FREE BUILD GUIDE

Pull weather images from orbit with a $48 radio kit

Build an RTL-SDR satellite receiver, decode Meteor weather images with SatDump, then join the SatNOGS network.

- Parts list with makers' prices
- V dipole for 137 MHz with measurements
- Drivers, SatDump and SatNOGS setup
- Your first Meteor pass and the ISS
- Troubleshooting and next projects

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SDR satellite receiver build guide

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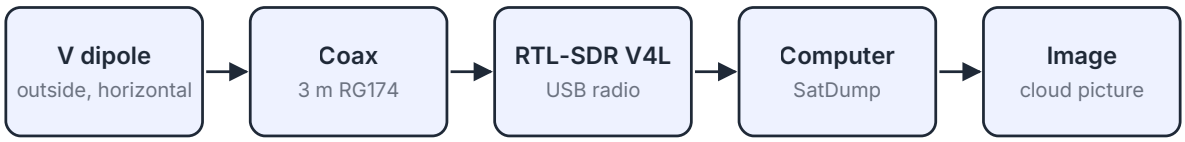
What you build

You build a radio receiver that pulls weather images straight from a Russian Meteor satellite and hears packets from the International Space Station, for $47.95 in parts plus a computer you already own. The receiver is an RTL-SDR Blog V4L, a USB software defined radio, with the RTL-SDR Blog dipole kit set up as a V dipole for 137 MHz. On a laptop, the open source SatDump program turns a single pass into a picture of the clouds over your region.

A second stage turns the same radio into an always on station. Add a Raspberry Pi and the SatNOGS client, and your receiver joins the SatNOGS network, where anyone can schedule satellite observations through it and the recordings land in a public archive.

This receiver belongs on theconsciousness.ai because the project's aerospace pillar asks what it takes to sense and compute in orbit, the hardware a perceiving machine would carry off the planet. Weather satellites are the oldest working example of a spacecraft that observes the Earth and sends the result down to anyone listening. Receiving one teaches the chain every CubeSat project depends on, from orbit prediction and Doppler to antenna pattern, demodulation and decoding.

This guide is the wideband companion to our TinyGS LoRa ground station guide. TinyGS hears one kind of signal on one band; this receiver tunes across the VHF and UHF bands where most CubeSats and weather satellites transmit.



The signal chain for stage one

How this guide was made. Every step comes from the official documentation of each project and the tutorials listed at the end, written in our own words, with every source credited. We have not built this exact station ourselves. The guide is free. Links marked "Amazon, affiliate link" earn theconsciousness.ai a commission at no extra cost to you. As an Amazon Associate I earn from qualifying purchases. Links marked "plain link" earn nothing.

Parts list

Stage one costs $47.95 for the V4L dongle and dipole kit bundle from RTL-SDR Blog. Stage two adds a Raspberry Pi. Prices below are the makers' own prices, read on their sites on November 12, 2026, except where marked. Amazon prices are not shown, so check them on Amazon.

Part	Price	Where to buy	Needed?
RTL-SDR Blog V4L dongle with multipurpose dipole kit	$47.95 at the RTL-SDR Blog store	RTL-SDR Blog store (plain link). Not stocked on Amazon USA yet	Yes
V4L dongle alone	$37.95 at the RTL-SDR Blog store	Same (plain link)	If you buy the antenna separately
Multipurpose dipole kit alone (two telescopic pairs, 60 cm RG174 base cable, 3 m RG174 extension, tripod, suction mount)	$17.95 at the RTL-SDR Blog store	Same store, or Amazon USA (Amazon, affiliate link)	Yes, unless bundled
A computer with a free USB port (Windows, macOS or Linux)	Owned		Yes, stage one
Raspberry Pi 4, 2 GB	$67.50 from October 1, 2026 (report)	Official Raspberry Pi resellers	Stage two
Pi power supply, microSD card, Ethernet cable	Not checked	Any	Stage two
RTL-SDR Blog Wideband LNA V2 (bias tee powered)	$19.95 at the RTL-SDR Blog store	Same store, or Amazon USA (Amazon, affiliate link)	Later upgrade

For buyers in Europe, RTL-SDR Blog's store says it can no longer ship directly to the EU from its webstore and sends EU buyers to its official AliExpress and eBay stores. It also lists V4L stock as limited because of manufacturing delays.

The guide uses the V4L because RTL-SDR Blog ended the V4 because its tuner chip, the R828D, is out of production, and the V4L replaces it with the R828S. Hackster reports that the R828S has two inputs instead of three, so the V4's extra input filtering is not possible, with the small upside of slightly better sensitivity. The V4L needs updated drivers, and on old ones it shows "no signal". RTL-SDR Blog says it is working with software makers to support it natively. RTL-SDR Blog V4L page, Hackster report

Check before you buy. Neither SatDump nor SatNOGS names the V4L as supported in its documentation, and SDRStore's SatDump guide tells readers to confirm SatDump compatibility before buying. The code shows that RTL-SDR Blog's own driver library added V4L support in March 2026. SatDump's Windows build scripts compile that same library, but SatDump's latest stable release (1.2.2) dates from November 2024, before that support existed. On Linux and macOS,

SatDump uses the rtl-sdr library installed on your system. So this guide has you install RTL-SDR Blog's current driver first, the route RTL-SDR Blog gives for programs that do not support the V4L yet. If you want a receiver with no driver step, ask in the SatDump or SatNOGS community which dongle they recommend today.

Tools

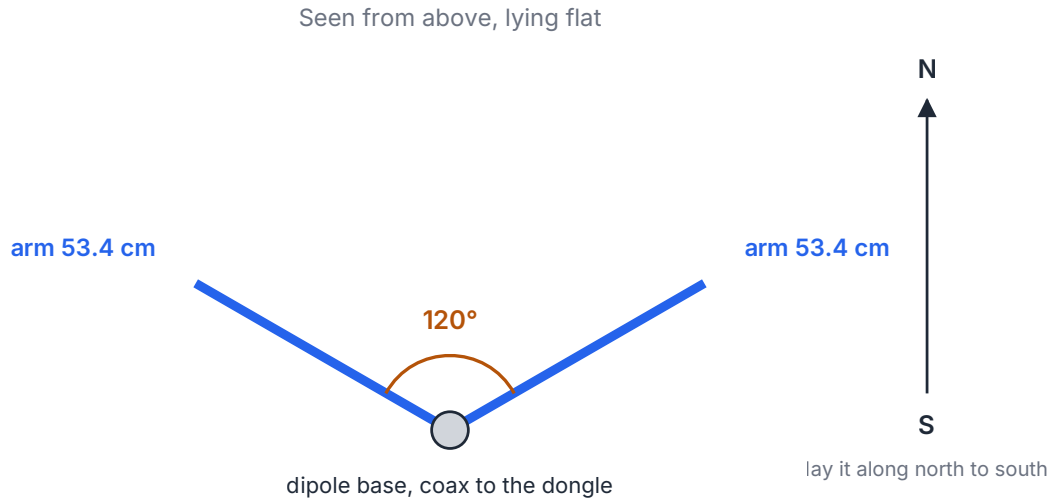
No soldering in stage one.

- A tape measure and a protractor, or a phone level app that shows angles
- A place outside with open sky to the north and south, such as a balcony rail, a garden pole or a flat roof
- Cable ties or tape to fix the tripod or suction mount
- A satellite pass predictor; SatDump has one built in
- A microSD card reader and a way to reach the Pi's command line (a keyboard and screen, or SSH from your computer), both for stage two

Build the antenna and receiver

The dipole kit becomes a V dipole tuned for 137 MHz, the band Meteor satellites use for images.

1. Screw the two large telescopic elements into the dipole base.
2. Extend each element to about 53.4 cm, roughly two and a half sections. Both arms must be the same length.
3. Open the arms to an angle of about 120 degrees between them, in a flat V.
4. Lay the V horizontal, not standing up, oriented north to south. Polar orbiting satellites cross the sky on north to south tracks, and this layout favors them.
5. Mount it outside with the tripod or suction mount, as high and clear of buildings as you can, and away from LED bulbs, USB chargers, monitors and Ethernet cables.
6. Run the 3 m RG174 extension inside, connect it to the base cable, and screw the SMA end onto the V4L dongle.
7. Plug the dongle into your computer.



The V dipole for 137 MHz, seen from above

The V lies flat because the satellites send circular polarization, and a horizontal V gives up about 3 dB on them in exchange for cutting vertically polarized ground signals by about 20 dB. Less ground noise means less overload. RTL-SDR Blog dipole guide

For the ISS at 145.825 MHz, shorten each arm a little. The dipole kit guide lists about 42 cm per side for 162 MHz and 60 cm for 115 MHz, so 145 MHz sits between them. Use an online dipole calculator for the exact length.

Software setup with drivers, SatDump and SatNOGS

Stage one, drivers and SatDump on your computer

1. Install the V4L driver. The V4L shows "no signal" on old drivers. On Windows, replace rtlsdr.dll in your SDR program's folder with the one from the RTL-SDR Blog driver release (x64 or x86 to match the program). On Linux, remove old rtl-sdr packages, build the current driver library, and blacklist the dvb_usb_rtl28xxu TV driver before rebooting. On macOS, RTL-SDR Blog points to SDR++. Source
2. Check the radio works on a strong local FM station in SDR++ or SDR# before you try a satellite.
3. Install SatDump, the stable release first, from its repository. On Windows, put RTL-SDR Blog's current rtlsdr.dll in SatDump's folder too.
4. Add the RTL-SDR as a source in SatDump's recorder.
5. Set the radio to a sample rate of 1.024 or 2.048 MSPS, with manual gain at a moderate value and the bias tee off.
6. Pick the Meteor LRPT pipeline that matches the satellite's current mode. Meteor commonly uses 72 ksym/s, but check the current mode before a pass.
7. Turn on baseband recording for your first passes, so you can decode the same pass again with other settings.

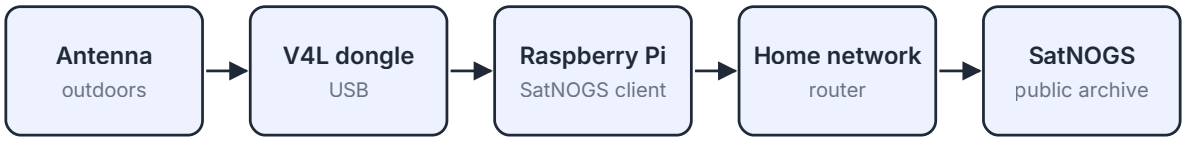
8. Check the pass list, update orbital data, confirm your location, and choose a pass with a high maximum elevation. Start recording just before the satellite rises.

Steps 3 to 8 follow SDRStore's SatDump beginner guide (May 2026).

Stage two, join SatNOGS with a Raspberry Pi

1. Sign up at network.satnogs.org, verify your email, add a ground station and create an API key. New stations start with a Testing flag.
2. Put Raspberry Pi OS on the Pi, and plug in the dongle and antenna.
3. Run the normal SatNOGS install command from the command line, `curl -sfL https://satno.gs/install | sh -s --`. The satnogs-setup menu comes up during the install.
4. In the basic options, enter the API token, station ID, latitude, longitude and elevation; set the SDR device to `driver=rtlsdr`, antenna RX and sample rate 2.048e6.
5. Set the gain. In an SDR program, start at zero and raise the gain until the noise floor just starts to rise. Close the SDR program afterward, since it blocks the dongle. Enter that value as SATNOGS_RF_GAIN under Advanced Setup, then Radio.
6. Exit the menu to apply the changes. This can take a few minutes.
7. Schedule a first observation and post good results in the SatNOGS community forum. The Testing flag comes off once others agree the station works.

Sources: SatNOGS Setup (edited July 2026), Get Started, Omnidirectional Station How To (2021, for the gain method).



Stage two puts your station on the SatNOGS network

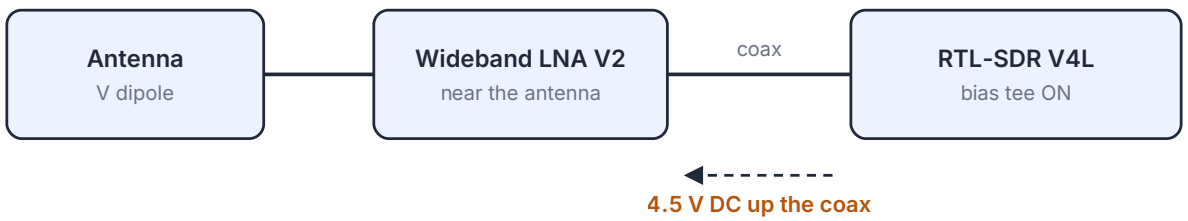
Antenna options

The V dipole is the cheapest antenna that works for weather images. SatNOGS's own guide warns that a fixed omnidirectional antenna makes CubeSat data difficult to receive, so plan an upgrade if you join the network.

Antenna	Cost	Best for	Notes
V dipole from the kit	In the $47.95 bundle	Meteor images, ISS APRS	Horizontal, 120 degrees, about 53.4 cm arms for 137 MHz

Antenna	Cost	Best for	Notes
V dipole plus Wideband LNA V2	$19.95 at the RTL-SDR Blog store	Long cable runs, weak passes	Powered by the dongle's bias tee; SatNOGS warns an LNA can overload the radio
Turnstile or quadrifilar helix (QFH)	DIY or bought	A permanent SatNOGS station	Circular polarization; the SatNOGS antenna page lists designs
RTL-SDR Blog L band patch set	$59.95 at the RTL-SDR Blog store	Inmarsat and Iridium at 1.5 to 1.6 GHz	Amazon USA (Amazon, affiliate link); a later step

Watch the bias tee. The V4L's bias tee supplies 4.5 V. RTL-SDR Blog warns against switching it on into an antenna that shorts DC unless an LNA sits between them. Turn it on only with the LNA connected. Source



Turn the bias tee on only with the LNA connected.
Never switch it on into an antenna that shorts DC.

Wiring the LNA

Your first satellites

Start with what is on the air in November 2026. Most older tutorials built around NOAA 15, 18 and 19 no longer apply. NOAA-18 was shut down in June 2025, and NOAA-15 and NOAA-19 were scheduled for shutdown in August 2025. Source

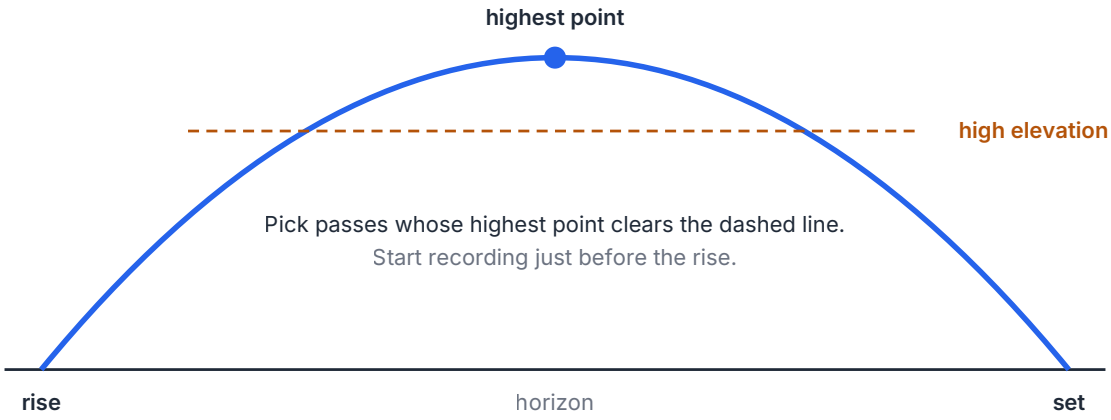
Target	Frequency	What you get	Notes
Meteor-M N2-4	LRPT near 137.1 or 137.9 MHz	Cloud images of your region	SatNOGS lists it as operational with 72k and 80k LRPT modes; check the current mode before a pass. SatNOGS DB
ISS APRS digipeater	145.825 MHz FM	Short data bursts relayed by the station	AMSAT calls it the most common ISS mode
ISS SSTV events	145.800 MHz FM	Pictures sent from orbit	Occasional

Target	Frequency	What you get	Notes
ISS voice repeater	437.800 MHz FM downlink	Voice from licensed operators	Listen only

ISS frequencies come from AMSAT.

Here is a first Meteor pass, step by step.

1. In SatDump, pick a Meteor pass with a high maximum elevation.
2. Start recording just before it rises.
3. Watch the waterfall. The signal grows as the satellite climbs and drifts in frequency because of Doppler shift.
4. Let the pipeline decode, then open the result in SatDump and save the image.
5. Gaps or noise in the picture mean the signal dropped. Raise the antenna, shorten the cable, or move away from electronics, and try the next high pass.



Choosing a pass

Keep a log of the time, elevation, gain and result of every pass. It is the start of a dataset about your own station.

Troubleshooting

Symptom	Likely cause	Fix
Dongle detected, no signal at all	Old drivers; the V4L needs the updated library	Install RTL-SDR Blog's current drivers
SatDump cannot find the device (Windows)	USB driver not set	SDRStore's guide uses Zadig with WinUSB on "Bulk-In Interface 0"; pick the device carefully, Zadig can overwrite other USB drivers

Symptom	Likely cause	Fix
Device busy	Another SDR program has it open	Close SDR++, SDR# or CubicSDR before decoding
Waterfall bright and noisy everywhere	Gain too high	Lower the gain
Signal visible, no image	Wrong pipeline, mode or sample rate	Match the pipeline to the satellite's current mode
Image has gaps	Signal dropped during the pass	Higher passes, higher antenna, shorter cable
Nothing on Meteor's frequency	Wrong time or a low pass	Update orbital data; check the pass prediction and your location
SatNOGS error "soapysdr::device::make() no match"	Library too old for the dongle	Update librtlsdr; a 2024 SatNOGS forum thread fixed a V4 this way
Local noise ruins observations	LED bulbs, USB chargers, monitors, HDMI or DVI cables, Ethernet near the antenna	Switch them off one at a time during a pass to find the source

Sources: SatDump beginner guide, RTL-SDR Blog V4L guide, SatNOGS forum thread, Omnidirectional Station How To.

Next projects

1. Build a TinyGS LoRa station. From about $20 in parts, a Heltec board receives CubeSat telemetry on 433 MHz and logs it on the TinyGS world map. Your SDR can show the same signals on its waterfall. See our free TinyGS ground station guide.
2. Add a weather dish. The site's weather satellite dish kit adds KrakenRF's Discovery Dish to the same V4L for images from GOES geostationary satellites. See the kits page.
3. Put a satellite on your desk. AMSAT's open CubeSatSim puts a working 1U model with a radio beacon on your table, and this receiver is how you hear it. The kits page has the details.

Credits and licenses

- SatDump is free software under GPL-3.0. The guide sends readers to the official project to download it. This guide contains none of its code.
- SatNOGS is a Libre Space Foundation project. Its wiki is under CC BY-SA 3.0, which means any text copied or adapted from it would make that part of our PDF share alike. We wrote every step in our own words and link to the wiki instead.

- RTL-SDR Blog guides state no content license, so their wording and photos are all rights reserved. Facts such as frequencies and antenna lengths are free to use; we paraphrase and link.
- RTL-SDR Blog, SatNOGS and SatDump are named only to say what the build uses. No logos appear. This guide is independent and is not affiliated with or endorsed by RTL-SDR Blog, the Libre Space Foundation or the SatDump project.
- Everything in this guide is receive only. Listening to satellites is legal in most countries; readers should check local rules.
- The guide is free. The links marked "Amazon, affiliate link" for the dipole kit, the Wideband LNA V2 and the L band patch set can earn a commission. As an Amazon Associate I earn from qualifying purchases. Every other link earns nothing.

Tutorials we built on

Source	Date	License	What we used
RTL-SDR Blog V4L page	2025 to 2026	None stated	Why the V4L exists, driver needs, bias tee warning
RTL-SDR Blog store page	Nov 12, 2026	Not applicable	Prices, stock, EU shipping
Hackster report	See article	Not applicable	R828D and R828S tuner change
RTL-SDR Blog driver library	March 2026	GPL-2.0	Date V4L support was added
RTL-SDR Blog dipole kit guide	2018, updated	None stated	V dipole lengths, angle and orientation for 137 MHz
SDRStore SatDump beginner guide	May 30, 2026	None stated	Install order, Windows driver, troubleshooting list
SatNOGS wiki	Ongoing	CC BY-SA 3.0	Client install, antenna advice, noise hunting (paraphrased only)
SatDump on GitHub	Ongoing	GPL-3.0	Pipelines, release dates and Windows build scripts
AMSAT ISS page	Ongoing	None stated	ISS frequencies
SatNOGS forum thread	2024	Forum post	V4 library fix

Video tutorials were not reviewed for this guide.

Where sources disagree, or only one source exists

1. Older tutorials, including SatNOGS how to pages from 2021, still teach NOAA APT. Those satellites were shut down in 2025. This guide uses Meteor instead.
2. Sources list both 72k and 80k LRPT and both 137.1 and 137.9 MHz. The guide tells readers to check the current mode before a pass.
3. SDRStore uses Zadig with WinUSB; RTL-SDR Blog describes replacing the rtlsdr.dll file. The guide gives both, the file swap for the V4L driver and Zadig if SatDump cannot find the device.
4. No documentation names the V4L as supported in either program. The guide says so plainly and gives RTL-SDR Blog's driver route.
5. The V4 SatNOGS fix rests on one forum thread.

Images

Every diagram in this guide was drawn for it by theconsciousness.ai. The guide uses no photos or screenshots from RTL-SDR Blog, SatNOGS, SatDump or any other site.