Rick Giuffre, KE5AOA

AMATEUR RADIO SATELLITES

OSCAR PROGRAM

- The Orbital Satellite Containing Amateur Radio (OSCAR) program began in 1961 and has continued with a succession of progressively more sophisticated and technologically advanced projects
- While the satellites gather useful telemetry information and conduct meaningful scientific inquiry, some are equipped with FM repeaters, allowing hams to communicate using their ground stations and, more recently, using hand-held and portable equipment from virtually anywhere

CUBE SATS AND MICRO SATS

- Cube sats were 8" to a side (such as AO-51)
- Utilized "trays" for functional organization, e.g., transmit/receive, guidance, power management, telemetry
- Were primarily deployed via Soyuz launch vehicle
- Cost to deploy obsoleted this form factor

- Micro sats are 4" to a side
- Volume is one-eighth of cube sat resulting in greatly lower deployment cost
- Electronics adapted from cell phone technology
- Reduced surface area created challenges for solar cell recharging
- Power output typically 250 milliwatts

WORKING LEO SATELLITES

- Some low earth orbit (LEO) satellites have FM repeaters allowing hams to make QSOs when a satellite is making a "pass" near the ham's QTH and each ham has line of sight contact with the satellite
- LEOs have an altitude of 1,200 miles or less and an orbital period of 128 minutes or less
- The 2-meter and 440 MHz bands are used for the uplink and downlink frequencies
- Communication can be accomplished using satellite tracking software with servo-controlled high-gain antennas with specialized satellite transceivers

- OR -

- A handheld transceiver with a high-gain manually guided antenna can accomplish the same thing…sometimes

EQUIPMENT CONSIDERATIONS

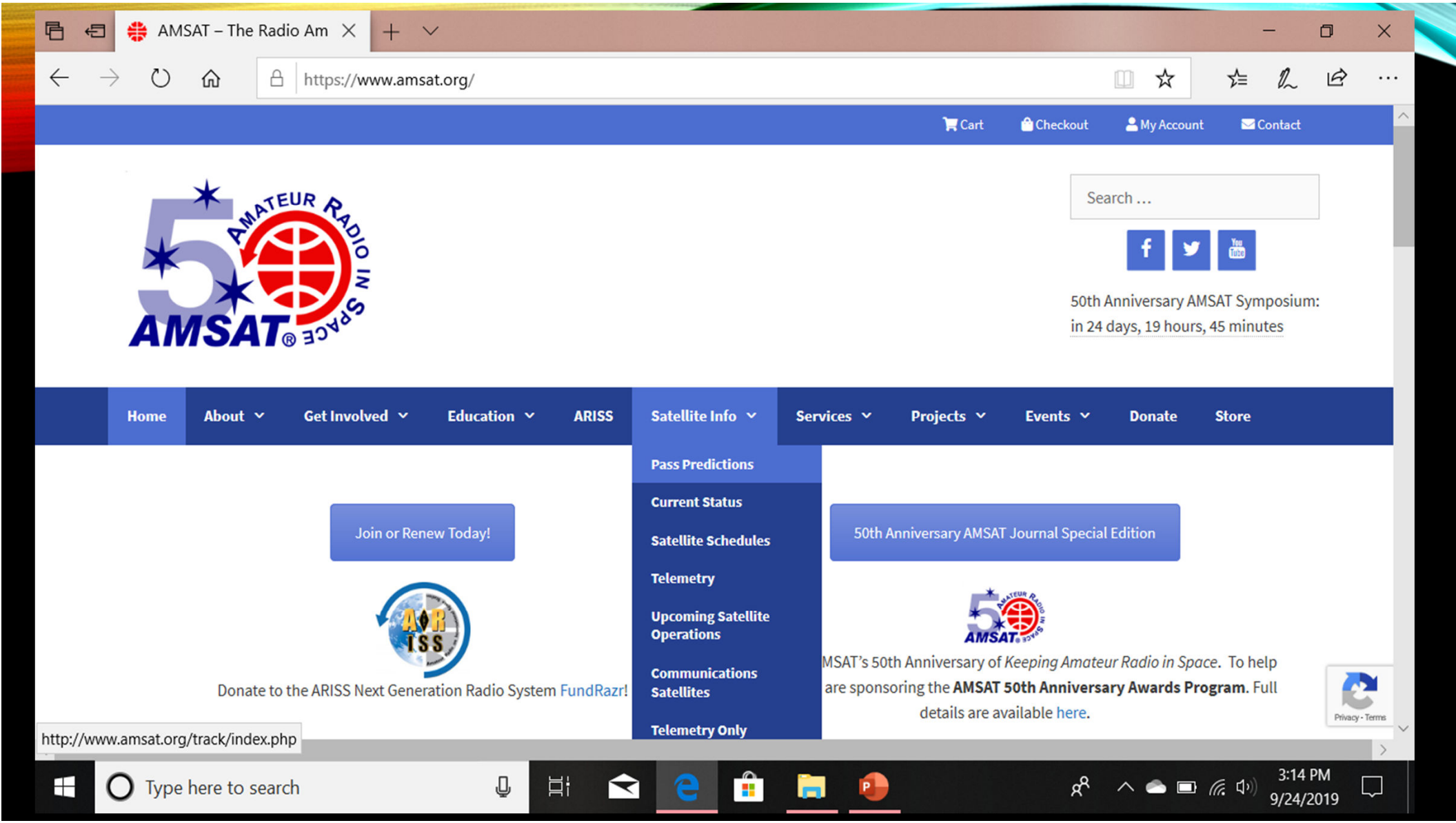
- A full-duplex transceiver is ideal so that you can confirm your signal has keyed the repeater in real time
- Only one or two new model hand-helds operate in true full-duplex mode
- Two transceivers can be used – one for the downlink and one for the uplink
- Alternatively, any dual band transceiver can be used with some success
- A high gain antenna is necessary to capture the satellite signal
- Two popular commercially made antennas are the Arrow Model 146/437-10WBP and the Elk Dual-Band 2M/440L5
- Numerous articles detail home-brew satellite antennas
- Useful accessories are a compass, a protractor and a tripod, SMA/BNC adapter

GETTING STARTED

- Go to amsat.org, select "Satellite Info" and click on "Pass Predictions"
- Select desired satellite (e.g. AO-91)
- Enter either your grid square or latitude and longitude
- Select number of passes to predict
- Click on "Predict"
- Identify passes with a maximum elevation at least 30 degrees
- In a clear, line-of-sight area, begin listening for the satellite as soon as it clears the horizon
- When traffic is clear, insert your call sign phonetically and grid square
- Limit exchanges to call signs and locations

THINGS TO JUGGLE SIMULTANEOUSLY

- Azimuth
- Elevation
- Polarization
- Time
- Doppler Shift
- Transmit/Receive
- Logging
- And you have to be listening, as well!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http://www.amsat.org/track/index.php
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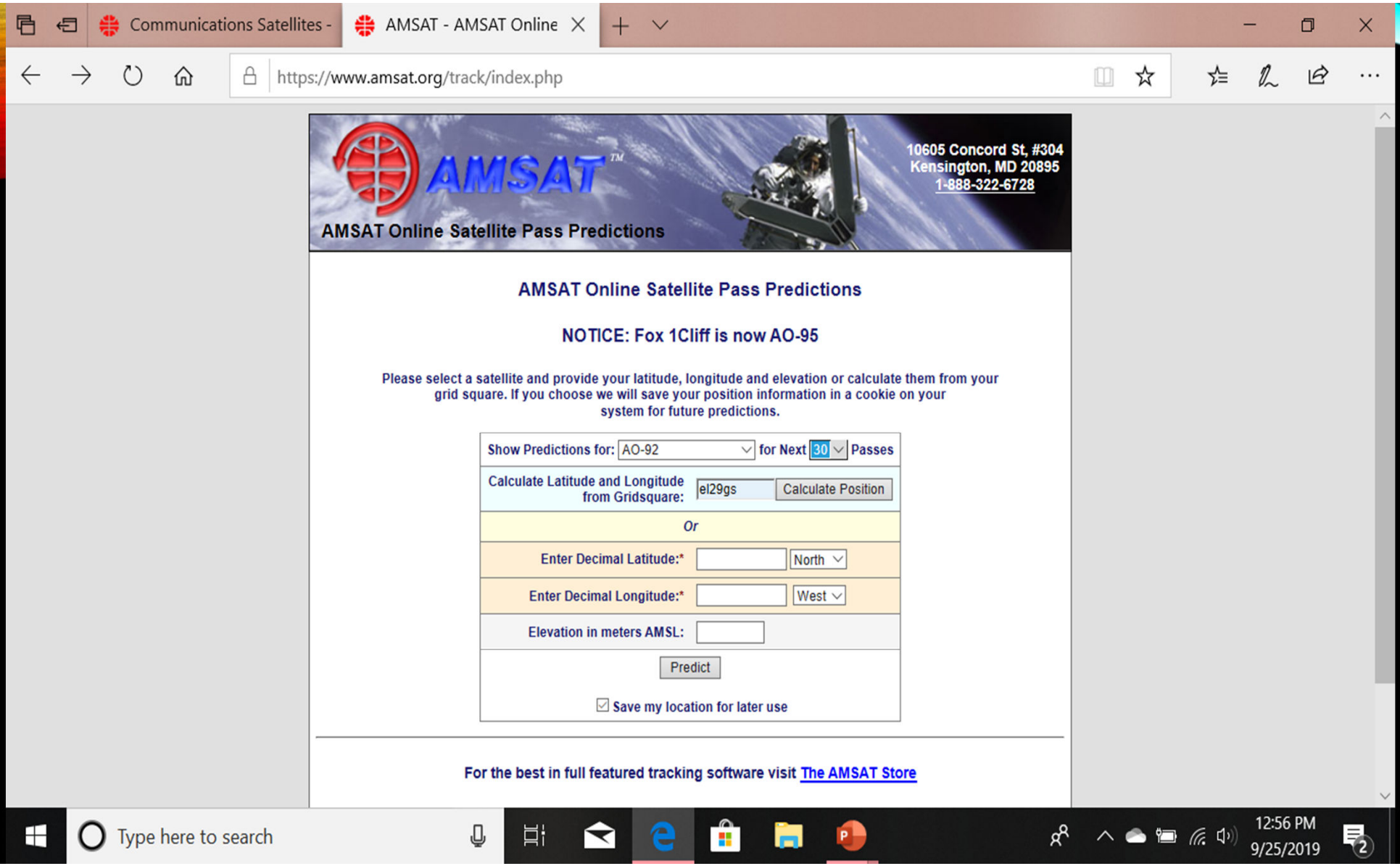
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AMSAT - AMSAT Online
https://www.amsat.org/track/index.php
AMSAT
AMSAT Online Satellite Pass Predictions
10605 Concord St, #304
Kensington, MD 20895
1-888-322-6728
AMSAT Online Satellite Pass Predictions
NOTICE: Fox 1Cliff is now AO-95
Please select a satellite and provide your latitude, longitude and elevation or calculate them from your grid square. If you choose we will save your position information in a cookie on your system for future predictions.
Show Predictions for: AO-92 for Next 30 Passes
Calculate Latitude and Longitude from Gridsquare: el29gs Calculate Position
Or
Enter Decimal Latitude:* North
Enter Decimal Longitude:* West
Elevation in meters AMSL:
Predict
Save my location for later use
For the best in full featured tracking software visit The AMSAT Store
Type here to search
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Communications Satellites - | AMSAT - AMSAT Online

https://www.amsat.org/track/index.php

AMSAT Online Satellite Pass Predictions - AO-91

View the current location of AO-91

Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
25 Sep 19	17:46:05	00:15:04	157	58	81	354	18:01:09
25 Sep 19	19:24:02	00:12:20	212	13	271	321	19:36:22
26 Sep 19	05:43:50	00:09:32	36	12	77	150	05:53:22
26 Sep 19	07:19:37	00:10:47	357	24	297	219	07:30:24
26 Sep 19	16:34:02	00:10:46	112	9	72	20	16:44:48
26 Sep 19	18:07:27	00:15:13	169	84	268	348	18:22:40
26 Sep 19	19:47:02	00:09:49	229	6	254	310	19:56:51
27 Sep 19	06:04:47	00:10:43	26	24	86	167	06:15:30
27 Sep 19	07:41:33	00:09:31	347	13	285	235	07:51:04
27 Sep 19	16:54:17	00:12:39	127	17	68	12	17:06:56
27 Sep 19	18:29:04	00:14:57	180	49	261	341	18:44:01
27 Sep 19	20:11:32	00:04:14	255	1	268	288	20:15:46
28 Sep 19	06:26:02	00:11:13	17	50	116	182	06:37:15
28 Sep 19	08:03:52	00:07:22	335	6	292	254	08:11:14
28 Sep 19	17:14:56	00:13:54	140	26	85	4	17:28:50
28 Sep 19	18:50:58	00:14:14	193	28	247	334	19:05:12
29 Sep 19	05:13:51	00:05:06	62	2	75	117	05:18:57
29 Sep 19	06:47:28	00:11:14	9	71	272	197	06:58:42
29 Sep 19	08:27:12	00:02:36	314	1	301	287	08:29:48
29 Sep 19	16:05:32	00:04:51	82	1	69	43	16:10:23
29 Sep 19	17:35:53	00:14:43	152	45	70	357	17:50:36

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https://www.amsat.org/track/index.php

AMSAT Online Satellite Pass Predictions - AO-92

View the current location of AO-92

Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
25 Sep 19	18:20:09	00:04:51	321	2	308	269	18:25:00
26 Sep 19	03:16:02	00:09:55	132	16	68	11	03:25:57
26 Sep 19	04:49:09	00:10:33	196	21	259	331	04:59:42
26 Sep 19	16:22:52	00:11:18	19	43	119	180	16:34:10
26 Sep 19	17:57:40	00:08:02	337	7	294	246	18:05:42
27 Sep 19	02:55:54	00:08:14	115	8	72	22	03:04:08
27 Sep 19	04:27:34	00:11:16	181	40	282	341	04:38:50
27 Sep 19	16:01:59	00:10:37	28	22	91	165	16:12:36
27 Sep 19	17:35:47	00:09:49	348	15	285	229	17:45:36
28 Sep 19	02:36:31	00:05:09	93	2	80	38	02:41:40
28 Sep 19	04:06:18	00:11:27	167	87	54	349	04:17:45
28 Sep 19	05:43:37	00:04:45	245	2	272	295	05:48:22
28 Sep 19	15:41:23	00:09:16	39	11	81	149	15:50:39
28 Sep 19	17:14:14	00:10:51	358	28	297	214	17:25:05
29 Sep 19	03:45:18	00:11:11	153	38	53	358	03:56:29
29 Sep 19	05:20:30	00:08:18	220	8	263	314	05:28:48
29 Sep 19	15:21:17	00:06:49	54	4	81	129	15:28:06
29 Sep 19	16:52:52	00:11:22	6	58	267	200	17:04:14
30 Sep 19	03:24:36	00:10:26	138	21	75	7	03:35:02
30 Sep 19	04:58:17	00:10:11	202	16	266	327	05:08:28
30 Sep 19	16:31:41	00:11:25	15	62	114	186	16:43:06

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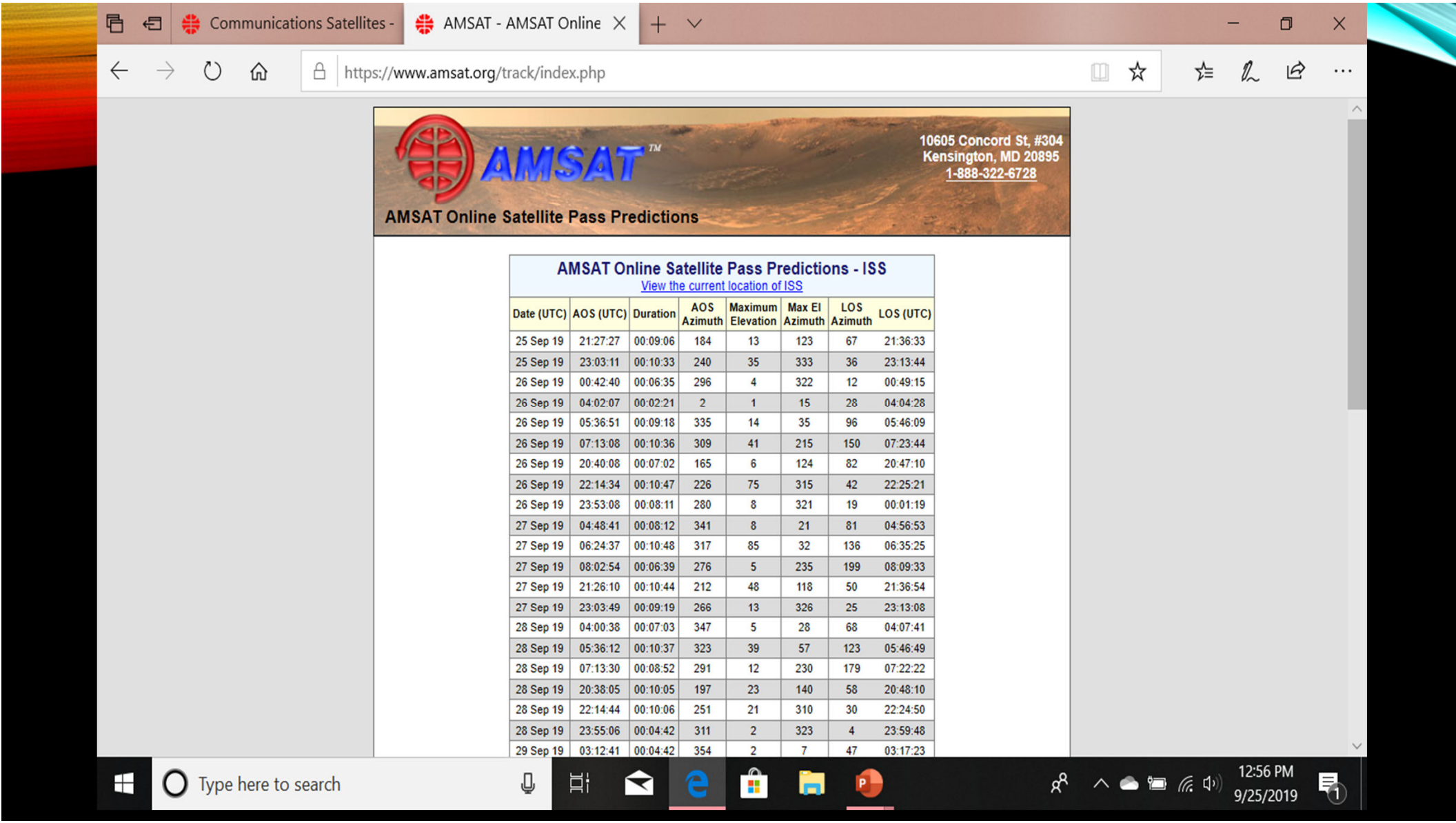
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AMSAT Online Satellite Pass Predictions
AMSAT Online Satellite Pass Predictions - ISS
View the current location of ISS
Date (UTC) | AOS (UTC) | Duration | AOS Azimuth | Maximum Elevation | Max El Azimuth | LOS Azimuth | LOS (UTC)
25 Sep 19 | 21:27:27 | 00:09:06 | 184 | 13 | 123 | 67 | 21:36:33
25 Sep 19 | 23:03:11 | 00:10:33 | 240 | 35 | 333 | 36 | 23:13:44
26 Sep 19 | 00:42:40 | 00:06:35 | 296 | 4 | 322 | 12 | 00:49:15
26 Sep 19 | 04:02:07 | 00:02:21 | 2 | 1 | 15 | 28 | 04:04:28
26 Sep 19 | 05:36:51 | 00:09:18 | 335 | 14 | 35 | 96 | 05:46:09
26 Sep 19 | 07:13:08 | 00:10:36 | 309 | 41 | 215 | 150 | 07:23:44
26 Sep 19 | 20:40:08 | 00:07:02 | 165 | 6 | 124 | 82 | 20:47:10
26 Sep 19 | 22:14:34 | 00:10:47 | 226 | 75 | 315 | 42 | 22:25:21
26 Sep 19 | 23:53:08 | 00:08:11 | 280 | 8 | 321 | 19 | 00:01:19
27 Sep 19 | 04:48:41 | 00:08:12 | 341 | 8 | 21 | 81 | 04:56:53
27 Sep 19 | 06:24:37 | 00:10:48 | 317 | 85 | 32 | 136 | 06:35:25
27 Sep 19 | 08:02:54 | 00:06:39 | 276 | 5 | 235 | 199 | 08:09:33
27 Sep 19 | 21:26:10 | 00:10:44 | 212 | 48 | 118 | 50 | 21:36:54
27 Sep 19 | 23:03:49 | 00:09:19 | 266 | 13 | 326 | 25 | 23:13:08
28 Sep 19 | 04:00:38 | 00:07:03 | 347 | 5 | 28 | 68 | 04:07:41
28 Sep 19 | 05:36:12 | 00:10:37 | 323 | 39 | 57 | 123 | 05:46:49
28 Sep 19 | 07:13:30 | 00:08:52 | 291 | 12 | 230 | 179 | 07:22:22
28 Sep 19 | 20:38:05 | 00:10:05 | 197 | 23 | 140 | 58 | 20:48:10
28 Sep 19 | 22:14:44 | 00:10:06 | 251 | 21 | 310 | 30 | 22:24:50
28 Sep 19 | 23:55:06 | 00:04:42 | 311 | 2 | 323 | 4 | 23:59:48
29 Sep 19 | 03:12:41 | 00:04:42 | 354 | 2 | 7 | 47 | 03:17:23
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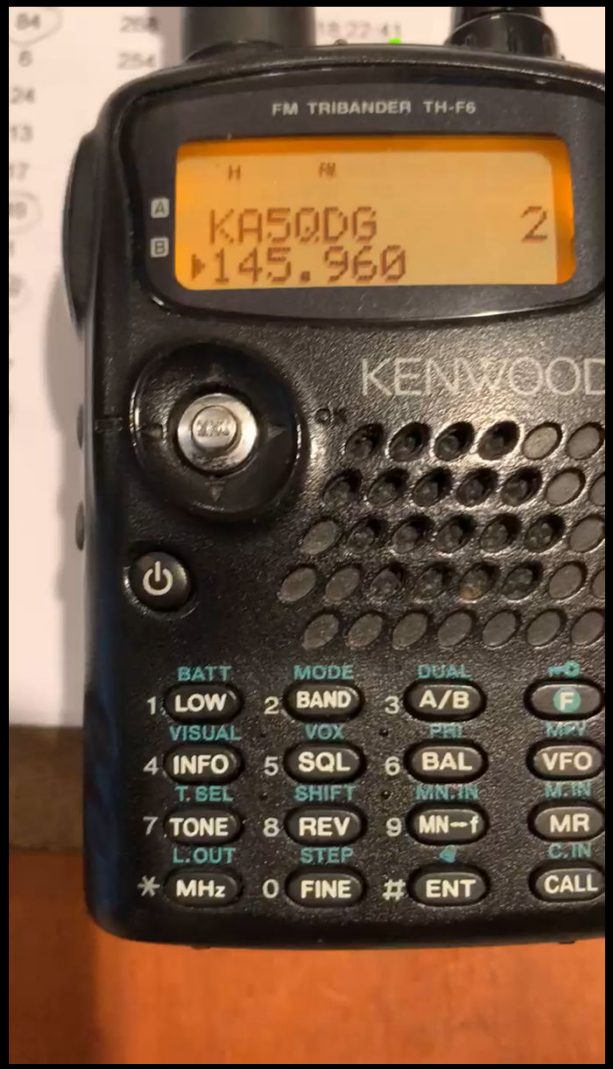
SET-UP

AO-91

Pass on
September 23

1:39 PM CDST



AO-91

Signal Captured Indoors!

INCLINOMETER

Aids in Aiming Antenna

LOG PERIODIC ANTENNA

- Each element is a driven element resonant on a different frequency
- Multiple driven elements result in a broad-banded antenna
- Lack of a reflector element and parasitic directors yields a lower gain antenna than a Yagi
- All elements mounted on same place eliminating rotation between transmit and receive for correct polarization
- No duplexer is required, thus eliminating insertion loss
- Feed point of antenna is at the front and at a right angle to the boom

ELK 2M/440L5

Detail of Connection Point

YAGI ANTENNA

- Yagi design uses reflector, driven element and one or more directors for each band
- Two bands can be mounted on one boom but must be phased
- Duplexer is utilized to isolate desired band
- Duplexer does result in some insertion loss
- Antenna must be rotated between transmit/receive for correct polarization
- Resonant frequency is narrower than log periodic but antenna is higher gain

Communications Satellites | AMSAT - AMSAT Online Sa | K6LCS clint BRADFORD | Getting Started with A

www.work-sat.com/Home.html

Work FM Amateur Radio Satellites

Home | Sat Skeds | Antennas | Tracking | Shack Aids | My Gear | Misc

Work-Sat.com K6LCS (909) 999-SATS

Site Search

[Work-Sat on Ham Nation again!](#)
And click here for photos from recent events and upcoming presentations.

Want to Work Your First Satellite This Week?

Getting started with ham satellites is easier than you may think! *Everything* you need is right here to access an FM satellite or two, monitor the ISS - *and more* - using equipment most ham radio operators already own!

"I want to thank you for your wealth of information on your Website. I've been a ham for a little over two months now, and using the information from your site I made contacts on SO-50 on my first try. ***This is way more fun than I thought I would have with an HT.***"

More comments ...

CLICK HERE for a tutorial covering the **satellite operating basics**!

CLICK HERE just for **SO-50, AO-91/92,** and **ISS** freqs.
Updated ***08/11/2019***

"Your Web site is really what we all should be looking at for satellite communications."
- **Bob Heil K9EID**

"Clint's site tells it all about working the FM ham satellites ... he's a space man of our own ... "
- **Gordon West WB6NOA**

We have moved our support message site to better serve you!

https://twit.tv/shows/ham-nation/episodes/361?autostart=false

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work-sat.com/Sat_Skeds.html
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Which are the "Easy" Sats?
SO-50 is fairly easy to work. AO-91 AND AO-92 are easier! AO-92 switches to a 1.2gHZ UPlink mode occasionally, and has other experiments on-board. Watch AMSAT's Twitter feed for AO-92's schedule. Please work these sats in "full duplex" mode and monitor the downlink as you transmit. There are occasional SSTV projects from the ISS on 145.800.***
The AO-51 and ARISSat-1 projects are long gone (click on those names to read about them). Up-to-date info on other workable birds is at ...
AMSAT-UK
N2YO.com
Once you've mastered the "easy" sats, there are several satellites with SSB/CW transponders on board. Click here for info on getting started with SSB/linear sats!
Use the drop-down menu below to see where the
ISS SO-50 AO-73 AO-91 and AO-92 are right now!
Schedules, Status Pages
WHAT'S UP?
AO-91 status - up and running!
SO-50 status - up and running!
AO-92 Schedule - up and running!
ISS - packet up, FM repeater DOWN.
Enter your reception reports (and unheard passes!) here:
Live OSCAR Status Page
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work-sat.com/Home_files/WorkSat-08112019.pdf

1 of 5 | Fit to page | Page view | Read aloud | Add notes

Work FM Satellites with your HT!

Most hams already have nearly all the equipment to work FM voice satellites.
This guide offers a quick start for successfully making contacts!

All cited resources are available to you at one Web site:

work-sat.com

If you have 2-meter and 440 capabilities (either "split frequencies" in one HT, or two radios), you can work FM voice satellites! For example, in satellite SO-50's VHF/UHF (**V/U**) mode, the **UPLINK** frequency (**to** SO-50) for FM voice is 145.850MHz. The **DOWNLINK** frequency (**from** SO-50) is 436.795 MHz.

First, you need to know **WHEN** and **WHERE** the satellites will be passing over your location. There are several commercial computer programs[1] that will tell you. In the home office, I use **MacDoppler** or **GPredict**. Outside, I'll use **PocketSat3** or **GoSatWatch** on my Smartphone. On Windows systems, **Nova** and **SatPC32** are marvelous. But there are free-of-charge info sources online, too, at ...

heavens-above.com -or- **amsat.org** -or- **N2YO.com**

Log in to these sites, plug in your grid square, and you will have access to accurate satellite pass information.

The one "absolute" for success is to **open up your SQuelch**. We are talking about "weak signals" from hundreds of miles away - so don't expect the satellites to be strong enough to break squelch like your local repeater does. Sure, it's a little noisy - but that's part of the process: That noise is an aid in locating the satellites! When the frequency starts exhibiting **quieting**, that's a sign that you are **capturing** the satellites' signals.

Improve your HT's stock antenna (most are rated at **NEGATIVE 6db** - or worse!). The

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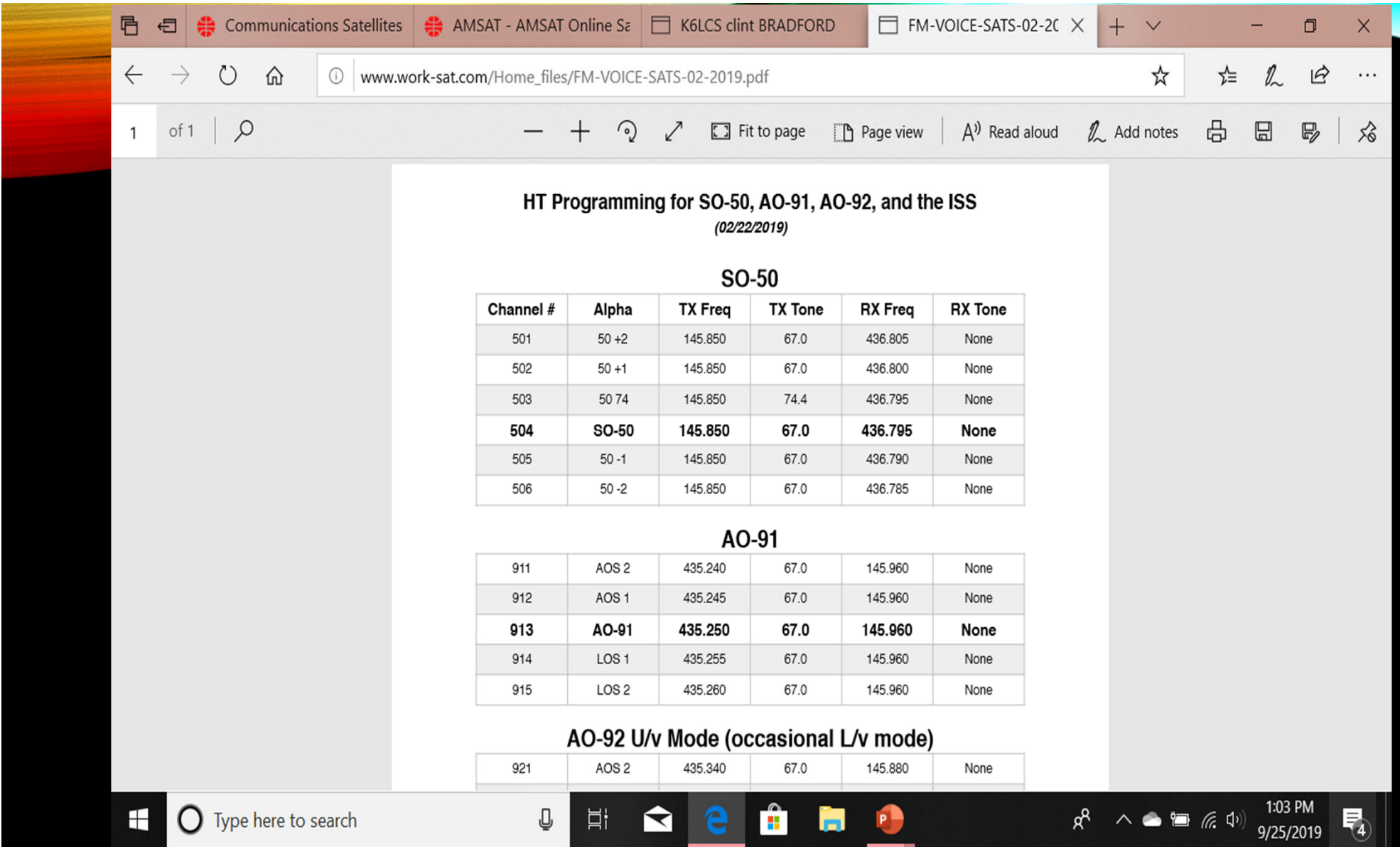
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Add notes
HT Programming for SO-50, AO-91, AO-92, and the ISS
(02/22/2019)
SO-50
Channel # | Alpha | TX Freq | TX Tone | RX Freq | RX Tone
501 | 50 +2 | 145.850 | 67.0 | 436.805 | None
502 | 50 +1 | 145.850 | 67.0 | 436.800 | None
503 | 50 74 | 145.850 | 74.4 | 436.795 | None
504 | SO-50 | 145.850 | 67.0 | 436.795 | None
505 | 50 -1 | 145.850 | 67.0 | 436.790 | None
506 | 50 -2 | 145.850 | 67.0 | 436.785 | None
AO-91
911 | AOS 2 | 435.240 | 67.0 | 145.960 | None
912 | AOS 1 | 435.245 | 67.0 | 145.960 | None
913 | AO-91 | 435.250 | 67.0 | 145.960 | None
914 | LOS 1 | 435.255 | 67.0 | 145.960 | None
915 | LOS 2 | 435.260 | 67.0 | 145.960 | None
AO-92 U/v Mode (occasional L/v mode)
921 | AOS 2 | 435.340 | 67.0 | 145.880 | None
Type here to search
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9/25/2019

AO-91

911	AOS 2	435.240	67.0	145.960	None
912	AOS 1	435.245	67.0	145.960	None
913	**AO-91**	**435.250**	**67.0**	**145.960**	**None**
914	LOS 1	435.255	67.0	145.960	None
915	LOS 2	435.260	67.0	145.960	None

AO-92 U/v Mode (occasional L/v mode)

921	AOS 2	435.340	67.0	145.880	None
922	AOS 1	435.345	67.0	145.880	None
923	**AO-92**	**435.350**	**67.0**	**145.880**	**None**
924	LOS 1	435.355	67.0	145.880	None
925	LOS 2	435.360	67.0	145.880	None

ISS Frequencies

FM Voice - ITU Region 1	FM Voice - ITU Regions 2/3
Europe, Middle East, Africa, North Asia	*N./S. America, Caribbean, Australia, S. Asia*
145.800 downlink 145.200 uplink	**145.800 downlink 144.490 uplink**

FM SSTV downlink 145.800 **AX.25 1200-baud packet 145.825**

Clint Bradford K6LCS **work-sat.com** **(909) 999-SATS**

FOR MORE INFORMATION

- AMSAT.ORG for pass predictions, schedules, useful articles
- WORK-SAT.COM Clint Bradford's website offering operating protocols and tips for success