Get on the Satellites for ARRL FIELD DAY

Practice these operating techniques so you'll be ready to capture that 100-point bonus on Field Day.

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More amateurs are discovering the fun of satellite operating. Stations can be small and portable; satellite passes don't take much time, and even Technician-class hams have privileges on most satellites.

During ARRL Field Day, there is a 100-point bonus for making one contact via satellite. This seems like an uncomplicated way to boost your score. However, every year, many stations try to make a satellite contact and do not succeed. In some cases, they inadvertently prevent others from making contacts on the satellite as well. Learning some basic satellite operating techniques for making a successful contact on an FM satellite during Field Day will prevent you from being that person.

James Williams, KB4FLC, used a simple dual-band, handheld transceiver and an Arrow handheld antenna to work FM satellites from Louisville, Kentucky, during Field Day 2017. [James Williams, KB4FLC, photo]

Intro to FM Satellites

Most of the FM satellites that are currently in orbit are known as *CubeSats*, a 10-centimeter cube with a dual-band FM transceiver and an antenna. They function like an orbiting repeater: only one station may transmit at a time. These satellites are known as *low-Earth orbit* (*LEO*). They are typically above the horizon for as little as a few seconds to a maximum of about 15 minutes. You can only communicate through a satellite if it is above your horizon. When a satellite first appears above the horizon at the beginning of a pass, that is called *acquisition of signal* (*AOS*); when it disappears below the horizon at the end of a pass, that is called *loss of signal* (*LOS*).

Most satellites transmit on one band and receive on another; the most common bands used are 2 meters and 70 centimeters. You transmit, or *uplink*, your signal to the satellite on one band, and receive, or *downlink*, the satellite's signal on the other band. At the time of this writing, there are four FM satellites that cover the US regularly: SO-50, AO-85, AO-91, and AO-92. Several more FM satellites should be operational by the end of 2018. Most satellites make five to six passes over the US every 24 hours. While there are other satellites that use SSB or data, those are beyond the scope of this article.

The Gear You Need

To be successful on satellites, you need to be able to transmit and receive on both 2 meters and 70 centimeters, antennas for each of those bands, and a way to track a

Many satellite operators use an extremely portable full-duplex station built around two Yaesu FT-817 transceivers for both FM and SSB (linear) satellites. The author used this setup when roving through Montana in May 2017. [Katie Allen, WY7YL, photo]

satellite's progress over your part of the sky. For FM satellites, a dual-band, handheld transceiver or two separate handhelds will work fine.

It is a big advantage to work satellites in *full-duplex* mode; this means you can hear the satellite's downlink as you are transmitting, allowing you to know when your signal is making it into the satellite. You can also operate satellites in *half-duplex* mode, meaning that when you transmit, you can't hear the satellite's signal, but this puts you at a disadvantage. Being able to know when you are making it into the satellite is a huge factor in a successful contact. Currently, all FM satellites require a 67.0 Hz CTCSS tone on your transmitted signal.

It's possible to make satellite contacts using simple vertical antennas, but you'll have more success if you use directional antennas with gain, such as a small Yagi, for both bands.

It's easy to build your own antenna, or there are several commercial antenna options for satellites, such as the Arrow or Elk antennas, which can be held in one hand and easily follow the satellite as it passes overhead.

You will need a *diplexer*, which isolates your transmitted signal from your receive radio. Without it, you will likely overload the front end of your receive radio and make contacts impossible. Several manufacturers offer diplexers; the Arrow antenna has an optional diplexer that is stored in the antenna handle.

Lastly, you'll need to know when satellites will be overhead and where to point your antenna. Resources that offer tracking information include the *GoSatWatch* ($10) smartphone app for iOS users (*SatSat* is a free option with less features), the *AMSATDroid* app for Android users, AMSAT's website, and **n2yo.com**.

Adjusting for Doppler

The Doppler effect impacts satellite operating and is more noticeable on 70 centimeters than on 2 meters; as a satellite pass progresses, you will need to adjust your 70-centimeter

FM Satellite Frequency Chart

Here's a list of frequencies used for five different phases of a satellite pass, from Acquisition of Signal (AOS) to Loss of Signal (LOS). These changes will help adjust for the Doppler effect.

SO-50 (2-meter uplink/ 70-centimeter downlink)

Part of Pass	TX Freq. (67Hz CTCSS)	RX Freq.
AOS	145.850 MHz	436.805 MHz
	145.850 MHz	436.800 MHz
Middle	145.850 MHz	436.795 MHz
	145.850 MHz	436.790 MHz
LOS	145.850 MHz	436.785 MHz

AO-85 Fox-1A (70-centimeter uplink, 2-meter downlink)

Part of Pass	TX Freq. (67Hz CTCSS)	RX Freq.
AOS	435.160 MHz	145.980 MHz
	435.165 MHz	145.980 MHz
Middle	435.170 MHz	145.980 MHz
	435.175 MHz	145.975 MHz
LOS	435.180 MHz	145.975 MHz

AO-91 RadFXSat/Fox-1B (70-centimeter uplink, 2-meter downlink)

Part of Pass	TX Freq. (67Hz CTCSS)	RX Freq.
AOS	435.240 MHz	145.960 MHz
	435.245 MHz	145.960 MHz
Middle	435.250 MHz	145.960 MHz
	435.255 MHz	145.960 MHz
LOS	435.260 MHz	145.960 MHz

AO-92 Fox-1D (70-centimeter uplink, 2-meter downlink)

Part of Pass	TX Freq. (67Hz CTCSS)	RX Freq.
AOS	435.340 MHz	145.880 MHz
	435.345 MHz	145.880 MHz
Middle	435.350 MHz	145.880 MHz
	435.355 MHz	145.880 MHz
LOS	435.360 MHz	145.880 MHz

The *GoSatWatch* smartphone app for iOS provides an easy way to track satellite passes in real time. Android users can check out the *AMSATDroid* app.

frequency. Depending on the satellite, this will be either your transmit or receive frequency. If you don't adjust for Doppler, you will either not properly hear the downlink, or you will not be transmitting on the correct frequency to get into the satellite. See the sidebar, "FM Satellite Frequency Chart," for proper frequency adjustments for the four FM satellites. You can program these into your radio, and adjust for Doppler easily.

Steps to Satellite Success on Field Day

As with any new undertaking, don't expect instant success. Learning how to make a contact through a satellite, especially during hyper-crowded conditions, like on Field Day, will depend on your abilities. There are some concrete things you can do to maximize success:

1 Practice before Field Day. Do not expect to simply turn on the radio and make a satellite contact. Take plenty of time to learn how to track satellites, aim the antenna throughout a pass, and listen for stations. Try working stations on satellites for several weeks before Field Day.

2 If you know a satellite operator, ask them to mentor you. Their expertise will only help you. You can also join the AMSAT Facebook group and get pointers from thousands of satellite operators who want to help you succeed.

3 Read the "FM Satellites Best Practices Guide" on AMSAT's website at **https://www.amsat.org/fm-satellites-good-operating-practices-for-beginning-and-experienced-operators/**. There are lots of good tips there.

4 If you live near the coasts, try working a pass that is mostly over water. This will reduce the number of stations that will have access to the satellite. During the extremely crowded conditions that Field Day brings, this will actually work in your favor, and increase the odds of you making a contact.

5 Consider passes in the middle of the night. Fewer people will be on, which will increase your chances of success.

6 Remember, you only need one contact on the satellite to earn your bonus. Many other stations will be trying to do the same. Make your contact, then get off the air to allow others a chance as well.

7 Don't transmit if you cannot hear the satellite. Even though you can't hear, you may still be getting into the satellite, which will interfere with other stations' contacts. This is unacceptable. If you are trying to work a satellite and do not hear yourself or other stations, stop transmitting and review your equipment; you may have a problem.

8 Your operating site should have as clear a view of the horizon as possible. Buildings and trees can interfere with your ability to hear the satellite; an open clearing on a high spot with no obstructions is the ideal operating location.

9 Know what Maidenhead grid square you are operating from. While it's not required for your Field Day exchange, many satellite operators exchange grid information during contacts.

10 If you have the capability, try SSB satellites instead. There is more of a learning curve, but with 20 KHz of bandwidth or more, SSB satellites can facilitate multiple contacts simultaneously, like being on an HF band. More information is on the AMSAT website.

Working the FM satellites is a lot of fun, but the thrill of 100 bonus points will bring a lot of inexperienced operators out to try to boost their Field Day score. With a little practice and education, you can increase your odds of success and continue in this exciting area of Amateur Radio well past Field Day. I hope to hear you on an upcoming pass soon!

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