# *Modbus RTU/TCP*
# *Installation and Programming Guide*
# *PC3400 Particle Counter*

## Introduction

This guide is for use with Chemtrac's PC 3400 D Particle Counters.

The Modbus RTU protocol defines how a "master" device polls one or more "slave" devices to read and write data in real time by means of RS232, RS422, or RS485 serial data communication. Modbus/TCP is the Ethernet version of this protocol.

The following table defines the Modbus registers.

### Modbus RTU/TCP Register Table for the PC3400 Particle Counter

| Register | Bytes | Data Width | Name | R/W | Range | Designator | | Function | Description |
|---|---|---|---|---|---|---|---|---|---|
| 40001 | 2 | 16 | Acquiring | Read | 0 - 1 | Number | Integer | 03 | 1 = Acquiring (ver. 1.22 and later) |
| 40002 | 2 | 16 | Reserved 1 | Read | | Number | Integer | 03 | |
| 40003 | 2 | 16 | Reserved 2 | Read | | Number | Integer | 03 | |
| 40004 | 2 | 16 | Reserved 3 | Read | | Number | Integer | 03 | |
| 40005 | 2 | 16 | LVAL | Read | 0 – 200 | Percent | Integer | 03 | Laser Condition |
| 40006 | 2 | 16 | CVAL | Read | 0 – 200 | Percent | Integer | 03 | Cell Condition |
| 40007 | 2 | 16 | Count Index | Read | 0 – 9999 | Number | Integer | 03 | Index Count |
| 40008 | 2 | 16 | Holding | Read | 0 – 1 | Number | Integer | 03 | Output Holding Flag |
| 40009 | 2 | 16 | Particle Count 1 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 1, High 16 Bits |
| 40010 | 2 | 16 | Particle Count 1 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 1, Low 16 Bits |
| 40011 | 2 | 16 | Particle Count 2 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 2, High 16 Bits |
| 40012 | 2 | 16 | Particle Count 2 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 2, Low 16 Bits |
| 40013 | 2 | 16 | Particle Count 3 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 3, High 16 Bits |
| 40014 | 2 | 16 | Particle Count 3 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 3, Low 16 Bits |
| 40015 | 2 | 16 | Particle Count 4 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 4, High 16 Bits |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 40016 | 2 | 16 | Particle Count 4 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 4, Low 16 Bits |
| 40017 | 2 | 16 | Particle Count 5 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 5, High 16 Bits |
| 40018 | 2 | 16 | Particle Count 5 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer5, Low 16 Bits |
| 40019 | 2 | 16 | Particle Count 6 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 6, High 16 Bits |
| 40020 | 2 | 16 | Particle Count 6 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 6, Low 16 Bits |
| 40021 | 2 | 16 | Particle Count 7 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 7, High 16 Bits |
| 40022 | 2 | 16 | Particle Count 7 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 7, Low 16 Bits |
| 40023 | 2 | 16 | Particle Count 8 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 8, High 16 Bits |
| 40024 | 2 | 16 | Particle Count 8 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer 8, Low 16 Bits |
| 40025 | 2 | 16 | Particle Count 9 (high) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer >, High 16 Bits |
| 40026 | 2 | 16 | Particle Count 9 (low) | Read | 0 - 65535 | Count | Integer | 03 | Count Buffer >, Low 16 Bits |
| 40027 | 2 | 16 | Total Counts (high) | Read | 0 - 65535 | Count | Integer | 03 | Total Counts, High 16 Bits |
| 40028 | 2 | 16 | Total Counts (low) | Read | 0 - 65535 | Count | Integer | 03 | Total Counts, Low 16 Bits |
| 40029 | 2 | 16 | Alarm Output (0) | Read | 0 – 17 | Number | Integer | 03 | Alarm Output Flag (0) |
| 40030 | 2 | 16 | Alarm Output (1) | Read | 0 – 17 | Number | Integer | 03 | Alarm Output Flag (1) |
| 40031 | 1 | 8 | Unit Address | Read/Write | 0 - 255 | Number | Integer | 03, 06 | Modbus Address |
| 40032 | 1 | 8 | Flow Rate | Read/Write | 0 – 255 | mL/min | Integer | 03, 06 | Set Flow Rate |
| 40033 | 2 | 8 | Size Ranges 1 (from) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | Start Point for Size Range 1 |
| 40034 | 2 | 8 | Size Ranges 1 (to) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | End Point for Size Range 1 |
| 40035 | 2 | 8 | Size Ranges 2 (from) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | Start Point for Size Range 2 |
| 40036 | 2 | 8 | Size Ranges 2 (to) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | End Point for Size Range 2 |
| 40037 | 2 | 8 | Size Ranges 3 (from) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | Start Point for Size Range 3 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 40038 | 2 | 8 | Size Ranges 3 (to) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | End Point for Size Range 3 |
| 40039 | 2 | 8 | Size Ranges 4 (from) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | Start Point for Size Range 4 |
| 40040 | 2 | 8 | Size Ranges 4 (to) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | End Point for Size Range 4 |
| 40041 | 2 | 8 | Size Ranges 5 (from) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | Start Point for Size Range 5 |
| 40042 | 2 | 8 | Size Ranges 5 (to) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | End Point for Size Range 5 |
| 40043 | 2 | 8 | Size Ranges 6 (from) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | Start Point for Size Range 6 |
| 40044 | 2 | 8 | Size Ranges 6 (to) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | End Point for Size Range 6 |
| 40045 | 2 | 8 | Size Ranges 7 (from) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | Start Point for Size Range 7 |
| 40046 | 2 | 8 | Size Ranges 7 (to) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | End Point for Size Range 7 |
| 40047 | 2 | 8 | Size Ranges 8 (from) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | Start Point for Size Range 8 |
| 40048 | 2 | 8 | Size Ranges 8 (to) | Read/Write | 0 – 127 | Number | Integer | 03, 06 | End Point for Size Range 8 |
| 40049 | 2 | 16 | Sample Frequency | Read/Write | 0 – 65535 | Seconds | Integer | 03, 06 | Sample Period (Frequency) |
| 40050 | 2 | 16 | Sample Time | Read/Write | 0 – 65535 | Seconds | Integer | 03, 06 | Sample Length (Period) |
| 40051 | 2 | 16 | CLOCK (year) | Read/Write | 2000 – 2050 | Number | Integer | 03, 06 | Real Time Clock (Year) |
| 40052 | 2 | 16 | CLOCK (month) | Read/Write | 1 - 12 | Number | Integer | 03, 06 | Real Time Clock (Month) |
| 40053 | 2 | 16 | CLOCK (day) | Read/Write | 1 - 31 | Number | Integer | 03, 06 | Real Time Clock (Day) |
| 40054 | 2 | 16 | CLOCK (hour) | Read/Write | 0 - 23 | Number | Integer | 03, 06 | Real Time Clock (Hour) |
| 40055 | 2 | 16 | CLOCK (minute) | Read/Write | 0 - 60 | Number | Integer | 03, 06 | Real Time Clock (Minute) |
| 40056 | 2 | 16 | CLOCK (second) | Read/Write | 0 - 60 | Number | Integer | 03, 06 | Real Time Clock (Second) |
| 40057 | 2 | 16 | ALARM HIGH THRESHOLD 1 | Read/Write | 0 – 65535 | Number | Integer | 03, 06 | Alarm High Threshold 1 |
| 40058 | 2 | 16 | ALARM LOW THRESHOLD 1 | Read/Write | 0 – 65535 | Number | Integer | 03, 06 | Alarm Low Threshold 1 |
| 40059 | 2 | 16 | ALARM HIGH THRESHOLD 2 | Read/Write | 0 – 65535 | Number | Integer | 03, 06 | Alarm High Threshold 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 40060 | 2 | 16 | ALARM LOW THRESHOLD 2 | Read/Write | 0 – 65535 | Number | Integer | 03, 06 | Alarm Low Threshold 2 |
| 40061 | 2 | 16 | ANALOG INPUT 1-1 | Read | 4000 - 20000 | Number | Integer | 03 | Analog Input 1-1 (mA x 1000) |
| 40062 | 2 | 16 | ANALOG INPUT 1-2 | Read | 4000 - 20000 | Number | Integer | 03 | Analog Input 1- 2 |
| 40063 | 2 | 16 | ANALOG INPUT 1-3 | Read | 4000 - 20000 | Number | Integer | 03 | Analog Input 1-3 |
| 40064 | 2 | 16 | ANALOG INPUT 1-4 | Read | 4000 - 20000 | Number | Integer | 03 | Analog Input 1-4 |
| 40065 | 2 | 16 | ANALOG INPUT 2-1 | Read | 4000 - 20000 | Number | Integer | 03 | Analog Input 2-1 (mA x 1000) |
| 40066 | 2 | 16 | ANALOG INPUT 2-2 | Read | 4000 - 20000 | Number | Integer | 03 | Analog Input 2- 2 |
| 40067 | 2 | 16 | ANALOG INPUT 2-3 | Read | 4000 - 20000 | Number | Integer | 03 | Analog Input 2-3 |
| 40068 | 2 | 16 | ANALOG INPUT 2-4 | Read | 4000 - 20000 | Number | Integer | 03 | Analog Input 2-4 |

**Size Ranges (Bins)**

There are 8 size ranges available with the PC3400. The PC3400 has two modes that determine how the size ranges will be configured. The first mode is **differential**. This mode uses two registers for each size range. The first register is used for the lower micron size value, while the second register is used for the higher size value. This allows the operator the ability to create size ranges that overlap. For instance, the user can create a size range of 2 to 5 microns, and then create a size range of 3 to 7 microns. See the example in the table (differential) below.

The other mode is **composite** (sequential). In this mode, size ranges are defined from the lower micron size value to the higher micron size value. Overlapping of size ranges is not possible in this mode. For example, the first size channel could be set from 2 to 5, where the first low channel is set for 2µm size particles and the first high channel is set for 5µm size particles. The second low channel automatically uses the high value from the previous channel. In this example, the second channel would automatically begin with 5µm. See the table (composite) below to get an idea of how this works.

The number of channels is determined by the number of sizes written to the Particle Counter. Setting a size value to 0 will stop the addition of size channels and will limit the total number to the number of size values written. All successive sizes must be written as 0. Again, see one of the tables below to see how this works.

The last channel is always configured for the last size value and higher. For example, if a size value of 15 was the last size value written to the counter, the last size channel would be for particle counts of size 15µm and greater.

Example (**differential mode**):

| Register Number | Value | Description |
|---|---|---|
| 40033 | 2 | The first size channel will be from 2µm to 5µm. |
| 40034 | 5 | |
| 40035 | 3 | The second size channel will be from 3µm to 7µm. |
| 40036 | 7 | |
| 40037 | 15 | The last size channel will be from 15µm and greater. |
| 40038 | 0 | |
| 40039 - 40048 | 0 | The next ten values must be set to 0 to limit the number of size ranges to three. |

Example (**composite mode**):

| Register Number | Value | Description |
|---|---|---|
| 40033 | 2 | The first size channel will be from 2µm to 5µm. |
| 40034 | 5 | |
| 40035 | 5 (Auto) | The second size channel will be from 5µm to 7µm. |
| 40036 | 7 | |
| 40037 | 7 (Auto) | The third size channel will be from 7µm to 15µm. |
| 40038 | 15 | |
| 40039 | 15 (Auto) | The last size channel will be from 15µm and greater. |
| 40040 | 0 | |
| 40041 - 40048 | 0 | The next nine values must be set to 0 to limit the number of size ranges to four. |

**Particle Counts & Multipliers**

There are 9 channels of particle count data available for the PC3400. Use the particle count registers (low & high) to calculate the actual particle count values. Multiply the high particle count register by 65536 and then add the particle low register to get the actual particle counts for the corresponding channel. For example, if the particle counts low for channel 1 is 6964, and the particle counts high value for channel one is 1, the actual counts would be 72500.

***Particle Counts = Particle Counts (low)[channel] + Particle Counts (high)[channel] * 65536***

Use registers 40027 (high) and 40028 (low) to calculate total counts.

Example:

| Values | | Calculated | Size Range |
|---|---|---|---|
| Particle Counts (low) | Particle Counts (high) | | |
| 3928 | 2 | 135000 | 2 - 5 |
| 4464 | 1 | 70000 | 5 - 7 |
| 142 | 0 | 142 | 7 - 15 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 20 | 0 | 20 | >15 |

.

**Cell Condition (40006)**

The cell condition value is a percentage value that shows the cleanliness of the flow cell in the sensor.  100% is the ideal reading for cell condition

.

**Flow (40032)**

The flow value represents the sample flow rate for the PC3400 Particle Counter in mL.  This default value is 75.  Changing this number will affect particle counts.

**Frequency (40049)**

The frequency is a value in seconds that determines how often the particle counter will take a sample.

**Address (40031)**

This read/write value represents the Modbus address of the unit.

## Port Settings

Use the following port settings if communication problems are encountered.

| Setting | Value |
|---|---|
| Bits per second | 9600 Baud |
| Data Bits | 8 (RTU) |
| Parity | None (RTU) |
| Stop Bits | 1 |
| Flow control | None |

## Modbus/TCP Settings

The default IP address for the particle counter is 192.168.1.1.  Use this address to configure the particle counter.

## Exception Codes

| Code | Field Name | Meaning |
|---|---|---|
| 01 | ILLEGAL FUNCTION | The function code received in the query is not an allowable action for the slave |
| 02 | ILLEGAL DATA ADDRESS | The data address received in the query is not an allowable address for the slave |
| 03 | ILLEGAL DATA VALUE | A value contained in the query data fields is not an allowable value for the slave |
| 04 | SLAVE DEVICE FAILURE | An unrecoverable error occurred while the slave was attempting to perform the requested action |
| 05 | ACKNOWLEDGE | The slave has accepted a request and is processing it, but a long duration of time is required. This response is returned to prevent a timeout. |
| 06 | SLAVE DEVICE BUSY | The slave is processing a long duration program command. The master should retransmit the message later when the slave is free. |
| 07 | NEGATIVE ACKNOWLEDGMENT | The function just requested could not be performed. |