R1 WURKS

DIGITAL - 3

INSTRUCTION MANUAL

1. Introduction

New from R1 Motor lab is the LCG Digital-3 2S/1S Wireless* programmable brushless speed controller. Developed using the most advanced MICROCHIP processor and a robust proprietary software, the LCG Digital-3 delivers the most technologically advanced features to date. Development of the LCG Digital-3 was focused on ultra smooth power delivery needed for modified racing as well as supreme power efficiency for our class leading line of Stock Motors. The controller offers the most advanced throttle and brake features to suit a wide range of driving styles. The unit features an A.C.L.C. (Advanced Component Level Cooling) system. This design allows individual encapsulated low resistance Mosfets (inner & outer components) to transfer heat directly to the upper heatsink. The system also comes equipped with an all new blinky mode (zero timing) for spec racing, using an advanced commutation algorithm called COOL POWER to keep the motor cool and deliver powerful, yet ultra smooth acceleration. The LCG Digital-3 boasts a redesigned case minimizing overall weight and lowering the center of gravity (LCG). We have minimized the weight from the upper case while improving heat dissipation, achieved by improving air velocity exits from all sides of the ESC case. All adjustable settings are easily programmed using the R1 WIRELESS ADAPTOR coupled with an iOS or Android app designed with an intuitive, easy to use interface. The new R1 Digital 3 app also features a super fast Live Telemetry and a built in Datalogger for after race analysis. Built in Amp draw meter for setting motor timng or race analysis. Using our new over the air updates feature, firmware updates are now easily downloaded through our iOS or Android apps.
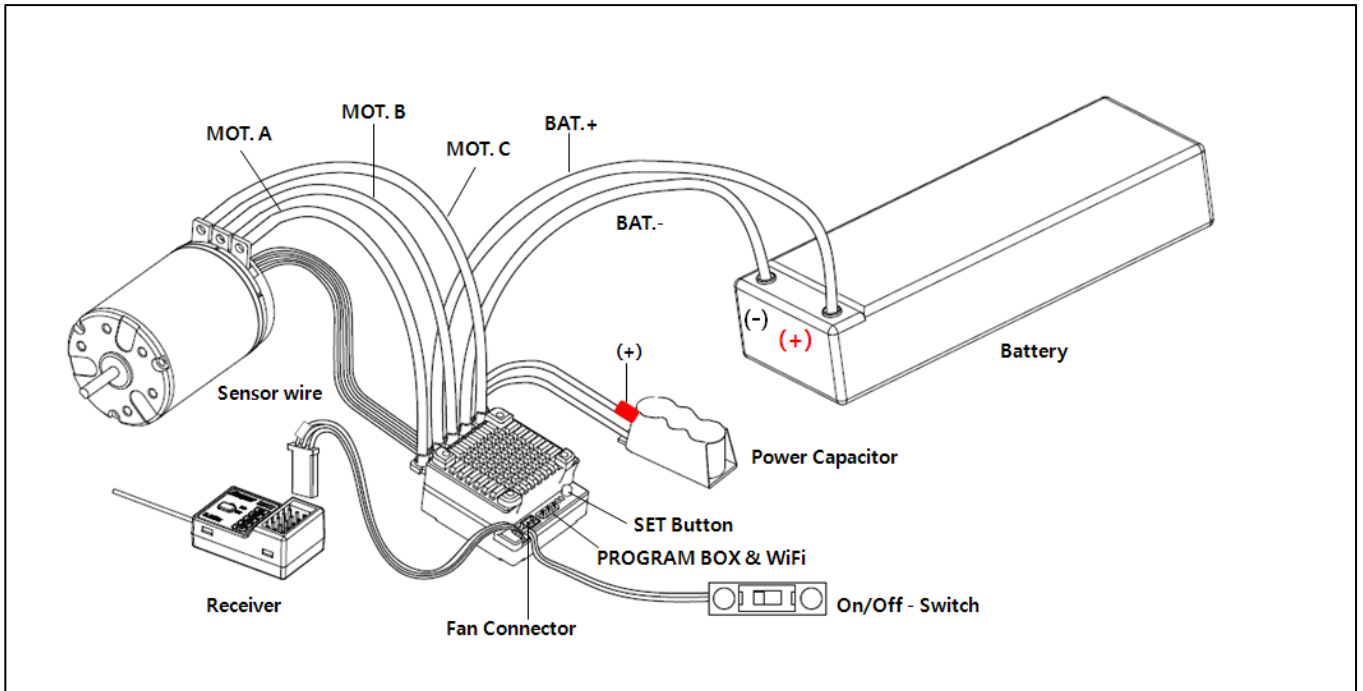
2. Caution

- Avoid short circuits: make sure all ESC wires and connections are protected and are not in contact with peripheral devices.
- When soldering input/output wires and connections, set the iron to 60W minimum.
- Protect the ESC from humidity, water, oil and other substances.   Keep the operation atmosphere dry.
- Provide the ESC with good ventilation to prevent overheating.
- Always separate the ESC from the battery after each use.

3. Features

- Full aluminum case and heat sink design
- Full compatibility with modified and stock racing
- Superlative FET and low-resistance power PCB design
- 30mm fan for maximum cooling
- Software/hardware upgrades increase speed by reducing motor temperature by modifying the communication algorithm
- The Built-in booster BEC has a Maximum voltage of 6V and 7.4V, making it easy to operate a variety of servo without the need for a separate receiver power supply
- New turbo / boost timing setting and delay time setting
- New brake response mode and PWM / brake frequency allows various race and control types
- Data port for connecting to WiFi module
- WiFi module allows program parameter settings and firmware upgrades
- ESC and motor (speed, temperature, current, voltage, RPM and battery consumption) can be stored in real time with the data log

4. Connection

- **Caution**

  For maximum performance, the black silicon wire without any connector is 12AWG. For soldering the battery and motor wires onto the solder bar, set the iron to a minimum of 60W. Avoid soldering more than 5 seconds or the ESC may overheat and become damaged. Use the provided tube casing to prevent the short circuit and to check the polarity after connection.

- **Motor Wire Connection**

  When connecting ESC and motor, the wire A/B/C should be inserted in their respective places. However, some cars are wired backwards. In this case, switch the Motor-Wiring setting from A-B-C to C-B-A. The C and A wires will be reversed from how they are shown on the figure above: incorrect setting and connection can cause critical problems. Keep in mind that if the ESC is reset, then the C-B-A wiring setting will default back to A-B-C; change it to C-B-A again before use.

  After connecting the A/B/C wires, connect the sensor wire to the 6-pin sensor port.

- **Power Capacitor**

  Never drive without the power capacitor! This is necessary to protect the ESC and improve performance. Pay attention to polarity: incorrect connection and poor soldering will damage the ESC. (The power capacitor is not covered by the warranty.)

  As shown in the figure above, connect the indicated red wire to positive (+) ESC post. Connect the short wire to negative (-) ESC post.

■ **Battery Wire Connection**

When connecting the battery, pay attention to polarity: incorrect connection will damage the ESC.   (The battery is not covered by the warranty.)

As shown in the figure above, connect the positive (+) wire is connected to (+) battery port, and the negative (-) wire is connected to the (-) battery port.

■ **Receiver Wire Connection**

Before connecting the ESC to the receiver, the transmitter should be in default settings.   See **Transmitter Settings**.

Connect the ESC throttle wire to the receiver CH2.   The signal wire has a white indicator.   The signal wire supplies 6-7.4V to the receiver, servo, etc., so there is no need to connect an additional battery. External power connected to the receiver may damage the ESC.

■ **Fan Connector**

A cooling fan, screws and fan protector are provided per the ESC specification. It is recommended using the fan under the extreme situations, such as modified or 4WD off-road. The fan will not operate if the ESC temperature is at or below 95°F (35°C) or if the motor RPM is low.

Connect the fan using 2-pin connector at the front of the ESC.   Mount the fan to the top of the heat sink.

5. **Connection Install Guide**
   ■ Place the ESC in a safe place where is easily accessible to connector and buttons.
   ■ Leave enough distance between the ESC, power wire and antenna/receiver to avoid the parts directly touching. Receivers and antennas placed too close together may result in signal confusion.   Parts must be re-install at a further distance apart.
   ■ Tightly affix the ESC with double-sided tape (included).
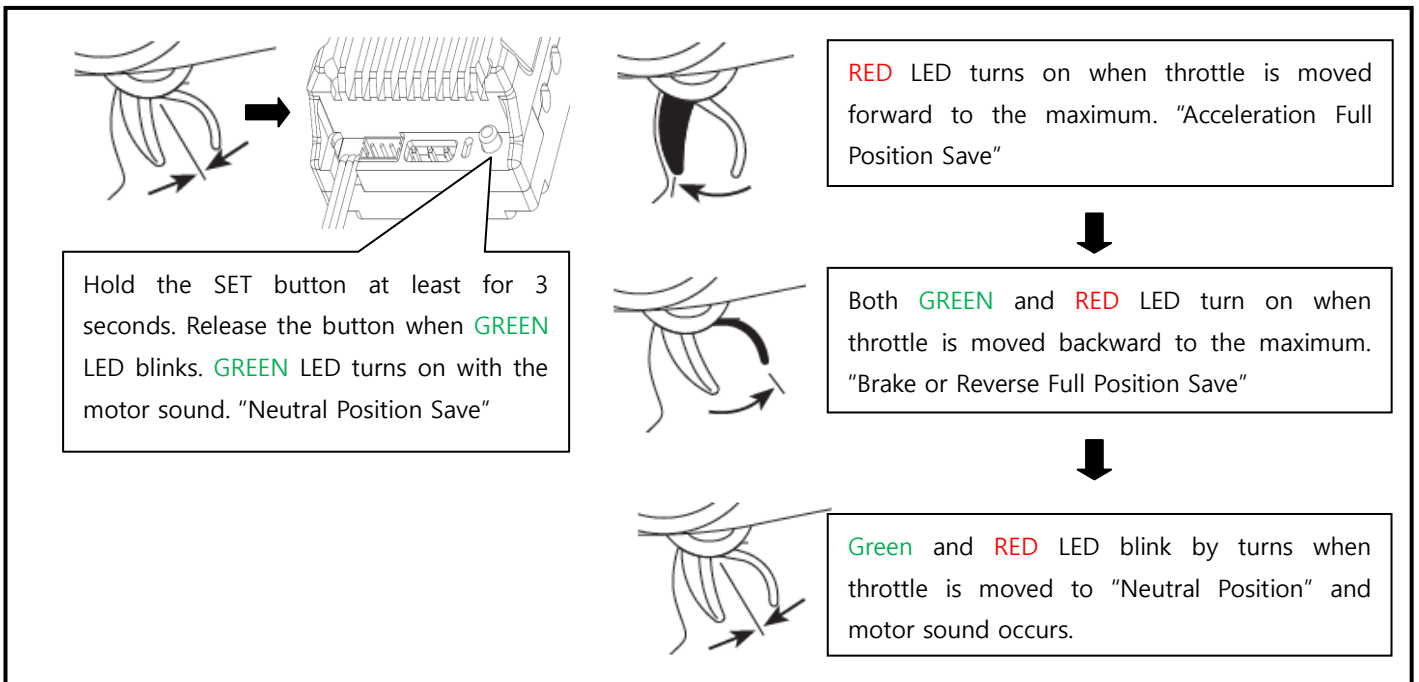
6. **Transmitter Settings**
   ■ Before connecting the ESC to the receiver, the transmitter should be in default settings, as shown in below:

Throttle Travel	High ATV,EPA	100%
Brake Travel	Low ATV,EPA,ATL	100%
Throttle Exponential	EXP,EXPO	Start with 0
Neutral Trim	SUB Trim	Center
Trigger	RATE Forward-Brake	F50 : B50

   ■ Disconnect the ESC from the battery.   Turn the ESC power switch **OFF**.
   ■ Remove the motor pinion, or lift the car off the ground and verify the wheels rotate freely.
   ■ Turn the transmitter **ON** and place the throttle in **NEUTRAL**.

7. CALIBRATION TO TRANSMITTER

- Turn the transmitter on and place the throttle on the neutral.
- Connect the ESC to the battery.   Turn the ESC power switch **ON**

Hold the SET button at least for 3 seconds. Release the button when GREEN LED blinks. GREEN LED turns on with the motor sound. "Neutral Position Save"

RED LED turns on when throttle is moved forward to the maximum. "Acceleration Full Position Save"

Both GREEN and RED LED turn on when throttle is moved backward to the maximum. "Brake or Reverse Full Position Save"

Green and RED LED blink by turns when throttle is moved to "Neutral Position" and motor sound occurs.

- If the motor moves at Neutral Position, there is an inconsistency in the saved neutral value. Re-calibrate the throttle range.
- The LED will broadcast the status of the ESC settings and throttle movements using the indicators listed below.

	GREEN LED	RED LED
Neutral ("BOOST ON MODE")	ON	OFF
Neutral ("BOOST OFF MODE")	Blinking	OFF
Max Acceleration	OFF	ON
Max Reverse or Brake	ON	ON

8. Programmable Items

Set detailed setting parameters and check racing information and telemetry data using the WiFi module. Connect the WiFi module using the 3pin connector on the front of the ESC. Refer to WiFi module manuals for specific information on those components.

	Programmable Items	Parameter Values		Default
1	Model Type	Sensor	Hybrid	Sensor
2	Select Battery	LiPo / LiFe / NiMh (NiCd)		LiPo
3	Cut Off Voltage	Disable / Auto / 3.0V ~ 7.5V (Step:0.1V)		Auto
4	Power Curve	0 ~ 10		5
5	Boost Max+TB	Boost Max + TB Off X X ON 0 ~ 58 (Hybrid:25) +TH 0 ~ 58 (Hybrid:25) ATH 0 ~ 58 (Hybrid:25)	0 ~ 58 (Hybrid:25) 0 ~ 58 (Hybrid:25) 0 ~ 58 (Hybrid:25)	Off
6	Boost-TH. Limit	TH 10,20,30,40,50,60,70,80,90,100	Limit 0~58 (Hybrid:25)	0
7	Boost Min-rpm	0~64500 (Step: 500rpm)		5000rpm
8	Boost Max-rpm	500~65000 (Step: 500rpm)		25000rpm
9	Turbo Delay	0.0 ~ 1.00s (step: 0.05s)		0.20s
10	Turbo + Slope	0.00 ~ 1.00s (step: 0.05s)		0.20s
11	Turbo - Slope	0.00 ~ 1.00s (step: 0.05s)		0.20s
12	Acceleration	0~10		5
13	Start Power	0~100 (step: 1%)		0%
14	Smooth Start Rate	0~30(step: 1)		0
15	Smooth Start Range	0~75%(step: 1%)		0%
16	Reverse Function	One Way / Two Way / Two Way2 / Two Way3		One Way
17	Reverse Delay	Off / 0.2s / 0.5s / 0.8s / 1.3s / 1.8s / 2.5s		2.5s
18	M- Reverse Amount	20% ~ 100% (step: 1%)		100%
19	Neutral Width	Narrow / Normal / Wide		Normal
20	Motor Direction	Normal / Reverse		Normal
21	Brake Response	0% ~ 100% (step: 1%)		0%
22	FAN Control	Auto, On		Auto
23	Drag Brake	0% ~ 100% (step: 1%)		0%
24	Min Brake Amount	0% ~ 100% (step: 1%)		30%
25	Mid Brake Amount	0% ~ 100% (step: 1%)		50%
26	Mid Brake Location	0% ~ 100% (step: 1%)		50%
27	Max Brake Amount	0% ~ 100% (step: 1%)		100%
28	Soft Brake	Hard / Soft	Soft	Soft
29	Brake Freq	1KHz ~ 16KHz(step: 1KHz) / 32Khz		1Khz
30	Motor Freq	1KHz ~ 16KHz(step: 1KHz) / 32Khz	8Khz / 16Khz	5Khz
31	Drag Freq	1KHz ~ 16KHz(step: 1KHz) / 32Khz		1Khz
32	Cut Off Temp	100° ~ 135°F (step: 5) / Disable		135°
33	Cut Off M-Temp	100° ~ 135°F (step: 5) / Disable		135°
34	B.E.C Voltage	6.0V / 7.4V		6.0V
35	Motor Pole Num	2 ~ 20 Pole		2 Pole
36	Gear Ratio	2.0 : 1 ~ 15.0 : 1		2.0 : 1
37	Tire Diameter	40mm ~ 200mm		63mm

38	Motor-Wiring	A-B-C / C-B-A	A-B-C
39	Units	Metric / English	Metric
40	Download	All parameters inside the setup card are downloaded to the ESC.	
41	Factory Setting	Change the setting of ESC to default factory status.	
42	Current Voltage	XX.X	
43	Current Temp	0° ~ 135°C	
44	Max Temperature	0° ~ 135°C	
45	Motor Temp	0° ~ 135°C	
46	Motor Max Temp	0° ~ 135°C	
47	Max Current	0A ~ 999 A	
48	Maximum Speed	XXX.X km/h	
49	Maximum RPM	XXX rpm	
50	Error History	M,T1,T2, S, V, R	

- **Motor Type**

  Sensor: The Sensor Mode is the recommended and default mode because it provides the power system with the highest efficiency and racing performance. If a sensor error occurs during operation, the transmission operates in the sensorless mode immediately; check the motor and sensor cable connections.

  Hybrid: In Hybrid Mode, after the ESC is switched ON it works with a sensored motor at low RPM. Conversely, upon being switched ON the ESC automatically works with a sensorless motor. This mode could be used for 4WD SCT of 4 pole motors.

- **Select Battery**

  Select the correct battery type. Incorrectly selecting the battery type can irreparably damage the battery.

- **Cut Off Voltage**

  Set the minimum voltage at which the battery will run. This function automatically cuts-off the battery to protect it from excessive discharging, which causes irreparable damage.

- **Power Curve**

  ESC output is effected by the throttle curve parameters in relation to the throttle position. Default setting is "**5**"; the power curve should be changed into other shapes using a PC program or WiFi module. For example, if +EXP value is added at the beginning of the curve, the value of the initial output is increased, conversely, if –EXP value is added, smaller throttle value is output.

- **Boost Max+TB**

  OFF: All timing is disabled. The LED should **blink GREEN at neutral** in this mode. This is the preferred mode for Stock Racing.

  ON: The speed and efficiency of the motor is depending on boost timing setting. When boost timing is bigger, speed should be fast, and it also impacts the output depending on the motor RPM. Higher values would increase the power

and RPM but also cause high heating. So, excessive setting could cause fatal problems to the ESC and motor.

- **TB** (TURBO): should be activated when the throttle is located at 100%. (Boost setting + TB setting) are applied into timing. Although the combined value of the two can be set up to 116, its upper limit is 88. If the motor timing is set to more than 60 from the center, it can cause heating in the motor and ESC. It is recommended to set to 60 or lower. This item is an ideal for long straight course. In Hybrid Mode, the maximum value of both settings is limited to 25.

- **ATH**(Auto Throttle)

  If the Auto Throttle function is set, the Boost does not get affected by RPM, but operates only according to the throttle ratio. For example, if the set value for the Boost is 30 and the throttle position is 40%, the operating boost outputs "12" which is 40% of 30.

- **Boost-TH. Limit**

  At Boost Mode, +TH mode allows the setting of timing limit with 10 steps of the throttle location. Please refer to the graphs below.

Boost "ON" MODE   "+TH" MODE
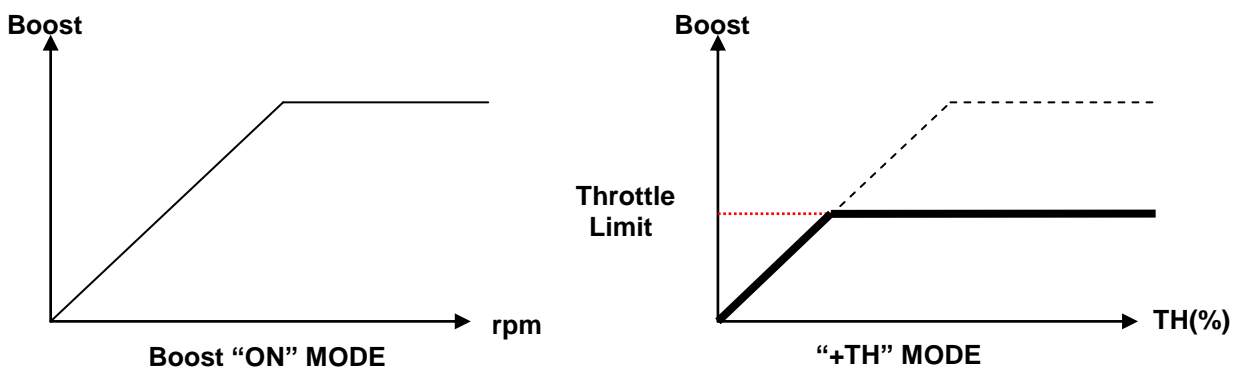
- **Boost Min-rpm**

  Set the minimum RPM that will activate the Boost timing.   For example, with a minimum set to 1000 RPM, the boost timing will be activated as soon as the RPM reaches 1000.   This option can be set between 0~64500 but cannot be higher than the Boost Max RPM.

- **Boost Max-rpm**

  Set the maximum RPM limit for the boost timing.   For example, with a boost value set to 20-degrees and maximum RPM set at 20000, the boost will cap out and hold at 20-degrees once the ESC crests 20000. This option can be set between 0~65000 but cannot be lower than the Boost Min RPM.

- **Turbo Delay**

  Delay the turbo activation.   Turbo is immediately activated when the delay value is set as "**0.00**" and the throttle is moved to "**full**".   When a value is entered, the turbo is only activated after the throttle is moved to full and the set delay time has elapsed.

- **Turbo + Slope**

  Set the amount of time it takes to reach turbo speeds after activation.   The lower the value, the more the acceleration

and heating is increased.

- **Turbo – Slope**

Set the amount of time it takes to recover from turbo speeds when the throttle is back to the original location. The lower the value, the more the brake effect and vehicle movement is decreased.

- **Acceleration**

Set the amount of time it takes to reach maximum output from idle.

- **Start Power**

Set the minimum amount of power to be used to start the motor or when the motor is rotated

- **Smooth Start Rate**

The modified motor has a large output when starting, which hinders a car from moving gently due to the strong power of its start. This function allows a gentle start with the effect of applying the boost value in "-" direction according to the set value.

- **Smooth Start Range**

This is to set throttle stick range for smooth start. For example, if it is set to 50%, the smooth start function works up to 50% of the throttle stick. If one of the Smooth Start Rate and the Smooth Start Range is set to "0", this function does not work.

- **Reverse Function**

One Way: forward / brake

Two Way: Forward / brake / reverse. Reverse is activated after reverse delay. Brake is activated during the delay period.

Two Way2: Forward / brake / reverse. Reverse is activated after 1second of motor pause, regardless of the reverse delay. Direction can be changed after max 6~7 seconds.

Two Way3: Forward / brake / reverse. When the motor is rotated forward, if the throttle stick is moved to the reverse, the brake is activated. Even if the stick stays there, reverse function is not activated. To activate reverse, move the throttle stick to the neutral position and back to the reverse direction again.

- **Reverse Delay**

Set the delay time between when the function is triggered and the reverse is activated.

- **M- Reverse Amount**

Set the max reverse speed during driving between 20~100%.

- **Neutral Width**

Set the neutral width.   The neutral width is the area around transmitter's neutral position.

- **Motor Direction**

Set the forward / reverse rotation of the motor.

- **Brake Response**

Adjust the break strength. The higher the percent, the stronger the brake.

- **FAN Control**

  In the Auto mode, it works depending on the ESC temperature and throttle position. In the On mode, it works all the time.

- **Drag Brake**

  Set the auto brake function to deliver a small brake effect at neutral position.

- **Min Brake Amount**

  Set the minimum percent of the brake range.

- **Mid Brake Amount**

  Set the middle percentage of the break range.

- **Mid Brake Location**

  Set the position of the middle brake range.
  This function is deactivated when mid brake amount and mid brake location are set at 0%.

- **Max Brake Amount**

  Set maximum percent of the brake range. Always leave the brake at the "**FULL BRAKE**" position.

- **Soft Brake**

  This is to set the brake power like "Hard" or "Soft". It is recommended to use "Hard" brake when using Stock Motor.

- **Brake Freq**

  This is to set the brake frequency. When the frequency is lower, control becomes also bigger, and if the frequency is higher, soft control is achieved.

- **Motor Freq**

  Set the motor frequency. The lower the frequency, the faster the initial acceleration; the higher the frequency, the softer the acceleration and more heat is generated by the ESC.
  Note: Hybrid Mode only supports 8khz and 16khz.

- **Drag Freq**

  Set the drag frequency. The lower the frequency the better the effect of the break control; the higher the frequency the softer the break control becomes.

- **Cut Off Temp**

  Set the ESC cutoff temperature. The ESC will cutoff when reaching the set temperature. Disabling this function is not recommended, as the ESC will not be temperature-protected and may become irreparably damaged.

- **Cut Off M-Temp**

  Set the motor cutoff temperature. The motor will cutoff when reaching the set temperature. Disabling this function is not recommended, as the motor will not be temperature-protected and may become irreparably damaged.

- **B.E.C Voltage**

  Set the voltage supplied to the receiver.　Refer to the servo specifications for accurate voltage values, as the ESC may become irreparably damaged.

  7.4V does not work when using a 1S battery.

- **Motor Pole Num**

  Set the motor poles.　Incorrect pole setting could result in inaccurate maximum speed readings.

- **Gear Ratio**

  Set the vehicle gear rate. Incorrect gear ration setting could result in inaccurate maximum speed readings.

- **Tire Diameter**

  Set the tire diameter. Incorrect tire diameter setting could result in inaccurate maximum speed readings.

- **Motor-Wiring**

  Set the motor cable connection: A-B-C or C-B-A.　Make sure the wire configuration and Motor-Wiring setting match, as the ESC could become irreparably damaged.

- **Units**

  You can change the unit to display temperature and speed.

- **Download**

  Download and store to the ESC any setting values changed on the setup card.

- **Factory Setting**

  Restore the ESC setting parameters to the original factory defaults.

- **Current Voltage**

  View the battery voltage when the program is connected.

- **Current Temp**

  View the ESC's temperature when the program is connected.

- **Max Temperature**

  View the ESC's highest temperature achieved during drive time when the program is connected.

- **Motor Temp**

  View the motor's temperature when the program is connected.

- **Motor Max Temp**

  View the motor's highest temperature achieved during drive time when the program is connected.

- **Max Current**

  View the highest current that achieved during drive time when the program is connected.

- **Maximum Speed**

  Set a maximum speed limit.   This speed will not be exceeded during drive time.

- **Maximum RPM**

  Set the maximum motor RPM limit.   This level will not be exceeded during drive time.

- **Error History**

  M = Motor connection problem / motor malfunction / motor damage

  T1 = Temperature issue in ESC

  T2 = Temperature issue in motor

  S = Sensor problem

  V = Voltage too low

  R = Receiver signal problem

10. LED Error Status

When the ESC is turned on the LED lights will flash to indicate the following statuses:

- **GREEN and RED LED blink simultaneously**: ESC is not connected to motor or ESC lines are short-circuited. If problem persists, the ESC's FET is damaged. Send the product to the R1WURKS Service Center for repair.
- **RED LED blinks one time repeatedly:** no receiver signal. Check the transmitter/receiver connection.
- **RED LED blinks two times repeatedly:** low voltage, cutoff activated.
- **RED LED blinks three times repeatedly:** motor sensor problem. Check the sensor cable connection and motor status.
- **RED LED blinks four times repeatedly:** ESC temperature protection activated.
- **RED LED blinks five times repeatedly**: PWM output is occurring but the motor is idle for more than 2 seconds. Check the motor status or check the car.
- **RED LED blinks six times repeatedly**: motor temperature protection activated.
- **RED LED blinks seven times repeatedly**: BEC output problem. Check the servo.

	GREEN LED	**RED LED**
ESC/Motor not connected	Blinking	Blinking
No receiver signal	OFF	Flashes 1x repeatedly
Low voltage	OFF	Flashes 2x repeatedly
Motor problem	OFF	Flashes 3x repeatedly
ESC temperature protection	OFF	Flashes 4x repeatedly
PWM output + motor idle 2sec	OFF	Flashes 5x repeatedly
Motor temperature protection	OFF	Flashes 6x repeatedly
BEC output problem	OFF	Flashes 7x repeatedly

11. Data Check

You can check the maximum temperature/current/speed/rpm of ESC and MOTOR through WiFi module.

12. Specification

DIGITAL-3	
Motor Type	Sensored / 4Pole Sensored
Motor Limit "Specification when using the fan"	>3.5T
Operating voltage	3.7-7.4V
Forward / Brake / Reverse	yes
Full aluminum case / heat sink	yes
Typ. Voltage Drop @20A per phase	0.0048V
Rated Current per phase	2549A
Plugged 30x30x10mm Fan	yes
BEC Output	6V/7.4V Bulit-in DC Booster, Continuous Current of 3A
Multi-Protection-System	yes
"Boost 0" Mode	yes
Multi-frequency system	yes
Power Wires	12Awg
USB Software Updateability	yes
Case Size(without fan)	32.9 x 34.6 x 21mm
Weight(without cable)	50g