

P Tower Serial Communication Protocol

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Introduction

This document outlines the communication protocol between the PC and the Tower microcontroller board.

P.1 Conceptual View

The PC or Tower can initiate a transfer of serial information at any time (asynchronously) using the Universal Serial Bus (USB). Information is transferred in packets, with each packet consisting of 5 bytes. A conceptual view of communication between the PC and the Tower is shown below:

Conceptual view of
information transfer
between PC and
Tower

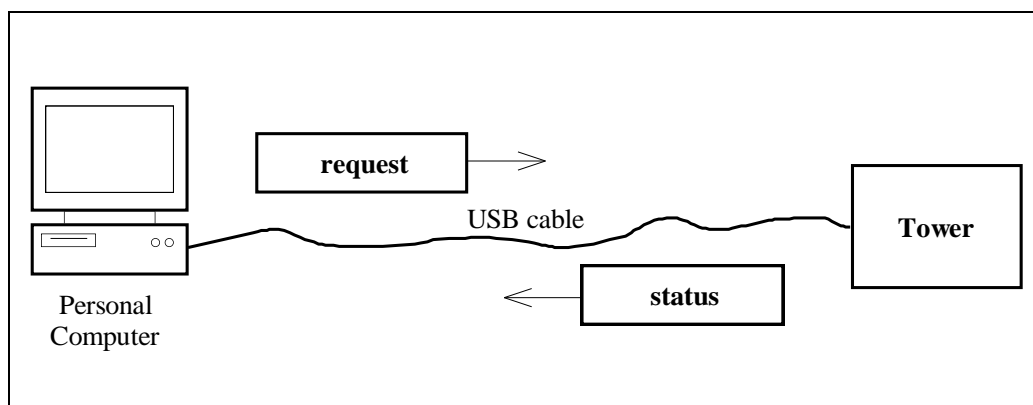


Figure 5.1

Sometimes a transmitted packet will request a response from the receiver. In this case, a response to the command is initiated once the command has been carried out (or attempted to be carried out).

P.2 PC and Tower Communication

A typical picture of the PC and Tower communicating is shown below:

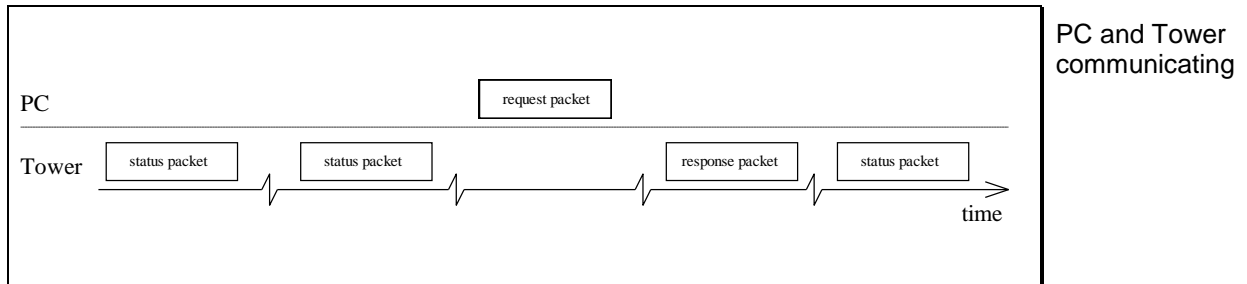


Figure 5.2

The Tower is continually updating the PC with information regarding the state of the various inputs and outputs of the module, such as push buttons, LEDs, A/D results and PWM duty cycles. This state information is only sent on start up and when the state of the Tower module changes – this prevents the PC from receiving many packets with the same information, which wastes processing time.

The PC will occasionally send a request packet to the Tower, asking it to carry out some task. It may or may not specify for the Tower to acknowledge that the request has been carried out successfully. If the PC does specify an acknowledgement, then the Tower will respond with a response packet.

P.3 Packet Structure

Each packet of information contains 5 bytes as follows:

Packet structure

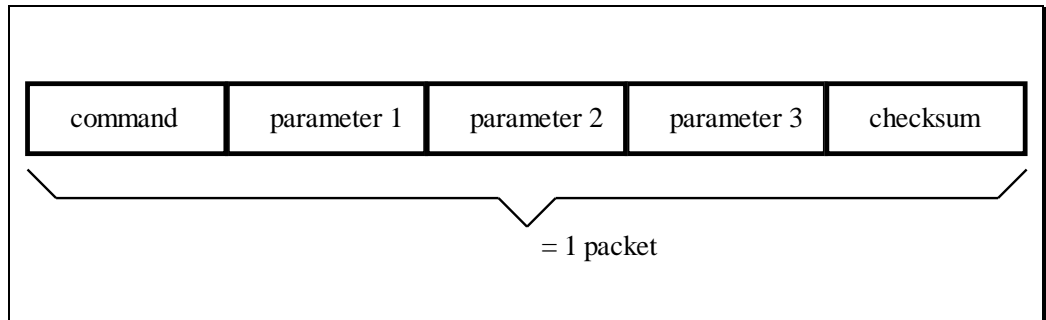


Figure 5.3

The command byte contains a command number, as listed in the tables that follow. The use of the three parameter bytes depends on the particular command being sent. The checksum is the exclusive-or (XOR) of the four preceding bytes and is used as a simple means to detect most transmission errors (corruption of a packet) and for packet synchronization.

P.4 Packets Transmitted from Tower to PC

The following table lists the packets that can be sent by the Tower to the PC:

Command	Data Stream
0x04	Tower Startup Parameter 1: 0 Parameter 2: 0 Parameter 3: 0 <i>Note: The Tower will issue this command upon startup to allow the PC to update the interface application and the Tower. Typically, setup data will also be sent from the Tower to the PC.</i>
0x08	Flash – Read byte Parameter 1: address offset (0-7) Parameter 2: 0 Parameter 3: data
0x09	Special – Master alarm Parameter 1: 12 Parameter 2: 0 Parameter 3: 2 <i>Note: If the PC receives this then the Tower is overloaded.</i>
0x09	Special – Tower version Parameter 1: 'v' = version Parameter 2: Major Version Number Parameter 3: Minor Version Number (out of 100) <i>Note: e.g. V1.3 has a major version number of 1 and a minor version number of 30.</i>
0x0A	Protocol – Mode Parameter 1: 1 Parameter 2: 0 = asynchronous 1 = synchronous Parameter 3: 0
0x0B	Tower Number Parameter 1: 1 Parameter 2: LSB Parameter 3: MSB <i>Note: The Tower number is an unsigned 16-bit number.</i>

0x0C	Time Parameter 1: hours (0-23) Parameter 2: minutes (0-59) Parameter 3: seconds (0-59)
0x0D	Tower Mode Parameter 1: 1 Parameter 2: LSB Parameter 3: MSB <i>Note: The Tower mode is just an unsigned 16-bit number – it is usually declared as an enumerated type.</i>
0x10	Accelerometer – Value Parameter 1: x-axis MSB Parameter 2: y-axis MSB Parameter 3: z-axis MSB
0x50	Analog Input – Value Parameter 1: analog channel (0-7) Parameter 2: LSB Parameter 3: MSB
0x51	Analog Output – Value Parameter 1: analog channel (0-1) Parameter 2: LSB Parameter 3: MSB

EXAMPLE P.1 Example Packet Sent from the Tower

For example, if the Tower were informing the PC that its version number is 1.3, then the packet would be:

Example packet
sent from Tower

0x09	0x76	0x01	0x1E	0x60
command	parameter 1	parameter 2	parameter 3	checksum

P.5 Packets Transmitted from PC to Tower

The following table lists the packets that can be sent by the PC:

Command	Data Stream
0x04	Special - Get startup values Parameter 1: 0 Parameter 2: 0 Parameter 3: 0 <i>Note: The PC will issue this command upon startup to retrieve the state of the Tower to update the interface application.</i>
0x07	Flash – Program byte Parameter 1: address offset (0-8) Parameter 2: 0 Parameter 3: data <i>Note: The address offset has a range of 0x00 to 0x08. An address offset of 0x08 will ERASE the entire Flash sector.</i>
0x08	Flash – Read byte Parameter 1: address offset (0-7) Parameter 2: 0 Parameter 3: 0 <i>Note: The address offset has a range of 0x00 to 0x07.</i>
0x09	Special – Get values Parameter 1: 'g' Parameter 2: 'i' Parameter 3: CR <i>Note: The Tower will send switch, counter and analog values, which the PC may or may not use.</i>
0x09	Special - Start bootloader Parameter 1: 'b' Parameter 2: 'l' Parameter 3: CR
0x09	Special – Toggle debug mode Parameter 1: 'd' Parameter 2: 'j' Parameter 3: CR
0x09	Special – Get version Parameter 1: 'v' Parameter 2: 'x' Parameter 3: CR
0x0A	Protocol – Mode Parameter 1: 1 = get Protocol mode 2 = set Protocol mode Parameter 2: 0 = asynchronous for a “set”, 0 for a “get” 1 = synchronous for a “set”, 0 for a “get” Parameter 3: 0

0x0B	Tower Number Parameter 1: 1 = get Tower number 2 = set Tower number Parameter 2: LSB for a “set”, 0 for a “get” Parameter 3: MSB for a “set”, 0 for a “get” <i>Note: The Tower number is an unsigned 16-bit number.</i>
0x0C	Set Time Parameter 1: hours (0-23) Parameter 2: minutes (0-59) Parameter 3: seconds (0-59)
0x0D	Tower Mode Parameter 1: 1 = get Tower mode 2 = set Tower mode Parameter 2: LSB for a “set”, 0 for a “get” Parameter 3: MSB for a “set”, 0 for a “get” <i>Note: The Tower mode is just an unsigned 16-bit number – it is usually declared as an enumerated type.</i>

EXAMPLE P.2 Example Packet Sent from the PC

For example, if the PC were requesting the Tower to write 0xA5 to Flash memory with an address offset of 5, then the packet would be:

Example packet
sent from PC

0x07	0x05	0x00	0xA5	0xA7
command	parameter 1	parameter 2	parameter 3	checksum

P.6 Packet Acknowledgement

The command ID has bit 7 (the most significant bit) reserved for packet acknowledgement purposes. The transmitter sets bit 7 to a 1 to request an acknowledgement, and leaves it cleared to 0 for no required acknowledgement.

The receiver, upon receiving a packet with an acknowledgement request, will firstly attempt to carry out the requested command. It will then either set bit 7 to indicate that the command was carried out successfully (an ACK), or clear it to 0 to indicate that the command could not be carried out (a NAK), and send the packet back to the requester.

For example, if the PC sends the following packet to write 0xA5 to Flash memory with address offset 5:

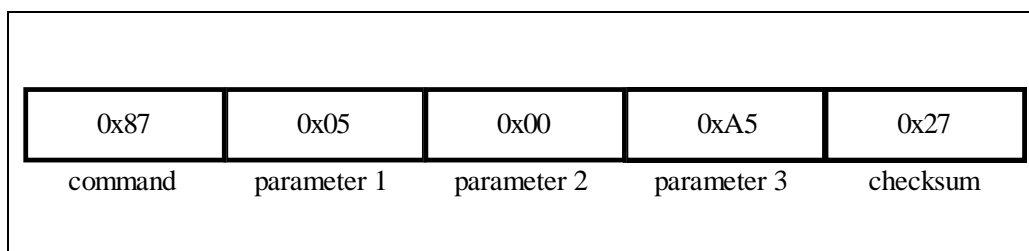


Figure 5.4

then the Tower will respond with the same packet, indicating it was carried out successfully.

However, if the PC asked to write to address offset 10 (which is out of range), then the Tower would respond with:

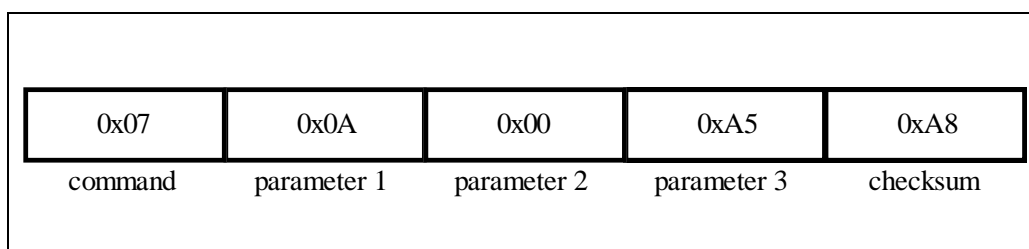


Figure 5.5


Note that the most significant bit of the command has been cleared, indicating that the requested command could not be carried out.

EXAMPLE P.3 Example of Packet Acknowledgement

The Tower PC Interface sends a normal “Startup” packet:

0x04	0x00	0x00	0x00	0x04
command	parameter 1	parameter 2	parameter 3	checksum


The Tower responds with:

Received Packets					
<input checked="" type="checkbox"/> Receive Enable		 Clear	Dump	Display Format All	
Raw	Command	Parameter 1	Parameter 2	Parameter 3	Checksum
I	0x04	0x00	0x00	0x00	0x04
IV	0x09	0x76 118 'v'	0x01	0x00	0x7E 126 'x'
II*	0x0B	0x01	0x2A 42 'x'	0x00	0x20 32 ''

The Tower PC Interface now sends a “Startup” packet with an acknowledgement request (the MSB is set in the command):

0x84	0x00	0x00	0x00	0x84
command	parameter 1	parameter 2	parameter 3	checksum

The Tower responds with:

Received Packets					
<input checked="" type="checkbox"/> Receive Enable		 Clear	Dump	Display Format All	
Raw	Command	Parameter 1	Parameter 2	Parameter 3	Checksum
I	0x04	0x00	0x00	0x00	0x04
IV	0x09	0x76 118 'v'	0x01	0x00	0x7E 126 'x'
II*	0x0B	0x01	0x2A 42 'x'	0x00	0x20 32 ''
I	0x84 132 'I'	0x00	0x00	0x00	0x84 132 'I'

Note that the Tower board has responded in the normal way first – it sends the “traditional” 3 packet response – and then it sends an **additional** packet to act as the acknowledgement packet, and in this case with the top bit set to indicate success.

P.7 PC Communication Parameters

P.7.1 Baud Rate and Virtual Com Ports

The USB drivers on the PC side implement a virtual COM port.

P.7.2 Baud Rate and Data Format

The baud rate used is selectable and is either 38400 or 115200 baud.

The data format used is 8N1 (8 data bits, no parity, 1 stop bit).