

## Interfacing With Monitor Lab's Line Of Instrumentation

### 1.0 General

The CPP-3794 supports serial interfaces with the following ML instruments;

Model 9841 - NOX analyzer,  
Model 9850 - SO2 analyzer,  
Model 9830 - CO analyzer,  
Model 9812 - O3 analyzer.

To use the serial interface, the ML instruments require a unit ID and come from the factory with a default, wild card analyzer ID of ????. The ML instruments use a command structure of [Cmd],[ID]<crLf>. When adding an ML instrument into the CPP, the CPP defaults to the wild card ID of ????. If only one ML instrument is connected to the CPP, then there is no requirement to change the ID. If more than one ML instrument is connected to the CPP, but all are connected to different serial ports on the CPP, then again, there is no requirement that the ID be changed.

If however, more than one instrument is being connected to the same serial port on the CPP, then they must be given different ID's, and the wild card ID can not be used. If the ID's are not made different, then all instruments will answer a poll from the CPP, resulting in a garbled reception, and loss of data collection. The ID's can be set to any 3 digit number. For consistency, a numbering nomenclature is given below.

Instrument	ID #1	ID #2
9841 - NOx	841	741
9850 - SO2	850	750
9830 - CO	830	730
9812 - O3	812	712

Depending on the firmware version, the CPP polls the instrumentation once a minute, or once every fifteen seconds. The CPP uses the DCONC,ID command which commands the instruments to return an instantaneous reading along with status. The retrieved status information is decoded by the CPP and appended to the status of the data values. The internal operating condition of the instrument are contained in the received status and are decoded by the CPP. Reference section 3.5 of the CPP manual for a more detailed discussion of status indicators. Those associated with the ML instruments are presented in section 6.0 below.

The operator can also communicate directly with the instrumentation. This feature is presented in the Operator/Instrument Interface section of this appendix.

## 2.0 Connections

The ML instruments and the CPP are both configured as DTE devices and have 9 pin female connectors on the rear panel. A standard 9 pin male -to-9 pin male RS-232 cable is used to connect the CPP to the instruments. Standard cables have a male connector on one end and a female connector on the other end. A null modem must be inserted in the line to twist pins 2 and 3. H2NS offers this as part number 9MTW, or such devices can be readily obtained from any computer store.

In a multi-drop configuration, all ML instrumentation is "daisy chained" together with 9 pin RS-232 cables. Then one 9 pin RS-232 cable is connected to an open connector on any one of the instruments and connected to a comm port on the CPP. This approach requires independent analyzer ID's.

Another approach is to run a separate cable from separate comm ports on the CPP to each ML instrument. Additionally, any combination of the above two methods can be utilized.

In normal operation, and with instrumentation that supports the feature, the CPP controls the time clocks in the instrumentation. Referencing section 2.6 of the CPP manual, the CPP real time clock is very stable. Following a power up condition, and then periodically, the CPP downloads the time and date to all connected instrumentation. If the time or date is changed in the CPP, the CPP sends the new settings to the instrumentation as well.

The ML instruments do not readily support this feature. The time/date in the instruments are set from front panel menu selections and pushbuttons. Setting the time and date depends on being able to see the displayed time and date, and depressing a pushbutton to increment the setting until the desired value is displayed. The time and date should be set from the front panel of the instruments. The time in the instruments is of importance only when data archived in the instrument is being retrieved, or the instrument clock is being used to start calibrations. In normal operation, the CPP is time tagging data received from the instruments, and is starting and stopping calibration sequences.

## 3.0 Establishing Communications

The first step in establishing communications with an ML instrument is to connect a computer or terminal to one of the instruments RS-232 serial ports. A standard 9 pin male to 9 pin female cable is used to make this connection. In ProComm, or a similar program, configure the port for 9600 Baud, 8 bits, no parity, and one stop bit. Via the front panel of the instrument, enter the INTERFACE MENU and verify that the instrument has these same settings. To match, the Baud rate can be changed at either the computer or the instrument. The other parameters must be set to 8 bits, no parity, and one stop bit.

From the Main Screen, depress the enter pushbutton (may be a bent arrow). This brings up the MAIN MENU. Use the down arrow and step down to the INTERFACE MENU. Depress the enter to bring up the INTERFACE MENU. The above parameters should be displayed.

Communications can be tested by sending **DCONC,???**<cr>. The instrument should respond with a message like 0.12345 0002. An NOx instrument would have three

concentrations returned. The only important thing here is that the instrument receives the command and returns a response.

To change the instruments ID, from the INTERFACE MENU, cursor down to the COMM PROTOCOL line. Press the enter to select this line. Use the up or down arrow to change the setting to BAVARIAN. This allows an instrument ID to be loaded into the instrument. From the computer enter **PIXXX<cr>** where **XXX** is the desired instrument ID. Verify that the instrument accepted the ID by entering **DCONC,ID<cr>**. The instrument should respond as above. The COMM PROTOCOL can be returned to the original setting or left at the BAVARIAN setting.

The instrument can now be connected to the CPP using a null modem in the serial cable.

To determine an analyzers ID, from the MAIN MENU select INSTRUMENT MENU. At the bottom of the screen the MAIN GAS ID: 7, is the instruments ID setting.

The comm ports in the CPP can be setup for either RS-232 or RS-485 communications. RS-232 operation is standard. RS-485/422 requires that an IC be installed in a socket in the CPP and some switch settings changed. Reference section 2.2 of the CPP manual for more discussion regarding the serial port configurations. Table 1 below provides the pin connections for either configuration.

Table 1  
CPP Serial Connector Pin Assignments

RS-232		RS-485	
<u>Pin</u>	<u>Signal</u>	<u>Pin</u>	<u>Signal</u>
2	CPP Rx Data	4	TX-
3	CPP Tx Data	9	TX+
5	Ground	6	RX+
8	CPP RTS (Output)	7	RX-
5	Ground	8	RTS (Out)

#### 4.0 Initialization

The CPP is initialized via the operator port, comm port #4. Entering an **I<cr>** results in the CPP bringing up a Main Menu selection. Selecting the channel initialization results in the CPP asking a series of questions as presented below. Operator responses are in bold, and **<cr>** means a carriage return. The numbers 1.), 2.) and so forth are used for discussion purposes only and are not printed in an actual system initialization.

- 1.) Channel # = **1<cr>**
- 2.) Name = NAME **SO2<cr>**
- 3.) Units = UNITS **PPB<cr>**
- 4.) Full Scale = 100.0 **500.0<cr>**
- 5.) Zero = 0.0 **0.0<cr>**
- 6.) Instrument Manufacturer  
00 = Other

- 01 = API
- 02 = CLI
- 03 = ML
- 04 = Thermo
- 7.) Setting = 01 **4**<cr>
- 8.) ML Model #
  - 01 = SO2 -
  - 02 = NO - 9841
  - 03 = NOx - 9841
  - 04 = NO2 - 9841
  - 05 = CO - 9830
  - 06 = O3 -
- 9.) Setting = 01 <cr>
- 10.) Half Dpx(H), Full Dpx(F) = F <cr>
- 11.) Comm Port (3-00 Thru 3-08) = 3-01 3- **02**<cr>
- 12.) Baud Rate
  - 1 = 300, 2 = 1200, 3 = 2400, 4 = 4800, 5 = 9600, 6 = 19.2K, 7 = 38.4K = 5 <cr>
- 13.) Instrument ID = 00 **8XX**<cr>
- 14.) IMD Installed = 00 <cr>
- 15.) # Points For Interim Avg = 01 **04**<cr>
- 16.) # Points For Final Avg = 01 **9**<cr>
- 17.) Channel # = <cr>

**NOTE:** The inputting of PPB as the measuring units in this initialization has nothing to do with what the ML instrument is sending out over the serial interface. Reference section 8.0 below to ensure that the set up units and those being sent by the instrument are the same.

**Line one** simply asks which channel is to be initialized. A carriage return here exits back to the Main Menu. In other steps, a carriage return input leaves the setting unchanged and the CPP goes to the next question. In cases where the operator must provide an input, the CPP asks the same question again.

**Lines 2 through 5** request information that is not required for proper operation when interfaced to an instrument over the serial port. It is, however, good operating procedures to set these inputs to match those in the instrument. The correct full scale and zero values are required if data stored in the CPP is being output to some other device (for example, Odessa Engineering's Envicom program) in a binary format. This is also true of channels set up as ADC input channels.

Channel names and channel units can be up to six characters in length. The full scale and zero values can be four digits in length and the number of digits after the decimal point (if a decimal point is used ) must be the same in the full scale and zero inputs. The inputs can also have a minus sign.

**Line 6** lists all of the manufacturer drivers that are resident in this software version. In the example, four manufacturers are presented. As the manufacturers are alphabetized, the numbers delineating the various manufacturers will change depending on how many drivers are installed.

**In Line 7** of our example, the operator selected ML as the manufacturer. The CPP then prints a list of the model numbers that are supported for the Monitor Labs Environmental instrument line.

**In Lines 8 & 9**, the operator input a carriage return which selects the SO2 analyzer.

**Line 10** is asking if the units are connected in a half of full duplex configuration. Almost all instruments operate in a full duplex mode, which is the most straight forward method. If half duplex operation is required with ML instruments, please contact H2NS for support.

**In Line 11** the CPP asks to which comm port this analyzer is going to be connected. This is the connector on the CPP into which the cable from the instrument is plugged. The allowable inputs are 00-08, which is nine comm ports. As discussed above, all ML instrumentation can be plugged into the same comm port. In our example, the operator selected comm port 3-02. The comm port nomenclature should not be made overly complicated or confusing. Although comm Ports 3-00 through 3-08 are independent serial ports, internally the comm port 3 designation references interfacing to the instrumentation. Comm port 3-00 addresses comm port #3 physically located on the CPP printed circuit board and labeled comm #3 on the CPP back panel. Comm ports 3-01 through 3-08 address comm ports physically located on the expansion printed circuit board and are labeled comm 3-01 through comm 3-08 on the CPP back panel.

It should be noted that comm port #2 can be used to interface to some instrumentation. The ML line of instrumentation is not included in that group, and should always be assigned to a comm port number 3 designation. Comm port #2 is usually used with instruments that broadcast, which is normally meteorological instrumentation.

**In line 12**, the CPP is asking what Baud rate should be used to communicate with this instrument. This setting must be the same as that set up in the instrument, and sticking with the manufacturer default (9600 Baud) is recommended.

**Line 13** asks if an instrument ID is required. Instrument ID's are always required with the ML instruments. Input the appropriate three digit ID. In the example, the user input the SO2 default ID of 850. This could be any other code as well, e.g., 750. An instrument ID of 00 indicates that no instrument ID is required, which is not allowed with the ML instruments and instructs the CPP to use the wild card ??? as an ID.

**Line 14** is asking if an IMD (Intelligent Multidrop Device) is installed in this comm port cabling. The IMD, manufactured by H2NS, allows a number of different instruments to be connected to a single comm cable. The instruments can have different protocols and

even different Baud rates. This is very useful when a collection of instrumentation is located remotely from the CPP. The IMD allows only one cable to be run between the CPP and the instruments, with the IMD providing the instrument multiplexing locally at the instruments. The IMD supports addresses from 01 through 60. An address of 00 indicates that an IMD is not installed in this comm cabling.

**Lines 15 & 16** are questions regarding data validity qualifiers. The first (line 15) asks how many valid one minute samples the CPP must have to qualify the interim average as valid. Question 16 asks the same in regards to the final average. Reference section 3.5 of the CPP manual for a more detailed discussion of status

### **5.0 Calibrations**

To set up this channel as a calibration channel reference section 5.0 in the CPP manual. Calibrations can be set up to be controlled by the ML instrument operating from its internal clock, or by the clock in the CPP, or by an external controller. The CPP can be configured (by channel) to detect external digital bits as calibration indicators, or the CPP can be configured to generate contact closures to control calibrations. The CPP checks each data point received from the instruments to see if it has autonomously (or if and operator using the front panel controls) switched into a calibration mode. If so the CPP breaks out and flags the calibration results from the sample data.

The CPP can also be configured to send serial commands to the ML instrumentation to start/stop and control instrument calibrations. The set up of calibrations is covered in section 5.0 of the CPP manual. Calibration schemes can take on many mixed configurations. If you have any questions regarding calibration configurations, please feel free to contact H2NS.

### **6.0 Internal/External Digital I/O**

Please reference sections 4.7 and 4.8 of the CPP manual for a more detailed discussion of internal and external control and status features. These quite often tie into the overall system calibration schemes. On an individual basis, with each data poll the CPP also decodes received status. The four hexadecimal digit status from the ML instrumentation is as follows.

(bit 15) 0000 (bit0)

Bit 15 = sysfail

Bit 14 = flowfail

Bit 13 = lampfail

Bit 12 = chopfail

Bit11 = cvfail

Bit10 = coolerfail

Bit 9 = heaterfail

Bit 8 = refail

Bit 7 = psfail

Bit 6 = hvfail

Bit 5 = out of service

Bit 4 = in zero mode

Bit 3 = in span mode

Bit 2 = background

Bit 1 = ppm or mg/m3  
Bit 0 = reserved

If bit 2 or any bit from bit 6 to bit 15 is set, the CPP flags the data as BAD along with an instrument alarm flag. A print out of the data point would have a BI modifier. If bit 5 is set, the data is flagged as BAD along with an off line flag. A print out of the data point would have a BL modifier. Bits 3 and 4 are detected and flag the data as being in calibration. A print out of the data point would have an oC modifier. The trailing edges of both of these bits are detected and used to capture and report calibration data.

## 7.0 Operator/Instrument Interface

This section explains how an operator can communicate directly with the instruments over comm port #4. To communicate with the instruments with the central software reference the H2NS DataLink Users Manual.

Via comm port #4, the CPP has a menu that defines the appropriate commands associated with the instrument selected. Input **D43<cr>**. The CPP prints a table of the instruments that have been connected to it. An example is presented below.

Chn#	Manu	Mdl#	Type
01 =	ML	SO2-9850	- SO2
02 =	ML	NOX-9841	- NOX
03 =	ML	NO2-9841	- NOX
04 =	ML	NO-9841	- NOX
04 =	CLI	WS-TMII	- WS
05 =	CLI	WD-TMII	- WD

Selection = **2<cr>**

02 = ML NOX-9841 - NOX Selected

CMD> **?<cr>**

#NM01 = Ret To Measure Mode (%ABORT,XXX)

#NM02 = Send Average Conc (%DAVGC,XXX)

#NM03 = Start Zero/Span cycle (%DAZSC,XXX)

#NM04 = Character Dump (%DCOMM,XXX)

#NM05 = Send Current Reading (%DCONC,XXX)

#NM06 = Send Gain Data (%DGAIN,XXX)

#NM07 = Print Status Menu (%DINSTR,XXX)

#NM08 = Print Temps Menu (%DTEMPS,XXX)

#NM09 = Enter Span Mode (%DSPAN,XXX)

#NM10 = Enter Zero Mode (%DZERO,XXX)

CMD>

The CPP will provide a menu of the available commands for the selected instrument, along with the instrument initialized in the CPP (the XXX above) Referencing the above example, the operator can set the instrument into the zero mode in two ways. The first

is to send the command as specified by the instrument manufacturer, e.g., [**%DZERO,XXX<cr>**].

The brackets [ ] are for clarity only. The percent sign (%) is required as it apprises the CPP that the string input by the operator is to be sent to the instrument. The string command must be used if parameters are being sent to the instrument.

Alternately, the operator can input [**#NM11<cr>**] and the CPP will assemble and send the command to the instrument. In both cases instrument responses are presented. A "No Response" message is printed if the instrument does not respond. These abbreviated commands can only be use to interrogate the instruments, not to send parameters to the instruments.

If the operator had input [**#NM01?<cr>**] the response would have been;

#NM01 = Ret To Measure Mode (%ABORT,XXX)

CMD>

or a definition of just this command as opposed to definitions of all available commands.

The first character following the #, in this example N, identifies that the operator is communicating with an NOX instrument. Had the SO2 instrument been selected, the commands would have a format of #SM01. The ozone instrument would be #OM01, and the CO instrument would be #CM01.

Over comm port #4, the pass through to a particular channel can be accomplished by inputting **D43xx<cr>**, where xx is the desired channel. The CPP bypasses presenting a listing of all connected instrumentation, and prints only the instrument connected to the selected channel, and then asks for the command. If an instrument is not connected to this channel, the CPP outputs a message so indicating and does not enter the pass through mode.

In the pass through mode, strings can then be sent to the instrument with the **%(string)<cr>** inputs. The CPP remains in the pass through mode with this channel until it is exited as discussed below, or the pass through times out from inactivity. To select another channel, the pass through mode can be exited and reentered with another **D43xx** input, or at the CMD> prompt, enter an **M<cr>**. The CPP will present a listing of all instruments connected and ask for a selection. Select the channel desired.

An operator can also communicate directly with the connected instrumentation over comm port #1. The \$ID feature must be enabled for the pass through to be enabled. This is enabled by sending the CPP a dollar sign and then a single character ID, where the ID is one larger that the switch setting. If the switches are at the factory default of 1, then this pass through feature is enabled with a **\$2**. The CPP responds with a > prompt. To communicate with the instruments input **D13<cr>**. The CPP responds with a list of connected instruments, as presented above. The abbreviated method using a **D13xx<cr>** input may also be used as discussed above for comm port #4.

If comm port #4 has the pass through mode, comm port #1 would get a PASS THRU BUSY response if the pass through was attempted. The converse is true as well. Only one comm port can have the pass through mode at any given time.

To terminate the pass through mode input [^<cr>] at the CMD> prompt. If a character is not input for two minutes, the CPP times out and the pass through mode is exited automatically.

The CPP remains on line collecting data even in the pass through mode. Operator commands are interlaced with the CPP normal polling or interrogation commands.

A couple of the instrument commands can not be used in the pass through mode. They are REMOTE and DIR. Although the CPP will send the command if it is entered, the CPP internal comm port controller initiates time outs with each command set to instrumentation. After the time out, the comm port is released so that other functions can send commands and interface with the same instrument. The DIR and REMOTE commands are not conducive with shared operation.

### 8.0 Error Log

The CPP maintains a running error log that lets the user determine if communications are occurring properly. After connecting instrumentation clear the error log by inputting an **EC<cr>**. After some period of time (two to three minutes) check the error log (**E<cr>**) for errors. In proper operation, there should be no errors. The Error Log lists the following.

- |                |   |
|----------------|---|
| No Response    | - No response from the instrument to an interrogation   |
| Response Error | - CPP received response but detected an error in the data field   |
| Unknown Resp   | - CPP received a response but could not decode the response   |
| Model # Error  | - CPP received a response but not from the type of instrument it is configured to interrogate on this channel |

The three most common causes of errors are, the cable does or does not need a null modem, or the cable is connected to the wrong comm port on the CPP, or the Baud rate set in the CPP does not match that set in the instrument. With ML instrumentation, another source of potential error is that the instrument ID set up in the instrument must match that set up in the CPP.

### 8.0 Instrument Sending Units

The ML instruments default to sending readings in ppm (parts per million). The other option is mg/m3. The ML manual details how to select the units being transmitted by the instrument.

The units that are being transmitted can be determined by sending a query command to the instrument. As presented in section 6.0 above, enter the operator interface to the instrument and send [ %**DCONC, ID<cr>**]. The instrument will respond with a concentration reading and four digits of status. Bit 2, in the last of the four digits,

indicates the units. If it is set, then the concentration is in ppm. If not set, then the concentration is in mg/m<sup>3</sup>.