



## Remotely Operated Auto Racers

### Requirements and Test Protocol for Non-Timing Brushless Electronic Speed Controls

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## 1. Scope & Purpose

This document provides requirements and tests for brushless electronic speed controls to comply with ROAR non-timing rules. The intended audience includes ROAR members and equipment manufacturers.

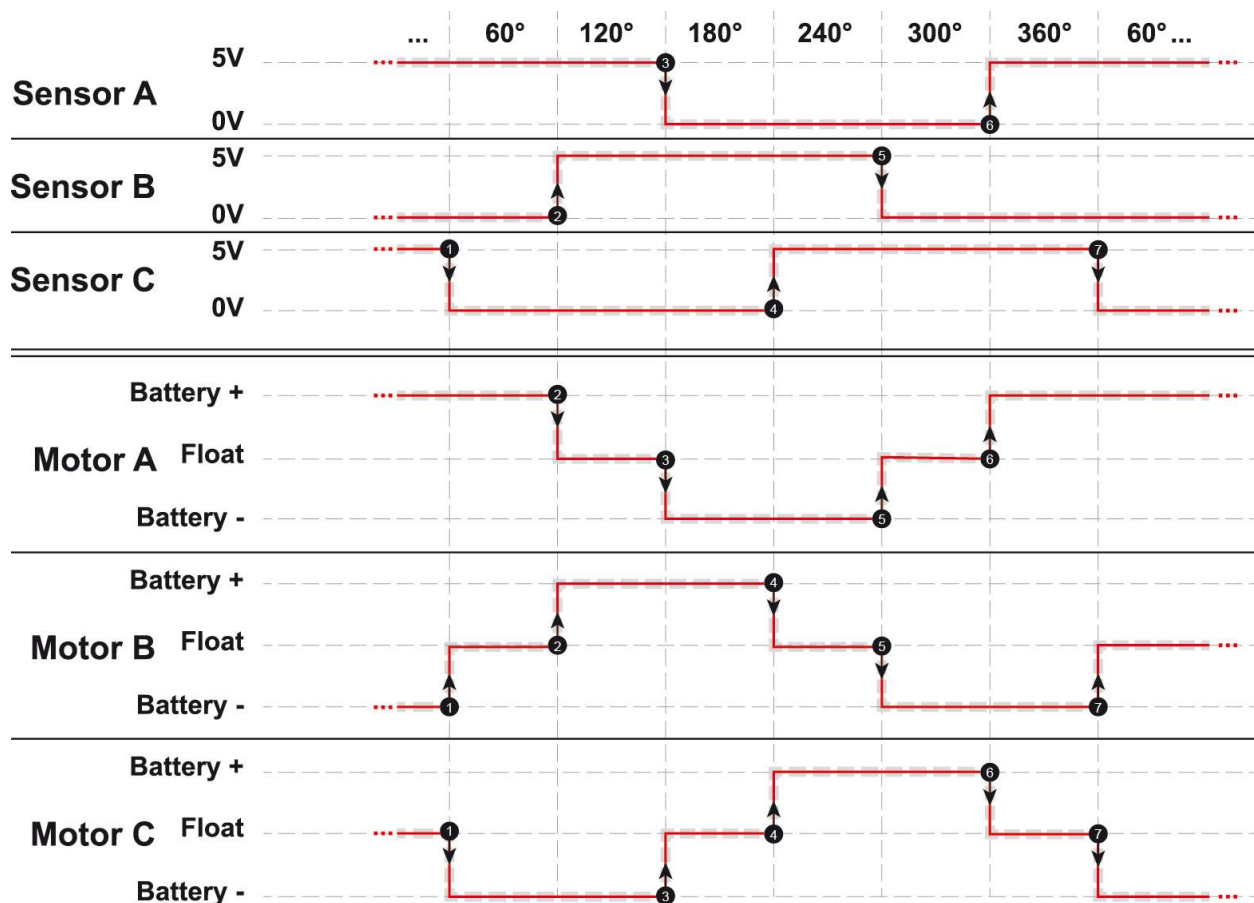
For expediency, the tests and their associated conditions given herein comprise a small subset of possible operating conditions. Under no circumstances should these be construed as the only conditions where the speed control must meet timing requirements. The speed control must meet timing requirements under the full range of operating conditions.

ROAR retains the right to modify these specifications and tests at any time without notice.

## 2. Requirements

### 2.1 General

The commutation sequence shall conform to the diagram shown below.



## **2.2 Timing Requirements**

### **2.2.1 Commutation After Sensor Change**

Commutation shall occur after the corresponding sensor signal changes state.

### **2.2.2 Maximum Delay**

The delay from sensor signal change to commutation shall be less than 10 microseconds.

## **3. Test Equipment**

### **3.1 Oscilloscope and Probes**

#### **3.1.1 Channels**

The oscilloscope shall have a minimum of two channels.

#### **3.1.2 Bandwidth**

The oscilloscope and probes shall have a bandwidth of not less than 10 MHz.

#### **3.1.3 Probe Matching**

##### **3.1.3.1 Type**

Oscilloscope probes shall be of the same manufacturer and part number.

##### **3.1.3.2 Length**

Oscilloscope probes shall be matched within 6 inches in length.

#### **3.1.4 Calibration**

The oscilloscope and probes shall have valid calibration documentation.

## 3.2 Digital Multimeter

### 3.2.1 Resolution

The meter shall indicate the measured values with at least three digits of resolution.

### 3.2.2 Accuracy

The meter accuracy shall be 0.5% +/- one count or better on the measurement ranges used during testing.

### 3.2.3 Calibration

The meter shall have valid calibration documentation.

## 3.3 Power Supply

### 3.3.1 Type

The power supply shall be one or more Lithium Polymer cells of 4000 mAh minimum capacity and 25C minimum discharge rate.

### 3.3.2 Number of Cells

The power supply shall have cell counts to match the range given in the manufacturer's published speed control specifications, i.e., if the range of operation includes one or two LiPo cells, then the low voltage used during testing shall be from one cell, and the high voltage used during testing shall be from two cells.

## 3.4 Pulse Generator

Tests shall be conducted using an appropriate pulse generator. A servo tester or transmitter/receiver pair may be used.

### 3.4.1 Operating Voltage

Operating voltage shall be at least 4.8 to 6.0V. (This applies to the receiver only if a transmitter/receiver pair is used.)

### **3.4.2 Pulse Amplitude**

Output pulse low level shall be less than 0.6V. Output pulse level shall be greater than 3.5V. (This applies to the receiver only if a transmitter/receiver pair is used.)

### **3.4.3 Pulse Width**

Output pulse shall be variable over the range of 1 to 2 milliseconds.

### **3.4.4 Pulse Repetition Rate**

The pulse repetition rate shall be between 7 and 20 milliseconds

## **3.5 Thermometer**

### **3.5.1 Resolution**

The thermometer shall have a resolution of at least 0.1 degree C.

### **3.5.2 Accuracy**

The thermometer shall have an accuracy of 0.3 degrees C or better.

### **3.5.3 Calibration**

The thermometer shall have valid calibration documentation.

## **3.6 Test Stand**

A test stand shall be used to safely support a test motor.

### **3.6.1 Test Motor**

The test motor shall be a ROAR-approved brushless of 17.5 turns.

### **3.7 Digital Camera**

A digital camera shall be used to capture the test execution.

### **3.8 Computer/Interface/Programmer**

If the speed control requires a computer, computer interface, or external programmer to download necessary software or activate non-timing mode, then the speed control manufacturer's requirements and instructions for these shall be used.

## **4. Test Conditions**

### **4.1 Temperature**

All tests shall be performed at an ambient temperature between 20 and 25 degrees C.

### **4.2 Supply Voltages**

The high test voltage used in this procedure must be within the range of 4.10 to 4.20 V per cell, inclusive. The low test voltage used in this procedure must be within the range of 3.60 to 3.70 V per cell, inclusive.



## 5. Test Procedure and Results

### 5.1 Equipment

Record the following information on the equipment used, if applicable:

DESCRIPTION	MANUFACTURER	MODEL	SERIAL NUMBER	CALIBRATION DATE
Speed Control				Not Applicable
Oscilloscope				
Digital Multimeter				
Power Supply			Not Applicable	Not Applicable
Pulse Generator				Not Applicable
Thermometer				TBD
Computer				Not Applicable
Programmer				Not Applicable
Test Motor				Not Applicable

### 5.2 Software and Timing Mode

If applicable, download the software version to be tested into the speed control. Record the software version here:

If applicable, activate the speed control's non-timing mode. Indicate the approximate frequency of LED flashing here:

If applicable, attach the manufacturer's directions and appropriate images here:

### 5.3 Setup

#### 5.3.1 Connections to Test Equipment

Connect the speed control to the test motor, power supply, and pulse generator according to the speed control manufacturer's instructions. Connect the oscilloscope to the motor sensor leads and stator terminals using appropriate adapters, if necessary. Attach the speed control manufacturer's directions and appropriate images here:

### **5.3.2 Speed Control Calibration**

Calibrate the speed control to the pulse generator according to the speed control manufacturer's instructions. Attach the speed control manufacturer's directions here:

### **5.3.3 Oscilloscope Adjustment and Trigger Setting**

Adjust the oscilloscope probes to the same attenuation, if applicable. Run the speed control at full throttle. Adjust the oscilloscope to trigger from the sensor signal at a level from 45 to 55% of the total amplitude.

## **5.4 Speed Control Timing Tests**

Verify that the timing requirements given in section 2 are met with the speed control at full throttle for the following signals and conditions:

### **5.4.1 Sensor A Change to Motor A Change**

#### **5.4.1.1 High Supply Voltage**

Record the ambient temperature here:

Record the supply voltage here:

Record the delay from Sensor A signal to Motor A signal here:

Attach oscilloscope screen shots of Sensor A and Motor A signals here:

#### **5.4.1.2 Low Supply Voltage**

Record the ambient temperature here:

Record the supply voltage here:

Record the delay from Sensor A signal to Motor A signal here:

Attach oscilloscope screen shots of Sensor A and Motor A signals here:

### **5.4.2 Sensor B Change to Motor B Change**

#### **5.4.2.1 High Supply Voltage**

Record the ambient temperature here:

Record the supply voltage here:

Record the delay from Sensor B signal to Motor B signal here:

Attach oscilloscope screen shots of Sensor B and Motor B signals here:

#### **5.4.2.2 Low Supply Voltage**

Record the ambient temperature here:

Record the supply voltage here:

Record the delay from Sensor B signal to Motor B signal here:

Attach oscilloscope screen shots of Sensor B and Motor B signals here:

### **5.4.3 Sensor C Change to Motor C Change**

#### **5.4.3.1 High Supply Voltage**

Record the ambient temperature here:

Record the supply voltage here:

Record the delay from Sensor C signal to Motor C signal here:

Attach oscilloscope screen shots of Sensor A and Motor A signals here:

#### **5.4.3.2 Low Supply Voltage**

Record the ambient temperature here:

Record the supply voltage here:

Record the delay from Sensor C signal to Motor C signal here:

Attach oscilloscope screen shots of Sensor C and Motor C signals here:

## 5.5 Test Summary

Indicate PASS or FAIL here:

If the result is failure, summarize the failure(s) here: