

An Easy Way to Work the L-Band Satellites

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In a recent *AMSAT Journal* article¹, I described my initial implementation of an L-band enhancement to my satellite station. I mentioned a future product from Down East Microwave, Inc. (DEMI), a Transmit Converter which would convert a low-level 10 MHz wide signal at 28, 50 or 430 MHz, and generate a 10 MHz wide output on 1260-1270 MHz (L-band) with up to 25 W power. That product now has been released as model Model L24TX.

All three regions of the IARU define a world-wide amateur satellite segment on 1260-1270 MHz that is uplink only. Thus, the downlink will be on other bands. But the limitation to uplink-only simplifies the design of modifications to current U/v satellite stations to encompass L/v capability. In the following, I will describe a modification that, with only minor changes, can be applied to most current U/v stations. I will use two examples: (1) my FlexRadio system, and (2) a generic U/v transceiver. Modifications to other systems should be very similar. Two satellite tracking software programs widely used, SatPC32 by Erich Eichmann DK1TB and MacDoppler by Dog Park Software, have a built-in capability to correctly calculate the Doppler shift of the L-band signal, which is about three times larger than the Doppler shift in U-band signals.

Current and Future L-band Satellites

Right now, we have only one satellite with active L-band use. AO-92 is commanded into L/v mode using FM every Saturday for 24 hours. I regularly work an average of seven contacts each pass with an elevation of at least 30 degrees. So, with each of us trying to work all the others, the pass can be very busy. We had high hopes that Fox-1 Cliff, AO-95, would provide another L/v satellite but, sadly, AO-95 failed to achieve operational status.

ESEO, currently in commissioning by AMSAT-UK, has the capability for a single-channel L/v FM transponder. Its IARU Coordinated Frequencies are FM Uplink 1263.500 MHz CTCSS 67 Hz and FM Downlink 145.895 MHz.

GOLF-TEE/-1, currently in development

by AMSAT-NA, includes the possibility of L-band up with U/S/X down.

Implementations

I won't repeat the description of the FlexRadio-based system detailed in footnote 1, but I will make note of the changes. Fortunately, the modifications using this DEMI Transmit Converter are simpler than the previous description. The former implementation used a complicated series of devices, a 28-144 MHz transverter, a 144-1260 MHz transverter, optionally followed by a 1260 MHz amplifier, each requiring power, PTT control, and interconnecting cables. This new implementation uses a single device, greatly simplifying the design.

The only difference between the FlexRadio implementation and the generic U/v radio is the method used to specify the offset frequency between the IF and L-band frequencies. FlexRadio provides a construct called a transverter band (XVTR) which is a named translation definition between the IF frequency and the output frequency and some other parameters such as IF drive level, as described in the article in footnote 1. For other radios using SatPC32 software to control the radio, a parameter in the Doppler.sqf file entry for a satellite defines the difference between the IF frequency and the output frequency.

Specifying the LO Offset with SatPC32

SatPC32 uses an auxiliary file Doppler.sqf to define all necessary parameters for a satellite's frequency and mode parameters. For example, the nominal data line for AO-92 for a U/v capable transceiver is:

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AO-92,145880,435350,FMN,FM,NOR,0,0,Voice U/V 67 Hz tone required
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where 145880 is the downlink frequency and 435350 is the uplink frequency in kHz. For the L-band mode, the nominal uplink frequency is 1267359 kHz.

The FlexRadio version of my satellite station has a built-in frequency converter that can use the nominal form of the data line with the actual uplink frequency. Flex has a construct called an XVTR band definition which specifies a LO frequency for the difference between the output frequency of the Flex radio and the transmitted frequency after being converted to the actual transmitted frequency from the antenna. This allows SatPC32 to calculate Doppler frequency corrections at the actual frequency.



So, the Doppler.sqf data line is:

AO-92,145880,1267359,FMN,FM,NOR,0,0,Voice L/V 67 Hz tone required 1267359 actual uplink.

But for a generic U/v capable transceiver, SatPC32 must send the UHF frequency to the transceiver but with the Doppler correction based on the actual uplink frequency. To do that, SatPC32 provides two parameters in the data line to specify the difference between the radio frequency and the satellite frequency. The two parameters normally are both zero. The first is for the downlink and the second for the uplink. For the U/v transceiver, I will be converting the 10 MHz segment from 430 MHz to 1260 MHz. The offset between radio and satellite frequency is 830 MHz. The parameters must be specified in kHz without commas. Thus, the two parameters 0,0 must be changed to 0,830000.0 with the optional fractional kHz separated with a period. So, the adjusted Doppler.sqf data line is:

AO-92,145880,1267359,FMN,FM,NOR,0,830000,Voice L/V 67 Hz tone required.

Specifying the LO Offset with MacDoppler

The process is similar in MacDoppler. In the Modes Preferences panel for a given satellite, put an entry in the Txverter column for the uplink offset. The Doppler shift is calculated for the actual frequency of the satellite, but the shift is applied to the IF frequency data sent to the radio. The offset is in decimal Megahertz.

The DEMI 24 cm Transmit Converter

The Down East Microwave 24 cm Transmit Converter, Model L24TX, is a highly configurable transmit-only product with up to 25 W output between 1260-1270 MHz designed specifically for the Amateur Radio satellite service. See Figure 1. It has options that enable the use of selectable IF frequency ranges and drive levels to work with an existing satellite system or a newly designed set-up. The converter takes a 10 MHz user-selectable range and up-converts it to the 23 cm worldwide satellite sub-band at 1260 MHz. Frequency accuracy is obtained with an on-board synthesizer locked to an external standard 10 MHz source. There are options for various drive levels from -20 dBm to 10 W and for transceivers that do not have continuous 10 MHz wide output at 10 m and 6 m. The output power can be monitored by a reference voltage available through an auxiliary connector.



Figure 1 — DEMI 24 cm Transmit Converter.

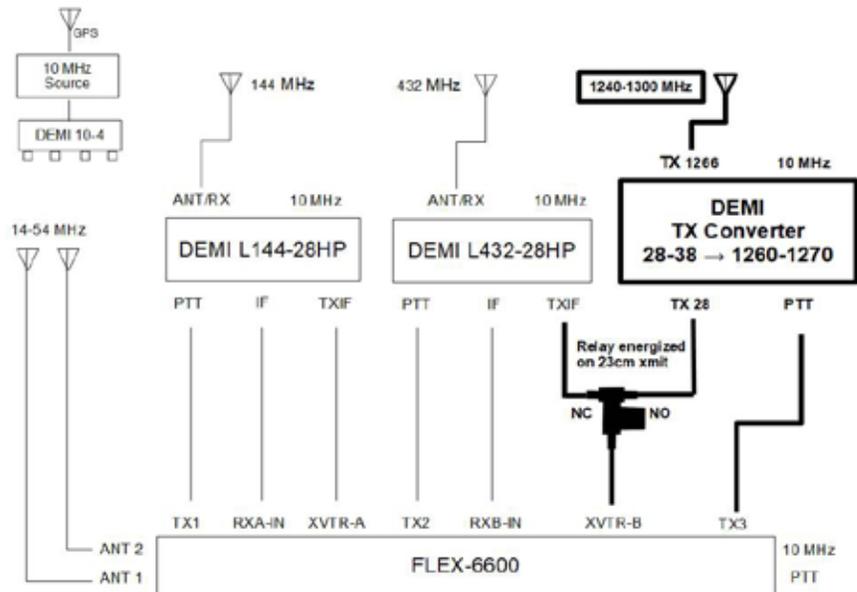


Figure 2 — Block diagram of the interconnections for the FlexRadio implementation. The parts in bold are changes from the paper in footnote 1.



There is an optional model, L24TXMM, which is mast-mountable and has provisions for monitoring all necessary functions. There is also an option to use a single coax which shares the 10 MHz and IF frequency signals.

The converter has a control wire (Pin 4 Power On) which enables the converter to be connected to its power supply continuously and turned on with a positive voltage applied to this control wire. The transceiver can supply this, so the converter is turned on when the transceiver is turned on or by an external switch. This would be especially useful for the mast-mountable model.

Using the Transmit Converter with My FlexRadio-based U/v Satellite System

The Transmit Converter was added to my Flex-based satellite system, as shown in Figure 2. The changes are highlighted with bold lines. When used with W0DHB's FlexSATPC program, the relay is energized automatically when the transmit frequency is in the 23 cm satellite sub-band. I use the same switched power line, controlled by FlexSATPC, which controls the coax relay that switches the output of the transceiver between the UHF transverter and the Transmit Converter, to control the Pin 4 Power On line to the Transmit Converter.

To associate the converter's base frequency of 1260 MHz with the IF base frequency of 28 MHz, I defined the XVTR Band named L/v, as shown in Figure 3. The maximum power output from the FLEX-6600 on 28 MHz is set to 10 dBm. This power is associated with the RF Power slider set to 100 in SmartSDR. Thus the converter option "MAX IF Drive Range" was chosen to be +10dBm when ordered.

The receive and transmit slice flags in SmartSDR are shown in Figure 4 using the



Figure 3 — FlexRadio SmartSDR XVTR definition for L/v mode.



Figure 4 — FlexRadio SmartSDR Slice Flags showing frequencies and modes.

XVTR band L/v definition, the association of the TX3 PTT connector with the L/v mode, and the SatPC32 Doppler.SQF L/v mode definition of the uplink and downlink frequencies for the satellite AO-92. These slice pictures were recorded with SatPC32 and FlexSATPC controlling the satellite system.

Using the Transmit Converter with a Generic U/v Satellite Radio

Figure 5 shows the interconnections for the generic U/v transceiver. The DEMI Transmit Converter must be optioned for 430-440

MHz IF frequencies. If the generic radio has a dedicated low-power output, the Transmit Converter should be optioned for "IF Drive Range" compatible with the radio, and this output used to drive the Transmit Converter. If the generic radio does not have a dedicated low power output, the Transmit Converter should probably be optioned for "IF Drive Range" of "10 Watt max." Carefully adjust the RF power output of the transceiver to be within the optioned drive range.

The coax relay or switch must be set to the NO connector when in L/v mode. Most transceivers will have an output

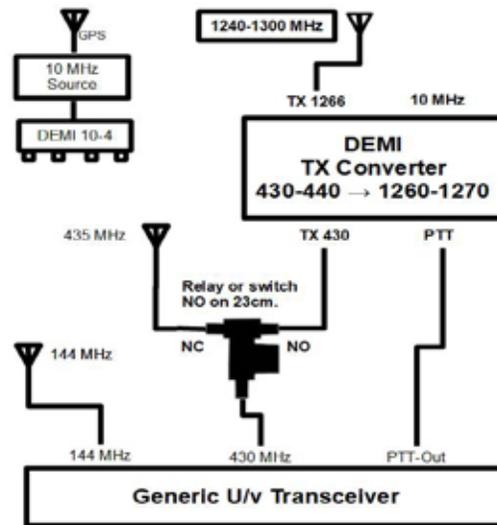


Figure 5 — Block diagram of the interconnections for the generic U/v transceiver implementation.

which is grounded when the transceiver transmits. This must be connected to the PTT connector on the converter.

Be sure to configure SatPC32, MacDoppler or whichever program you use to adjust frequencies as discussed in specifying the LO offset with SatPC32 above so the Doppler shifts will be correctly calculated.

When in use, the display of the radio will look like it is operating mode U/v. But the UHF frequency will be changing about three times more than usual as the Doppler shift is about three times larger for L band than U band.

Operation

With either of these two configurations, operating L/v mode is just like operating U/v mode. Consistent with good operating practice, you will want to use the lowest power output that will provide good communication. Since the power output of the L24TX is more or less proportional to the drive level, you can use your usual methods of adjusting power output. The output power can be monitored by a power meter in the antenna feed line or use the monitoring provided by a reference voltage through the auxiliary connector.

To switch to L/v, just power on the L-band equipment, choose the appropriate Doppler. sqf line or equivalent in MacDoppler, switch the coax relay/switch and operate. For the 23 cm uplink, I use the M2 Antenna model 23CM22EZA. It has a 70" boom and is rear-mounted — very easy assembly. Received signal reports have been good.

Footnotes

1. Parsons, Ronald G., "L/v Mode Enhancement to SDR Satellite Station," *The AMSAT Journal*, November/December 2018, p. 13. 

