

Sumo Bots Frequency Facts

Meeting the Three Frequency Requirement

According to Section 2, Paragraph (d) of the 2012 Wisconsin Science Olympiad Sumo Bots Rules, the bot must be able to operate on three different radio frequencies to avoid interference with an opponent's bot. The major frequencies designated by law for use with radio controlled cars are 27 MHz, 49 MHz and 75 MHz. Each of these frequencies has a set of sub-frequencies, sometimes referred to as channels (see Table 1). **These frequency channels should not be confused with the number of channels a remote control has, which refers to the number of different motors the remote can operate.** The three frequency requirement can be met by using three sub-frequencies of one frequency (e.g. 27 MHz, channels 1, 3, and 5) or a combination of different major frequencies (e.g. 49 MHz, Channel 2 and 75 MHz, Channels 63 and 72). As long as you can change the frequency your bot uses among three different standard frequencies (or sub-frequencies) shown in Table 1, you have met the requirement.

In addition to the three major frequencies listed above, 2.4 GHz controls (including bluetooth devices) may also be used to control bots. If you are using the 2.4 GHz frequency, your bot will automatically switch to an unused frequency; and there is no need to worry about the three frequency requirement.

Please note that 72 MHz has been designated by the Federal Government for use by model airplanes and helicopters only, and it is against Federal law to allow that frequency to be used to control a land vehicle such as a Sumo Bot.

Changing the Frequency of Controls

Many remote control transmitter/receiver pairs that can operate on more than one frequency come with interchangeable crystals installed (the crystal is a chip that determines which sub-frequency the transmitter is sending out and the receiver is accepting). In the 27 MHz and 75 MHz ranges, additional crystals are sold in pairs (one for the transmitter and one for the receiver). The 49 MHz range seems to have fallen out of favor with remote control enthusiasts, and it has become almost impossible to find additional 49 MHz crystals. It is recommended that you only consider using 49 MHz controls if you already have the additional 49 MHz crystals to meet the three frequency requirement.

If your transmitter/receiver pair is either 27 MHz, 49 MHz or 75 MHz and does not have interchangeable crystals, there are only two other ways you can change the frequency. Some digital controls allow you to dial a new frequency on the transmitter's readout screen and turn a setting wheel on the receiver to the same frequency. In addition, some transmitter/receiver pairs have a switch that can be set for three different frequencies (usually designated as 27 MHz, channel A, B and C). To meet the construction specifications, the transmitter/receiver pair must have one of the three features described above to change the frequency or must operate at 2.4 GHz.

Please keep in mind that some of the cheaper R/C models available that operate on more than one frequency utilize a non-standard method of designating their frequencies (i.e. 27 MHz, channel A and B). To insure that there is no interference between bots, the Event Supervisor **MUST** know what frequencies your bot uses, and **MUST** be able to tell you to switch to a frequency that is not being used by anyone else. It is the responsibility of the team to determine what frequencies are represented by non-standard designations. If a team cannot tell the Event Supervisor what frequencies their bot uses (in standard format according to Table 1), they do not meet the construction specifications.

Additional Information on Radio Control Frequencies

Table 1 on the follow page serves as a reference for teams that use replaceable crystals to change frequencies. The possible sub-frequencies are listed along with their corresponding channel numbers. 27 MHz controls have 6 primary sub-frequencies. There are two standard ways to refer to these sub-frequencies: either by their frequency number or by their channel number. The FCC has recently added an additional 6 sub-frequencies (channels 7-12). Channels 7 to 12 are really intermediate channels between 1 and 6. Only the most modern transmitters/receivers can use those channels without causing interference. For example, if you are using channel 7 for your bot, you could cause interference for an opponent using an older transmitter/receiver pair on channel 1 or 2. Therefore, the sub-frequencies of 27 MHz allowed for Sumo Bots are those designated as channels 1-6 only. 49 MHz controls have 5 sub-frequencies. As stated above, crystals for 49 MHz are extremely difficult to find, and this frequency range is not recommend unless a team already has crystals available for use. 75 MHz controls have 30 sub-frequencies from Channel 61 to Channel 90, with frequencies that start at 75.41 for Channel 61 and rise by 0.02 MHz.

The number of channels available for 2.4 GHz depends on the manufacturer of the transmitter and receiver. Spektrum and other Direct Sequence Spread Spectrum (DSSS) or Digital Spectrum Modulation (DSM) models divide the 2.4 GHz frequency into 80 channels. Other manufacturers may divide the frequency into more or fewer channels. The advantage of the 2.4 GHz frequency is that no crystals are required to change the channel – the transmitter searches for an unused frequency and locks the receiver to that frequency. Many 2.4 GHz transmitters and receivers are paired to prevent interference; they will only connect to each other. If you are using a 2.4 GHz control, it is strongly recommended that you use a transmitter and receiver that are paired. If you wish to use a transmitter and receiver that is not specifically designed for controlling an R/C car (e.g. a bluetooth device, transmitting from either a computer or a cell phone), then you will need to program the receiver to operate your bot based on the signals it receives from the transmitter. If you use a 2.4 GHz transmitter/receiver combination that isn't paired, please be aware that some 802.11g wireless systems operate on 2.4 GHz and may cause interference. You also need to be aware that if your transmitter cannot find an available channel because many other wireless devices are in use (e.g. bluetooth enabled cell phones), then it simply will not transmit until a channel becomes available.

27 MHz Transmitter/Receiver	
<i>Channel Number</i>	<i>Sub-Frequency</i>
1	26.995
2	27.045
3	27.095
4	27.145
5	27.195
6	27.255
7 - 12	NOT ALLOWED
49 MHz Transmitter/Receiver	
<i>Channel Number</i>	<i>Sub-Frequency</i>
1	49.830
2	49.845
3	49.860
4	49.875
5	49.890
75 MHz Transmitter/Receiver	
<i>Channel Number</i>	<i>Sub-Frequency</i>
61	75.41
62	75.43
63	75.45
... (continues by increment of 1) (continues by increment of 0.02 MHz) ...
89	75.97
90	75.99

Table 1: Sub-frequencies for 27, 49 and 75 MHz radio control systems

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