THORNTON

Leading Pure Water Analytics

Part No. 84423

2000 Communications Manual

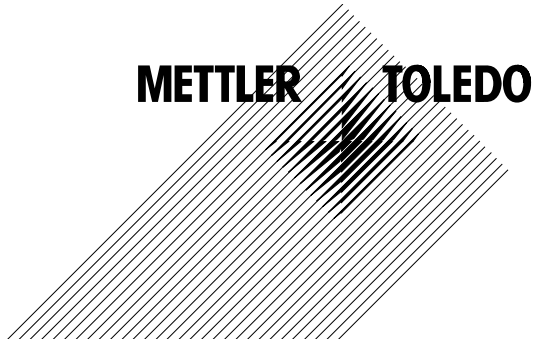

TABLE OF CONTENTS

2000 COMMUNICATIONS INTERFACE

This manual covers serial communications only. For general coverage of the 2000 instrument, refer to manual 84401.

DESCRIPTION

Each 2000 is equipped with a digital communication interface. The communication interface can be configured as either an RS232 or an RS422 port. This interface can be connected to a personal computer, programmable logic controller, or a printer. The wiring of the meter will determine which interface will be used. An external isolator is recommended for the digital communications signals to prevent ground loops from affecting measurements.

WIRING CONNECTIONS

Connections to the communication interface are made at the terminal block TB4 at the rear of the meter. The wiring for each interface is shown in Tables 1 and 2.

TB4 Label	**RS232 Function**
GND	Ground
TXD+	Not Used
TXD-	Transmit Data
RXD+	Not Used
RXD-	Receive Data

Table 1: RS232 Connections

TB4 Label	**RS422 Function**
GND	Ground
TXD+	Transmit Data Positive
TXD-	Transmit Data Negative
RXD+	Receive Data Positive
RXD-	Receive Data Negative

Table 2: RS232 Connections

RS232 / RS422 SETTINGS

The default interface is set with the following characteristics:

- 19, 200 Baud
- Even Parity
- 8 Data Bits
- 1 Stop Bit

The baud rate and parity setting can be changed via the menus (see next section). The available baud rates are: 19,200, 9600, 4800, 2400, and 1200. The number of data bits and stop bits cannot be changed.

CHANGING BAUD RATE AND PARITY SETTINGS

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until the “Set Serial Port” menu is displayed.

Set Serial Port

Press the OK/NEXT key to access this menu. A typical menu may appear as:

Baud=9600 P=Even

The cursor is initially under the baud rate setting. Press the UP and DOWN keys to change the baud rate. Use the RIGHT arrow key to move the cursor to the parity field. The parity setting can be switched between even parity and no parity.

Press the OK/NEXT key when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

INITIALIZATION MESSAGES

Upon power-up the 2000 will initialize the communication interface and transmit the following messages:

"Thornton Associates – 68xx Verx.x" "Ready"

Each message is terminated with a carriage-return character. The 2000 is now ready for communications. If the automatic data output feature is enabled (see the AUTOMATIC DATA OUTPUT section), the meter will begin transmitting measurement data. The 2000 is now ready to receive a command.

COMMUNICATING WITH THE 2000

The 2000 communication interface contains a complete set of commands for controlling the meter. All operational parameters can be inquired and modified.

A command is defined as a string of ASCII characters transmitted to the 2000. **All commands must be terminated with a carriage-return character, CHR$(13)**. The first character of a command is called the opcode. The command may contain additional characters called parameters.

The 2000 will always return a response when a command is received. The response to a command may contain the requested information, an acknowledgment, or an error message. Some response examples are:

1. **"OK"** - indicates that the command was accepted and properly executed.
2. **"ERROR #01** - this is an error response indicating that the command was invalid.
3. **"G0E=1.000000K"** - this is a typical response containing data.

RESPONSE MESSAGES

1. **"OK"** - the command was accepted and properly executed.
2. **"ERROR #01"** - invalid command opcode or an invalid parameter in the command.
3. **"ERROR #02"** - overrun error. The command contains too many characters or too many commands have been sent.
4. **"ERROR #08"** - parity error on one or more characters in the command.
5. **"ERROR #09"** - framing error. This is most likely caused by noise on the communications line.

AUTOMATIC DATA OUTPUT

The 2000 can be set to output measurement data once per second. The data is transmitted as a string of ASCII characters. All four measurements are contained in the string.

To enable or disable this feature press the OUTPUTS key.

Output: **Analog**

Press the UP arrow key until "Serial" is displayed. Press the OK/NEXT key to access this menu.

Output **off** >001s

Press the UP arrow key and toggle the serial output from "Off" to "On". Setting the serial out feature to "On" enables the automatic data output. Use the RIGHT arrow key to move the cursor to the time field.

Output On >**0**01s

Use the arrow keys to set the desired time interval in seconds.

Note: Entering a value greater than 255 seconds will automatically set the timer interval to 255 seconds.

Press the OK/NEXT key when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

DATA OUTPUT FORMAT

Measurement data is transmitted as a string of 61 ASCII characters as follows:

“Dabbbbbb ccccc deeeeee fffff ghhhhhh iiiii jkkkkkk lllll mmnn” The lower case letters are variables defined as:

Position	Field	Description
01:	“D”	This character always “D”.
02:	“a”	Channel A Primary setpoint condition. (“ “= no error, “>” = high setpoint exceeded, “<” = low setpoint exceeded).
03-08:	“bbbbbb”	Channel A Primary measurement.
9:	“ “	Always a space.
10-14 :	“ccccc”	Units for measurement (example: Mo-cm).
15:	“ “	Always a space.
16.	“d”	Channel A Secondary setpoint condition.
17-22:	“eeeeee”	Channel A Secondary measurement.
23:	“ “	Always a space
24-28:	“fffff”	Channel A Secondary units.
29:	“ “	Always a space.
30:	“g”	Channel B Primary setpoint condition.
31-36:	“hhhhhh”	Channel B Primary measurement.
37:	“ “	Always a space
38-42 :	“iiiii”	Channel B Primary units.
43:	“ “	Always a space
44:	“j”	Channel B Secondary setpoint condition.
45-50:	“kkkkkk”	Channel B Secondary measurement
51:	“ “	Always a space
52-56:	“lllll”	Channel B Secondary units.
57:	“ “	Always a space
58-59	“mm”	This field is always “01”.
60-61:	“nn”	Exclusive-or checksum of all preceding characters.

Examples:

```
“Dabbbbbb ccccc deeeeee fffff ghhhhhh iiiii jkkkkkk lllll   mmnn”
“D  8.182 Ko-cm > 25.00  DegC  S **** Mo-cm   ****.  DegC   015F”
“D 513.67 Ko-cm  30.637  DegC  1.0178 Mo-cm  14.511  DegC   01C7”
```

COMMAND SET

	Command	Function	Opcode
1	Attention	Returns the software revision level	A
2	Set Data Output	Enables or disables the automatic data output	B
3	Get Data	Returns the latest set of measurement data	D
4	Reset	Performs a complete system reset	R
5	Set Parameter	Sets a parameter	S
6	Get Parameter	Returns the value of a parameter	G
7	Key press	Simulates a key press, returns the menus displayed	K
8	Display Message	Displays a message	M
9	Self Test	Performs all of the self tests	T
10	Keypad Test	Used to test the keypad	Y
11	Echo Command	Echoes the characters in the command(for testing the port)	E
12	Set Analog outputs	Set the analog output current to a level (for testing)	O

Table 3: Command Set Summary

All other opcodes will return an “ERROR #01” message.

Attention Command

Description:

This command will return the software revision level. It is also used to determine if the meter is on line and able to communicate.

Command Format:

“AT”

Response Format:

“Thornton Associates- 68xx Ver x.x”

Example:

Command: **“AT”**

Response:

“Thornton Associates- 6822 Ver 1.0”

Set Data Output Command

Description:

This command will enable or disable the automatic data output.

Command Format:

“Baa”

Where aa: = “00” to enable the data output, “FF” to disable the data output.

Response Format:

“OK”

Example:

To enable the data output:
Command: **“B00”**

Note: When enabling the data output, the output timer is set to 1 second intervals.

Response: **“OK”**

Get Data Command

Description:

This command will return the latest set of measurement data

Command Format:

“D01”

Response Format:

Data is returned in the format described in the Data Output Format section.

Example:

Command: **“D01”**

Response: **“D 513.67 Ko-cm 30.637 DegC 1.0178 Mo-cm 14.511 DegC 01C7”**

Reset Command

Description:

This command will set the meter to the default conditions.

Command Format:

“R*” – System Reset

"R*a", where "a" is optional

a options:

"R*M" to clear the measurement buffers.

Response Format:

“OK”

Example:

“R*”

Response:**”OK”**

Set Parameter Command

Description:

This command will set a parameter value.

Command Format:

“Saa=bbbbbbbbc”

Where:

aa = code of parameter to be changed.

bbbbbbbb = value (up to 8 digits including a decimal point)

c = optional multiplier (“u” = micro, “m” = milli, “K” = kilo, or “M” = mega.

Response Format:

If the command is accepted: **“OK”**

If the command is rejected: **“ERROR #01”**

Example:

Set the value of setpoint #1 to 0.001125.

Command: **“S0E=1.125000m”**

Response: **“OK”**

Set setpoint #2 to use signal B, relay #1, and as a high setpoint:

Command: **“S0B=65”**

Response: **“OK”**

Set channel A to measure conductivity in the range of micro-siemens/cm.

Command: **“S3F=03”**

Response: **“OK”**

Code	Parameter Name	Description	Range
01	PASSWORD	Password	00000-99999
02	A_SIG1_MULT	Multiplier cell constant for A Cell	no range
03	A_SIG2_MULT	Multiplier cell constant for A Temp	no range
04	B_SIG1_MULT	Multiplier cell constant for B Cell	no range
05	B_SIG2_MULT	Multiplier cell constant for B Temp	no range
06	A_SIG1_ADD	Additive cell constant for A Cell	no range
07	A_SIG2_ADD	Additive cell constant for A Temp	no range
08	B_SIG1_ADD	Additive cell constant for B Cell	no range
09	B_SIG2_ADD	Additive cell constant for B Temp	no range
0A	SP1_SETUP	Setpoint #1 setup information: Bits 7:5=signal (000=None, 001=A, 010=a, 011=B, 100=b). Bits 4:2=relay number (000=no relay, 001=relay #1, etc.) Bits 1:0=state (00=off, 01=high setpoint, 10=low, 11 = USP) **Note: This number is sent and received in hexadecimal format.**	00-FFH
0B	SP2_SETUP	Setpoint #2 setup information	00-FFH
0C	SP3_SETUP	Setpoint #3 setup information	00-FFH
0D	SP4_SETUP	Setpoint #4 setup information	00-FFH
0E	SP1_VALUE	Setpoint #1 value	no range
0F	SP2_VALUE	Setpoint #2 value	no range
10	SP3_VALUE	Setpoint #3 value	no range
11	SP4_VALUE	Setpoint #4 value	no range
12	R1_DELAY	Relay #1 delay value in seconds	0-999
13	R2_DELAY	Relay #2 delay value in seconds	0-999
14	R3_DELAY	Relay #3 delay value in seconds	0-999
15	R4_DELAY	Relay #4 delay value in seconds	0-999
16	R1_HYSTER	Relay #1 hysteresis value in % Note: This number is sent and received in hexadecimal format.	(0-99) **00-63H**
17	R2_HYSTER	Relay #2 hysteresis value in % **Note: This number is sent and received in hexadecimal format.**	(0-99) **00-63H**
18	R3_HYSTER	Relay #3 hysteresis value in % **Note: This number is sent and received in hexadecimal format.**	(0-99) **00-63H**
19	R4_HYSTER	Relay #4 hysteresis value in % **Note: This number is sent and received in hexadecimal format**.	(0-99) **00-63H**
1A	R1_STATE	Relay #1 state (0-normal, 1=inverted)	0-1
1B	R2_STATE	Relay #2 state (0-normal, 1=inverted)	0-1
1C	R3_STATE	Relay #3 state (0-normal, 1=inverted)	0-1
1D	R4_STATE	Relay #4 state (0-normal, 1=inverted)	0-1
1E	AOUT_SIGNALS	Sets the signal assigned to the outputs: High nibble = Aout2 low nibble = Aout1 0=none, 1=A, 2=a, 3=B, 4=b. **Note: This number is sent and received in hexadecimal format**.	00-44H
1F	AOUT1_MIN	Minimum value for analog output #1	no range

Code	Parameter Name	Description	Range
20	AOUT1_MAX	Maximum value for analog output #1	no range
21	AOUT2_MIN	Minimum value for analog output #2	no range
22	AOUT2_MAX	Maximum value for analog output #2	no range
2B	A_MAN_TEMP	Ch A, manual temperature setting in DegC (must set A_TEMP_STATE variable to enable manual temperature)	no range
2C	B_MAN_TEMP	Ch B, manual temperature setting in DegC	no range
2D	A_LINEAR_COMP	Ch A, linear compensation value in %/°C (must set COMP_METHOD variable to enable linear compensation)	no range
2E	B_LINEAR_COMP	Ch B, linear compensation value in %°C	no range
3F	AP_MODE	Ch A, measurement mode 0=no mode, 1=resistivity, 2=conductivity (S/cm), compensated, 3=DegC, 4=DegF, 5=TDS, 6=%Rejection, 7=S/m , 8=ratio, 9=difference, A=pH, B=Volts, C= %HCl, D=%NaOH, E=%H_2SO_4, F = conductivity, Uncompensated, 10 = Tohms (ohms reading of the RTD), 11=g/L 02, 12=0_2 ppm, 13=02 ppb, 14=%Sat **Note: This number is sent and received in hexadecimal format**	0-14H
40	AS_MODE	Ch a, measurement mode	0-14H
41	BP_MODE	Ch B, measurement mode	0-14H
42	BS_MODE	Ch b, measurement mode	0-14H
43	DISPLAY_MODE	Selects the data to be displayed 00 = display A and B measurements 01 = display a and b measurements 02 = display A and a measurements 03 = display B and b measurements **Note: This number is formatted as two digits**	00-03
44	LOCKOUT	Lockout mode and keys: each bit is used as follows: Bit 7: Set to enable lockout. Other bits listed below must be set to lockout functions. Bit 0: Set to lockout Measure key. Bit 1: Set to lockout Setpoint key. Bit 2: Set to lockout Relays key. Bit 3: Set to lockout Outputs key. Bit 4: Set to lockout Calibrate key. Bit 5: Set to lockout Menus key. Bit 6: Set to lockout Display keys.	
45	MAVE_N	Averaging method. The averaging method for both channels A and B are combined into one byte. High nibble = Ch B, low nibble = Ch A. 0=low, 1=medium, 2=high, 3-special **Note: This number is sent and received in hexadecimal format.**	00-33H
46	AUTO_SEND	Auto send measurement data via the serial port: 0=disabled, 1=send data at the set timer interval (see OUTPUT_TIMER)	0-1

Code	Parameter Name	Description	Range
47	COMP_METHOD	Compensation method: High nibble = Ch A, low nibble = Ch B. 0=none, 1=standard, 2=linear, 3=cation, 4=alcohol, 5=Light 84 **Note: This number is sent and received in hexadecimal format.**	00-55H
48	BAUD_ RATE	Baud Rate: 0=19200, 1=9600, 2=4800, 3=2400, 4=1200. **Note: A measurement reset command, R*M, must be issued after this command in order for the new setting to take effect.** **Note: This number is formatted as two digits**.	00-04
49	PARITY_ENABLE	Enables or disables the parity feature. 1=even parity, 0=no parity **Note: A measurement reset command, R*M, must be issued after this command in order for the new setting to take effect**.	0-1
4A	OUTPUT_TIMER	Output timer in seconds. This is the number of seconds between transmissions of measurement data when the automatic data output is enabled.	00-9FH
4B	AUTO_SCROLL	Display scroll mode 0=display scroll off, 1= on	0-1
4C	A_TEMP_STATE	Ch A: 0=normal, 1=manual temperature	0-1
4D	B_TEMP_STATE	Ch B: 0=normal, 1=manual temperature	0-1
4E	MEASURE_PER_LINE	Sets the number of measurements that will be displayed on one line: 0=2 measurements per line, 1= 1 measurement per line	0-1
4F	FREQ	Sets the input power line frequency to reduce measurement noise 0=50Hz, 1=60Hz	0-1
50	SP1_ACTIVE_ON_ERR	Setpoint 1 activation on error. 0 = setpoint will not be active on cell error (overange), 1 = active	0-1
51	SP2_ACTIVE_ON_ERR	Setpoint 2 activation on error. 0 = setpoint will not be active on cell error (overange), 1 = active	0-1
52	SP3_ACTIVE_ON_ERR	Setpoint 3 activation on error. 0 = setpoint will not be active on cell error (overange), 1 = active	0-1
53	SP4_ACTIVE_ON_ERR	Setpoint 4 activation on error. 0 = setpoint will not be active on cell error (overange), 1 = active	0-1
54	AOUT1_ERROR_STATE	Output 1 Error State 1 = Analog output will go to minimum level on cell error (overange), 0 = go to maximum level.	0-1

Code	Parameter Name	Description	Range
55	AOUT2_ERROR_STATE	Output 2 Error State 1 = Analog output will go to minimum level on cell error (overange), 0 = go to maximum level.	0-1
5A	AP_RANGE	Ch A, Range The upper nibble sets the range and units: 1= no range, 2=auto-ranging, 3=micro, 4=milli, 5=unit, 6=Kilo, 7=mega, 8=PPB, 9=PPM, A=PK The lower nibble is zero. **Note: This number is sent and received in hexadecimal format**	10-A0H
5B	AS_RANGE	Ch a, Range	10-A0H
5C	BP_RANGE	Ch B, Range	10-A0H
5D	BS_RANGE	Ch b, Range	10-A0H

Note: All codes not listed above should not be used.

Get Parameter Command

Description:

This command will return the value of a parameter.

Command Format:

"Gaa"

Where aa = code of parameter to be gotten (refer to previous section for definitions).

Response Format:

"Gaa=bbbbbbbbc"

Where aa = code of parameter to be gotten.

bbbbbbbb = value (8 digits including a decimal point).

c = multiplier ("u" = micro, "m" = milli, "K" - kilo, "M" = mega, or a space character).

Example:

Get the value of setpoint #1.

Command: **"G0E"**.

Response: **"G0E=1.000000K"**

Key Press Command

Description:

This command is used to simulate a key press from the front panel. The response is a string of 16 characters which is the message displayed as a result of the key press. Also, the cursor position is returned.

Command Format:

"Kaa"

Where "aa" is the key code as follows:

00 = Not used.

01 = MEASURE key.

02 = MENUS key.

03 = OK/NEXT key.

04 = Right arrow key.

05 = Not Used.

06. = SETPOINT key.

07 = CAL key.

08 = Down arrow key.

09 = Up arrow key.

0A = Not used.

0B = RELAYS key.

0C = OUTPUTS key.

0D = Left arrow key

FF = special code to make the unit exit the menu mode.

All other codes are not used

Response Format:

If the key code is valid then the display message will be returned as:

“Kaaaaaaaaaaaaaaaa:bb”

“aaaaaaaaaaaaaaaa” is the message displayed as a result of the key press. “bb” is the cursor position (01 to 16).

Invalid key codes will return an error message as **“ERROR #1”**.

Example:

Command: **“K06”**

Response: **”KSp1 on signal a:02”.**

Display Message Command

Description:

This command is used to display a message for approximately 5 seconds. If the unit is in the menu mode then the menus will be terminated before the message is displayed.

Command Format:

“Maa.... aa”

Where “aa..aa” is the message to be displayed (16 characters).

Response Format:

“OK”

Example:

Command: **“MThis is a test”**

Response: **“OK”**

Perform Self-Test Command

Description:

This command is used to perform the self-test/diagnostic test.

Command Format:

“T*”

Response Format:

This response will be “OK” if all of the tests pass. If one or more tests fail then the response will be “FAILED=xx”, where “xx” is the results code. A bit of this code will be set to indicate the test(s) that failed.

bit 0 = set when the RAM test fails (01h)

bit 1 = set when the timer test fails (02h).

bit 2 = set when the analog test fails (04h).

bit 3 = set when the keypad test fails (08h).

bit 4 = set when the ROM test fails (10h).

bit 5 = set when the NVRAM test fails (20h).

Example:

Command: **“T*”**

Response: **“FAILED=12”**. This response indicates that the ROM test and timer test failed.

Keypad Test Command

Description:

This command puts the meter into the keypad test menu. When a key is pressed a message will be displayed and sent out the serial port.

Command Format:

"Y*"

Response Format:

"OK"

When a key is pressed the message sent out the serial port is in the format "Kaa" where "aa" is the key code.

Echo Command

Description:

This command is used to test the serial communication port. The characters in the command are sent back in the response.

Command Format:

"Eabcdefgh"

Where abcdefgh are any ASCII characters except CR.

Response Format:

"E=abcdefghii"

Where "ii" = "OK" if no communication problem, else "ERROR".

Example:

Command: **"E12345678"**

Response: **"E=12345678OK"**

Set Analog Output Current Command

Description:

This command is used to set an analog output current to a specific value.

Command Format:

"Oabbbbbbbb"

Where a = output number, bbbbbbb = output current in mA.

Response Format:

"OK"

Example:

Set output #1 to 12.125mA

Command: **"O112.125"**

Response: **"OK"**

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