

AZT_ORR_BL_GS_ARI Revision 2







File Name: AZT_ORR_BL_GS_RAM Revision: 02 Effective Date: 02/17/2020

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AzTechSat-1

Amateur Radio Instructions



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DOCUMENT HISTORY LOG

Document	Effective	Description	Author
Revision	Date		
1	02/10/2020	Initial Release	AFA, JCL, CG
2	02/17/2020	Format, updates with figures and steps	AFA, JCL

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AzTechSat-1 Amateur Radio Instructions

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PURPOSE / SCOPE

This procedure is intended for AzTechSat-1 satellite mission operations to receive beacon packets every 60 seconds from the spacecraft through the HAM radio operator's international community.

SATELLITE RADIO CHARACTERISTICS

- Downlink frequency
- Modulation type
- Baud rate
- Beacon transmission interval
- Frame Format
- Bit Codification
- Codification Channel
- Left/Right hand circular polarization

437.3 MHz

GFSK 9600 bps

- 60 seconds
- ASM + Golay
- **NRZ**, most significant bit first
- Reed-Solomon + CRC32

HARDWARE REQUIREMENTS

Description	QTY
Software defined radio module (recommended ADALM- PLUTO SDR Active Learning Module)	1
Computer	1
70 cm band preamplifier	1
70 cm band antenna	1

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SOFTWARE REQUIREMENTS

- GNU/Linux 18.04.3 LTS (Bionic Beaver) Ubuntu Mate distribution
- GQRX Software Defined Radio
- GNU Radio Companion software 3.7.12 version
- Required sattools for GNU: ASM + Golay Decoder, Binary Slicer.

SETUP PROCEDURE

Beacon Recorder.

To capture the AztechSat-1 beacon at your Ground Station while running **Ubuntu Mate** on your computer you will need to connect the **SDR Module** (in this case SDR Pluto module) and open the **GQRX** program. The "**Configure I/O devices**" window will appear where you should configure the entry fields as follows, after that click OK.

I/Q Inpuc		
Device	PlutoSDR	-
Device string	plutosdr	
Input rate	1500000	•
Decimation	None	-
Sample rate	1.500 Msps	
Bandwidth	0.000000 MHz	-
LNB LO	0.000000 MHz	+
Audio output		
Device	Default	\$
Sample rate	48 kHz	\$

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The **control interface panel** will then appear. The **Receiver Options** window is located on the right-hand side of the panel.



Next the **Receiver Options** window should be configured as follows:

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Hardware freq	:				43	7.300000 MH
Frequency					437300.000 🕻	kHz
Filter width	Wide				:	
Filter shape	Normal				\$]
Mode	Raw I/Q				*	
AGC	Off				:	
Squelch				-150.0 dB	: A	R
Noise blanker		NB1		NB2		
	k					

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To be able to record the beacon **click** the following button as shown in the image.



Next the **"I/Q recording and replay tool"** window will appear. To be able to record the beacon's sound you first must specify a **Location:** where all the "raw" data recordings will be stored.





Look for the **play button** to start listening, which is located in the upper left-hand section of the **option bar** and **click** it.

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+0	1.000.0	,00		-100 dBFS				0.00) ()	kHz
							Hardware freq	:	437.	.300000 MHz
-50							Frequency	43730	0.000	kHz
-100							Filter width	Wide	* *	
-100							Filter shape	Normal	* *	
436.8	437.0	437.2	437.4	437.6	437.8	438.0	Mode	Raw I/Q	*	
							AGC	Off	Å	
							Squelch	-150.0 dB 📜	Α	R
							Noise blanker	NB1	NB2	
							Input controls	Receiver Option	s FFT Se	ttings
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							-20			
							-40 5	10	15	20
							Gain:			-9.0 dB
							UDP	Rec	Play	
								DSP	ß	
	Cary 2.11 E. plutas	de								-

When you are ready to record, click the "**Rec**" button to record a raw file. **NOTE: Short clip recordings are recommended.**



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Once captured, go to **Configure I/O devices** window again by **clicking** the button as show in the image. Now is the time to convert the raw file into another format for later use in the **GNU** program. To do this you will replay the captured beacon in **GQRX** program.

 Menu Gqrx 2.11.5 - plutosdr Elle Tools View Help 					(EN \$ 1 4 +0) ⊄ ∨	Ved Feb 5, 15:08
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	979 4922		Nardware free: Frequences Hitter shade (sharp Mode Narrow FM Acc (orr Squitch) Noise blanker Net Net Noise blanker		0 0 k 417100.000 -1150.000 [2] A NB2	HZ 57.300000 MHz kHz m m m m
			Input controls Audio	neceiver Options TPT Sattings d d 0 10 12 CP Rec CCP	14 13 13 20 Pby	(8)R 22 2 -20.0 d8

The **Configuration I/O devices** window will appear and select **Other** for device and in the **device string** field enter the path to your raw file recording. The exact name of raw file to be replayed should be entered in the **device string** field with the following format being used:

file=/path_to_your_file.raw,*freq=437.3e6*,*rate=1.5e6*,*repeat=true*,*throttle=true* Configure the rest of the fields as shown in the image

• Configure I	0 devices	8
I/Q Input		
Device	Other	:
Device string	file=/Desktop/raw_sound/gqrx_20200205_225304_437300000_1500000_fc.raw,freq=437.3e6,rate=1.5e6,repeat=true,throttle=true	
Input rate		•
Decimation	None	:
Sample rate	1.500 Msps	
Bandwidth	0.000000 MHz	i.
LNB LO	0.000000 MHz	1
Audio output		
Device	Default	4
Sample rate	48 kHz	:
	0	<u>C</u> ancel] (√ <u>O</u> K)

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It will then be necessary to reconfigure the **Receiver Options** as show in the next image.

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Frequency					43730	00.000	kHz
Filter width	Wide					÷	
Filter shape	Sharp					\$	
Mode	Narrow FM					*	
AGC	Off					÷.	
Squelch					-150.0 dB 🗘	А	R
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Next play the raw file recording. Click the **"screen" icon** in the upper left-hand side of the bar as shown.

Menu • Gqrx 2. File Tool	11.5 - plutosdr s View Help								(EB \$ 14 4	n) 🗘 We	1 Feb 5, 15:0
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		437.300	.000		-64 dBFS			0.0	0 0	kH:	2
							Hardware freq	E		437.	300000 MHz
							Frequency		437	300.000	kHz
							Filter width	Wide		0	
							Filter shape	Sharp		:	
							Mode	Narrow FM			- 10
							AGC	orr		•	
							Squeich		-150.0 dB	A	R
							Noise blanker	NB1	NB2		
								\$			
							Input controls	Receiver Options FFT Settings			
							Audio -20 -40 -60 -2 Goin:UC	4 6 8 10 1: 00 Rec	P 14 16 10 Play	20	8 8 22 2 -20.0 dB
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Enter the path to your raw file and click **play** to reproduce it.

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437 300 000	-100 -80 -60 -40 -20 0	Receiver Options		ØX
+01:000:000	-63 dBFS	0	.000	kHz
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		Filter width Wid	de 🛟	
-100		Filter shape Sha	arp 🋟	
436.8 437.0 437.2	437.4 437.6 437.8 438.0	Mode Na	rrow FM 🛟	
		AGC Off	f ‡	
		Squelch -15	50.0 dB	R
I/O recording and replay tool		Noise blanker	NB1 NB2	
Location: /home/ground/Escritorio/raw_sound Select				
gqrx_20200131_225531_437300000_1500000_fc.raw gqrx_20200131_225632_437300000_1500000_fc.raw		Input controls Re	eceiver Options FFT Se	ttings
gqrx_20200131_225725_437300000_1500000_fc.raw ggrx_20200131_225826_437300000_1500000_fc.raw		Audio	. ,	Ø×
gqrx_20200131_225927_437300000_1500000_Fc.raw				
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As soon as possible click the **play button** on the **GQRX interface** to start the listening portion of the pre- recorded beacon (raw file).

Note: you must be hearing the beacon at the exact moment in which beacon sound begins to record it again as a new file.



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To **record** the new file, **enter a file location path** to save your files by clicking the next button as shown in the image.



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AzTechSat-1 Amateur Radio Instructions

Now click in the "Rec" button to record the audio for the GNU Radio program. Es 🜒) 11:50 밙 di 💷 🛅 🔒 🖹 🔛 🛃 🗶 🦂 @ X Receiver Options 100 -80 -60 -40 -20 0 437.300.000 0.000 437.300000 MHz Hardware freg: Frequency 437300.000 🗘 kHz -50 Filter width Wide \$ Filter shape Sharp ‡ Mode Narrow FM ‡ AGC Off : Squelch -150.0 dB 🗘 🛛 A R Noise blanker NB1 NB2 😣 💷 I/Q recording and replay tool Location: /home/ground/Escritorio/raw_sound Select gqrx_20200131_225531_437300000_1500000_fc.raw Input controls Receiver Options FFT Settings gqrx_20200131_225632_437300000_1500000_fc.raw gqrx_20200131_2259725_437300000_1500000_[cr.aw gqrx_20200131_225826_437300000_1500000_[cr.raw gqrx_20200131_225927_437300000_1500000_[cr.raw gqrx_20200131_230022_437300000_1500000_[cr.raw gqrx_20200131_230126_437300000_1500000_[cr.raw Audio 0 8
 Image: Plot

 <u>Play</u>

 00:00:05 / 00:00:08

 WW -20.0 dB Gain: Play UDP Rec Playing /home/ground/Escritorio/raw_sound/gqrx_20200131_225725_437300000_1500000_fc.raw

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Beacon Decoder

Once you have the final .wav audio file, open the **GNU** program called "AztechSat_decoder.grc" (you can download it from the Mission Operations webpage <u>https://upaep.mx/aztechsat/missionoperations</u>). Next **select the block** shown in image below to load the audio file.



A new window for **"Properties: Wav File Source"** will appear. Look for the audio file and click the **accept button**.

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File Edit View Run Tools Help				
📑 🔻 🖻 👻 📳 🗙 I 🌌 🚍 I 💥	🖳 💼 😣 । <table-cell-rows> 🗢 । 😑 🍋</table-cell-rows>		Properties: Wav File Source ×	
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Generate Options: QT GUI		Repeat	No 🔹	
Variable Variable	Wav File Source	N Channels	1	
ID: samp_rate ID: baudrate	Repeat: No			
Value: 48k Value: 9.6k				
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Value: 6.4k				
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Click the play button in the options bar to start the conversion from audio to hexadecimal characters.



Note: in previous tests we captured the conversion from audio to hexadecimal characters in one out of five .wav file capture tests. You may need to try more than once to capture the hexadecimal characters.

If the conversion from audio file to hexadecimal is successfully you should see hexadecimal characters in the lower left corner as shown.



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Next **copy** the **hexadecimal characters** into a **text editor** to format properly. The formating consists of **eliminating all csp-headers** (outlined in the red rectangle below) from each hexadecimal line and removing the spaces between each line.

Archivo Editar Ver Insertar Formato Estilos Tabla Formulario Herramientas Ventana Ayuda
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Estilo predeter 🔽 😵 🔮 Liberation Serif 🔽 🔽 a. 🖉 궠 귝 라 라, 🕰 🧕 🍊 🖅 등 등 등 등 등 등 등 등 등 등 등 등 🧰
0000 c3 c2 80 00 68 74 74 70 73 3a 2f 2f 75 70 61 65
0010 70 2e 6d 78 2f 61 7a 74 65 63 68 73 61 74 20 3c
0020 48 4b 3e 01 65 01 5c 01 66 1c f6 00 c8 00 00 00
0030 00 00 15 00 78 00 6f 00 39 00 00 00 05 01 01 01
0040 00 00 00 1 29 00 00 6 d6 00 00 00 de 00 17 00
0050 fc ff 72 ff 74 01 00 00 00 00 00 01 bf a4 1a
0060 42 c1 b8 9d 8a c4 01 2a <u>ab bf</u> c7 8f 78 3f a3 84
0070 38 3d b6 <u>db</u> 6d 02 03 05 0a 04 00 0a 00 00 00 00
0080 00 00 00 00 00 00 00 17 00 00 b9 fc ce e3 04
0090 00 04 00 04 00 04 00 04 00 00 00 00 00
00a0 00 00 00 00 00 00 00 00 00 00 00 00
00b0 cf 24 40 0f 13 af 00 3c 2f 48 4b 3e 00 00 00 00

It should look like the following image

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Página 1 de 1		the second second second				

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Finally look for a **hexadecimal to ASCII converter** (<u>https://www.rapidtables.com/convert/number/hex-to-ascii.html</u>) and paste the formatted hexadecimal lines into the converter. If the process was done correctly you will be able to see our web page address <u>https://upaep.mx/aztechsat/</u> in front of the other ASCII characters.

	 ASCII text to hex converter
74 01 00 00 00 01 bf a4 1a 42 c1 b8 9d 8a c4 01 2a ab bf c7 8f 78 3f a3 44 38 3b b6 db db 02 03 05 ab 04 00 ab 00 <t< td=""><td>Base converter Binary converter Binary to ASCII text converter Binary to decimal converter</td></t<>	Base converter Binary converter Binary to ASCII text converter Binary to decimal converter
Character encoding ASCII	Binary to hex converter Date to roman numerals converter Decimal to fraction converter
Convert X Reset 1 Swap	Decimal to percent converter Decimal to binary converter
AA https://upaep.mx/aztechsat	Decimal to octal converter
AA https://upaep.mx/aztechsat <hk>rer\rfLöE ⊥ x o 9 rrr r) −O Þ İ ûÿrÿtr r¿¤+B Á.ŠÄ *«¿Çx?£"8=¶0m J</hk>	Decima to occar converter Decimal to hex converter Degrees to deg,min,sec converter
AA https://upaep.mx/aztechsat <hk>rer\rfLö E → x o 9 rrr r) → P ↓ ûÿrÿtr r¿H+B Å,ŠÅ *«¿Çx?£"8=90m ↓ 3ŭĨŝJ J J J اêů! </hk>	Decima to occar converter Decima to hex converter Degrees to deg,min,sec converter Deg,min,sec to degrees converter Degrees to radians converter Fraction to decimal converter

Please then paste the character encoded line(s) onto our Amateur Radio Operations Dashboard form by clicking the Amateur Radio Operators button on the right side of the webpage: <u>https://upaep.mx/aztechsat/missionoperations</u> and send. **You should receive a Certificate of Capture once we have received your input and a QSL once it has been verified.**

Thank you for supporting our mission! Feel free to send comments to us at our email address: <u>missionoperations@upaep.mx</u>



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Appendix

This is how the waterfall analyzer looks like when a beacon sent by the AzTechSat-1 is received over **GQRX**.

