

## Interfacing With Thermo Environmental's Line Of Instrumentation

### 1.0 General

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

Model 42C - NOX analyzer,  
 Model 43C - SO2 analyzer,  
 Model 48C - CO analyzer,  
 Model 49C - O3 analyzer.

The Thermo instruments require a unit ID and come from the factory with a default analyzer ID. The factory ID default is the model number. For example, the Model 43C, SO2 analyzer has a factory ID default of 43, and the Model 42C, NOX analyzer has a factory ID default of 42. Any serial communications with a Thermo instrument must start with a special character that is the unit ID plus 128. For a Model 42 this turns out to be 10101010 in binary or 0AA in hexadecimal. These characters are difficult for a user to generate from a keyboard, so the CPP will calculate and insert these special characters.

The CPP polls the instrumentation once a minute. The Thermo instruments require two interrogations. The first Interrogation is to retrieve the present data reading, and the second interrogation is to retrieve the instrument status. The retrieved status information is decoded by the CPP and appended to the status of the data values. Internal operational alarms, high or low data values and status indications are contained in the received status and are decoded by the CPP. Reference the CPP manual for a more detailed discussion of status indicators.

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 pin assignments for the 9 pin DB to RJ-11 connector are presented below. The DB9 female to RJ-11 will plug directly into the CPP and a Teco Instrument. The pin assignments assume that a standard, twisted telephone cable is used.

9 Pin	9Pin DB To TECO		
	Color	RJ-11	RJ-11 Signal@CPP
2 Rx	Blk	2	2 - Tx
3 Tx	Yel	5	5 - Rx
5 Gnd	Grn	3	3 - Gnd

In a multi-drop configuration, all Thermo instrumentation is "daisy chained" together with 9 pin RS-232 cables or telephone cable and the DB9 to RJ-11 converters. Then one 9

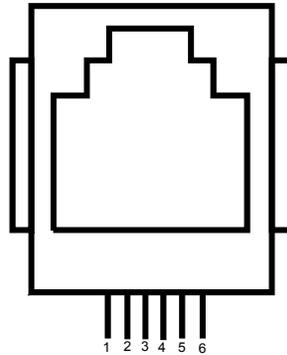
pin RS-232 cable is connected to an open connector on any of the instruments and connected to a comm port on the CPP.

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

It should be noted that if more than one analyzer of the same type are "daisy chained" together then the analyzers must be given different ID's and the CPP set up accordingly. If this is not done, then both instruments respond to a CPP interrogation, which results in a garbled reception and data loss. This is not true if the analyzers are connected to separate comm ports on the CPP.

### Rear Panel Connectors

H2NS installs a 6 pin, RJ11, connector into the CPP rear panel. The majority of applications only use four of the 6 pins, which are pins 2,3,4,5. A null modem can be readily implemented by either twisting or not twisting the cable, which is readily detectable because the cable is color-coded. **Standard, purchased telephone cables are twisted.** Presented below are the pin assignments set up by H2NS for the RJ11 connector.



- 1 RTS Output
- 2 TX+ Output of CPP
- 3 Gnd (TX- in RS-422/485)
- 4 Gnd (RX- in RS-422/485)
- 5 RX+ Input to CPP
- 6 CD Input
- 7

H2NS can also provide RS-232 connectors that are terminated in an RJ11 connector. One of the RS-232 connectors can be connected to an instrument and then connected with an RJ11 cable to the CPP. The wire colors for the 9 pin, DB male and female connectors are given below

Pin	9 Pin Male	9 Pin Female
1	Blu	Wht
2	Yel	Blk

3	Grn	Red
4	Red	Grn
5	Blk	Yel
6	Wht	Blu

### RJ-11 Connection

The pin assignments for the 9 pin DB connectors are presented below. The DB9 female to RJ-11 will plug directly into a Thermo Instrument. The pin assignments assume that a standard, twisted telephone cable is used.

9Pin DB To Thermo				
9 Pin	Color	RJ-11	RJ-11 Signal	
2 Tx	Blk	2	2 - Rx	
3 Rx	Yel	5	5 - Tx	
5 Gnd	Grn	3	3 - Gnd	

In normal operation the CPP controls the time clocks in the instrumentation. 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 comm ports in both the CPP and the Thermo instruments can be setup for either RS-232 or RS-485 communications. Switch settings in the CPP and in the Thermo instruments select the type of operation. Both should be set to the same mode. 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.

The Thermo instruments default to 9600 Baud operation. This can be changed. It is only important that the Baud rate in both the CPP and the instrument be the same. The Thermo instrumentation RS-232 word length should always be set for 8 bits, no parity, and one stop bit.

The Thermo instruments have a dip switch on the motherboard. Position #1 on this dip switch should be on enabling the remote I/O capability. From the parameter display, the instrument can be toggled between Remote and Local operation. The front panel display should display Remote.

### 3.0 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 brackets, 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 = Thermo
- 7.) Setting = 01 **3**<cr>
- 8.) Thermo Model #
  - 01 = SO2 - 43C
  - 02 = NOX - 42C
  - 03 = NO2 - 42C
  - 04 = NO - 42C
  - 05 = CO - 48C
  - 06 = O3 - 49C
- 9.) Setting = 01 <cr>
  
- 10.) Half Dpx(H), Full Dpx(F) = F <cr>
- 11.) Comm Port (3-00 Thru 3-08) = 3-00 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 = 0000 **43**<cr>
- 14.) IMD Installed = 00 <cr>
- 15.) # Points For Interim Avg = 01 **04**<cr>
- 16.) # Points For Final Avg = 01 **9**<cr>
- 17.) Unip(U)/Bip(B) = U <cr>
- 18.) Unip(U)/Bip(B) Cals = B <cr>
- 19.) Channel # = <cr>

**NOTE:** The inputting of PPB as the measuring units in this initialization has nothing to do with what the Thermo 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, three 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 Thermo as the manufacturer. The CPP then prints a list of the model numbers that are supported for the Thermo 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 straightforward method. If half-duplex operation is required with Thermo 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 0-8, which is nine comm ports. As discussed above, all Thermo instrumentation can be plugged into the same comm port. In our example, the operator selected comm port 3-2. The comm port nomenclature should not be made overly complicated or confusing. Although comm Ports 3-0 through 3-8 are independent serial ports, internally the comm port 3 designation references interfacing to the instrumentation. Comm port 3-0 addresses comm port #3 physically located on the CPP printed circuit board and labeled comm #3 on the CPP back panel. Comm ports 3-1 through 3-8 address comm ports physically located on the expansion printed circuit board and are labeled comm 3-1 through comm 3-8 on the CPP back panel.

It should be noted that comm port #2 can be used to interface to some instrumentation. The Thermo 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 Thermo instruments. Input the appropriate two digit ID. In the example, the user

input the SO2 default ID of 43. This could be any other code as well, e.g., 63. An instrument ID of 00 indicates that no instrument ID is required, which is not allowed with Thermo instrumentation.

**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 the CPP manual for a more detailed discussion of status

**Lines 16 & 17** This allows negative data values to either be accepted or set to zero. Usually, negative values are set to zero, except during calibrations.

#### **4.0 Calibrations**

To set up this channel as a calibration channel reference the CPP manual. Calibrations can be set up to be controlled by the Thermo 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.

#### **5.0 Internal/External Status**

Please reference appropriate sections 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 sends commands that return the instruments status. Flags indicating the operational mode, either sampling, zero, span, or diagnostics are retrieved and decoded by the CPP. Any potential abnormal condition is flagged with an I modifier. The eight hexadecimal digit status bytes returned from the Thermo instrumentation is interpreted as follows.

#### **5.1 Model 42C            NOX Ozonator/PMT**

The instrument is considered on line if the PMT is on and the ozonator is off. All other conditions are flagged as an off line condition.

#### **Mode**

The mode bits must indicate remote operation or the off line flag (L) is set.

#### **Measurement Mode**

The measurement mode bits must indicate auto or the off line flag (L) is set.

### **Gas Mode Status**

The two bits are interpreted as presented in the manual, providing an indication of the operational mode, either sample, zero or span.

### **Alarms**

The status bits provided are decoded in two groups. The first provides a high/low indication for the data value, and the second provides an indication of any instrument internal alarm.

### **5.2 Model 43C      SO<sub>2</sub>**

#### **Flash Lamp/Test LED Status**

The flash lamp on and the test LED off is interpreted as an on line condition. All other conditions are flagged as an off line conditions.

### **Gas Mode Status**

The two bits are interpreted as presented in the manual, providing an indication of the operational mode, either sample, zero or span.

### **Alarms**

The status bits provided are decoded in two groups. The first provides a high/low indication for the data value, and the second provides an indication of any instrument internal alarm

### **5.3 Model 48C      CO**

#### **AGC Status**

This status indication is not used.

### **Gas Mode Status**

The two bits are interpreted as presented in the manual, providing an indication of the operational mode, either sample, zero or span.

### **Alarms**

The status bits provided are decoded in two groups. The first provides a high/low indication for the data value, and the second provides an indication of any instrument internal alarm.

### **5.4 Model 49C      O<sub>3</sub>**

#### **Gas Mode Status**

The two bits are interpreted as presented in the manual, providing an indication of the operational mode, either sample, zero or span.

### **Alarms**

The status bits provided are decoded in two groups. The first provides a high/low indication for the data value, and the second provides an indication of any instrument internal alarm.

## **6.0 Operator/Instrument Interface**

The CPP supports two modes in which an operator can communicate directly with the connected instruments. One is an on line mode, in which the CPP interleaves operator and polling commands, and the second is an off line, unabated pass through mode.

### On Line Communications

Via comm port #4, the CPP has a menu that defines the appropriate commands associated with the instrument selected. Via comm port #1, enter SETQ to switch comm port #1 into comm port #4. Input **D43<cr>** and the CPP responds with a list of instrumentation connected to the unit, as shown below;

Chn#	Manu	Mdl#	Type
01 =	THERMO	SO2-43C	- SO2
02 =	THERMO	NOX-42C	- NOX
03 =	THERMO	NO2-42C	- NOX
04 =	THERMO	NO-42C	- NOX
04 =	CLI	WS	- WS
05 =	CLI	WD	- WD

Selection = **2<cr>**

02 = THERMO NOX-42C - NOX Selected

CMD> **?<cr>**

#NF01 = Local/Remote Operating Mode (%MODE)

#NF02 = Set Local Mode (%SET MODE LOCAL)

#NF03 = Set Remote Mode (%SET MODE REMOTE)

MORE>

Note - this is an example, the actual list is much longer. The MORE> indicates that more commands are available. At this point commands can be sent to the instruments as well as from the CMD> prompt. A carriage return input presents more commands.

The CPP will provide a menu of the available commands for the selected instrument. Referencing the above example, the operator can set the instrument to the remote mode in two ways. The first is to send the command as specified by the instrument manufacturer, e.g., [ **%set mode remote<cr>**].

The brackets [ ] are for clarity only and should not be included in the string. 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 CPP will insert the appropriate special characters required to communicate with the Thermo instruments. It can also be inserted in the string by the operator, but this can be difficult. This string command must be used if parameters are to be sent to the instrument.

Alternately, the operator can input [**#NF03<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 [**#NF01?**<cr>] the response would have been;

#NF01 = Local/Remote Operating Mode (%MODE)

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 #SF01. The ozone instrument would be #OF01, and the CO instrument would be #CF01.

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 **D43** 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.

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.

### Off Line Pass Through

Invoking this feature removes the CPP from the loop, and allows a user to communicate directly, unabated, with the instrument. More discussion of this is provided in Tech Note 36.

### 7.0 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 Thermo instrumentation, another source of potential error is that the instrument must be set for REMOTE operation (which enables the RS-232 port) and the instrument ID set up in the instrument must match that set up in the CPP.

From the main screen (data values being displayed) on the Thermo instruments, the Remote/Local selection can be toggled by depressing the ENTER push-button. The Local mode must be selected to make changes in the instrument from the front panel, but it needs to be returned to the Remote mode for proper system operation.

### **8.0 Instrument Sending Units**

The Thermo instruments default to sending readings in ppb (parts per billion). The other options are ppm (parts per million) and  $\mu\text{g}/\text{m}^3$ . Appendix B of the Thermo 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 [ **%GAS UNIT<cr>**]. The instrument will respond with “gas unit ppb (or ppm or  $\mu\text{g}/\text{m}^3$ ).” The units can be changed by sending [ **%SET GAS UNIT PPM<cr>** (OR **UG/M3**) ]. The instrument will respond with “set gas unit ppm ok.”