



BotsIQ: Radio Control System Specifications

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I. Introduction

This document sets forth the specifications for wireless radio control (R/C) systems for robotic teleoperator control in BotsIQ¹ events. Due to the potentially hazardous nature of competitive robots, a robust and reliable radio system must be employed. With the current state-of-the-art in modern R/C as used in the hobby industry, such systems are readily available. Representative systems are listed in this document.

II. Requirements

The primary objective in the selection of an R/C system for competitive robotic application is safety, along with the parallel goal of preventing unintended damage to humans, robots and their environment. For this, a competition R/C system should possess the following characteristics:

- Use of spread-spectrum² techniques in the 2.4 GHz (ISM) band
- Use of receiver-to-transmitter binding/pairing
- Failsafe on all channels relating to propulsion and offensive weaponry

The spread-spectrum requirement aims to reduce, if not eliminate, interference from electromagnetic sources other than the robot operator's radio, including other radio transmitters. This was a common problem with previous fixed-frequency systems that operated in the 27 MHz or 72/75 MHz bands. Spread-spectrum techniques also provide secure communication links by employing digital, packet-based transmissions with error detection. Binding of receivers to a fixed transmitter effectively forces a receiver to only "listen" to the one transmitter that it is bound to. This essentially eliminates jamming and "lockout" problems in the presence of other transmitting sources. Application of failsafe control is a back-up measure that can be used to guarantee that a "rogue" robot ceases any current motion and immediately disables any on-board weaponry. One example of this scenario would be when a transmitter dies due to insufficient battery charge while the robot is still active.

III. Example R/C Systems

With "2.4 GHz" technology relatively mature the R/C hobby industry, numerous systems meeting the above requirements are readily available. Although a variety of both turnkey systems and aftermarket solutions can be found, this document focuses on mainstream systems from major manufacturers such as Futaba³, JR/Spektrum⁴, and Airtronics⁵. Representative systems are listed in table 1. These systems generally include one receiver, batteries for both transmitter and receiver, and are sometimes available with or without servos. A number of other lower-cost radio systems not included here were reviewed; however, they do not provide failsafe on all channels and were discounted from inclusion in this document.

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Manufacturer	Model	Channels	Failsafe	Comments
Airtronics	SD-10G	10	all channels	Higher end
Futaba	10C	10	all in 10ch mode only (6008 or 6014 Rx)	Higher end
JR	X9303A/S	9	all channels	Higher end
Spektrum	DX7	7	all w/ AR7000	Mid range

Table 1: Appropriate R/C Systems for BOTS-IQ

One other combination that provides failsafe on all channels is the Spektrum DX6/DX6i when coupled with the BR6000 bot receiver. This was a popular choice in previous years. Acceptance of this system should be verified with regional standards and regulations. For example, the Southwestern Pennsylvania division of BOTS-IQ recognizes this system as acceptable for use in the 2009-2010 competition year.

IV. Failsafe

Although modern 2.4 GHz R/C systems provide much more robust radio links than previous systems, failsafe is still required to even further mitigate undesired actions on behalf of the robot in the event of a radio link problem. The failsafe feature allows for receiver channels relating to robot motion and weaponry to immediately go to a predetermined setting. In this scenario, the robot should immediately cease any motion and instantly disable all weaponry. A valid test for this is to simply switch off the transmitter while currently linked and teleoperating the robot and verify for proper immediate “cease and desist” resulting action. Make sure the robot is appropriately tethered or otherwise restrained during this test!

About the author

Jeffrey Sumey is an associate professor of over twenty years in the Department of Applied Engineering and Technology at California University of Pennsylvania. He has developed and taught courses in the ABET accredited B.S. Electrical Engineering Technology (EET), the ABET accredited B.S. Computer Engineering Technology (CET), the Computer Science and Multimedia Technology programs. He also recently developed and is program coordinator for the A.S. Robotics Engineering Technology (RET) program launched during the fall 2009 semester.

¹ <http://www.botsiqpa.org>

² http://en.wikipedia.org/wiki/Spread_spectrum

³ <http://futaba-rc.com>

⁴ <http://www.jrradios.com> and <http://www.spektrumrc.com>

⁵ <http://www.airtronics.net>