Section1.   Connectors and button on the HW DATA LINK

1.   Region "1" contains all connectors for data input/output：

All pins marked with "-"are GND. All pins marked with "+" in region "5" can output 5V, but all pins marked with "+" in region "6" are not connected to any circuit (that means they are unused/empty pins)

D1-D8: Connect to the UART wires of ESC#1 to ESC#8

R1-R8: Connect to the RPM signal wires of ESC#1 to ESC#8

TX1 RX1: It is the 115200bps UART of DATA LINK, it connects to Hobbywing WiFi Express Module. By using the HW Link App, the telemetry data of 8 ESCs can be transferred by wireless connections and shown on the smart phone at real time.

TX2 RX2: It is the 1M bps UART of DATA LINK, it outputs the telemetry data of 8 ESCs and the RPM data of each ESC at higher refreshing rate. This port usually connects to Fligh Control (FC).

Note: Please make sure all ESCs have the same GND as the HW DATA LINK. Up to 8 ESCs can be connected to one DATA LINK.

2.   LED

LED Status	Description
1. LED R&B(=Pink), quick double flashes Off 400ms - On100ms – Off 100ms – On 100ms	After connecting to PC, in 5 seconds the DATA LINK successfully completes the hand-shake with the upper computer software and ready for its own firmware upgrade.
2. LED R&B(=Pink), slow single flash On 500ms – Off 500ms	Switch to ESC firmware upgrade mode
3. LED Green, solid on	The upper computer software activates the DATA LINK firmware upgrade function, the DATA LINK is erasing its own flash memory
4. LED R&B(=Pink), quick single flash On150ms – Off 150ms	DATA LINK firmware upgrade has been successfully finished.
5. LED R&G(=Yellow), slow single flash On 500ms – Off 500ms	After connecting to PC, in 5 seconds the DATA LINK is failed to hand-shake with the upper computer software then the DATA LINK enters USB disk mode.
6. LED Red, quick single flash On100ms – Off 100ms	Error message. The DATA LINK enters USB disk mode but the SD card is not installed properly or SD card has some errors.
7. LED Blue, slow single flash On 500ms – Off 500ms	The DATA LINK collects and transfers data properly.
8. LED R&G&B flashes alternately	If the PC (MS Windows OS) doesn't have the driver for DATA LINK, then the PC can't recognize this device. In such a case, hold the "SET" button then power on the DATA LINK, the PC will install the driver for it.

3.   The "Key" button is used to install the PC driver for DATA LINK when it is connected to PC at the 1st time.

4.   It is the power supply to the DATA LINK, the input voltage ranges from 6V to 50V (2 to 12 cell Lithium).
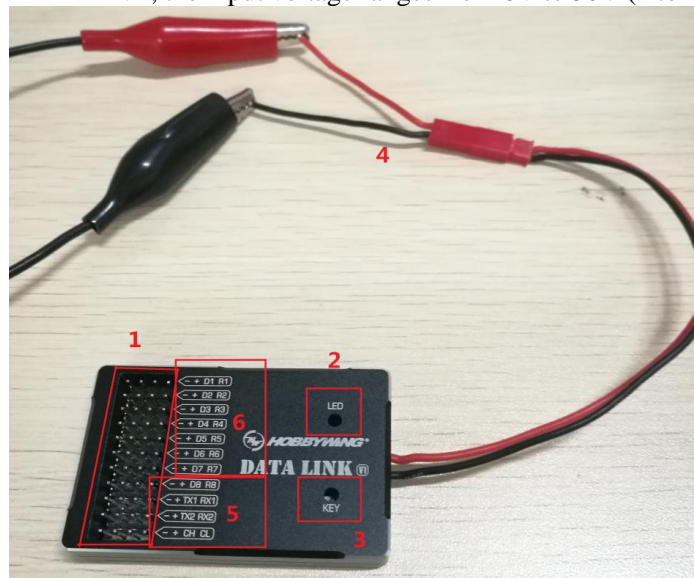
Section2.   Connections

1: It is the HW ESC. Please plug the UART wires (black/red/white) and the RPM wire (yellow) of the ESC into the DATA LINK correctly (Please pay attention to the color of each wire)；

2: RX1 TX1 is connected to HW WiFi Express Module for building wireless connections to App on smart phone.
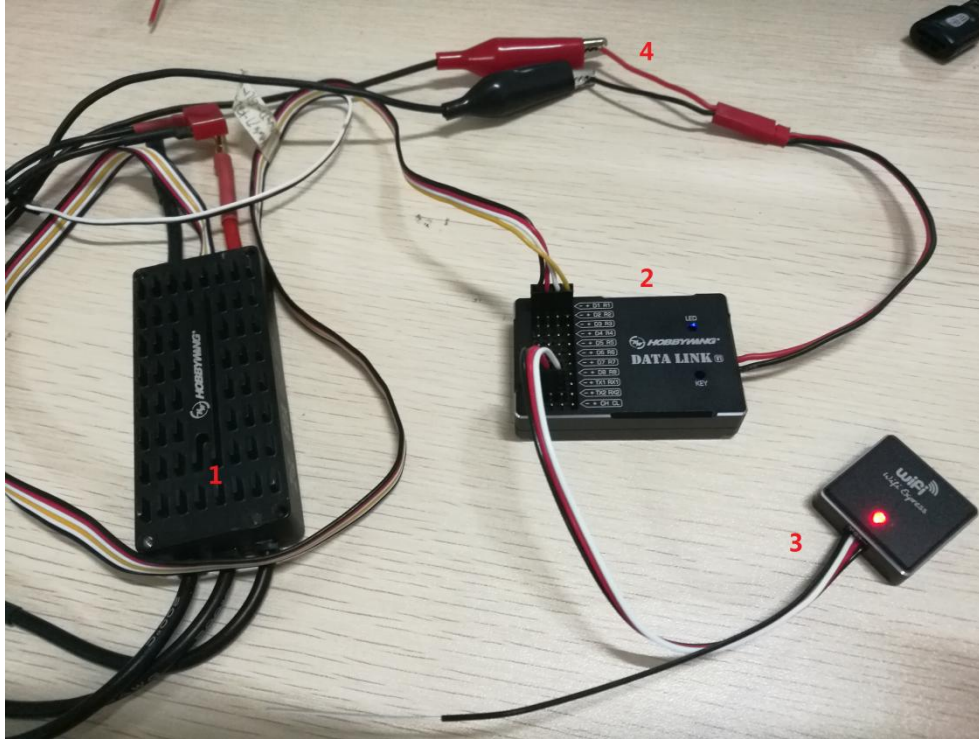
Section3.   Data Packets from the UART ports (TX1/RX1 and TX2/RX2) of DATA LINK

1:   TX1/RX1 UART

Baud rate 115200bps, 8 bit data + 1 bit stop, no parity.
CRC_CCITT 0x1021, big endian format.
Note: Big endian format is used for all multi-byte data.

Byte 0	1	2	3	4-5	6-157(19*8)	Byte 158-159
Head	Frame Length	Protocol Version	Command	Frame Number	ESC Data Section	CRC
0x9B	0xXX	0xXX	0x02	0xXXXX	0xXX….	0xXXXX

The ESC Data Section contains the telemetry data of 8 ESCs, each ESC has 19 bytes data, so totally this section has 19*8=152 bytes. The data format for ESC #1 is shown as below.

Byte 6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21	22	23-24
ESC Channel No.	Packet No. for this ESC	Input Throttle	Output Throttle	e-RPM	Input Voltage	Input Current	Phase Current	MOSFET Temp	Capacitor Temp	Status Code
0x01	0xXX 0xXX	0xXX 0xXX	0xXX 0xXX	0xXX 0xXX	0xXX 0xXX	0xXX 0xXX	0xXX 0xXX	0xXX	0xXX	0xXX 0xXX

The Byte number of the "ESC Data Section" in the whole frame is listed below:

ESC	Byte Number
ESC #1	6----24
ESC #2	25----43
ESC #3	44----62
……	……
ESC #n	(n-1)*19+6----n*19+5
……	……
ESC #8	139----157

Status Code Bytes

Lo-Byte							
Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7
Voltage too high	Voltage too low	Over current	Input throttle error when ESC is armed (*Note A)	Input throttle signal is lost	Input throttle is too high when ESC is armed	MOSFET overheat	Capacitor overheat
Hi-Byte							
Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7
Motor is blocked	Upper bridge of MOSFET is open-circuit	Upper bridge of MOSFET is short-circuit	Wire is broken in motor	Operational amplifier is abnormal in Phase A	Operational amplifier is abnormal in Phase B	Operational amplifier is abnormal in Phase C	CW/ CCW (motor rotation)

Note A: When the ESC is armed, it will check the input throttle signal. If the high level pulse width is less than 500us, the bit 3 will be set to indicate the error of input throttle signal

How to calculate the ESC telemetry data:

uint16_t TEMP=16Bit   //This is the original data output from ESC；

Throttle=TEMP/32767

e-RPM=TEMP

Voltage=TEMP/10

Current=TEMP/64

Temp=Table lookups (The ESC just outputs the A/D value of the temperature. The DATA LINK has an internal table to change the A/D value to readable temperature value in centigrade degree. Please check the table at the end of this article)

The sample of a data frame on TX1/RX1 port:

9B 9E 00 02 88 3F (Head+Length+Protocol Version+Command+Frame Number)

01 00 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 (ESC Number+Packet Number for this ESC+16Bytes ESC Date)

02 00 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

03 00 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

04 00 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

05 00 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

06 00 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

07 00 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

08 00 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

1D 11 (CRC)

2. TX2/RX2 UART

a) RPM Data Frame

The RPM Date Frame is refreshed once per 2ms.

Note: The checksum is calculated by 8bit unsigned char, 2 bytes in Big Endian.

Byte 0	1	2	3	4-5	6-8	9-11	……	27-29	30-31
Frame Head	Length	Protocol Version	Command	Frame Number	ESC #1 & e-rpm of ESC #1	ESC #2 & e-rpm of ESC #2	……	ESC #8 & e-rpm of ESC #8	Checksum
0x9B	0xXX	0xXX	0x03	0xXXXX	0x01 0xXXXX	0x02 0xXXXX	……	0x08 0xXXXX	0xXXXX

Here is an example of the "RPM Data Frame" on TX2/RX2 port:

9B 1E 00 03 5E 4C 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 8A

b) ESC Telemetry Data Frame

Each frame contains the telemetry data of 4 ESCs, Sub-frame #0 contains the data of ESC#1 to ESC#4, and Sub-frame #1 contains the data of ESC#5 to ESC#8.

2 Frames will be sent once in 50ms, so the telemetry date of all of 8 ESCs will be refreshed once per 50ms.

0	1	2	3	4	5-6	7-82	83-84
Frame Head	Length	Protocol Version	Command	Sub-Frame Number	Frame Number	4 ESC Telemetry Data	CRC
0x9B	0xXX	0xXX	0x02	0xXX	0xXXXX	……	0xXXXX

Here is an example of the "ESC Telemetry Data Frame" on TX2/RX2 port:

9B 53 00 02 00 03 C5
01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
03 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
22 32
9B 53 00 02 01 03 C5
05 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
06 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
07 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
7C 78

c) **The Entire Data on the TX2/RX2 Port**
The RPM of each ESC is refreshed per 2ms, other telemetry data is refreshed per 50ms. So, in a 50ms cycle, the RPM Date Frame is refreshed 25times, and ESC Telemetry Data Frame (including Sub-frame #0 and #1) is refreshed once. The entire data is listed as below (Blue=ESC Telemetry Data Frame, Green =RPM Data Frame)

9B 53 00 02 00 03 C5
01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
03 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
22 32
9B 1E 00 03 5E 56 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 94
9B 53 00 02 01 03 C5
05 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
06 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
07 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
7C 78
9B 1E 00 03 5E 57 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 95
9B 1E 00 03 5E 58 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 96
9B 1E 00 03 5E 59 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 97
9B 1E 00 03 5E 5A 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 98
9B 1E 00 03 5E 5B 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 99
9B 1E 00 03 5E 5C 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 9A
9B 1E 00 03 5E 5D 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 9B
9B 1E 00 03 5E 5E 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 9C
9B 1E 00 03 5E 5F 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 9D
9B 1E 00 03 5E 60 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 9E
9B 1E 00 03 5E 61 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 9F
9B 1E 00 03 5E 62 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A0
9B 1E 00 03 5E 63 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A1
9B 1E 00 03 5E 64 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A2
9B 1E 00 03 5E 65 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A3
9B 1E 00 03 5E 66 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A4
9B 1E 00 03 5E 67 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A5
9B 1E 00 03 5E 68 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A6
9B 1E 00 03 5E 69 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A7
9B 1E 00 03 5E 6A 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A8
9B 1E 00 03 5E 6B 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 A9
9B 1E 00 03 5E 6C 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 AA
9B 1E 00 03 5E 6D 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 AB
9B 1E 00 03 5E 6E 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 AC

9B 53 00 02 00 03 C6
01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
03 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

12 91
9B 1E 00 03 5E 6F 01 00 00 02 00 00 03 00 00 04 00 00 05 00 00 06 00 00 07 00 00 08 00 00 00 AD
9B 53 00 02 01 03 C6
05 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
06 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
07 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4C DB
…………

Appendices

1. The table of A/D Value vs. Temperature

```
// 0-129 Degree Centigrade (130 numbers in total, precision=1 degree)
const uint16_t NTC_RT[]={
1556,   1477,   1402, 1332, 1266, 1203,  1144,   1089,   1036,   986,
939 ,   895,    853,  813,  775,  740,   706,    674,    643,    614,
587 ,   561,    536,  513,  491,  470,   449,    430,    412,    395,
378 ,   363,    348,  333,  320,  307,   295,    283,    272,    261,
251 ,   241,    232,  223,  214,  206,   198,    191,    184,    177,
170 ,   164,    158,  152,  147,  142,   137,    132,    127,    123,
118 ,   114,    110,  107,  103,  100,   96,     93,     90,     87,
84  ,   81,     79,   76,   74,   71,    69,     67,     65,     63,
61  ,   59,     57,   55,   54,   52,    50,     49,     47,     46,
45  ,   43,     42,   41,   40,   39,    37,     36,     35,     34,
33  ,   32,     32,   31,   30,   29,    28,     27,     27,     26,
25  ,   25,     24,   23,   23,   22,    22,     21,     20,     20,
19  ,   19,     18,   18,   18,   17,    17,     16,     16,     15
};
```