SMARTBALL v1.0

DATAGRAM SPECIFICATIONS V0.1

last update – 16/09/2019

INTRODUCTION

Smartballs send and receive specific UDP Datagrams, this choice has been made over OSC, Artnet or other kind of existing protocol to save bandwidth as much as possible. This protocol is still in active development and will likely to evolve during the alpha and beta test phase.

This document is compatible with the following release:

- hardware v1.x : https://github.com/siteswapjuggler/smartball-hardware
- firmware v0.1 beta2 : https://github.com/siteswapjuggler/smartball-firmware/tree/v0.1-beta.2
- externals v0.1 beta2 : https://github.com/siteswapjuggler/smartball-externals/tree/v0.1-beta.2

VERSION NOTE

Initial release of the datagram protocol.

SUMMARY

DATAGRAM STRUCTURE

UPSTREAM PACKETS .....

- Start of packet 1 byte
- Command 1 byte
- Data Length 2 bytes
- Data (optional)
- Checksum 1 byte

SOP – Start of Packet

Start of packet is always 0xE7.

CMD – Command

Commands byte is unique to every message.

LEN – Data length

Length bytes are the MSB and LSB of the uint16 number of data.

DATA (optional)

Data depends on each command and is optional. See command description below for further information.

CKS – Checksum

Checksum is the sum modulo 256 of every byte from CMD byte to the last DATA byte.

DOWNSTREAM PACKETS.....

- Start of packet 1 byte
- Serial number 2 bytes
- Command 1 byte
- Length 2 bytes
- Data depending on length
- Checksum 1 byte

SOP – Start of Packet

Start of packet is always 0xE7.

SN – Serial Number

Two bytes uint16 serial number.

CMD – Command

Commands byte is unique to every message.

LEN – Data length

Length bytes are the MSB and LSB of the uint16 number of data.

DATA (optional)

Data depends on each command and is optional. See command description below for further information.

CKS – Checksum

Checksum is the sum module 256 of every byte from CMD byte to the last DATA byte.

UPSTREAM COMMANDS

PING

Ping command trigger a pong answer.

SOP	CMD	LEN		CKS
0xE7	0x01	0x00	0x00	0x01

REBOOT

Reboot command trigger the reboot of the ball (*does not work on first boot after firmware update*).

SOP	CMD	LEN		CKS
0xE7	0x02	0x00	0x00	0x02

SLEEP

Sleep command trigger the deep sleep mode. Balls need to be power off and on again to restart.

SOP	CMD	LEN		CKS
0xE7	0x03	0x00	0x00	0x03

FACTORY SETTINGS

Factory settings command sets new factory settings value. Factory settings includes a serial number, a device flag and an adc scaling factor.

SOP	CMD	LEN		DATA	CKS
0xE7	0x10	0x00	0x05	5 bytes	checksum

DATA STRUCTURE:

- serial number: uint16 value from 0 to 65535
- device flag: 16 bits flag describing available devices
- adc scaling factor: unsigned Q15.1 value from 0.0 to 6553.5

SN_MSB	SN_LSB	FLAG_MSB	FLAG_LSB	SCL_MSB	SCL_LSB

DEVICE FLAG STRUCTURE:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	-	-	BUZ	MOT	IRL	IMU	RGB

SAVE FACTORY SETTINGS

Save factory command trigger EEPROM writing of the factory settings.

SOP	CMD	LEN		CKS
0xE7	0x11	0x00	0x00	0x11

COLOUR (FOREGROUND)

Colour command change current colours according to the number of RGB values sent. To be clearer data length will implicitly tell the ball which colour mode to apply, see options below:

- 3 values: 1 colour mode
- 6 values: 2 colours mode (1 per hemisphere)
- 9 values: 3 colours mode (3 pairs of opposite leds)
- 18 values: 6 colours mode (6 individual leds)

SOP	CMD	LEN		DATA	CKS
0xE7	0x20	0x00	variable	variable	checksum

DATA STRUCTURE:

- Colour 1 Red value : uint8 value from 0 to 255
- Colour 1 Green value : uint8 value from 0 to 255
- Colour 1 Blue value : uint8 value from 0 to 255
- (optional) colour 2/3/4/5/6 RGB values

R1	G1	B1	(R2)	(G2)	(B2)	and so on…

STREAM

Stream command act almost the same way as colour command apart that you can address multiple balls at one time. Doing this you need to add one extra data byte to precise the number of colours sent for each ball. Balls will change colours according to its serial number modulo (LEN-1)/(N_COLOURS * 3).

SOP	CMD	LEN		DATA	CKS
0xE7	0x21	variable	variable	variable	checksum

DATA STRUCTURE EXAMPLE:

Even serial number balls goes red & blue while odd serial number balls goes black & white:

N_COL	RGB1.1	RGB1.2	RGB2.1	RGB 2.2
0x02	0xFF 0x00 0x00	0x00 0x00 0xFF	0xFF 0xFF 0xFF	0x00 0x00 0x00

This command has been design for the first 30 balls during the alpha tests. Future firmware will use customisable id values instead of serial numbers.

IMU SETTINGS

IMU settings command will change current IMU feedback settings.

SOP	CMD	LEN		FLAG	CKS
0xE7	0x30	0x00	0x01	variable	Checksum

DATA STRUCTURE:

- IMU flag: 8 bits flag describing available feedbacks.

DEVICE FLAG STRUCTURE:

7	6	5	4	3	2	1	0

-	-	-	-	TMP	MAG	GYR	ACC

ACCELEROMETER RANGE

Accelerometer range command will change current accelerometer full-scale range settings.

SOP	CMD	LEN		PAR	CKS
0xE7	0x32	0x00	0x01	variable	checksum

DATA STRUCTURE:

- Full-scale parameter: 8 bits parameter.

PARAMETER VALUES:

- 0x00: -2g / +2g.
- 0x01: -4g / +4g.
- 0x02: -8g / +8g.
- 0x03: -16g / +16g (default).

GYROSCOPE RANGE

Gyroscope range command will change current gyroscope full-scale range settings.

SOP	CMD	LEN		PAR	CKS
0xE7	0x33	0x00	0x01	variable	checksum

DATA STRUCTURE:

- Full-scale parameter: 8 bits parameter.

PARAMETER VALUES:

- 0x00: -250dps / +250dps.
- 0x01: -500dps / +500dps.
- 0x02: -1000dps / +1000dps.
- 0x03: -2000dps / +2000dps (default).

SAVE IMU SETTINGS

Save IMU command trigger EEPROM writing of the IMU settings.

SOP	CMD	LEN		CKS
0xE7	0x031	0x00	0x00	0x31

INFRARED

Infrared command change the current value of the infrared channel PWM.

SOP	CMD	LEN		DATA	CKS
0xE7	0x40	0x00	0x02	2 bytes	checksum

DATA STRUCTURE:

- value : uint16 value from 0 to 1023

VAL_MSB	VAL_LSB

MOTOR

Motor command change the current value of the motor channel PWM.

SOP	CMD	LEN		DATA	CKS
0xE7	0x50	0x00	0x02	2 bytes	checksum

DATA STRUCTURE:

- value : uint16 value from 0 to 1023

MSB	LSB

DOWNSTREAM COMMANDS

PONG

Pong is answering the ping command.

SOP	SN		CMD	LEN		CKS
0xE7	MSB	LSB	0x01	0x00	0x00	0x01

BATTERY VALUE

Battery feedback transmit V_{share} voltage value stored as $1/100^{th}$ Volts per LSB.

SOP	SN		CMD	LEN		DATA	CKS
0xE7	MSB	LSB	0x00	0x00	0x02	2 bytes	0x01

DATA STRUCTURE:

- value: Q14.2 value from 0V to 5.2V, this value is adjusted by the ADC scaling factory setting.

VAL_MSB	VAL_LSB

IMU VALUES

IMU feedback transmit IMU values according to the current IMU flag.

SOP	SN		CMD	LEN		DATA	CKS
0xE7	MSB	LSB	0x30	0x00	variable	variable	Checksum

DATA STRUCTURE:

- IMU flag: 8 bits flag describing available feedbacks (see IMU settings for description)
- (optional) accelerometer XYZ : 6 bytes containing the XYZ Q14.2 values of the accelerometer.
- (optional) gyroscope XYZ : 6 bytes containing the XYZ Q14.2 values of the gyroscope.
- (optional) magnetometer XYZ : 6 bytes containing the XYZ Q14.2 values of the magnetometer.
- (optional) temperature : Q14.2 temperature value.

DATA STRUCTURE EXAMPLE:

Optional data stacks after directly after the flag depending on enable bits order.

FLAG	GYR_XYZ	TEMP
0x0A	6 bytes	2 bytes

DOCUMENT VERSION	
V1.0	Initial release