

# Notes on RC Servos

## 1 Introduction

Remote Control Servos (RC Servos) are intended as actuators for remote-controlled model vehicles such as aircraft and cars, where they typically actuate functions such as throttle, control surfaces and steering.

An RC servo is a complete self-contained angular position servo. It requires an electrical power supply and an input position reference signal, and produces an angular position on the output shaft. Figure 1 shows a typical RC Servo.



Figure 1: A Typical Analogue RC Servo

An analogue RC servo contains all of the components needed to form a complete position control loop, implemented in analogue electronics. There is at least

- a DC motor;
- a reduction gear train and output shaft;
- output shaft angular position sensor (usually a potentiometer);
- input position reference signal conditioning circuitry; and
- analogue control circuitry.

The input position reference signal is converted to a position reference voltage and compared to the feedback voltage that represents the current angular position of the output shaft. Any difference is amplified and drives the motor so that the error is minimised.

## 2 Power Supply

Most RC servos require a power supply between 4.0 VDC and 6.0 VDC, at a few hundred milliamps. Do not exceed the voltage specified by the manufacturer, as the motor will overheat and may be destroyed.

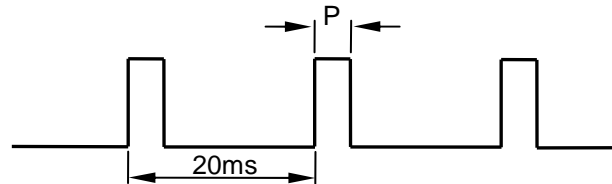
## 3 Input Reference Signal

An RC servo receives its position command in the form of a series of pulses, with the reference *position* encoded as the *duration* of the pulses. This could be called pulse duration modulation (PDM). The input position reference signal is shown in Figure 2. It consists of a 50 Hz pulse train, where each pulse has duration 'P' between 1000  $\mu$ s and 1000  $\mu$ s. A pulse of

1000  $\mu\text{s}$  duration commands the servo to move to one extreme position, and a pulse of 2000  $\mu\text{s}$  duration commands the servo to move to the other end of its travel. The commanded position varies linearly between these extremes, so that a 1500  $\mu\text{s}$  pulse corresponds to the servo's mid-position.

The input reference signal voltage *must not exceed* the power supply voltage.

The input reference signal frequency *must not exceed* 50 Hz.



**Figure 2: Position Reference Input Pulse Encoding**

## 4 Output

The output of an RC servo is the shaft position. Given a continuous position reference input pulse train, the servo will adjust the motor current in an attempt to hold the output shaft at the commanded position. The current drawn therefore depends on the load.

An RC servo will typically have approximately 180° of mechanical rotation on the output shaft. Of this, perhaps 90°-120° can be electrically commanded.

## 5 RC Servos in Use

We are currently using two RC servos: JR (Japan Radio) model NES-537 and Hitec model HS-425BB. The JR NES-537 servo is no longer available and is being replaced by the Hitec HS-425BB as needed. The two servos have nearly identical specifications, given below.

### 5.1 JR Model NES-537

This is a standard-sized servo that is fitted with one ball race on the output shaft; both the internal gears and the output shaft are plastic. The model NES-537 has the basic specification shown in Table 1. The connector pin out is given in Table 2.

**Table 1: Basic Specification - JR Model NES-537**

Quantity	Value
Dimensions	32.5 x 19.0 x 38.5 mm
Weight	45 g
Voltage	4.8 to 6.0 V DC
Speed	240°/sec @ 4.8V
Torque	0.28 N.m @ 4.8V
Min Pulse Width	900 $\mu\text{s}$
Max Pulse Width	2100 $\mu\text{s}$

**Table 2: JR Servo Pin out**

Function	Colour
+0.0 V DC	Brown
+4.8 V DC	Red
Position Ref Pulse	Orange

## 5.2 Hitec Model HS-425BB

This servo is fitted with two ball races on the output shaft. The model HS-425BB has the basic specification shown in Table 3. The connector pin out is given in Table 4.

**Table 3: Basic Specification - Hitec Model HS-425BB**

Quantity	Value
Dimensions	36.6 x 19.8 x 40.6 mm
Weight	45.5 g
Voltage	4.8 to 6.0 V DC
Speed	286°/sec @ 4.8V
Torque	0.32 N.m @ 4.8V
Min Pulse Width	900 $\mu$ s
Max Pulse Width	2100 $\mu$ s

**Table 4: Hitec Servo Pinout**

Function	Colour
+0.0 V DC	Black
+4.8 V DC	Red
Position Ref Pulse	Yellow

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