

Nova_Tune

A radio tuning addition to
Nova for Windows

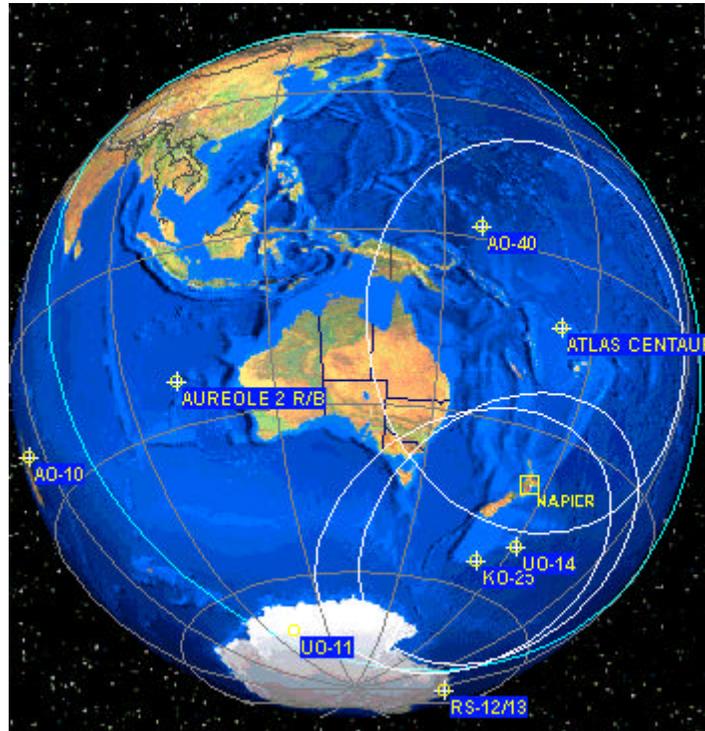


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Caveat

The designers of this hardware and software disclaim any and all liability for any direct, indirect, incidental, consequential (including loss of profits) or punitive charges whether based on contract, tort, or any other legal theory, which some person may invent.

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December 2001

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System requirements

Hardware:

- ? Standard parallel (printer) port on host computer. Port cannot be shared with another device.
- ? 25-pin printer cable

Software :

- ? Microsoft® Windows 95, Windows 98, Windows Me, NT4, Windows 2000 Pro, and Windows XP operating systems;
- ? Nova for Windows ver 2.1q or later

Introduction

Nova_Tune consists of combined *Software* and *Hardware*. Both components work with Nova for Windows to adjust frequency of radios. Nova_Tune communicates with Nova via Dynamic Data Exchange (DDE).

The Nova_Tune hardware unit provides a micro processed environment that passes the host computer's Doppler corrected frequencies out to a number of radios. It is powered by an external +9 to +14 VDC supply with reverse polarity protection. The hardware unit allows up to four radios to be connected at any time, any two of these radios may be set up in an UpLink and Downlink configuration on a satellite by satellite basis.

A 4 bit wide External Control Port (ECP) is also provided by the hardware. This port can also be configured on a satellite-by-satellite basis. The port can be used to switch external components, which might be required for a particular satellite tracking session.

Nova_Tune is Full Doppler Tuning (FDT) capable.

List of radios supported by Nova_Tune.

The following equipment is interfaced. Mixing of equipment is permissible.

VHF/UHF Multi Band Full Duplex:

FT-736R, FT-847, TS-790, IC-970, IC-820, IC-821, TS-2000, IC-910

VHF/UHF Single Band Full Duplex:

TS-711, TS-811, IC-271, IC-471, IC-275, IC-475, IC-1271, IC-1275

Receivers:

Full Duplex when mixed with equipment above.
(Standard Rx mode or with down converter)
IC-R8500, IC-R7000, IC-R9000, PCR-1000, AR5000, AR8000

HF Equipment

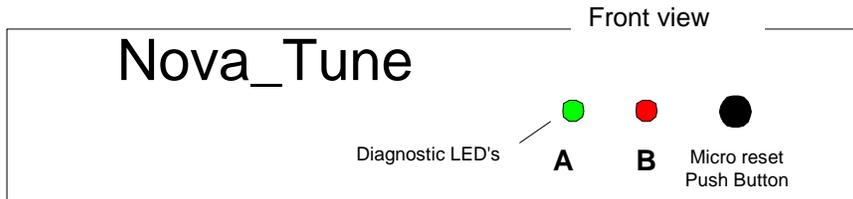
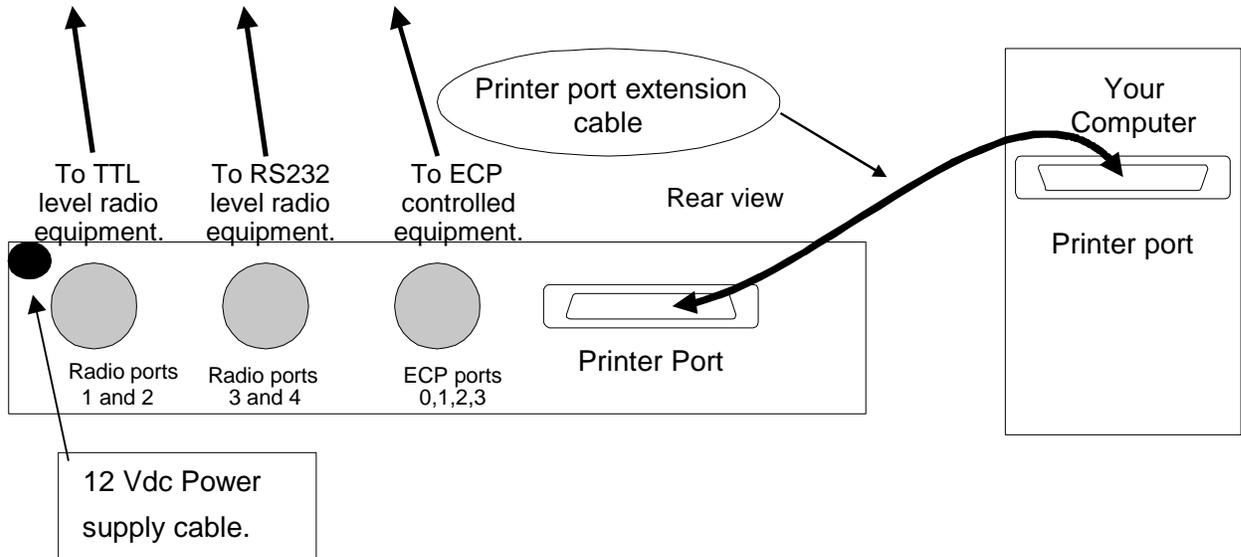
(Mode K. Mode B simplex with up and down converters)
TS-440, TS-680, FT-757, IC-728, IC-729, IC-751A, FT-980, IC-7456PRO

Simplex only HF/6m/VHF/UHF

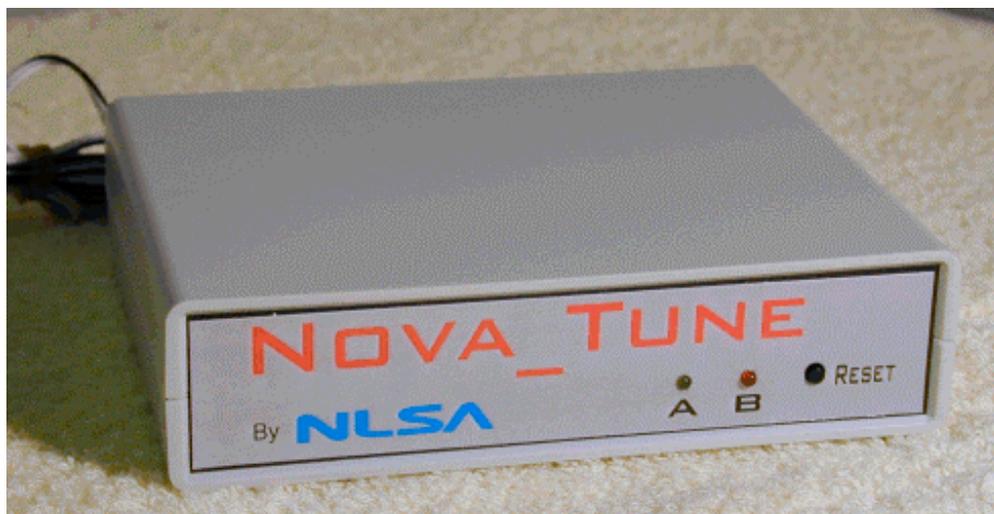
IC-706MKII/G, IC-706, FT-100, IC-746, IC-706MKII

HARDWARE

Wiring Overview



Front Panel



Indicator LEDs:

The Nova_Tune hardware is provided with two indicator LEDs "A" & "B" on the front panel

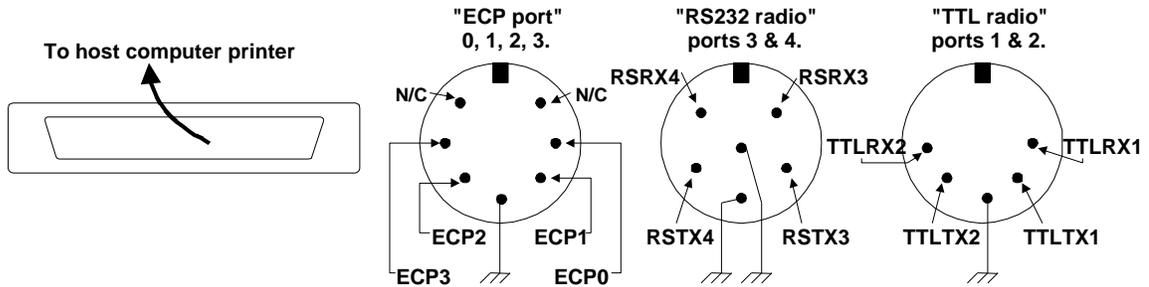
NOVA_TUNE Diagnostic LED's

Condition	LED "A"	LED "B"
Only DC power applied, printer cable not connected.	Flash approx. every 2 seconds.	Off
Start "NOVA_TUNE" software	On (constant) after first update.	On (constant) after first update.
This condition indicates bad data arriving at the Microprocessor, check your Printer extension cable.	Off	On

Rear Panel



REAR PANEL CONNECTIONS



Power **MUST NOT** be applied to **ANY** of the DIN connector pins.

The above view is looking at the rear of the case from the outside

Power (9 to 14 Vdc) applied to this unit via wired in cable, it is terminated at the supply end. **The stripe indicates "Negative"**

Radio port designations
 PORT 1 : TTLRX1 & TTLTX1
 PORT 2 : TTLRX2 & TTLTX2
 PORT 3 : RSRX3 & RSTX3
 PORT 4 : RSRX4 & RSTX4

The ECP port provides 4 pins that have TTL level output through internal 10k ohm resistors. Take care when connecting devices to this port. Make sure the external device will not back a voltage into this port as could damage the microprocessor

For ICOM "CI-V" connection use the TTLRX1 pin and ground, and make the link inside the case, or alternatively leave the internal link set to YAESU and link the TTLRX1 and TTLTX1 pins in the Din connector plug

If you plan not to use "ECP" port then it probably a good idea to leave the un-terminated DIN plug in this socket as a safety guard. You may also connect all ECP port pins to ground in this connector for added protection

The Printer Port Cable is a normal DB-25 cable. It must have a DB-25 **male** connector fitted at one end with a DB-25 **female** connector fitted at the other end. All 25 pins of the DB-25 connectors must be connected pin to pin. This cable is normally referred to as a "printer port extension cable."

Inside

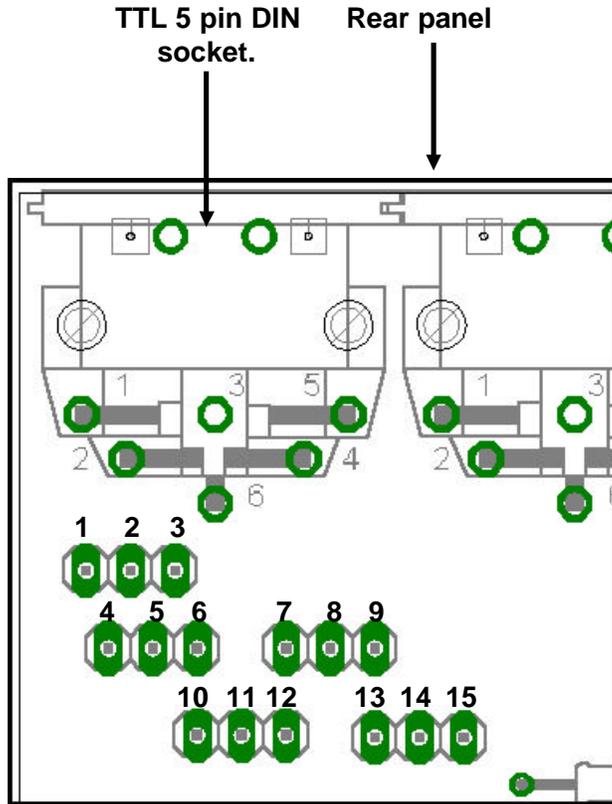


Fig. 1 Internal jumpers

TTL Radio Equipment jumper settings:

PORT	Direction	YAESU	KENWOOD	ICOM "Remote" Buss
1	Normal/ ICOM	Jumper pins 2 & 3	Jumper pins 2 & 3	Jumper pins 1 & 2
	RX	Jumper pins 5 & 6	Jumper pins 4 & 5	Jumper pins 5 & 6
	TX	Jumper pins 8 & 9	Jumper pins 7 & 8	Jumper pins 8 & 9
2	RX	Jumper pins 11 & 12	Jumper pins 10 & 11	Not Available
	TX	Jumper pins 14 & 15	Jumper pins 13 & 14	Not Available

Please note: The above jumper settings ONLY apply to radio equipment that is controlled by TTL level commands, Equipment controlled at RS232 level require no jumper settings and MUST use the middle DIN socket marked **RS232**.

Example: You want to connect a Yaesu FT-980.

This rig uses TTL levels to communicate with the outside world so you could use Port 1 or Port 2 as both are TTL level Radio Equipment ports. Let us for this example use Port 1, connect pin "TTLRX1" on the "TTL radio port" (Receive) to the data output pin of the rig's connector and pin "TTLTX1" (Transmit) to your rig's receive data pin (see Fig. 2), and refer to your rig's handbook for the correct pins to use on your equipment. These connections should be made with screened (shielded) cable, the screens (shield) can be connected to the ground pin that is available on the above connector.

Having completed the hardware radio connections, check that the TTL radio equipment jumper settings inside the case are as per Fig 4, i.e. make the following port 1 jumper links: 2&3, 5&6, 8&9. (PORT 1 YAESU)

Most ICOM rigs use a bi-directional buss (CI-V) for computer communication. For these, **use Port 1** "TTLRX1" with the internal jumpers for Port 1 set to Yaesu and the ICOM jumper linked 1&2 (see Fig 4). In this case, only one screened cable need be used, with the other end connected to a 3.5 mm mono jack plug (inner to tip, screen (shield) to outer).

Rigs that use RS232 for computer control would use the RS232 transmit/receive connector e.g. "RSRX3 & RSTX3" or "RSRX4 & RSTX4" and use ports 3 & 4 respectively. No internal jumper adjustments are required for RS232 ports.

WARNING:

Always double check your wiring and only attach to your radio equipment when you are certain you have made the right connections, if you are not sure seek advice.

WARNING REGARDING THE ICOM PCR-1000.

Every effort has been made to ensure correct operation of the Icom PCR-1000 receiver in this Nova_Tune environment.

It is the user's responsibility to ensure that a back up of the receiver's EPROM is made PRIOR to using the program.

A suitable program which incorporates a EPROM backup routine may be found at <http://www.grosoft.co.uk/talkpcr/tpv24.zip>

The following list (Fig 6.) is to be taken as a guide only, it is the USER'S DIRECT RESPONSIBILITY to confirm the correct Mode of communication and pin connections between the Nova_Tune unit and their radio equipment. Please consult your Radio equipment manual.

NOVA_TUNE RADIO EQUIPMENT INTERFACES

Brand	Model No	Mode RS232/TTL	Software Radio Number	Radio connector
Yaesu	FT-100	RS232	23	DB9 Female
	FT-736R	TTL	1	Din 5 or 6 pin 270 Deg
	FT-757	TTL	16	Supplied with radio.
	FT-847	RS232	2	DB9 Female
	FT-980	TTL	20	Din 5 or 6 pin 270 Deg
	FT-1000	RS232	24	DB25 Female
Icom	IC-271	TTL	10	<p>All these ICOM models use a 3.5 mm Mono Jack Plug.</p> <p>Connect the "ICOM Jumper" on the board</p> <p>Use the TTL Data Port 1 "TTLRX1"</p> <p>This goes to the TIP of the Jack plug.</p> <p>Port 1 Jumpers must also be set to "Yaesu"</p> <p>And not "Kenwood". see chart.</p>
	IC-275	TTL	12	
	IC-471	TTL	11	
	IC-475	TTL	13	
	IC-1271	TTL	37	
	IC-1275	TTL	38	
	IC-706	TTL	22	
	IC-706MKII	TTL	29	
	IC-706MKII/G	TTL	21	
	IC-728	TTL	17	
	IC-729	TTL	18	
	IC-735	TTL	31	
	IC-746	TTL	28	
	IC-751A	TTL	19	
	IC-756PRO	TTL	25	
	IC-820	TTL	14	
	IC-821	TTL	15	
	IC-910	TTL	27	
	IC-970	TTL	9	
	IC-R7000	TTL	32	
	IC-R8500	TTL/RS232	3	RS232 DB25
	IC-R9000	TTL	33	
	PCR1000	RS232	34	DB9 male ** See WARNING above **
Kenwood	TS-440	TTL	5	Din 270 Deg 5 or 6 Pin
	TS-680	TTL	6	Din 270 Deg 5 or 6 Pin
	TS-711	TTL	7	Din 270 Deg 5 or 6 Pin
	TS-790	TTL	4	Din 270 Deg 5 or 6 Pin
	TS-811	TTL	8	Din 270 Deg 5 or 6 Pin
	TS-2000	RS232	26	DB9 Female ** Pins 7&8 must be linked **
AR	AR5000	RS232	35	DB9 male
	AR8000		36	

The Icom bi-directional single wire "CI-V" buss requires the TTL TX/RX pins be joined together. This means that the port feeding the buss cannot be used for anything other than multi Icom equipment mixing. Other TTL equipment must use a non-shortcd port.

A shorting jumper labeled "Icom" see Fig 5. short circuits the correct pins (1&2) associated with radio port #1 for "ICOM" remote operation.

Apart from the Icom series, other TTL only rigs must use separate un-shortcd TTL ports.

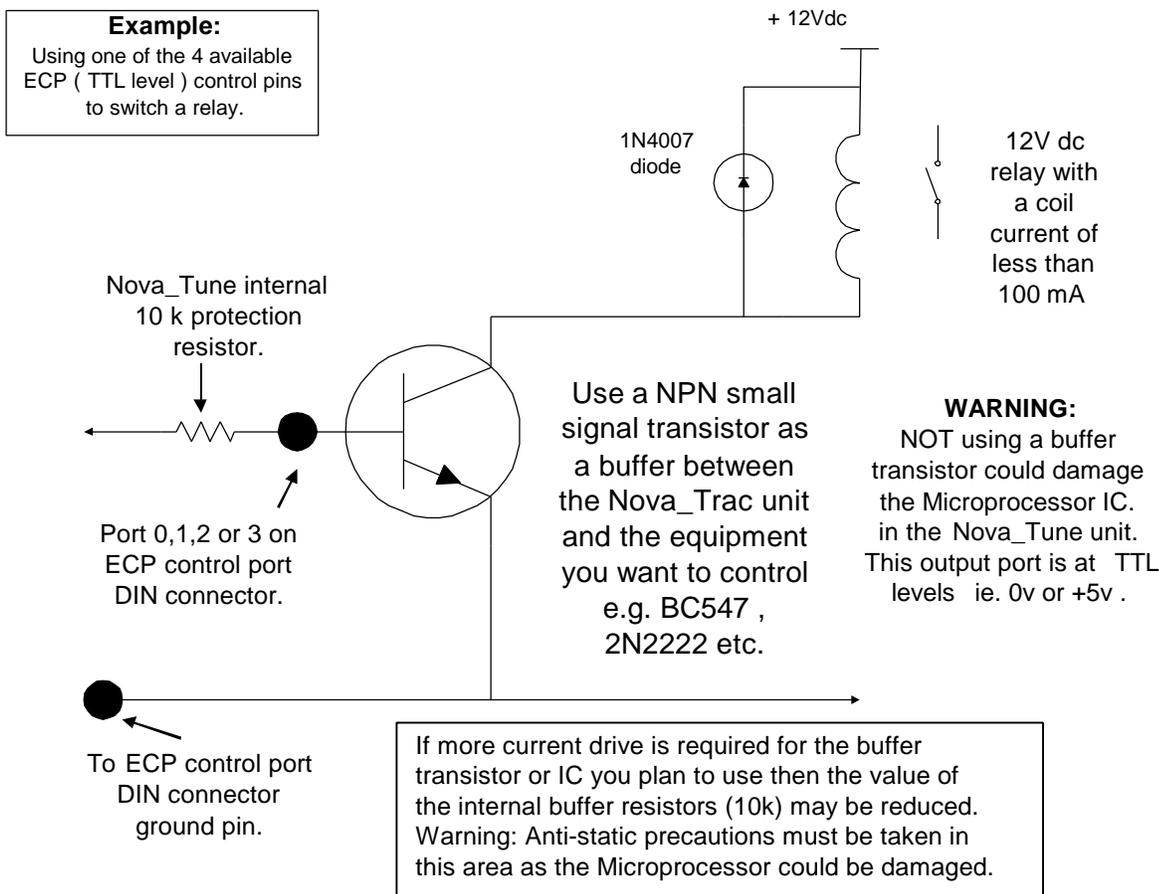
Using the External Control Port (ECP):

The following circuit demonstrates the application of one of the External Control Ports to switch a relay. In this example we are using ECP Bit 0 from the Nova_Tune ECP port connector.

When this pin goes high, it switches the transistor on and in so doing places the coil across the external 12Vdc supply, this in turn closes the relay contact. This type of setup may for example be used to switch on a remote buzzer to tell you that a particular satellite is being tracked, etc .

The use of a protection diode across the relay coil is recommended as the transistor could be damaged without it.

Warning: It is recommended that the following circuit (Fig. 7) NOT be used to switch an antenna relay directly as your rig could be seriously damaged, use a interlocking circuit so that the relay may NOT change state during RF transmitting. As this is an output port only, external voltages must not be applied to any "ECP" pin as this could damage the internal circuit.



******WARNING******

For predictable operation, the DC power **MUST** be applied to the Nova_Tune hardware whenever the printer cable is attached. In some situations when the DC power to Nova_Tune is removed, the printer port of the computer may attempt to power Nova_Tune with unpredictable results.

DO NOT USE THE UNIT WITHOUT DC POWER BEING APPLIED.

The 4 ECP ports may be used singly or externally De-multiplexed using a Logic I.C. to give up to 16 output control lines, should this number ever be required.

Setting up the External Control Port

ECP Status Box value	ECP 3	ECP 2	ECP 1	ECP 0
0	LO	LO	LO	LO
1	LO	LO	LO	HI
2	LO	LO	HI	LO
3	LO	LO	HI	HI
4	LO	HI	LO	LO
5	LO	HI	LO	HI
6	LO	HI	HI	LO
7	LO	HI	HI	HI
8	HI	LO	LO	LO
9	HI	LO	LO	HI
10	HI	LO	HI	LO
11	HI	LO	HI	HI
12	HI	HI	LO	LO
13	HI	HI	LO	HI
14	HI	HI	HI	LO
15	HI	HI	HI	HI

The above table shows the relationship between the number (0 to 15) entered in the satellite file and the change in voltage levels appearing at the hardware rear panel ECP port.

The ECP status box is the value entered in the sat file, the “Lo” and “Hi” refer to the voltage level at the 4 ECP connector pins on the rear panel of the hardware (ECP0 to ECP3). Note: this value is only updated when the green box counter rolls over to zero, or this green box is updated by a mouse click.

SOFTWARE

Setup

The distribution software will automatically install and register the required files during the installation. After installation both Nova for Windows and Nova_Tune will be aware of each other. No other user setups are required to connect the two programs.

NOTE for Windows NT, Windows 2000, and XP users: You must separately run the driver installation program after installing Nova_Tune. This will register the “NT” drivers with your operating system. The default location for the file is C:\Program Files\Northern Lights Software Associates\Nova_Tune\Drivers\Port95NT.EXE.

Operation

Nova for Windows must be operational for Nova_Tune to function. Nova_Tune is launched from Nova’s Main Menu.

The first time Nova_Tune launches, the default hexadecimal printer port address of 378 is stored in the PC’s registry. Provision for changing the address is available by clicking the **printer port** label shown in Fig 1

The hardware box is updated by the NOVA_TUNE software when the “green” counting box cycles through zero. This box may be clicked to effect an immediate update.

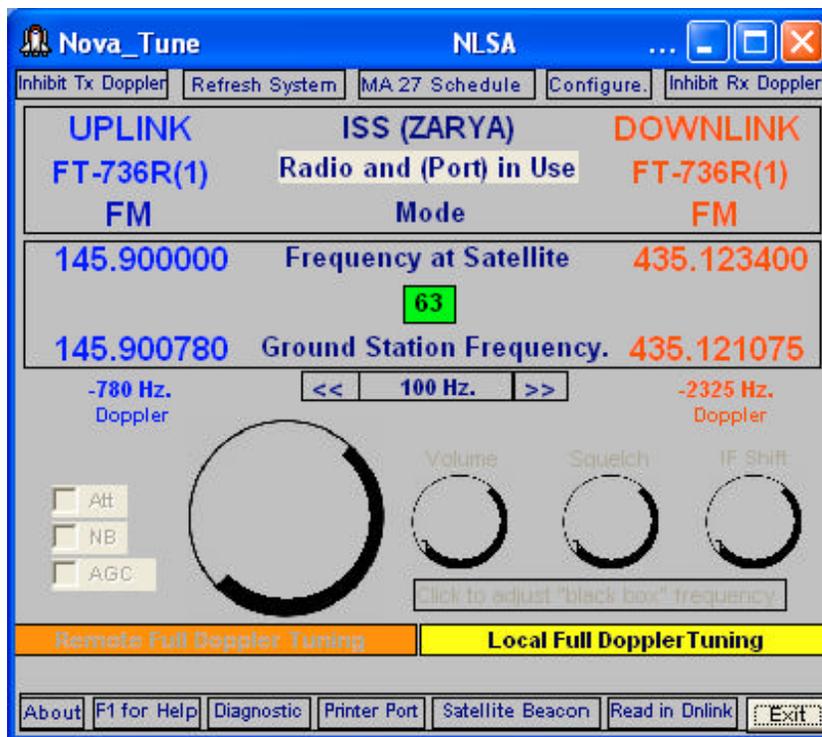


Fig 1. Nova_Tune User Interface

Mini HELP

By moving the mouse over most of the boxes and labels on the screen and holding it there for about 1 second, a brief explanation of the box’s function will appear.

Inhibit Tx/Rx Doppler

Double clicking either of these two boxes will inhibit the updating of the corresponding Up or Downlink radio. Only the radio themselves will be inhibited. The Doppler calculating engine will continue to run and update the screen display. Click either of the two boxes to restore operation.

Refresh System

Clicking this box will cause a Master Reset of the Nova_Tune hardware and the current satellite's database record will be opened. Click the refresh button to return.

MA Schedule

The box shows the relative position of the satellite in its orbit. The orbit is divided into 256 units. (MA 0-255). Use the Nova for Windows Schedule Dialog to set up various MA boundaries. Refer to the section AO-40 MA Scheduling (below).

Double clicking this box will cause Nova_Tune to use the MA scheduling information to re-configure various radio equipment during the course of the orbit. The box will turn RED when enabled. Unscheduled operation will be restored if the box is clicked again.

Satellite name

This indicates the current satellite being auto tracked by Nova for Windows.

Uplink and Downlink Mode

These indicate the modes set up in the satellite file and may be edited at any time. There are special requirements when entering data for the PCR-1000, AR5000, and the AR8000 radios. A help file is available if these radios are to be used.

Frequency at Satellite

The information in these boxes is derived from the satellite data file and forms the basis for of all the frequency calculations.

If a transponder offset frequency has been entered into the satellite file, double-clicking this label will change to a slider and an indication of the offset frequency entered into the satellite file. The slider can be adjusted to trim the transponding action during the course of a session. The trimmed offset frequency should be noted and entered permanently into the satellite file eventually.

Clicking the Yellow frequency indication will restore normal operation with the trimmed frequency being used until the end of the session.

Corrected Output Freq. boxes

These boxes portray the Doppler corrected transmit and receive frequencies at the ground station. The values in these boxes are transferred to the radios via the Nova_Tune hardware.

Corrected Output Freq. Labels

Double Clicking this label will freeze all frequency transactions temporarily to allow further research into the links. Restore instructions are shown on screen.

Side Arrows in the Frequency Panel

These sliders each have a range of plus or minus 100 steps of the frequency shown in the box directly above the sliders. Clicking the boxes at each end of this upper box increments or decrements the value shown, in decade steps. i.e. multiplies or divides the figure shown in the box by a factor of 10.

Moving the right hand slider changes the downlink Frequency at Satellite. The left slider offsets the Corrected Output Freq of the Uplink radio for side band voice quality trimming. This offset is temporary and the offset amount shown should be entered permanently into the satellite file.

Sat Beacon

Double Clicking this box will insert the satellite's beacon frequency into the downlink system. The operating frequency will have been saved and will be re inserted into the downlink system once the Satellite Beacon button is clicked again. The beacon frequency MUST BE in the same frequency band as the downlink for this to work

Read in Buttons

When either of these buttons is clicked, the frequency present on the dial of most radio equipment is read into the Nova_Tune system and Doppler processed from there on. The user should switch the updating off with the Radio Inhibit button prior to reading the frequency. Once the process has completed re-activate the Radio Inhibit

Doppler Counter Gate Box

This small GREEN box indicates the state of the Doppler Frequency Gate, i.e. it counts up to the figure set in the satellite file and updates the radios when a set value is reached. Clicking the box immediately resets the counter and updates the radios.

The displayed frequency on the Nova_Tune screen and the radio display may not agree at an in-between time. The key is to watch the counter. If you have set 100 Hz in a satellite file, the radio will be updated when the counter reaches 100, or as stated above, when you click the counter box to force an update.

Dn and Up Conversion Labels

If Converter Local Oscillator frequencies have been entered into the satellite file then labels will appear to the right and left of the Doppler Gate box. Double clicking the Dn Conversion label will produce the Local Oscillator frequency as entered in the satellite file and a slider. Adjusting the slider will trim the frequency for the duration of the session. The trimmed amount should be noted and entered permanently into the satellite file.

Full Doppler Tuning Buttons

The Full Doppler Tuning method of analog satellite control was first discussed in an article by Paul Williamson, KB5MU, in the Jan 1, 1994 issue of *OSCAR Satellite Report*. He called it "The One True Rule" and defined it as tuning "both the transmitter and the receiver to achieve a constant frequency at the satellite". He went on to state that "If everybody did this, there would be no problem with everybody staying together on the same frequency, and there would be no drift through the pass band."

The method requires that all stations continuously adjust both their transmit and receive frequencies with the result that all stations hear each other at the same spot on the dial as they hear their own echoed signal irrespective of the up and down Doppler frequency shift applying to each individual station in the QSO. Practically speaking, the method is impossible to achieve manually and requires the aid of a computer.

UNI_TRAC has supported the method described above for a number of years. What is new is the convenience now built into Nova_Tune to make the whole FDT feature transparent.

The use of the FDT button is best described with an example. Consider this:

Dial Method

You hear a QSO or a CQ call on AO-40. Spin the dial of the rig for a good quality ssb audio signal then click the FDT box on the Nova_Tune screen, Within a second or so all the calculations and frequency changes to the rig will have automatically occurred and you will hear your echoed signal when you speak into the microphone.

Slider Method

For those rigs that do not allow frequency read back, Nova_Tune provides on screen tuning of the rig. Click the ends of the FDT sliders and walk the receiver through the satellites pass band. Once reasonable voice quality is achieved nothing further is required, Nova_Tune will have automatically adjusted the uplink to match.

The operator at the other end of the QSO may not be FDT fitted and will probably have trouble keeping synchronized. To revert to the traditional "AO-13" method use FDT to "net" your system then immediately inhibit the downlink and manually keep the other QSO person resolved

Anytime you or the other station wander apart during non-FDT mode, simply retune for best audio and click the FDT button again. You are back in step instantaneously.

If both or a Net of Users are using Nova_Tune or FDT from other programs then forget about tuning, dials etc. and carry on with the QSO without switching out of FDT.

All the above manipulations are fine in theory, however there are frequency errors associated with a number of the calculations. Errors like a minor shift in the satellite's local oscillator, minor errors in instantaneous Doppler shift, etc. etc. The net result is "SSB duck talk" on your echoed signal. Nova_Tune uses the left hand slider which will trim your up link frequency in the FDT mode. The amount of offset to resolve "decent audio" is shown and should be transferred into the satellite file in the voice quality position. This can be done the first time you trial the link. There after you will always be within a few Hertz of "decent audio."

One last point. The Doppler frequency gate updating figure in the satellite file should be reduced to say 50 - 100 Hz for the LEO satellites and to about 15 Hz. when AO-40 is out further than 8,000 km.

The intermediate actions of the FDT buttons are shown on screen and instructions are provided as the process completes its tasks.

Doppler Hz. Boxes

These boxes show the instantaneous value of the Doppler correction. Note that in the case of converter usage the Doppler is calculated from the Frequency at Satellite figure and then applied to the converted frequency.

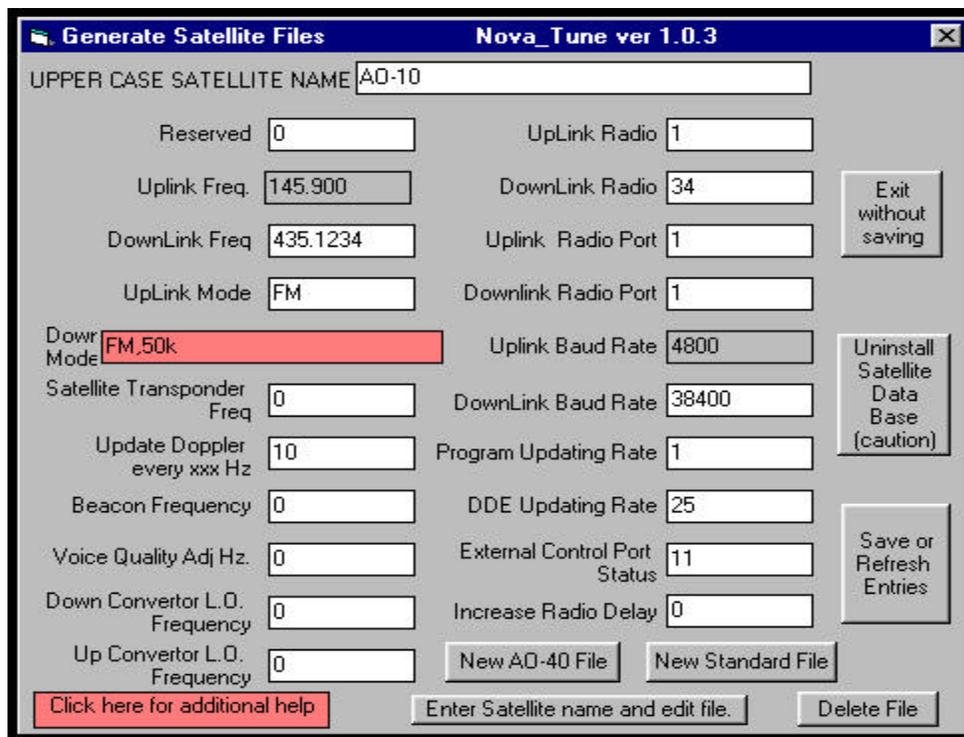
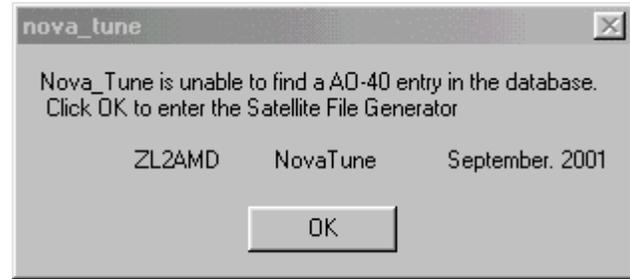
Printer Port

Click this box to change the printer port address. Your computer's printer port address(s) may be found by going into your Windows "control panel," then selecting "System" then "Device Manager." Click on the + to left of Ports (COM & LPT), select the LPT port you would like to use for Nova_Tune, say LPT2, highlight this line, then select properties, press the Resources tab then look at the "Setting" column for the Input/Output Range, the first group of characters to the left of the – sign will be the ones you need to enter into the "Printer Port" box in the Nova_Tune software. If you see 0278-027A, you can drop the leading 0 and you would enter 278, the default used by Nova_Tune is 378

Diagnostic

Click this box to invoke a routine which portrays the data being transferred back and forth from the host computer to the Nova_Tune hardware. You may be asked to send details of the two panels if serious malfunction occurs. The diagnostic program is normally used to provide the author with computer control codes in the event of a new radio interface being required. Using this program will cancel the Nova_Tune program, after the diagnoses are completed this program must be closed and the Nova_Tune program restarted. Click the left hand panel to restore the normal screen.

The first time Nova_Tune launches, an error message appears. Let us assume that the satellite AO-40 is the satellite being auto tracked by Nova for Windows. At this stage Nova_Tune has no knowledge of how to set up the radios or ECP port.



Satellite File Generator

The name of the satellite being tracked by Nova for Windows will automatically appear in the first field of the record. Clicking either the AO-40 or the Standard file buttons will flood the balance of the fields with default parameters. This default file is stored into the registry by clicking the Save button. As soon as the Save button is clicked the program returns to its main function. The data the program is working with may not be correct, however Nova_Tune will be fully operational.

Clicking the Configure button in Fig 1 will instantly return the current satellite being tracked record, and the fields can be edited to suit. The main Nova_Tune program will redefine the radios and what ports and baud rates are to be sent to the hardware immediately and automatically on its return from the Satellite File Generator editing.

The above scenario occurs every time Nova_Tune cannot find a corresponding file name in the registry database. As different satellites are auto tracked by Nova for Windows then Nova_Tune will build a database of the user's preferred tracking requirements.

Naming conventions will be those transferred from Nova for Windows DDE, including the characters / , \, space, and hyphen which may be present in the satellite's name.

Corrective parsing is carried out for countries that use the comma as a decimal point or period.

AO-40 MA Scheduling:

Let us assume we want to track telemetry from MA 240 to 255 and MA 0 to MA 30, then work the satellite from MA30 to MA 100 using mode U/S2, and from MA 100 to 240 we want to use mode L1/S2.

There are different rigs required to achieve this schedule.

Open Nova for Windows AO-40 scheduling and name position 1 through 4 as TELEM, U/S2, L1/S2, and TELEM. Set up the corresponding MA boundaries.

In Nova_Tune we click the MA Schedule in Fig 1. Nova Tune will now add the mode term to the file name. i.e. AO-40(U/S2). This will configure Nova_Tune say with an FT-847 rig. When the MA changes to 100 the file will change to AO-40(L1/S2) due to the mode changing in the DDE string. Nova Tune immediately reconfigures at the file name change and sets up say a FT736R uplink transmitter and a PCR-1000 downlink receiver.

Using Up and Down Converters or Transverters

Because the Converter's local oscillator (F_{LO}) may be below the received frequency (F_{RX}) or above the received frequency (F_{RX}), the program will need to determine which side your local oscillator is on so that Doppler correction can be correctly calculated for the I.F. receiver (F_{IF}). This is the question asked in the satellite configuration file about Local Osc. frequency.

Example:

If your receive frequency (F_{RX}) is 2400 MHz and your I.F receiver (F_{IF}) tunes to 144.000 MHz, for a typical mode S converter, the local oscillator may be 2256.000 MHz or 2544.000 MHz. A problem arises in the case of high side mixing in that sideband and Doppler correction need to have their signs reversed.

If the Doppler is +1 kHz then:

$$F_{LO} \text{ on lower side} = 2400.001 - 2256.000 = 144.001$$

F_{LO} on high side = 2544.000 - 2400.001 = 143.999 ; an apparent reversal of the Doppler correction, which must be passed to the (F_{IF}) receiver in the correct sense.

Following the same logic, if your F_{LO} is on the high side and you expect USB signals from the satellite, then you would need to enter the opposite into the satellite configuration file. i.e. = LSB.

FM signals are unaffected by this effect, and you need only to enter the FM command i.e. = FM

Nova Tune covers these considerations and only requires you to enter the frequency of the converter's local oscillator. Nova_Tune does NOT however automatically determine whether you should use LSB or USB for the uplink and downlinks. Use the information presented above to determine what mode should be entered into the satellite file.

Amateur Satellite Frequency and Mode Information:

AO-10 AMSAT-OSCAR 10 P-3-B 14129

Mode B

Uplink 435,175-435,025 MHz LSB SSB/CW

Downlink 145,825-145,975 MHz USB SSB/CW

Beacon 145,810 MHz

UO-11 UoSAT-OSCAR 11 UoSAT-2 14781

Telemetry Beacon 145,826 MHz FM AFSK-ASCII 1200Bd

Telemetry Beacon 435,025 MHz FM AFSK-ASCII 1200Bd

Telemetry Beacon 2401,5 MHz

UO-14 UoSAT-OSCAR 14 UoSAT-3 20437

Uplink 145,975 MHz FM FM Speech

Downlink 435,070 MHz FM FM Speech

AO-16 AMSAT-OSCAR 16 PACSAT 20439

PACSAT-11 / PACSAT-12

Uplink 145,900/920/940/960 MHz FM Manchester AX25

Downlink/Beacon 437,02625 MHz USB PSK AX25

437,05130 MHz USB RC PSK AX25

2401,1428 MHz USB PSK AX25

LU-19 LUSAT-OSCAR 19 LUSAT 20442

LUSAT-11 / LUSAT-12

Uplink 145,840/860/880/900 MHz FM Manchester AX25

Downlink 437,15355 MHz USB PSK AX25

437,12580 MHz USB RC PSK AX25

CW-Beacon 437,125 MHz CW CW

FO-20 FUJI-OSCAR 20 JAS-1B 20480

Mode JA (analog)

Uplink 146,000-145,900 MHz LSB SSB/CW

Downlink 435,800-435,900 MHz USB SSB/CW

Beacon 435,795 MHz CW CW

Mode JD (digital)

Uplink 145,850/870/890/910 MHz FM Manchester AX25

Downlink 435,910 MHz USB PSK AX25

UO-22 UoSAT-OSCAR 22 UoSAT-5 21575

UOSAT5-11 / UOSAT5-12

Uplink 1 145,900 MHz FM 9600 bit/s FSK-AX25

Uplink 2 145,975 MHz FM 9600 bit/s FSK-AX25

Downlink/Beacon 435,120 MHz FM 9600 bit/s FSK-AX25

1200 bit/s AFSK-ASCII

KO-23 KITSAT-OSCAR 23 KITSAT-A 22077

HL01-11 / HL01-12

Uplink 1 145,900 MHz FM 9600 bit/s FSK-AX25

Uplink 2 145,850 MHz FM 9600 bit/s FSK-AX25

Downlink/Beacon 435,175 MHz FM 9600 bit/s FSK-AX25

435,175 MHz 1200 bit/s AFSK-ASCII

KO-25 KITSAT-OSCAR 25 KITSAT-B 22828

HL02-11 / HL02-12

Uplink 1 145,870 MHz FM 9600 bit/s FSK-AX25

Uplink 2 145,980 MHz FM 9600 bit/s FSK-AX25

Downlink/Beacon 436,500 MHz FM 9600 bit/s FSK-AX25

1200 bit/s AFSK-ASCII

sek. Downlink 435,175 MHz FM 1200 bit/s AFSK-ASCII

IO-26 ITAMSAT-OSCAR 26 ITAMSAT-A 22826

ITMSAT-11 / ITMSAT-12

Uplink 145,875/900 MHz FM 1,2 kbit/s Manchester/4,8 kbit/s

145,925 MHz FM 1,2 kbit/s Manch./9,6 bit/s/exp.

145,950 MHz FM 1,2 kbit/s Manchester/9,6 bit/s

Downlink/Beacon 435,867 MHz USB PSK 1200 bit/s

sek. Downlink 435,822 MHz USB PSK 1200 bit/s
FM AFSK 1,2/FSK 9,6/FM analog

AO-27 AMRAD-OSCAR 27 EYESAT-A 22825
Uplink 145,850 MHz FM FM Speech
Downlink/Beacon 436,800 MHz FM FM Speech

FO-29 FUJI-OSCAR 29 JAS-2 24278
Mode JA (analog)
Uplink 146,000-145,900 MHz LSB SSB/CW
Downlink 435,800-435,900 MHz USB SSB/CW
Beacon 435,795 MHz CW CW
Mode JD (digital)
Uplink FSK-AX25 145,850/870/890/910 MHz FM Manch. AX25/9k6 bit/s
Downlink FSK-AX25 435,910 MHz USB PSK AX25/9600 bit/s
Digitaler 435,900 MHz FM digital Speech

TO-31 TMSAT-OSCAR 31 TMSAT-1 25396
TMSAT1-11 / TMSAT1-12
Uplink RX1 145,925/975 MHz FM 9600 bit/s FSK-AX25
Uplink RX2 145,975/925 MHz FM 9600 bit/s FSK-AX25
Downlink 436,900/925/950/975 MHz FM 38400 bit/s FSK-AX25
9600 bit/s FSK-AX25

GO-32 GURWIN-OSCAR 32 TECHSAT-1A 25397
Uplink V1 145,850 MHz FM 9600 bit/s FSK AX25/1200 bit/s
Uplink V2 145,890 MHz FM 9600 bit/s FSK AX25/1200 bit/s
Uplink V3 145,930 MHz FM 9600 bit/s FSK AX25/1200 bit/s
Uplink L1 1269,700 MHz FM 9600 bit/s FSK AX25/1200 bit/s
Uplink L2 1269,800 MHz FM 9600 bit/s FSK AX25/1200 bit/s
Uplink L3 1269,900 MHz FM 9600 bit/s FSK AX25/1200 bit/s
Downlink 1 435,225 MHz FM/USB 9600 bit/s FSK/1200 bit/s PSK
Downlink 2 435,325 MHz FM/USB 9600 bit/s FSK/1200 bit/s PSK

UO-36 UoSAT-OSCAR-36 UoSAT-12 25693
UO120-11, UO121-11,
UO-122-11 / UO120-12,
UO121-12, UO-122-12
Uplink Mode V/U 145,960 MHz FM 9600 bit/s FSK-AX25
Downlink Mode V/U 437,025 MHz FM 9600 bit/s FSK-AX25
Downlink Mode V/U 437,400 MHz FM 38400 bit/s FSK-AX25
Downlink 2430 MHz FM FM 38400 bit/s FSK-AX25

RS 12/13 . 21089
Mode A
Uplink 145,910-145,950 MHz (12) USB SSB/CW
145,960-146,000 MHz (13) USB SSB/CW
Downlink 29,410-29,450 MHz (12) USB SSB/CW
29,460-29,500 MHz (13) USB SSB/CW
ROBOT Uplink 145,8308 MHz (12) CW CW
145,8403 MHz (13) CW CW
ROBOT Downlink 29,4543 MHz (12) CW CW
29,5043 MHz (13) CW CW
Beacon 29,4081 (29,4543) MHz (12) CW CW
29,4582 (29,5043) MHz (13) CW CW
Mode K
Uplink 21,210-21,250 MHz (12) USB SSB/CW
21,260-21,300 MHz (13) USB SSB/CW
Downlink 29,410-29,450 MHz (12) USB SSB/CW
29,460-29,500 MHz (13) USB SSB/CW
ROBOT Uplink 21,1291 MHz (12) CW CW
21,1385 MHz (13) CW CW
ROBOT Downlink 29,4543 MHz (12) CW CW
29,5043 MHz (13) CW CW
Beacon 29,4081 (29,4543) MHz (12) CW CW
29,4582 (29,5043) MHz (13) CW CW
Mode T
Uplink 21,210-21,250 MHz (12) USB SSB/CW
21,260-21,300 MHz (13) USB SSB/CW

Downlink 145,910-145,950 MHz (12) USB SSB/CW
145,960-146,000 MHz (13) USB SSB/CW
Beacon 145,9125 (145,9587) MHz (12) CW CW
145,8622 (145,9083) MHz (13) CW CW
ROBOT Uplink 21,1291 MHz (12) CW CW
21,1385 MHz (13) CW CW
ROBOT Downlink 145,9587 MHz (12) CW CW
145,9083 MHz (13) CW CW

RS-15 . 21089

Mode A
Uplink 145,858-145,898 MHz USB SSB/CW
Downlink 29,354-29,394 MHz USB SSB/CW
Beacon 1 29,3525 MHz CW CW
Beacon 2 29,3987 MHz CW CW

SO-41 Saudi OSCAR 41 SAUDISAT-1A 26546

SASAT1-11, SASAT1-12
Uplink ? FM Speech / 9600 bit/s FSK-AX25
Downlink 437,075 MHz FM Speech / 9600 bit/s FSK-AX25

SO-42 Saudi OSCAR 42 SAUDISAT-1B 26549

SASAT2-11, SASAT2-12
Uplink ? FM Speech / 9600 bit/s FSK-AX25
Downlink 436,775 MHz FM Speech / 9600 bit/s FSK-AX25

ISS Int. Space station ALPHA 25544

Uplink 1 145,200 MHz FM FM Speech
Uplink 2 145,990 MHz FM Packet Radio (1200 Bd)
Downlink 145,800 MHz FM Speech + Packet Radio

AO-40 AMSAT-OSCAR 40 AMSAT Phase-3D 26609

AO-40 Uplink Frequencies

UPLINK Digital Analog Passband
15 m none 21.210 - 21.250 MHz
12mnone24.920-24.960 MHz
2 m 145.800 - 145.840 MHz 145.840 - 145.990 MHz
70cm 435.300 - 435.550 MHz 435.550 - 435.800 MHz
23cm(1) 1269.000 - 1269.250 MHz 1269.250 - 1269.500 MHz
23cm(2) 1268.075 - 1268.325 MHz 1268.325 - 1268.575 MHz
13cm(1) 2400.100 - 2400.350 MHz 2400.350 - 2400.600 MHz
13cm(2) 2446.200 - 2446.450 MHz 2446.450 - 2446.700 MHz
6cm 5668.300 - 5668.550 MHz 5668.550 - 5668.800 MHz

AO-40 Downlink Frequencies

DOWNLINK Digital Analog Passband
2m 145.955 - 145.990 MHz 145.805 - 145.955 MHz
70cm 435.900 - 436.200 MHz 435.475 - 435.725 MHz
13cm(1) 2400.650 - 2400.950 MHz 2400.225 - 2400.475 MHz
13cm(2) 2401.650 - 2401.950 MHz 2401.225 - 2401.475 MHz
3cm 10451.450 - 10451.750 MHz 10451.025 - 10451.275 MHz
1.5cm 24048.450 - 24048.750 MHz 24048.025 - 24048.275 MHz

AO-40 Telemetry Beacons (IHU)

BEACON General Beacon (GB) Middle Beacon (MB) Engineering Beacon (EB)
2 m none 145.898 MHz none
70cm 435.438 MHz 435.588 MHz 435.838 MHz
13cm(1) 2400.188 MHz 2400.338 MHz 2400.588 MHz
13cm(2) 2401.173 MHz 2401.323 MHz 2401.573 MHz
3cm 10450.975 MHz 10451.125 MHz 10451.375 MHz
1.5cm 24047.885 MHz 24048.035 MHz 24048.285 MHz

Beacon Frequencies have been measured before launch at Kourou and may change due to aging, vibrations or temperature. 2-m-MB and 13-cm(2)-MB have already been measured in orbit.

Remarks:

All Receivers are inverting!

Telemetry Beacons are for command purposes and are modulated in 400 Bit/s BPSK, AMSAT format.

The MB can be switched between IHU-1 or IHU-2 telemetry.

Table of Transponder AO-40 Offset Frequencies

S2	Tx Band							
	15m	12m	V	U	L1	L2	S1	
V	167.13	170.84	-	581.575	1415.275	1414.35	2546.375	2592.475
U	456.83	460.54	581.50	-	1704.975	1704.05	2836.075	2882.175
S1	2412.58	2425.29	2546.25	2836.025	3669.725	3668.80	-	-
S2	2422.58	2426.29	2547.25	2837.025	3670.725	3669.80	-	-

Finding an Uplink Frequency

Find the row for the Rx downlink frequency band (your receiver's band) in the left column.

Find the column for the Tx uplink frequency band (your transmitter's band) across the top.

Read the conversion constant K from the table in that row and that column.

Calculate your transmitter frequency (in MHz), by subtracting your receive frequency (in MHz) from the conversion constant K

$$\text{Tx(freq)} = K - \text{Rx(freq)}$$

Example:

Suppose you want to operate mode U/V, with an uplink on UHF (70cm or 435 MHz) and a downlink on VHF (2m or 145 MHz). This is the old favorite "Mode B".. In the "V" row of numbers, the number in the "U" column is 581.575.

So you calculate $581.575 - 145.980 = 435.685$ and set your transmitter to this frequency.

Doppler Shift

The calculation above ignores Doppler shift, the frequency shift caused by the motion of the satellite relative to each ground station. Doppler shift is proportional to frequency, and to the radial velocity of the satellite. Uplink Doppler is proportional to uplink frequency, and downlink Doppler is proportional to downlink frequency. Because the transponders are all inverting ($\text{Tx} = \text{C} - \text{Rx}$), the total Doppler shift you will observe in your receiver is proportional to the difference in frequency.

$$\text{Doppler} = (\text{Rx} - \text{Tx}) * \text{Velocity}/\text{C}$$

Much has been written about the best way to compensate for Doppler shift. Phase3D's higher frequencies and the possibility of multiple simultaneous uplink bands translated into multiple simultaneous downlink bands make the problem more complex than ever before. For more on Doppler compensation, see The Radio Amateur's Satellite Handbook article.

Preliminary Values:

The numbers shown in the chart are nominal, based on design and laboratory measurements. They will be revised after the spacecraft is launched and the oscillators have stabilized in the vacuum and thermal environment of P3D in space.

Conversion table supplied by Freddy de Guchteneire, ON6UG, of AMSAT-DL.