

Interface Control Document Addendum 1 TP <-> MBED INTERFACE

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Autonomous Chariot

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Contents

[2. INTRODUCTION 2](#_Toc414736555)

[3. COMMUNICATION PROTOCOL 2](#_Toc414736556)

[4. MESSAGE STRUCTURE 2](#_Toc414736557)

[4.1 Header 2](#_Toc414736558)

[4.2 Payload 2](#_Toc414736559)

[5. MESSAGE DEFINITIONS 3](#_Toc414736560)

[5.1 TP to MBED Messages 3](#_Toc414736561)

[5.1.1 TP Ready (Message ID = 0) 3](#_Toc414736562)

[5.1.2 Motion Request (Message ID = 2) 4](#_Toc414736563)

[5.1.3 Ranger Reading Request (Message ID = 4) 4](#_Toc414736564)

[5.2 MBED to TP Messages 5](#_Toc414736565)

[5.2.1 MBED Ready (Message ID = 1) 5](#_Toc414736566)

[5.2.2 Motion Request Acknowledge (Message ID = 3) 5](#_Toc414736567)

[5.2.3 Ranger Reading Results (Message ID = 5) 6](#_Toc414736568)

# INTRODUCTION

This document defines the interface between the Raspberry Pi Tactical Processor (TP) and the mbed controller.

# COMMUNICATION PROTOCOL

The mbed and TP shall support two different communication protocols:

1. UART Serial (TTL) – See Section 3.1
2. 10/100 Mbit/s Ethernet – See Section 3.2

## UART SERIAL (TTL)

The TP and mbed shall communicate using a 50000 baud rate, non-inverting UART serial port configured in 8N1 format.

As a result, 2 bits (start and stop) are not used for data transmission and only 80% of the bits are available for data. This equates to a data rate of 40000bits/s (50000 symbols/sec \* 0.8) or equivalently **39kB/s**.

## 10/100 Mbit/s Ethernet

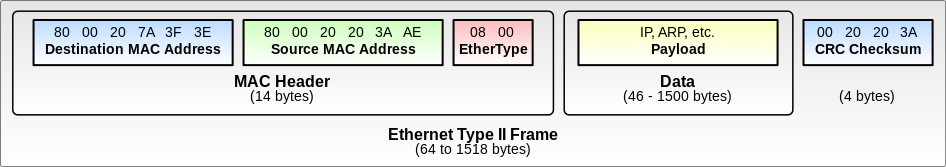
The TP and mbed shall communicate using 10/100 Mbit/s.

### Auto-negotiation

Auto-negotiation for link speed shall be enabled at both ends of the link (TP and mbed).

### Ethernet Frame

#### Structure

The Ethernet frame used shall be an Ethernet II frame as below. Note field values are for illustrative purposes only. See sections below for actual values.

##### MAC Header

The MAC header shall contain the following field values:

###### Destination MAC Address

The destination MAC address shall be set to the MAC broadcast address of FF:FF:FF:FF:FF:FF (hex)

###### Source MAC Address

The source MAC address shall be the manufacturer MAC address of the mbed or TP.

###### EtherType

This field shall be set to 06 00 (hex) at all times.

##### Data Payload

The data payload shall be a minimum of 46 bytes in length. A payload of less than this length shall be padded with zeros.

The contents of the data payload shall as per Section 4.

##### CRC Checksum (Frame Check Sequence)

This shall be calculated automatically by the PHY (Level 1) hardware on the TP and mbed.

# MESSAGE PAYLOAD

Each message shall adhere to the following structure to allow for variable length messages.

Bytes are ordered and sent in Big Endian format (MSB first).

## Start Message

This is a single 0xFF byte appended to the start of each message to indicate the start of a message.

## Header

This 3-byte header defines the message ID (type of message) and the payload length (bytes) and is appended to the start of each data payload.

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID | Payload Length Byte 1 (MSB) | Payload Length Byte 2 (LSB) |

## Payload

The maximum payload length is 1497 bytes (limited by the max. sized Ethernet frame payload).

**Byte 4 Byte N+4**

|  |  |  |
| --- | --- | --- |
| Payload Byte 1 | …. | Payload Byte N (where N can be a max. of 1497) |

## End Message

This is a single 0x0A (line feed - \n) byte appended to the end of each message to indicate the end of a message.

# MESSAGE DEFINITIONS

## TP to MBED Messages

### TP Ready (Message ID = 0)

This message is a zero-length payload message used as part of an interface handshake to tell the mbed that the TP is initialised (TP to IP link initialised etc.) and is ready to issue commands.

**The TP should issue this command every second (1Hz) until it gets an acknowledgement that the mbed is also ready.**

The acknowledgement from the mbed is Message ID 1 defined in Section 5.2.1.

#### Header

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID = 0 | Payload Length Byte 1 = 0 | Payload Length Byte 2 =0 |

### Motion Request (Message ID = 2)

This message is used to command the mbed to move the chariot in the TP specified direction until a stop command is received.

**If a new motion request message is not received within 2s of the previous motion request message the mbed will request the chariot to stop automatically for safety reasons. Thus the TP should send motion requests at the rate of 0.5Hz minimum if continuous uninterrupted motion is required.**

#### Header

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID = 2 | Payload Length Byte 1 = 0 | Payload Length Byte 2 =2 |

#### Payload

This message has a two byte length payload.

The first byte determines the motion type and the second the speed of the motion.

**Byte 1** **Byte 2**

|  |  |
| --- | --- |
| Motion Type: Values 0..4 | Speed: Values 0..100 Units: Percent |

The meaning of the motion type byte values are described below:

##### Byte 1 – Motion Type

|  |  |  |
| --- | --- | --- |
| **Byte Value** | **Meaning** | **mbed action on receipt** |
| 0 | Stop | mbed commands chariot to come to a halt. |
| 1 | Forwards | mbed commands chariot to move forwards at mbed pre-determined speed. |
| 2 | Backwards | mbed commands chariot to move backwards at mbed pre-determined speed. |
| 3 | Left | mbed commands chariot to do a neutral turn left at mbed pre-determined speed. |
| 4 | Right | mbed commands chariot to do a neutral turn right at mbed pre-determined speed. |

**Note:** For a Motion Type of Stop, the speed value is ignored by the mbed as long as it is within the valid range of 0 to 100.

### Ranger Reading Request (Message ID = 4)

This a zero-length payload message sent to the mbed to request the mbed to return ranger readings from all six rangers.

#### Header

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID = 4 | Payload Length Byte 1 = 0 | Payload Length Byte 2 =0 |

### Emergency Stop Request (Message ID = 6)

This is a zero-length payload message used by the TP to command the MBED to halt the chariot motors and stop sending or processing messages from the TP until the operator commands the mbed to do so again.

#### Header

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID = 6 | Payload Length Byte 1 = 0 | Payload Length Byte 2 =0 |

## MBED to TP Messages

### MBED Ready (Message ID = 1)

This message is a zero-length payload message used as part of an interface handshake to tell the TP that the mbed is initialised and is ready to receive TP commands. The message is sent in response to the TP Ready message (Message ID 0).

**The mbed will not issue this message if it is not in start mode or detects any ranger or GPIO14 controller failures.**

#### Header

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID = 1 | Payload Length Byte 1 = 0 | Payload Length Byte 2 =0 |

### Motion Request Acknowledge (Message ID = 3)

This message is a zero-length payload message acknowledging the previous TP Motion Request (Message ID 2). This will not be sent if a message error is detected.

#### Header

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID = 3 | Payload Length Byte 1 = 0 | Payload Length Byte 2 =0 |

### Ranger Reading Results (Message ID = 5)

This message is a 12 byte payload message that returns readings from all six rangers after request from the TP via the Ranger Reading Request (Message ID 4).

#### Header

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID = 5 | Payload Length Byte 1 = 0 | Payload Length Byte 2 =12 |

#### Payload

Two bytes are required per ranger to accommodate the full valid range of the ranger readings (up to 600cm). Units are in cm.

A value of 601 indicates an invalid reading because:

1. Sensor disabled or
2. Sensor returned invalid (0cm) reading

**Byte 4-5 Bytes 6-7 Bytes 8-9**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sensor 1 Reading**  Values: 0..601 | | **Sensor 2 Reading**  Values: 0..601 | | **Sensor 3 Reading**  Values: 0..601 | |
| Sensor 1 Reading (MSB)  Values: 0..2 | Sensor 1 Reading (LSB)  Values: 0..255 | Sensor 2 Reading (MSB)  Values: 0..2 | Sensor 2 Reading (LSB)  Values: 0..255 | Sensor 3 Reading (MSB)  Values: 0..2 | Sensor 3 Reading (LSB)  Values: 0..255 |

**Byte 10-11 Bytes 12-13 Bytes 14-15**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sensor 4 Reading**  Values: 0..600 | | **Sensor 5 Reading**  Values: 0..600 | | **Sensor 6 Reading**  Values: 0..600 | |
| Sensor 4 Reading (MSB)  Values: 0..2 | Sensor 4 Reading (LSB)  Values: 0..255 | Sensor 5 Reading (MSB)  Values: 0..2 | Sensor 5 Reading (LSB)  Values: 0..255 | Sensor 6 Reading (MSB)  Values: 0..2 | Sensor 6 Reading (LSB)  Values: 0..255 |

### Emergency Stop Acknowledge (Message ID = 7)

This is a zero-length payload by the mbed to acknowledge that it has received and processed the Emergency Stop Request and halted the chariot motors. After this message is received, the mbed shall no longer send or process messages from the TP until the operator commands the mbed to do so again. This will not be sent if a message error is detected.

#### Header

**Byte 1 Byte 2 Byte 3**

|  |  |  |
| --- | --- | --- |
| Message ID = 7 | Payload Length Byte 1 = 0 | Payload Length Byte 2 =0 |

# MESSAGE ERROR HANDLING

The TP and mbed shall reject messages sent to them from their counterpart if:

## Header Error

The header contains an invalid message ID, or the payload length indicated in the header does not match the required message ID’s payload length as defined in this document.

## Payload Error

The actual payload length in the message on the wire does not match the required message ID’s payload length as defined in this document.

**OR**

The payload data is deemed invalid by the message handler for the received message.