

Using the GREENCUBE Digipeater with IC-9700

by Mike Swiatkowski, AA9VI

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v1.1

with some very valuable help from Dave, KGØD

Also, credits to FG8OJ: <https://fg8oj.com/news/greencube-digipeater>

ZR6TJ: <https://www.zr6tj.co.za/2022/11/18/adventures-with-greencube-satellite/>

and KP4MD: <https://www.qsl.net/kp4md/freqdev.htm>



GreenCube
Microgreens cultivation
in a CubeSat

Introduction

This is a GREAT satellite. It does not take an antenna setup with large beams and expensive preamps to make a contact across the world. I have managed to contact several locations in North and South America, Europe, the Middle East, Africa, and Asia with just the [IC-9700](#), [MiniKits preamplifiers](#), the [Fox Delta](#) rotator controller, and the [WiMo X-Quad antennas](#). Since this is a 435 MHz MEO signal, you will almost certainly need a UHF preamp and some sort of directional beam antenna for a decodable signal to noise ratio.

The learning curve for configuring your radio and computer software is a steep one. So, be patient and willing to make mistakes in order to learn. The most difficult parts of this activity are setting doppler correction to be very accurate and setting the audio levels on both the computer and radio. Although this document lists my specific station configuration, many of the techniques presented can be applied to different radios, software, or rotators.

Procedure

1. Download the following software tools to your PC
 - a. USB driver (if you haven't already done this):
<https://www.icomjapan.com/lineup/products/IC-9700USA/?open=4#drivers>
 - b. SATPC32: <http://www.dk1tb.de/indexeng.htm>
 - c. SATPC32ISS patch: http://www.dk1tb.de/SatPC32ISS_2.zip
 - d. UH7ZO soundmodem & digipeater: <https://uz7.ho.ua/greentnc.zip> (Check frequently for latest versions)
 - e. Sound card sample rate checker: <http://wa8lmf.net/miscinfo/CheckSR-Setup.exe> (optional)
2. Configure the IC-9700 as follows:
 - a. Connect USB cable between the IC-9700 and PC. Install the
 - b. AGC OFF (see the [ZR6TJ page](#) instructions on this)
 - c. Menu→ Set→ Connectors→ Mod Input→

USB Mod Level = 24%

Data Mod = USB
 - d. Menu→ set→ Connectors→ USB AF/IF Output

AF Output Level = 40%
 - e. Set radio to USB-D mode (make sure whenever you make a contact you are using this mode not FM. Sometimes the satellite software tries to change your radio to FM)
 - f. Turn off sub band VFO (by pressing the sub band VFO button for 2 seconds until the subband disappears)
3. Install SATPC32, launch it and alphabetically add the following line in the ?--> Auxiliary Files→ Doppler.SQF file.
IO-117,435308.5,435308.5,USB-D,USB-D,NOR,0,0,1200pkt

Then save the file and exit notepad. Exit SATPC32.
4. Extract the SATPC32ISS zip from step 1c into C:\Program Files (x86)\SatPC32 and launch the SATPC32ISS_2.exe Make sure you are using v12.10 or later of SATPC32ISS since there is an important bug fix in 12.10. SATPC32 is great for linear/FM UV or VU satellites, but SatPC32ISS is better suited for packet communications.
5. You will also need to set your radio and rotator controllers in the Setup menu. I have a Yaesu G-5500 rotator and the Fox Delta rotator controller. Some have had excellent success with the [SAT controller](#), too. Here are my settings:

✕

Rotor Setup

For hints: [how to setup automatic rotor control open menu "?/Hints \[Rotor\]"](#)

Rotor interface/controller:

SAEBRTrackBox

Search

Settings:

LPT (1 - 4, only IF-100, FODTrack, RifPC)
Delay (only IF-100, FODTrack, RifPC)
Turning point of azim. rotor (S or N)
Minimum elevation

2

30

N

0

2

Help

Port address: \$0278

0

Decimals of Azimuth/Elevation Values (0,1,2)

Store

Optional settings:

Update antenna positions:
☒ in time intervals
☐ at sat. position change

Max. elevation
☐ 90 degr.
☒ 180 degr.

Azimut rotor
☒ 360 degr.
☐ 450 degr.

Time interval (sec.)

15

Pos. change (deg.)

5

Optional settings:
☐ constant
☒ gain related

OK

Store

Figure 1. Yaesu G-5500 rotator and the Fox Delta controller configuration

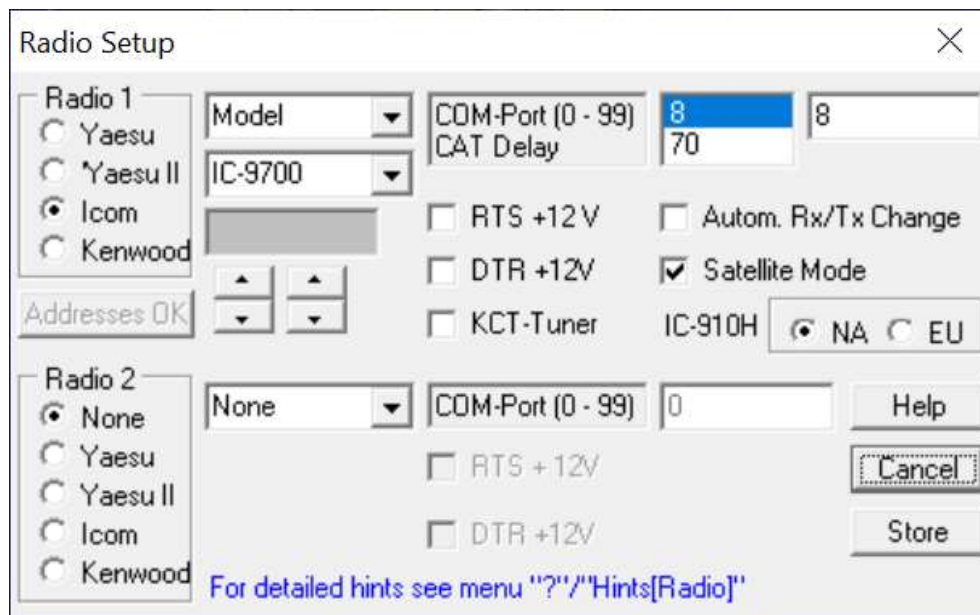


Figure 2. IC-9700 Radio Setup

6. Inside SATPC32ISS, you will want to download the latest Keplerian elements by going to Satellites→ Update Keps. Choose the nasabare.txt source file. Update this every Thursday.
7. You will also want to add IO-117 (Greencube) to a list of satellites by double clicking on the name in the middle column so it is added to the right column as seen in Figure 3.

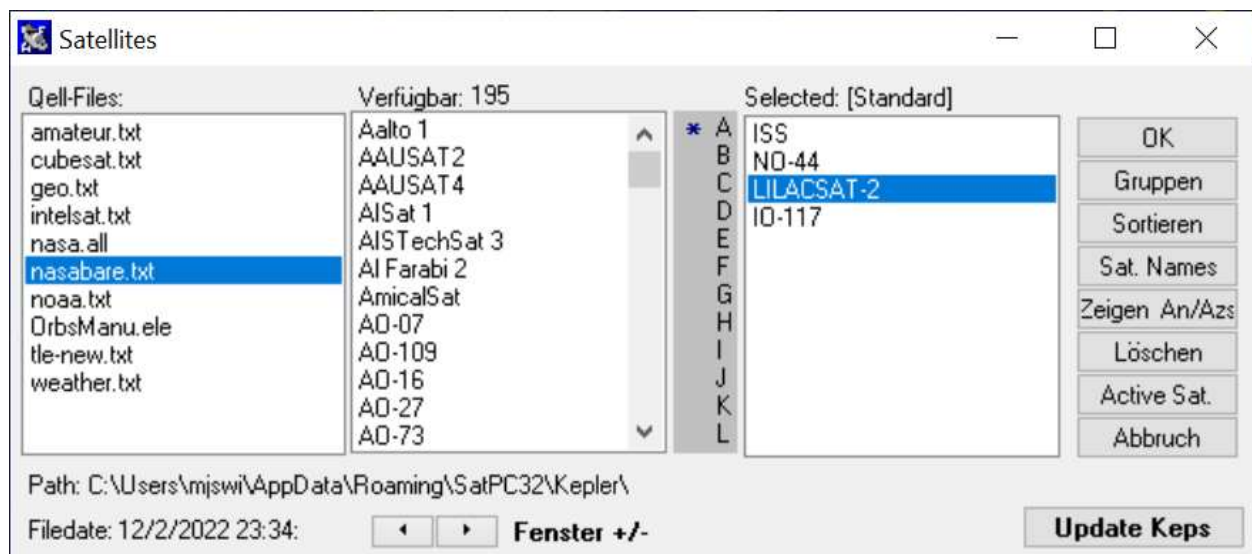


Figure 3. SatPC32ISS selected satellites.

8. Now click on the D on the lower left corner of the SatPC32ISS . (You may choose a different letter if IO-117 is higher up in the Selected (standard) List. You can customize this later.) Then click on CAT at the top of the screen. One realization from my early trials is the need to frequently update doppler during the pass. I choose to update the radio's uplink and downlink as soon as the doppler delta > 50 Hz. The Leo Bodnar board (http://www.leobodnar.com/shop/index.php?main_page=product_info&products_id=352) will be helpful here to make sure you have a very accurate frequency reference for doppler correction. If you don't do this, you may have to manually center the receive filter on the soundmodem waterfall too often.

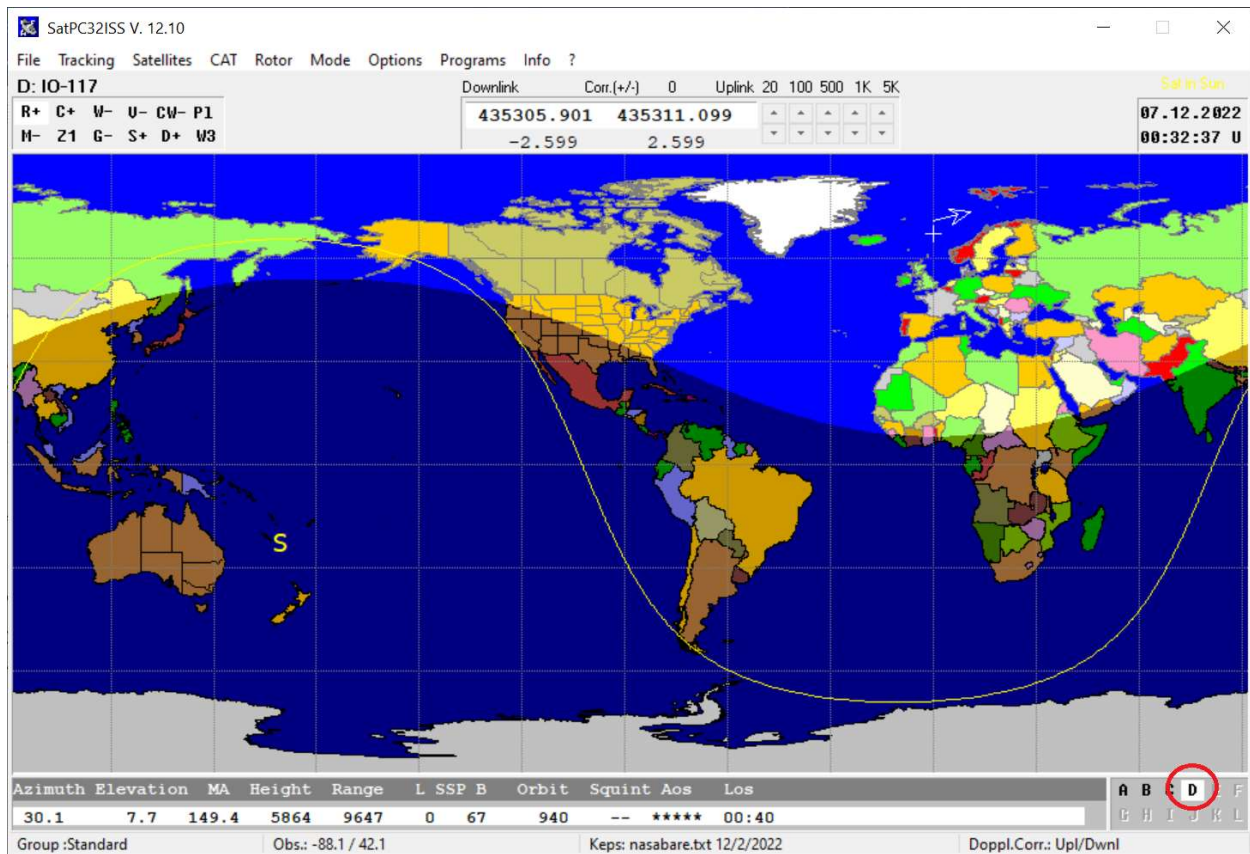


Figure 4. Choosing the desired satellite to track on SATPC32ISS

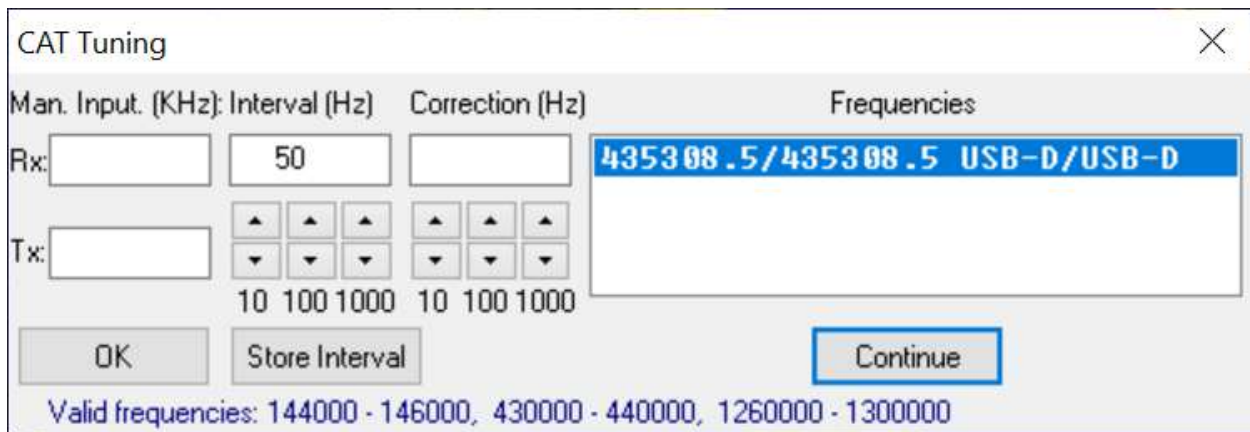


Figure 5. SatPC32ISS CAT Tuning

9. Unzip greentnc.zip and save CheckSR-Setup.exe to C:\packet\GreenCube-Latest (This is just an easy place to find the files and you won't have permissions issues executing them). I also recommend making a shortcut to this directory on your desktop for easy access.
10. Once you have unzipped the greentnc.zip file you will have 4 subdirectories as shown in Figure 5, below. "ssb" is for the SoundModem, "client.v18" is for the digipeater GUI.

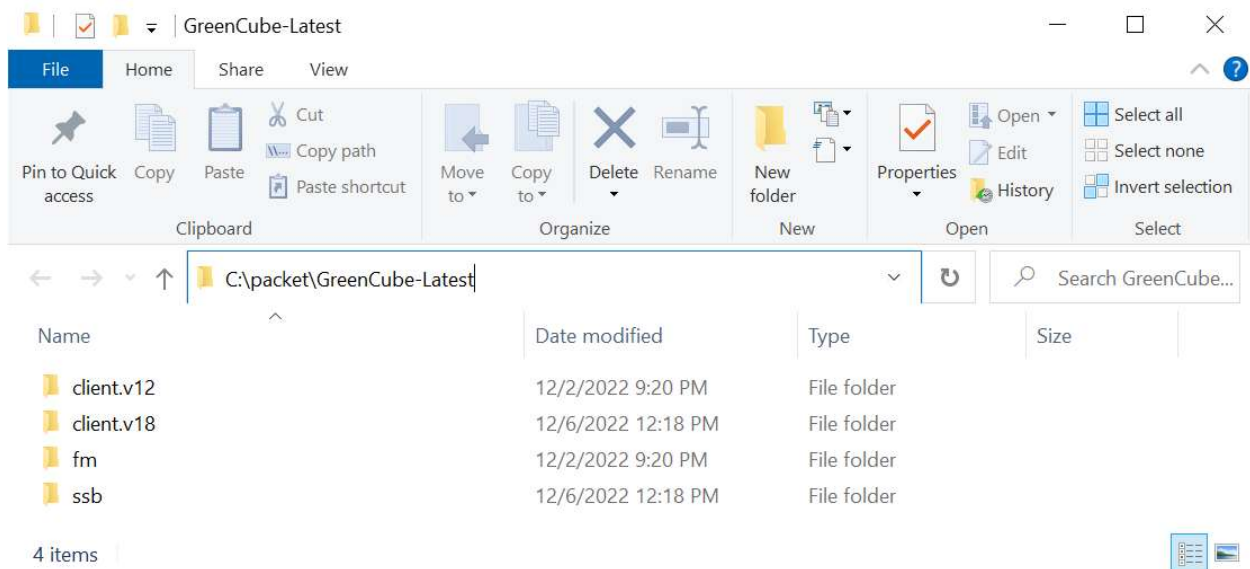


Figure 6. Greentnc subdirectories

11. Double click on the "ssb" directory. Then launch soundmodem.exe The first time you launch this a soundmodem.ini directory will be created.

12. Now, go to Settings. My settings for Devices and Modem are shown in Figures 7 & 8. By default the devices for the IC-9700 are listed as a USB CODEC. You can rename them like I did for easy reference.

The screenshot shows the 'Settings' dialog box for UH7ZO Soundmodem. It is divided into three main sections: 'Sound Card', 'Server setup', and 'PTT Port'. The 'Sound Card' section has dropdowns for 'Output device' (set to 'IC-9700 in (USB Audio CODEC)') and 'Input device' (set to 'IC-9700 out (USB Audio CODEC)'). Below these are checkboxes for 'Dual channel', 'TX rotation', 'Single channel output', 'Color waterfall' (checked), 'Stop waterfall on minimize', and 'Minimized window on startup'. To the right of these are input fields for 'TX SampleRate' (12000), 'TX corr. PPM' (-87), 'RX SampleRate' (12000), and 'RX corr. PPM' (98), along with a 'Priority' dropdown set to 'Highest'. The 'Server setup' section has input fields for 'AGWPE Server Port' (8000) and 'KISS Server Port' (8100), each with an 'Enabled' checkbox. The 'KISS' checkbox is checked. The 'PTT Port' section has a 'Select PTT port' dropdown set to 'COM9', a 'Dual PTT' checkbox, and a 'Swap COM pins for PTT' checkbox. An 'Advanced PTT settings' button is also present. At the bottom are 'OK' and 'Cancel' buttons.

Section	Setting	Value
Sound Card	Output device	IC-9700 in (USB Audio CODEC)
	Input device	IC-9700 out (USB Audio CODEC)
	Dual channel	☐
	TX rotation	☐
	Single channel output	☐
	Color waterfall	☒
	Stop waterfall on minimize	☐
	Minimized window on startup	☐
	TX SampleRate	12000
	TX corr. PPM	-87
Server setup	AGWPE Server Port	8000
	AGWPE Server Port Enabled	☐
	KISS Server Port	8100
	KISS Server Port Enabled	☒
PTT Port	Select PTT port	COM9
	Dual PTT	☐
	Swap COM pins for PTT	☐
	Advanced PTT settings	Button

Figure 7. UH7ZO Soundmodem Device settings

Modem settings

Modem filters ch: A

BPF Width

TXBPF Width

LPF Width

BPF Taps

LPF Taps

☒ Default settings

PreEmphasis filter ☒ All

Modem filters ch: B

BPF Width

TXBPF Width

LPF Width

BPF Taps

LPF Taps

☒ Default settings

PreEmphasis filter ☒ All

Modem type ch: A

Mode

TXDelay msec

TXTail msec

Add. RX pairs

Add. RX shift Hz

Modem type ch: B

Mode

TXDelay msec

TXTail msec

Add. RX pairs

Add. RX shift Hz

Figure 8. UZ7HO Soundmodem Modem settings

13. You'll notice I have a correction factor applied to the TX PPM and RX PPM in the device settings. These numbers were obtained by running the Sound card sample rate checker: mentioned in step 1d. Press start. Then wait for until the difference PPM numbers start to settle, maybe 30 seconds. Use those numbers in your TX and RX corr. PPM fields. Otherwise, you may leave them at 0 if that works for you.

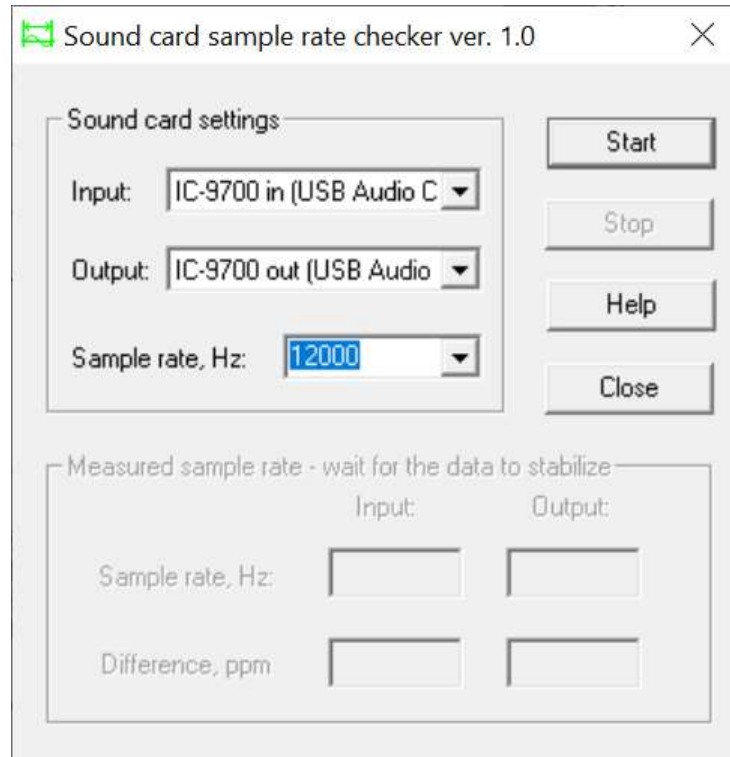


Figure 9. Additional sound card correction program

14. Set your PC's audio levels to/from the IC-9700 CODEC to both be 50%. (A reference value used for the next step that is easy to remember in case you make any changes to soundcard settings on your PC)

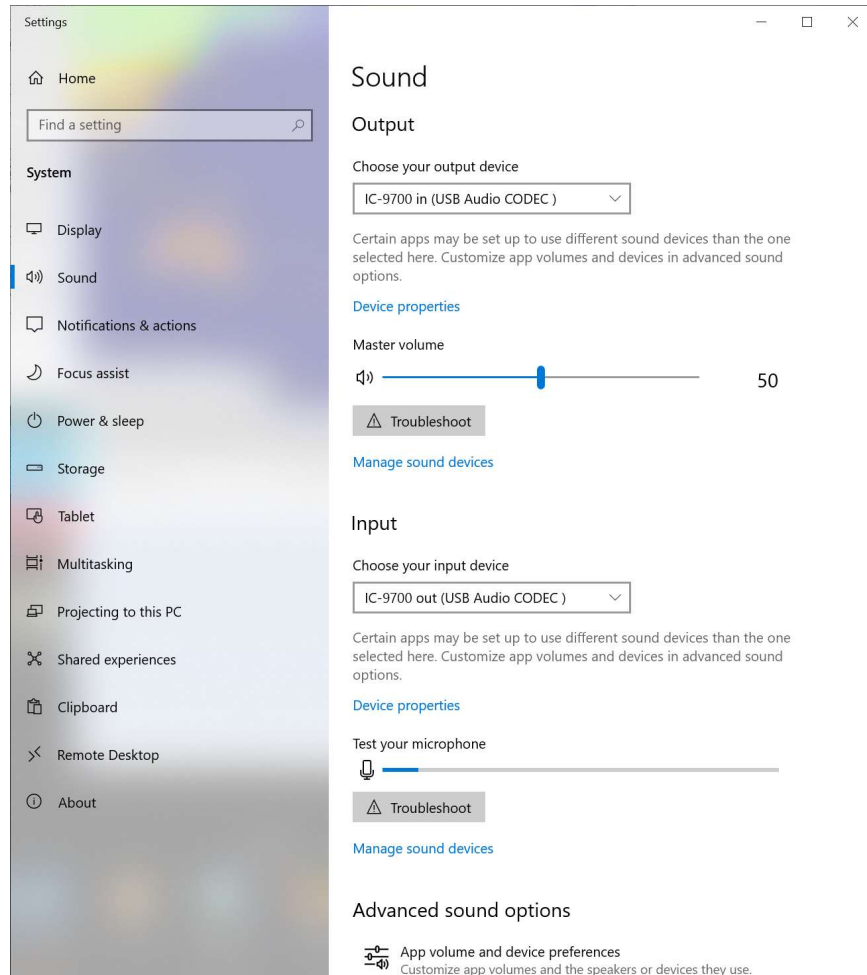


Figure 10. PC audio levels

15. Go to the Calibration menu in the SoundModem software. Click on the Low Tone box of Channel A in the Calibration menu. Set your IC-9700 to show the ALC meter.

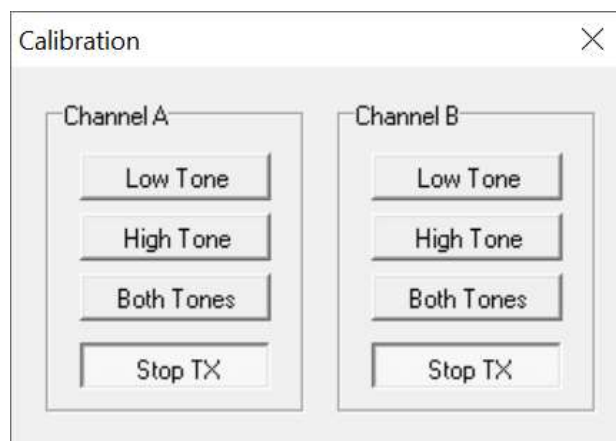


Figure 11. SoundModem Calibration

Adjust the Menu→ Set-> Connectors→ Mod Input→ USB Mod Level until the tone shows a 3 on the ALC meter for single tone and 5 on the ALC meter for both tones. I achieved this at 24%. You can now click on Stop TX in the Calibration GUI. ***This is the most important configuration!***

16. Now open the GreenCube Digipeater program and ensure the port matches the one in SoundModem as shown below.

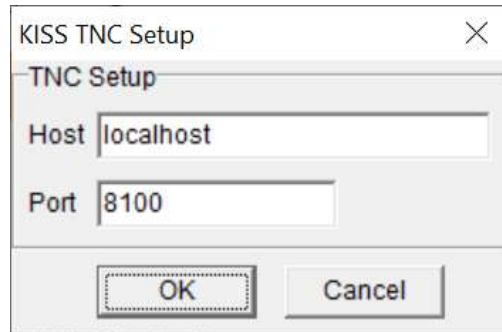
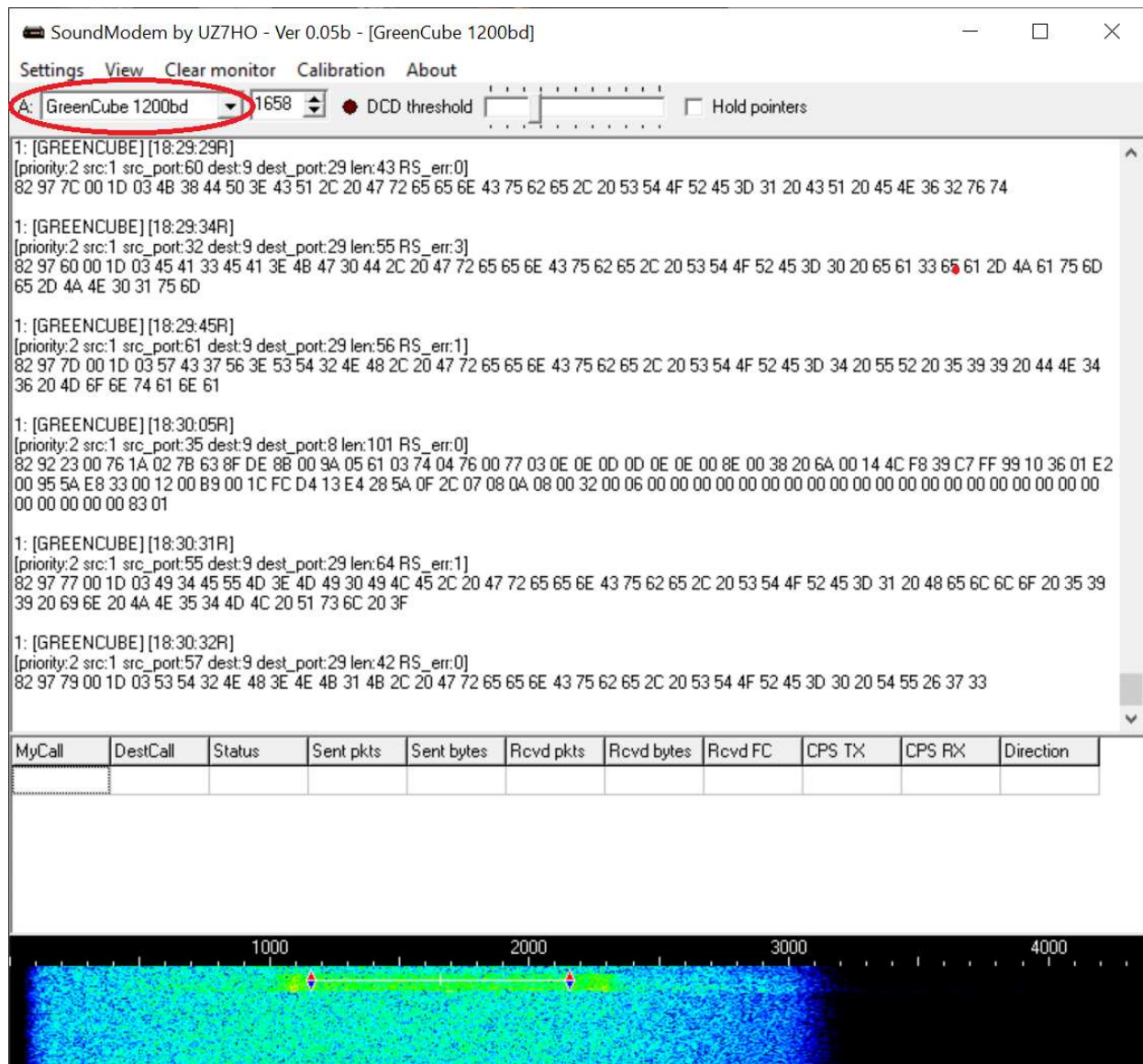


Figure 12. KISS TNC setup.

17. Wait for the packet to be sent from GREENCUBE. Sometimes it will be 1200 baud, and other times it will be 300 baud. You can easily determine the data rate by watching the waterfall signal spectrum. Choose the correct baudrate in SoundModem using the A: GreenCube drop down in the upper left corner of the program.



18. If necessary, use SatPC32ISS and the arrow buttons near the 20/50/500/1K/5K numbers to adjust the receiver's center frequency so that the waterfall markers are centered on the signal as shown in Figures 14 or 15. You may have more success decoding packets with FIL2 or FIL3 that are just wide enough for the signal in the waterfall. Remember to make them a little wider than the signal to account for the worst case 50 Hz doppler shift.

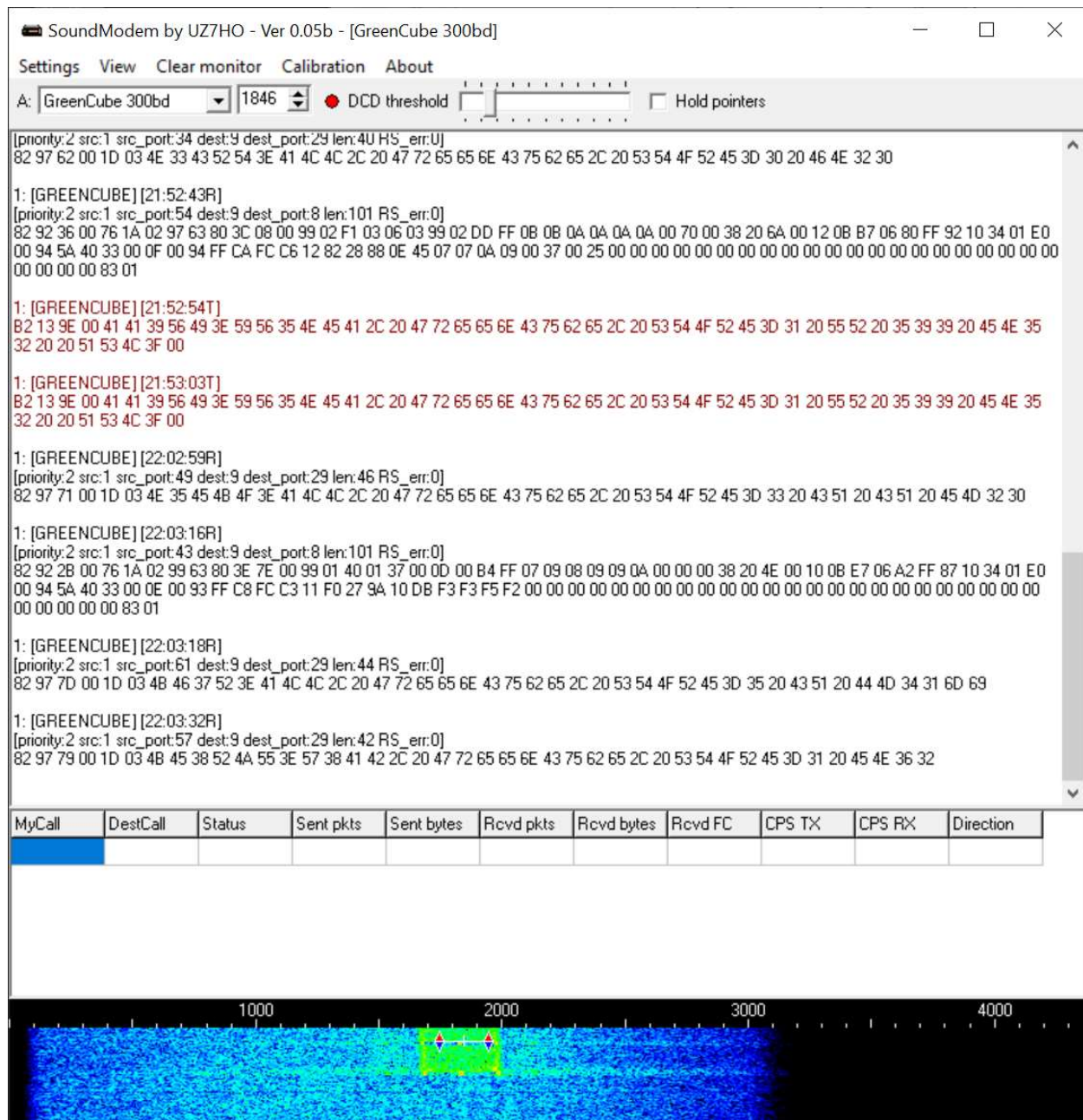
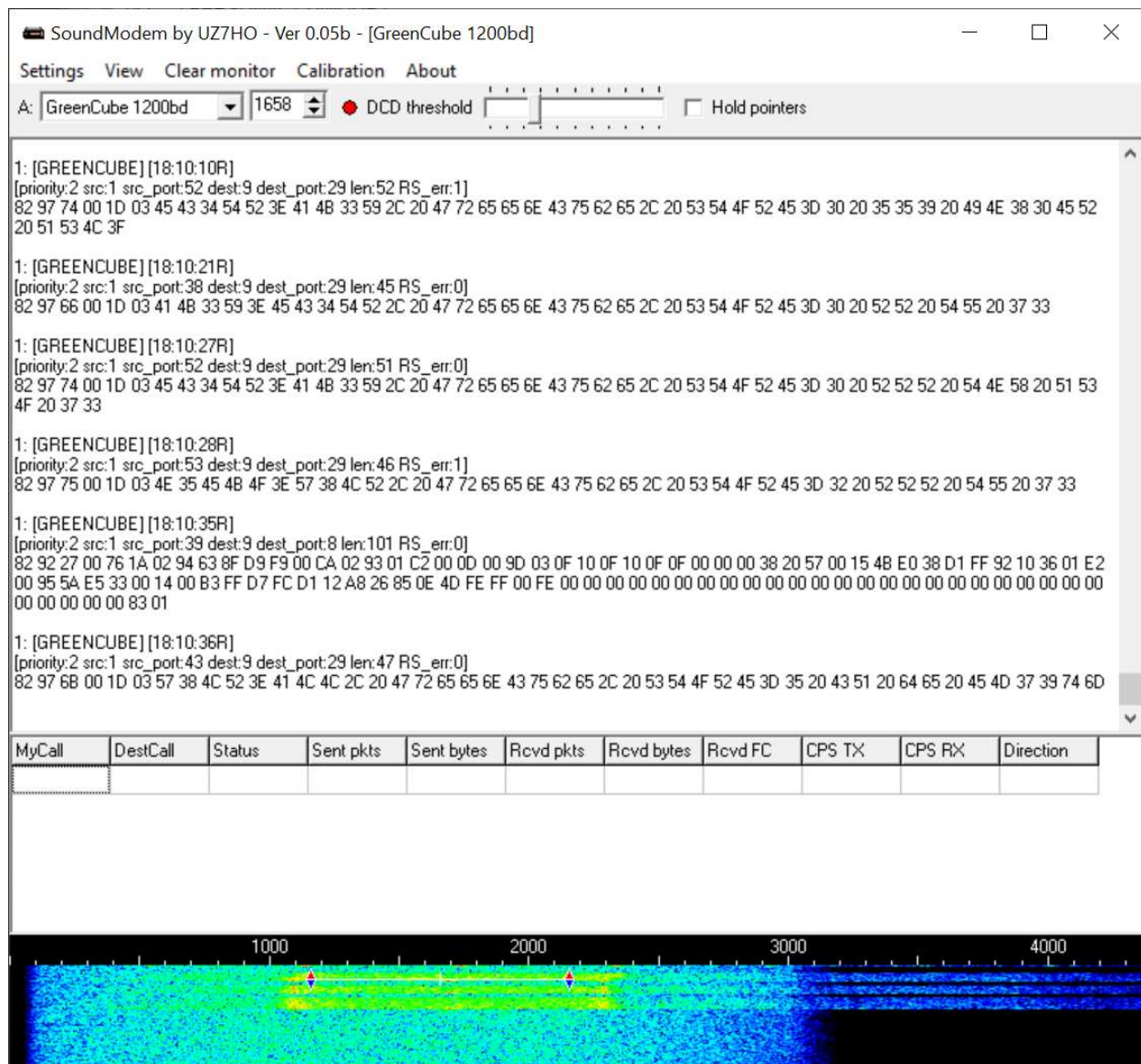


Figure 14. Decoding a 300 baud signal



19. Once you have successfully decoded packets FROM the satellite, you are ready to send your packets TO the satellite. This is much more difficult since you have to consider packet collisions and TX audio compression. Using the GreenCube Digipeater software (in your C:\packet\GreenCube-Latest\client.v18 subdirectory) you will see callsigns appearing. You may double click on a "From" callsign and respond to him/her using the MSG line with send, or you may use one of the macro buttons at the top. If you do not see your packet digipeated, the other station cannot hear you. So, send a message again. Try to be courteous and not cause interference to others. Wait and listen for the right moment to repeat your packet.

I color coded packet types using the View→ Monitor Color and TX Message Color menus. This makes it easier to spot an incoming packet. Below in Figure 16, orange is a packet I sent, white is digipeated from the satellite, and blue is digipeated from the satellite and directed to me. Green indicates someone is calling CQ.

GreenCube Digipeater - v0.18

KISS TNC Setup View Show Log

CQDX CQ QSL? RRR73 QSL Chi CQ EU

MyCall: AA9VI ToCall: I4EUM ReTX Delay: 0 Ch: 0 Log QSO Clear Send

MSG: 599 EN52 QSL?

ALL PERSONAL UNIQUE

Date (UTC)	From	To	Message	Type
07.12.22 00:04	EB2CDU	KB9STR	HELLO. IN93AG. QSL	RX:0
07.12.22 00:04	EC4TR	AA9VI	559 IN80ER QSL?	RX:0
07.12.22 00:04	EB2CDU	WP4T	HELLO. IN93AG. QSL	RX:0
07.12.22 00:04	KB9STR	EB2CDU	RRR TU 73	RX:0
07.12.22 00:04	I4EUM	ALL	CQ de I4EUM JN54ML	RX:1
07.12.22 00:04	I4EUM	ALL	CQ de I4EUM JN54ML	RX:1
07.12.22 00:04	AA9VI	EC4TR	RRR 73 de EN52	TX:0
07.12.22 00:04	AA9VI	EC4TR	RRR 73 de EN52	TX:0
07.12.22 00:04	AA9VI	EC4TR	RRR 73 de EN52	TX:0
07.12.22 00:04	AA9VI	EC4TR	RRR 73 de EN52	TX:0
07.12.22 00:04	EC4TR	WP4T	TNX 73	RX:0
07.12.22 00:04	AA9VI	EC4TR	RRR 73 de EN52	RX:0
07.12.22 00:04	WP4T	EC4TR	RRR,TNX, 73'	RX:0
07.12.22 00:04	W5CBF	G0MRF	EM30 QSL?	RX:0
07.12.22 00:04	EB2CDU	WP4T	HELLO. IN93AG. QSL	RX:0
07.12.22 00:04	EC4TR	AA9VI	RRR TNX QSO 73	RX:0
07.12.22 00:05	N5EKO	ALL	CQ EM20	RX:2
07.12.22 00:05	NK1K	CQ	CQ FN42	RX:0
07.12.22 00:05	AA9VI	I4EUM	599 EN52 QSL?	TX:0
07.12.22 00:06	I4EUM	AK3Y	RR Tnx Qso 73	RX:1
07.12.22 00:06	N1PEB	ALL	CQ N1PEB EL98	RX:0
07.12.22 00:06	N5EKO	K8DP	RRR TU 73	RX:2
07.12.22 00:06	AA9VI	I4EUM	599 EN52 QSL?	TX:0
07.12.22 00:07	AA9VI	I4EUM	599 EN52 QSL?	RX:0
07.12.22 00:07	W8LR	ALL	CQ de EM79tm	RX:5
07.12.22 00:07	N5EKO	N1PEB	599 EM20	RX:2
07.12.22 00:07	G0MRF	W8LR	UR 599 IO91TK	RX:0
07.12.22 00:07	W5CBF	G0MRF	EM30 QSL?	RX:0
07.12.22 00:07	N5EKO	N1PEB	599 EM20	RX:2

Digipeater Status: ON TNC: ON

Figure 16. Digipeater software shown packets sent, digipeated, and received

You can log your successful QSOs using the log function on the GreenCubeDigi client program. Click on the line of a successful QSO and then click on the Log QSO button near the top right of the screen. You can view your log by selecting Show Log at the top left of the screen. (You cannot transmit while viewing the log.)

Final Notes

From time to time during the pass you will have to fine tune the filter on the waterfall of the SoundModem. Try to keep it centered on the signal best as possible. Even with the radio set to correct for doppler when it changes only 50 Hz, sometimes this accuracy is not enough for weaker signals. If SATPC32ISS is sending a CAT command to the radio to change the TX and RX frequencies it momentarily will lose sync with the packet digipeated from the satellite. You could be missing a reply to your sent packet. Therefore, if you set your doppler correction in step 8 to be more often than 50 Hz you will decode less packets.

Second point: IO-117 (Greencube) has some deep fades during passes due to the satellite tumbling in space. Don't waste your time sending a packet if you cannot decode incoming packets. Just wait 30 seconds or so until you are reliably decoding packets again. Always send packets with the TX delay set to 0 unless you are sending a time delayed packet outside the satellite's current footprint (i.e. mainland USA to Australia). Much like HF contesting during a pileup, your chances of a successful contact depends more on ***your ability to listen*** than to transmit. Understand the deep fades, get a feel for when packets are being sent and time your transmissions to avoid packet collisions.

Good luck and please QSL. I collect cards!

73 de Mike, AA9VI

Decoding Telemetry from GREENCUBE Digipeater with IC-9700

This is even easier than receiving and transmitting. Use the above directions except do not launch the Digipeater software. Instead, download DK3WN telemetry decoder from this location: <https://www.satblog.info/software/>

Software is updated frequently. Grab the latest GREENCUBE version. Extract the zip file to C:\packet\GreenCubeDK3WN

Launch the executable file. Connect to the soundmodem by checking the TCP client box. Telemetry is 300 baud. Telemetry is often sent when the Transponder is OFF, (i.e. hams are not sending packets)

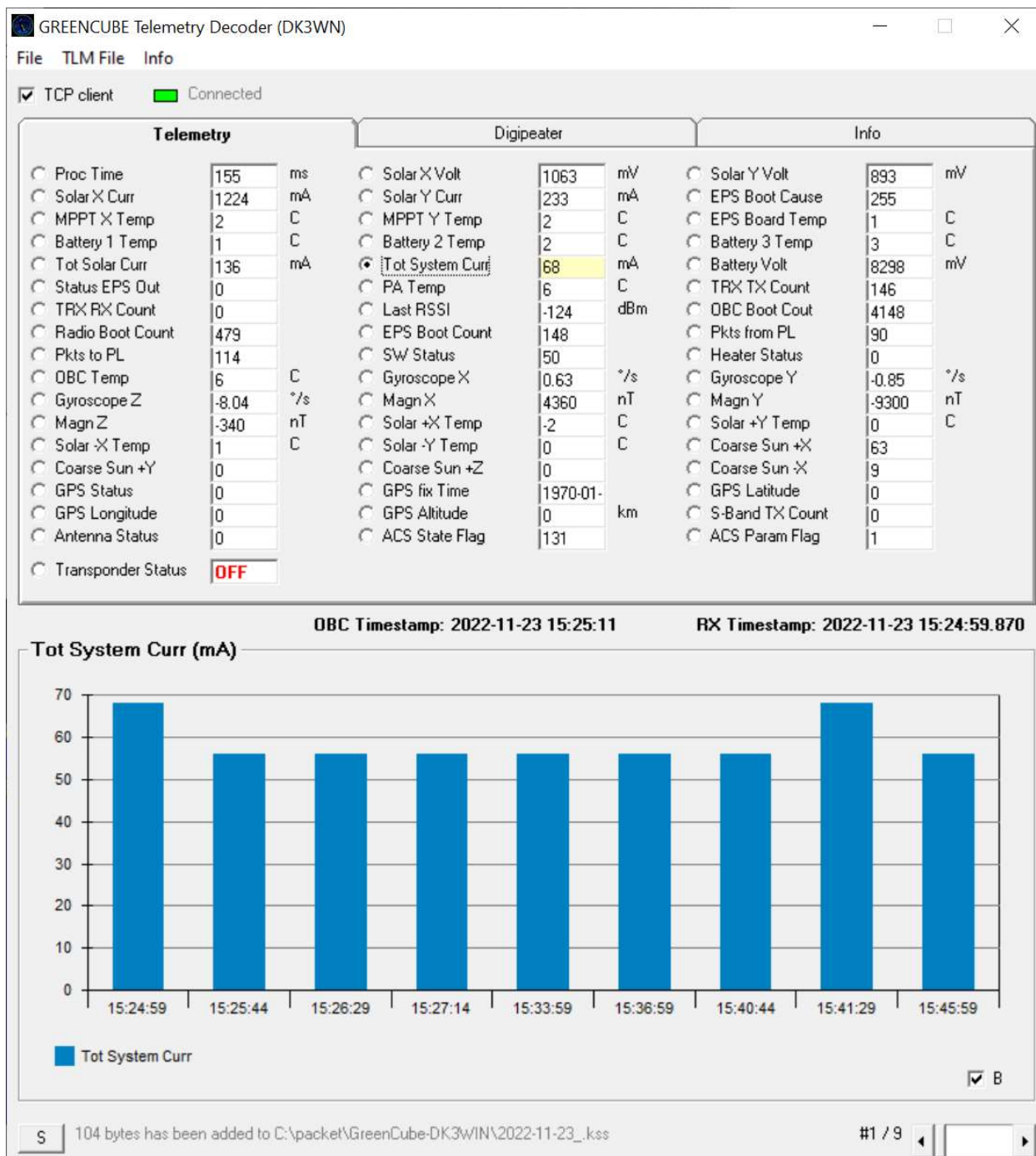


Figure 17. GreenCube Telemetry Decoded (300 baud)