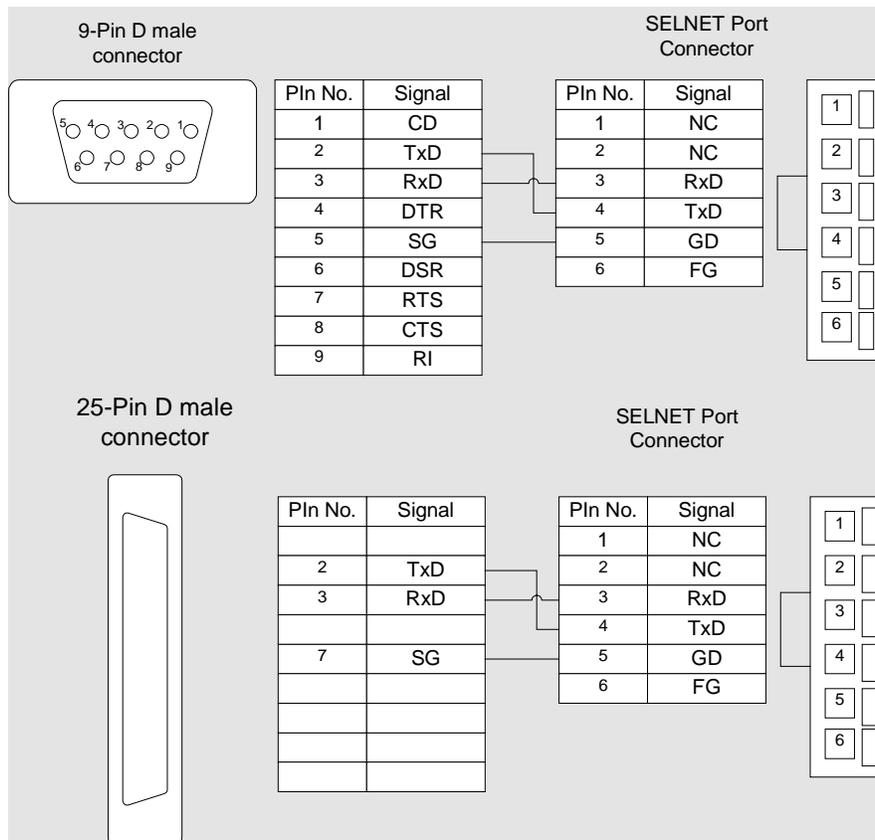
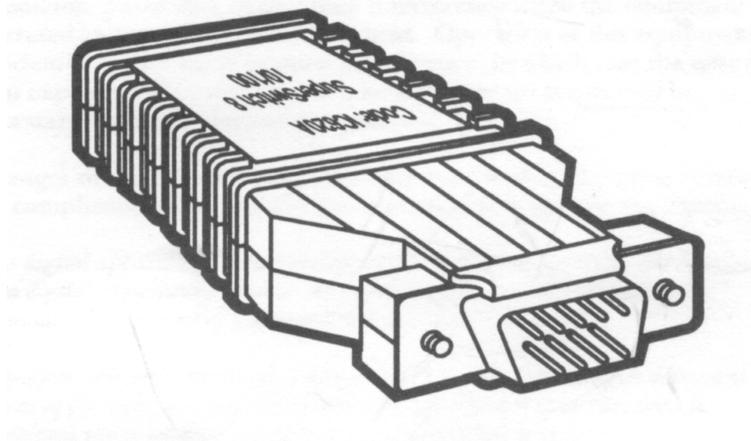


Figure 3 Straight-through DB9 and DB25 to SELNET Cables

A BlackBox interface converter (DVT part # CON-4T2) is currently offered as an option to be shipped with 600 systems. This converter has a RJ-11 plug on the RS-422/485 side and a 9-pin female D connector on the RS-232 side (See Figure ). It was chosen to interface with a PC RS-232 port. The converter obtains power from the RS-232 side of the connection. Specifically from either the DTR (pin 4), the RTS (pin 7) or RI (pin 9). When interfacing with a PC port, the converter sees these signals and can draw power from them. The SELNET port provides TxD, RxD and ground wires only so the BlackBox converter cannot draw power from the connection and communications are not possible.



**Figure 4: BlackBox Converter (Optional with DVT Systems)**

Known problem:

Communication between a DVT 600 and the IAI controller using the converter provided as an option with DVT systems is not directly possible. The converter needs 6-12 volts supplied to certain pins in order to obtain power.

Several solutions to this problem can be proposed. The advantages and disadvantages of each will be discussed.

### Solution #1

Use a different interface converter that is powered externally. Several options will be presented here. The prices vary depending on the type of isolation and complexity of the devices. BlackBox offers several converters that are powered by 115 VAC, 60 Hz. Although they provide extremely good isolation and configuration flexibility, the foot print of these converters is about 5 x 8 inches and they are priced higher.

RS-232-RS-422/485 Converter Plus :      Part # IC108A      List price : \$259

RS-232-RS-422/485 Converter Plus w/Opto-Isolation:

Part # IC109A-R2      List price : \$308

For information on other converters visit [www.blackbox.com](http://www.blackbox.com).

The connectors on the converters mentioned above are a 4 point terminal block on the RS-422/485 side and a 25-pin female D connector on the RS-232 side. The RJ-11 cable from DVT must be wired directly to the terminal block and a SELNET-DB25 Male connector must be ordered or constructed as in figure 4 (simply connect transmit, receive and ground wires.) The converters can be configured as a DCE (Data Communications Equipment such as a PC) or DTE (Data Terminal Equipment, devices such as Bar code readers). The default configuration is DTE; so transmit and receive lines are crossed at the terminal block. See Figure.

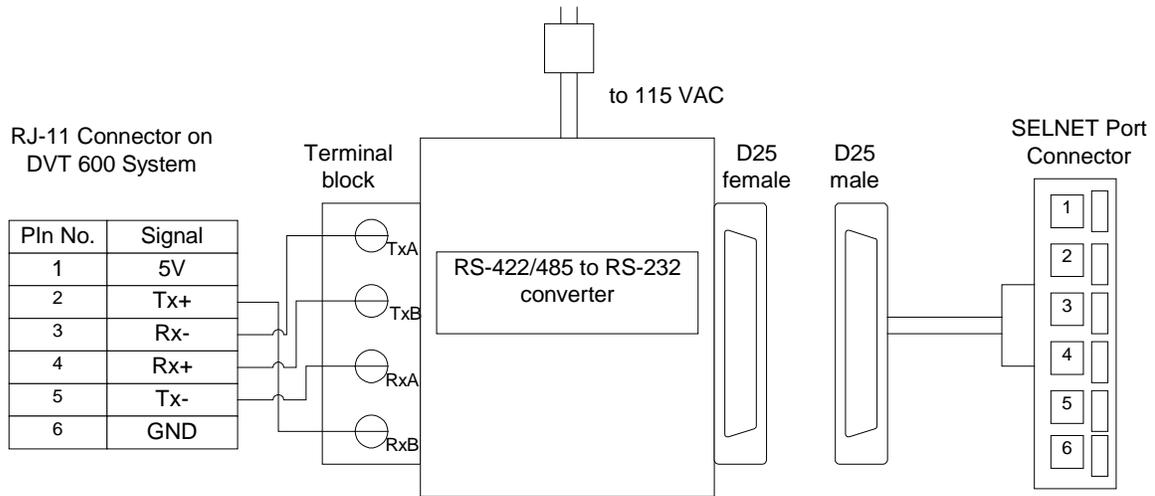


Figure 5: Connections with Externally Powered BlackBox Converter

B&B Electronics manufactures an externally powered converter with terminal block connectors on the RS-422 and DB9 or DB25 connectors on the RS-232 side. It comes with an optional 100VAC to 12V DC transformer that provides power to 2 terminals in order to enable the driver. The price of this converter is around \$70 in a very small package; one drawback is that it does not provide opto-isolation. The part number is 422LPCOR . For more information visit [www.bb-eec.com](http://www.bb-eec.com)

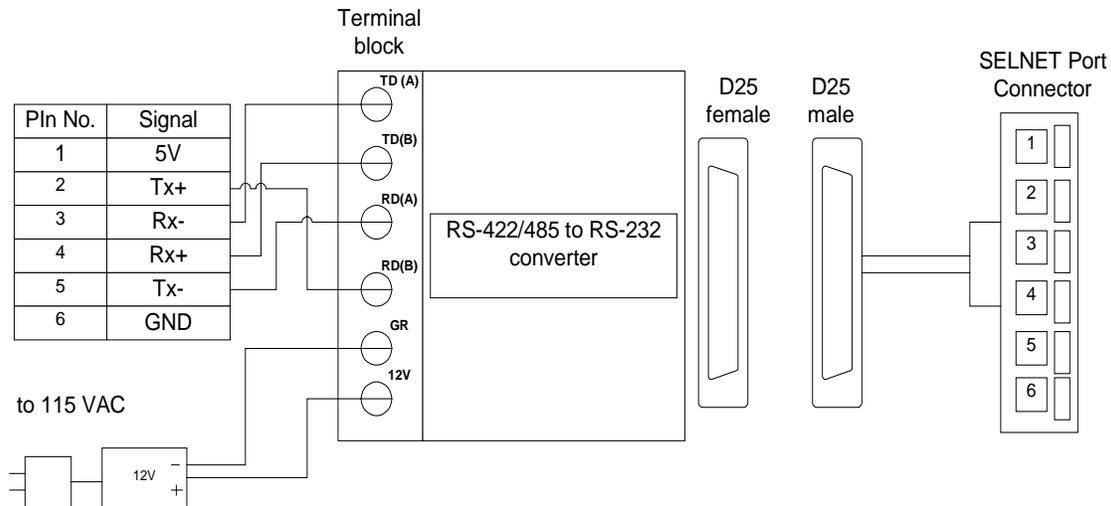


Figure 5: Wiring for B&B electronics converter.

Obtaining one of these externally powered converters constitutes the most robust solution to the problem without special restrictions on the distances of the wires. Some disadvantages of this solution may be the increased price of the converter and the need for an extra power line on the installation.

**Solution #2**

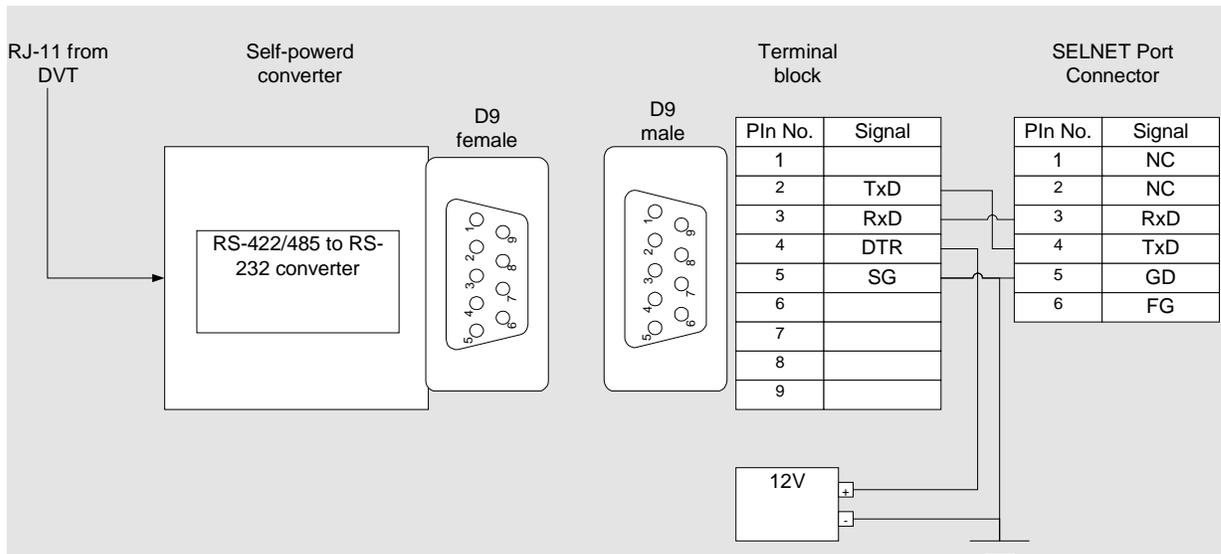
If the currently available converter is to be used then there must be power provided to it. A voltage of 6–12 volts with respect to SG (pin 5) can be applied to any of the following pins exclusively:

DTR: pin 4

RTS: pin 7

RI : pin 9

A terminal block with a 9 pin male connector will be ideal for this approach. The RS-232 side of the BlackBox converter plugs into the block and the TxD, RxD, and ground lines from the SELNET cable are connected to the corresponding terminals. In addition a 12 V line should be connected to the terminal corresponding to pin 4 in order to power the converter. See Figure for a schematic.

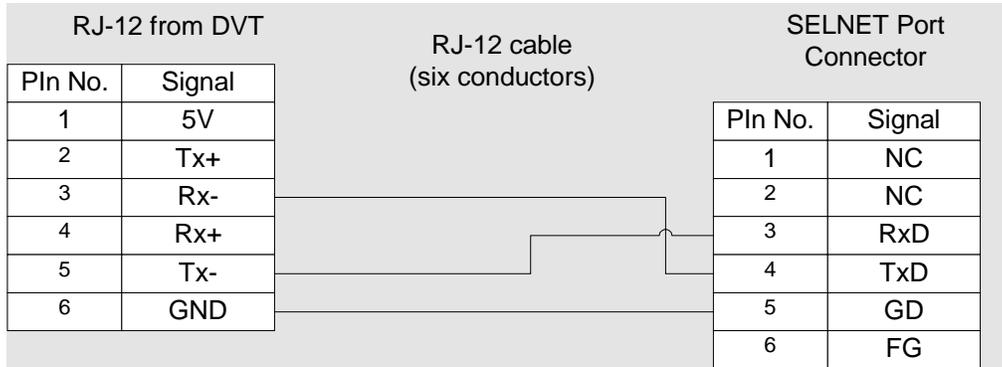


**Figure 7: Connections with Current BlackBox Converter**

This approach will provide a fast solution with the equipment currently available to DVT users. It carries almost no extra cost or space and has no special restrictions on the distance of the wires. A disadvantage of this solution is the need for an extra 12V line on the installation.

### Solution #3

The final solution presented here consists of completely bypassing the converter. By wiring the TxD- and RxD- and ground wires from the RS-422 side to the TxD, RxD and ground from the RS-232 side. To implement this solution, a different cable must be used on the DVT side. Instead of using a RJ-11 cable which carries only four conductors, a RJ-12 cable (same plug connectors but carries 6 conductors) must be used so that a common ground exists. A simple terminal block can be used for this approach. For the wiring details see Figure .



**Figure 8: Direct Wiring w/o Converter**

This solution is only applicable over very short distances (a few feet.) The RS-422/485 standard uses differential voltages to transmit data (allowing for greater distances), while the RS-232 standard uses absolute voltages. By performing the direct wiring explained above, the absolute signal levels produced in the RS-422/485 side and seen by the RS-232 side become close to the  $\pm 3V$  limit as the distance of the wires increases. In addition, this solution would make the system more vulnerable to noise. However, it has the advantage of not having to use a converter or an extra power line in the installation.

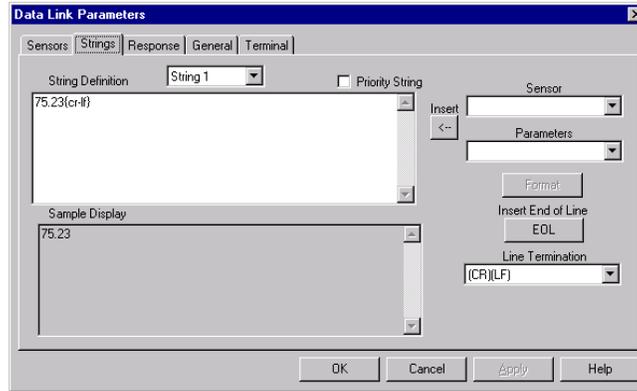
### Software-Example

One of the solutions described in the hardware section should be implemented for the data exchange connection and the connections should follow the diagram in Figure 2.

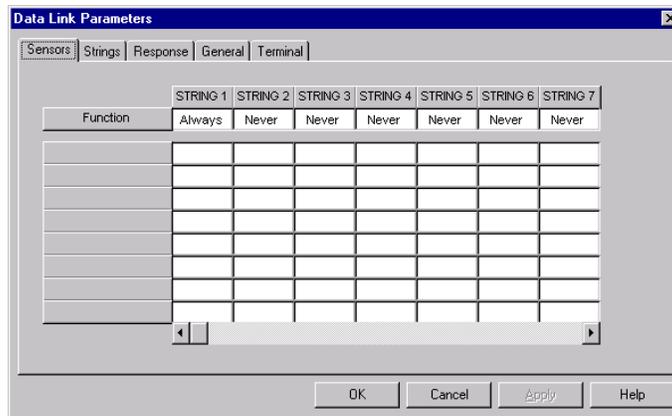
The best way to illustrate the necessary software steps is to go through a very simple example. A basic and common operation is to obtain the position of an object from the SmartImage sensor and feed it into a point table in the IAI controller. For the sake of simplicity this example will show how to send a single floating point number from the DVT system into the IAI controller (without regard for coordinate transformations). The steps necessary to accomplish this are:

On the DVT side:

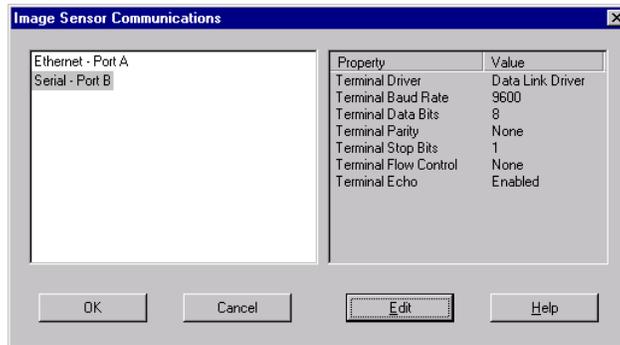
1. Set up DataLink to output a string with the desired format. This simulates a soft sensor outputting a position result from an actual inspection. Write a floating point number as a string and note the EOL characters (LF last).



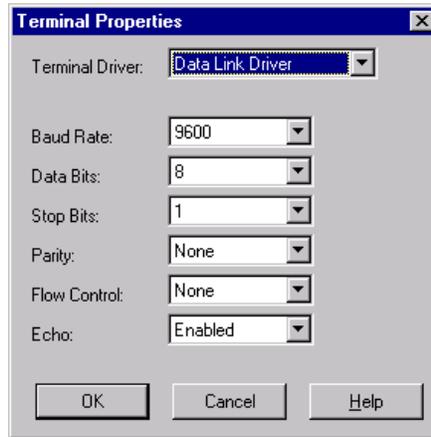
2. Output the string on every inspection



3. Configure the serial port B to the DataLink Driver and set connection parameters compatible with the SELNET requirements. It is important to use exactly these parameters or the connection will not work



The SELNET port expects data at 9600 Baud, 8 Data bits, 1 Stop bit, no parity check and no flow control. Some of these settings can be modified on the controller side. Simply make sure that they coincide with DVT settings.



4. Wait until the IAI controller is ready to receive the data and trigger and inspection to test the installation.

On the IAI side:

1. Write a simple program to read in the ASCII characters and place them in columns.
2. Convert the data to a floating point number and store it in a local variable.
3. Store the number in a point table.
4. Run the program and trigger a DVT inspection.
5. Open the point table to verify new addition.

The following Super SEL program accomplishes the tasks defined above. It was written to for a 2- axis robot. The comments for every line appear below.

| Step | E | N | Cnd | Cmd  | Operand1 | Operand2 | Pst | Comment |
|------|---|---|-----|------|----------|----------|-----|---------|
| 1    |   |   |     | WTON | 7        | 99       |     |         |
| 2    |   |   |     | HOME | 11       |          |     |         |
| 3    |   |   |     | SVOF | 11       |          |     |         |
| 4    |   |   |     | SCHA | 10       |          |     |         |
| 5    |   |   |     | OPEN | 1        |          |     |         |
| 6    |   |   |     | READ | 1        | 10       |     |         |
| 7    |   |   |     | SLEN | 5        |          |     |         |
| 8    |   |   |     | VAL  | 350      | 10       |     |         |
| 9    |   |   |     | LET  | 199      | *350     |     |         |
| 10   |   |   |     | PPUT | 1        | 10       |     |         |
| 11   |   |   |     | CLOS | 1        |          |     |         |
| 12   |   |   |     | EXIT |          |          |     |         |

**Line 1: WTON 07 99**

Wait 99 seconds for input port 07 to turn ON and continue to next step.

**Line 2: HOME 11**

Home both axes.

**Line 3: SVOF 11:**

Turn both servos off.

**Line 4: SHCA 10**

Set the ending character to ASCII 10 or LF character. This signals the controller to read ASCII characters until it sees the LF character.

**Line 5: OPEN 1**

Open SELNET PORT 1.

**Line 6: READ 1 10**

Read ASCII characters from port 1 and start placing them on local column variable 10. The READ Operation stops when the first LF character is read. In this particular example, after the READ command the local column variables should look like:

Column Number 10 11 12 13 14 15 16

|   |   |   |   |   |    |    |
|---|---|---|---|---|----|----|
| 7 | 5 | . | 2 | 3 | CR | LF |
|---|---|---|---|---|----|----|

**Line 7: SLEN 5**

Set the number of characters to convert to 5

**Line 8: VAL Convert ASCII 350 10**

Convert the ASCII string starting at column number 10 and having a length of 5 characters into a floating point number. Place the number in the global real variable number 350. Note: be careful to choose a real variable here and not an integer variable. Check your IAI documentation for the appropriate ranges according to your controller. For the G controller the global real variables go from No.s 300-399 and the local real variables from No's 100-199.

**Line 10: LET 199 \*350**

Put the contents of variable No. 350 into variable No. 199 (special register that holds data to be subsequently placed inside a point table).

**Line 10: PPUT 1 10**

Places the contents of variable No. 199 into position No. 10 (axis 1) inside the point table.

**Line11: CLOS 1**

Closes port 1.

**Line 12: EXIT**

Ends the program.

In order to obtain more detailed information about the format of SEL commands refer to the SEL programming guide, publication number IAI-040C, that comes with your controller. For communications review the string management functions and the SCHA, OPEN, READ, WRIT, and CLOS commands.

To test the setup run the program under the SELNET Windows interface. The status will let you know when the port is open and ready to read data. At this time trigger the DVT inspection. The program then ends and the status reads normal ending. To verify communications open the position table and under axis 1, position No. 10 the value 75.23 should appear listed.