# DMAUART Interface Requirement for

# Command and Telemetry Operation of Payload

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## Configuration of Onboard Computer(OBC) DMAUART

RS-422 driver/receiver(Tx : HX422D, Rx : HX422R, 3.3V, Honeywell) + FPGA Core(Actel UART Core + KARI Designed Direct Memory Access(DMA) function)

## HW Interface Requirement

1) Tx driver and Rx receiver for command and telemetry operation of payload should be RS-422 exclusive product. (It is not allowed to use LVDS, RS-485, RS-232, TTL, and discrete CMOS part configuration)

2) Below fail safe circuit and impedance matching resistor(including value) configuration are recommended.

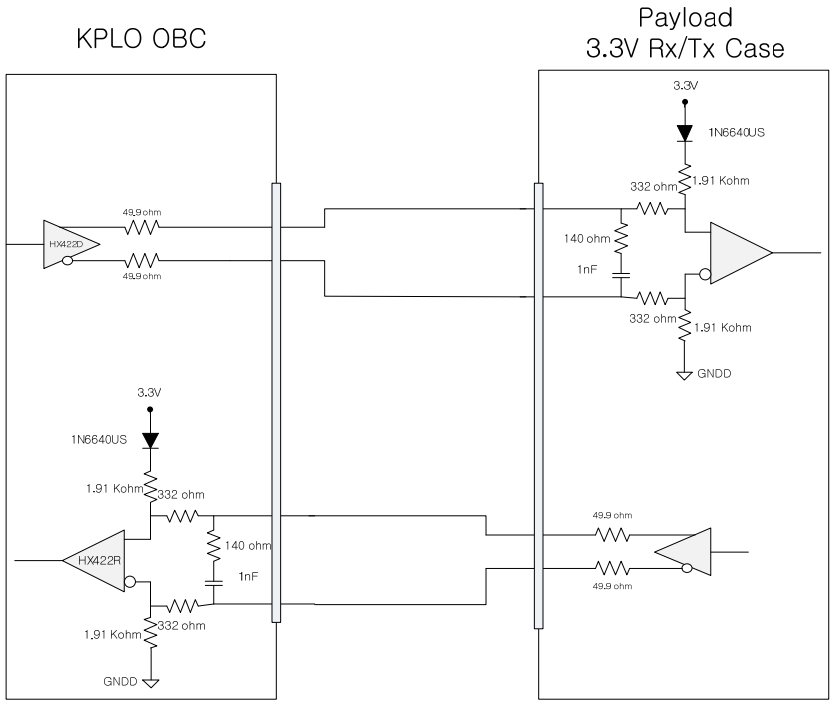


**Figure 1 recommended Fail Safe and Impedance Matching Configuration for 3.3V Tx/Rx**

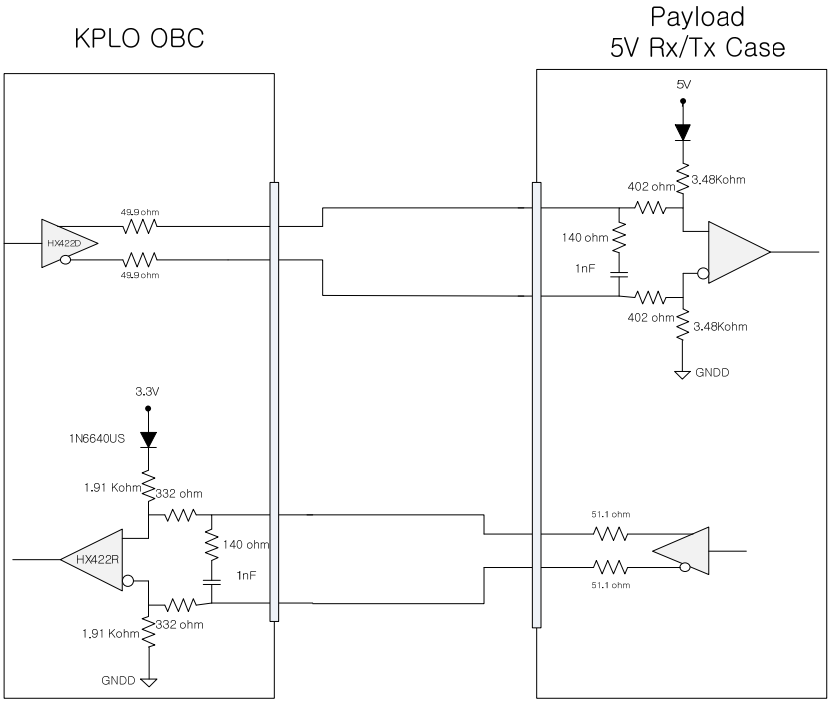


**Figure 2 recommended Fail Safe and Impedance Matching Configuration for 5V Tx/Rx**

3) Including of redundant interface is choice of payload.

OBC transmits Tx primary and redundant simultaneously.

OBC selectively receives transmitted data from payload. Active unit status is utilized for receiving path(primary or redundant) selection of OBC.

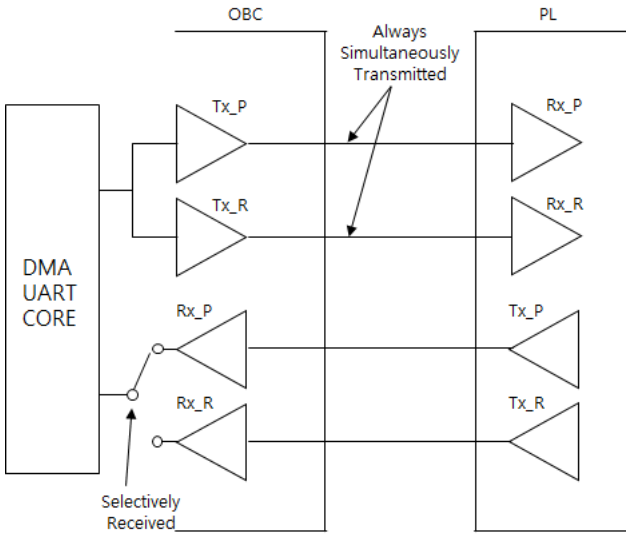


**Figure 3 Tx and Rx Configuration of OBC DMAUART**

# Protocol

## 1. Data Format

Payload should follow below format for command(receive)/telemetry(transmit) operation.

Start(1 Bit, 0) + Data(8 Bit) + Parity(1 Bit, Optional) + Stop(1 Bit, 1)

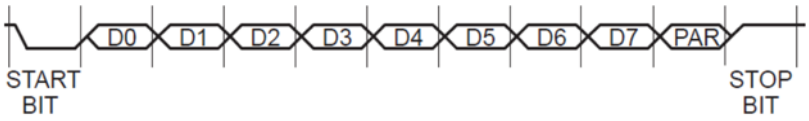


**Figure 4 Data Format for Command and Telemetry Operation**

## 2. Baud Rate

Payload can select standard baud rate up to 115200bps.

## 3. Half Duplex Communication

Simultaneous command and telemetry operation is not allowed.

## 4. Types of Command and Possible Transmission Interval

Flight software schedules telemetry request command, On Board Time(OBT) transfer command, and command from ground for prevention of overlap. Since OBT transfer command and telemetry request command are predefined on board periodic operation, ground command has lowest priority. Omission of command from ground does not occur(only delayed at buffer).

### 4-1) Command from Ground

Command Link Transmission Unit(CLTU) is transmitted to KPLO, and only command data field of command frame is delivered to payload via DMAUART interface. (Service ID and CMD Number will be assigned for each payload)

| | Command Type | ID | Length | Week | Octant Second | SVC ID | CMD No. | Command Data | CRC |
|---|---|---|---|---|---|---|---|---|---|
| Bits | 8 | 16 | 8 | 16 | 32 | 8 | 8 | **Max. 560[TBD] bits** | 16 |

**Figure 5 Command Frame of CLTU**

Command from ground will be stored at DMAUART buffer, and sequentially transmitted to payload. Possible minimum transmission period of command from ground is one second except DTNPL.

### 4-2) Telemetry Request Command from Flight Software

Flight software will send telemetry request command to payload. After receiving, payload can transmit telemetry to on-board computer with command echo back or ok check pattern(Chapter 5). Principal investigator can request desired gathering interval to KARI. and interval should be the divisor of 32 seconds(currently 8s, 16s, and 32s are acceptable).

### 4-3) OBT Transfer Command from Flight Software

Flight software can deliver on board time to payload. Principal investigator can request desired on board time receiving interval to KARI. The form(TBD) of on board time is two bytes week plus four bytes octant second(total six bytes).

## 5. Echo Back and OK Check Response to Command from OBC

After receiving each command from on board computer, payload should transmit ok check pattern or command echo back. For choice of ok check, payload can propose fixed OK check pattern to KARI.

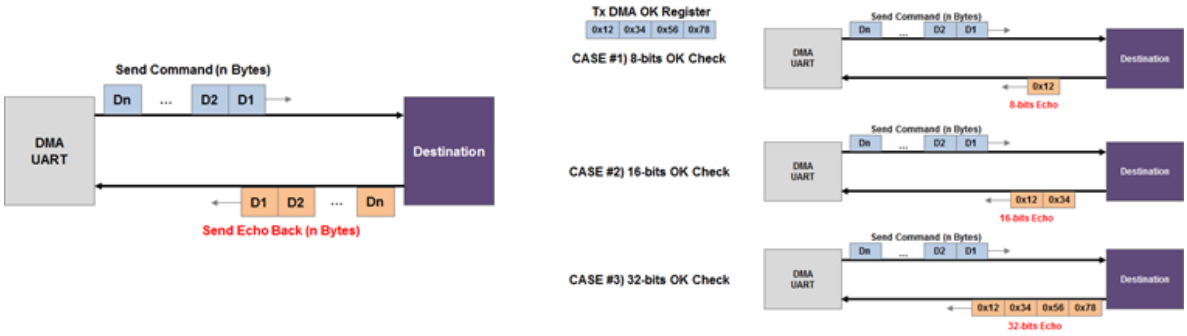


**Figure 6 Conceptual Operation of Echo Back and OK Check**

## 6. Definition of Response Time and Telemetry Gathering Time

### 6-1) Definition of Response Time

The time between command transmission finish and receiving(ok check or command echo back) start moment at OBC side.

The time between command receiving finish and transmission(ok check or command echo back) start moment at payload side.

**6-2) Value of Response Time**

Payload should respond within 100us.

**6-3) Definition of Telemetry Gathering Time**

The time between transmission finish of echo back(or OK Check) and telemetry transmission start moment at payload side.

**6-4) Value of Telemetry Gathering Time**

Payload can suggest required telemetry gathering time to KARI. But it should be shorter than several milliseconds.

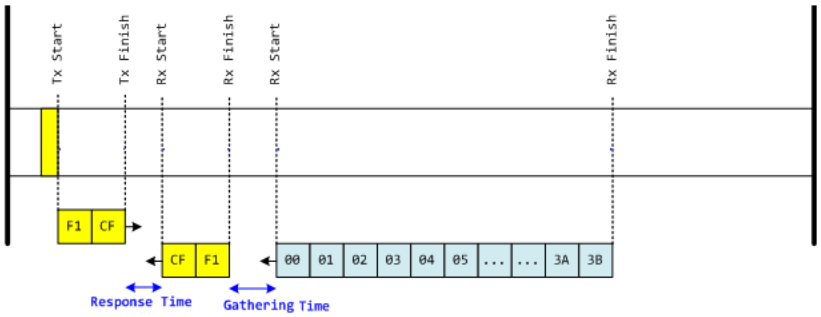


**Figure 7 Response and Telemetry Gathering Time**

**7. Fixed Command and Telemetry Bundle Size**

The size of command from ground should be fixed. Only predefined one size can be transmitted.

The size of telemetry bundle from payload should be fixed. Only predefined one bundle size can be transmitted.

Size of on board time transfer(and telemetry request) command is treated as an exception.

**8. Command from Ground and Telemetry from Payload are not Processed at Flight Software**

**8-1) Command**

Command data field of command frame is transmitted as it is.

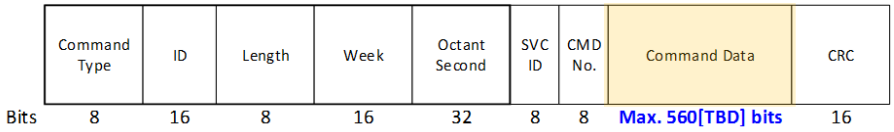


**Figure 8 Command Frame of Command Link Transmission Unit**

### 8-2) Telemetry

Received telemetry bundle from payload is transmitted as it is.

## 9. Communication Format

### 9-1) Command from Ground and On Board Time Transfer Command

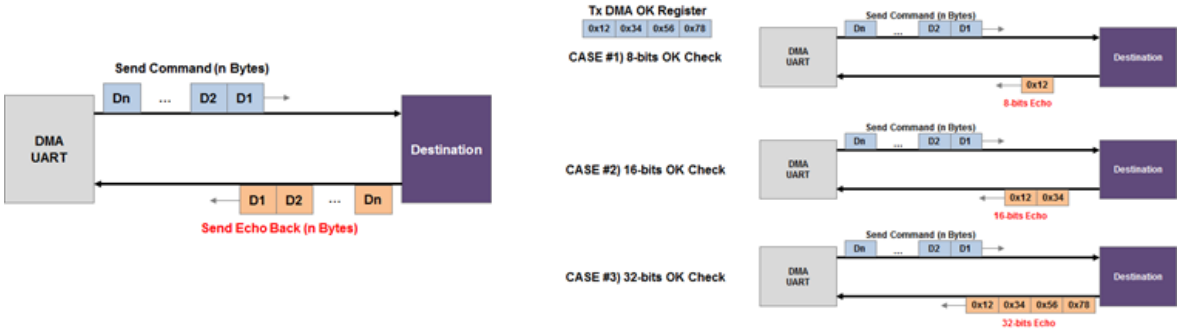


**Figure 9 Conceptual Operation Diagram for Command from Ground and On Board Time Transfer Command**

### 9-2) Transmission of Telemetry Request Command and Telemetry Receiving

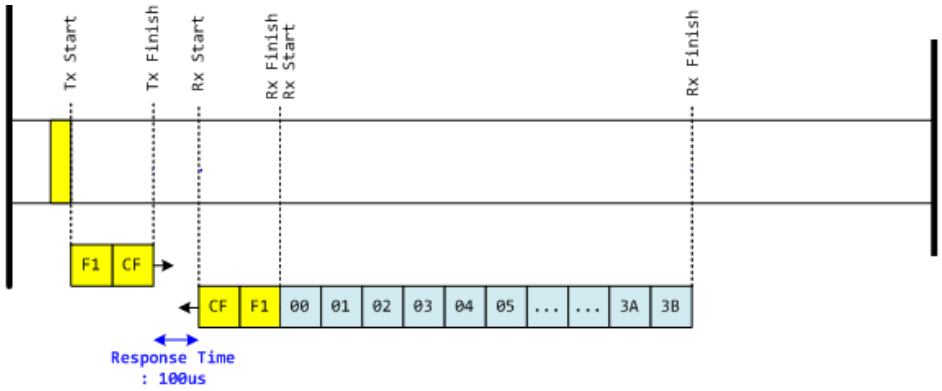


**Figure 10 Transmission of Telemetry Request Command and Telemetry Receiving at OBC (with Echo Back Response from Payload, without Telemetry Gathering Time of Payload)**

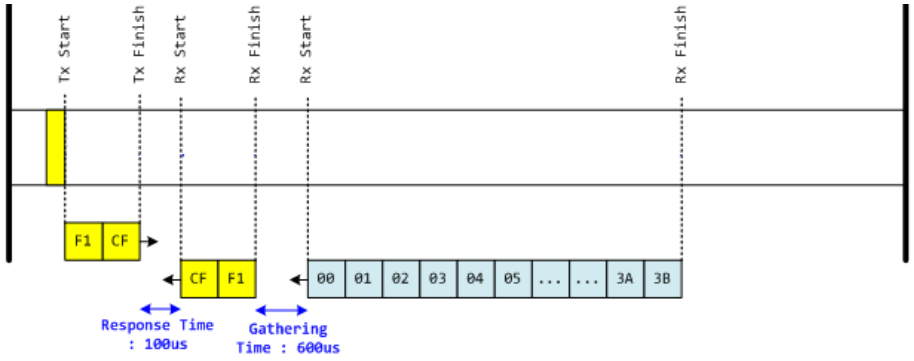


**Figure 11 Transmission of Telemetry Request Command and Telemetry Receiving at OBC (with Echo Back Response from Payload, with 600us Telemetry Gathering Time of Payload)**

## 10. Types of Communication Error and Management Plan

### 10-1) Types of Communication Error

Command echo back(or ok check) receiving fail at on board computer

Excess of response time and expected telemetry receiving completion time

Size error of received data

Parity error

Other things can be discussed.

### 10-2) Management Plan

Record error and communication hold.

## 11. Precaution

The maximum allowable size of command data is 70bytes.

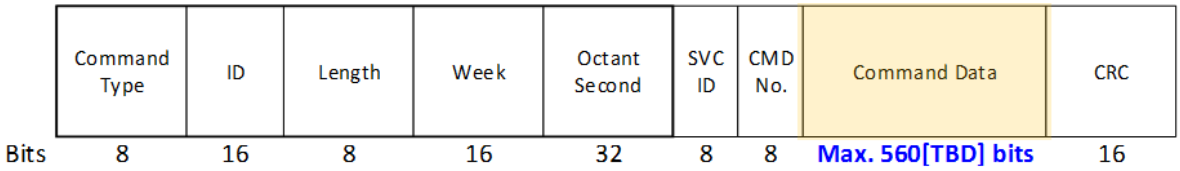


**Figure 12 Command Data Field of Command Frame**

The maximum allowable size of telemetry data for one payload is less than 70bytes.

Telemetry gathering interval can be discussed. Currently expected moderate interval is longer than eight seconds.

Each command and telemetry operation should be completed within sub-minor cycle duration of flight software with 25% margin(46.875ms = 62.5msec * 0.75).

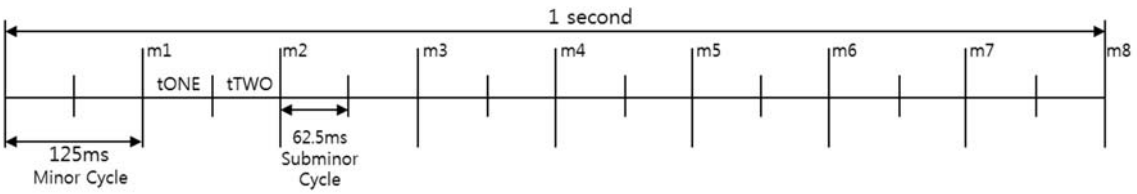


**Figure 13 Minor Cycle and Sub Minor Cycle for Flight Software Operation**

### 11-1) Command Transmission Example

Including start, stop, parity. Eleven bits are necessary for eight bits data transmission

Baud rate = 19200, 1 byte transmission time = (1/19200)*11= about 0.57292ms

Transmission of two bytes size command

Response time is 100us(echo back type response)

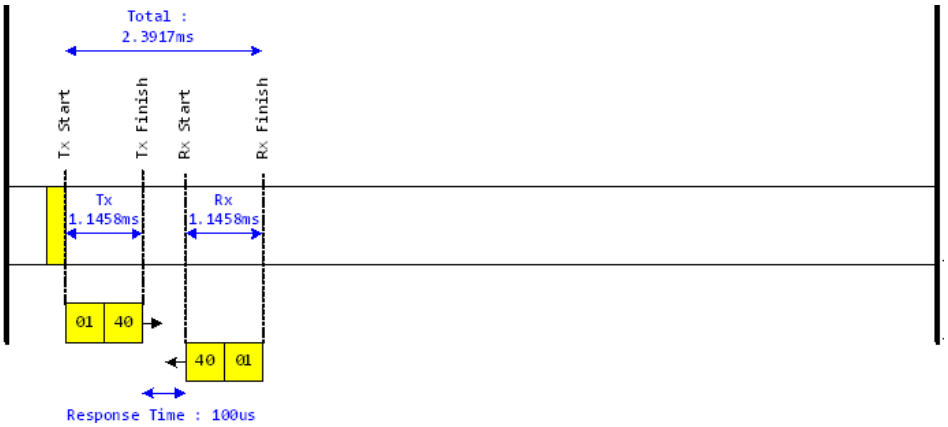


**Figure 14 Diagram of Command Transmission Example**

### 11-2) Telemetry Gathering Example

Including start, stop, parity. Eleven bits are necessary for eight bits data transmission

Baud rate = 19200, 1 byte transmission time = (1/19200)*11= about 0.57292ms

Two bytes size telemetry request command

Response time is 100us(echo back type response)

Telemetry gathering time of payload is 600us

Size of telemetry bundle is 60 bytes

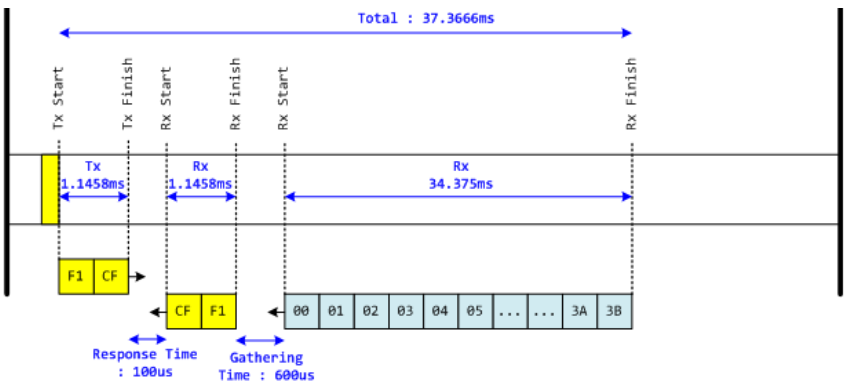


**Figure 15 Diagram of Telemetry Gathering Example**