Product Review Column from *QST* Magazine

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KLM 2M-22C and KLM 435-40CX Yagi Antennas

Ten-Tec 2510 Mode B Satellite Station

TEN-TEC 2510 Mode B Satellite Station

One of the most exciting aspects of Amateur Radio these days is satellite communications. AMSAT-OSCAR 10 brings improved communications possibilities by staying in view longer and provides greater range than its predecessors. OSCAR 10 operates Mode B and Mode L. Mode B is a transponder with an uplink (input) at 70 cm and a downlink (output) at 2 meters. (The Mode L transponder has a 23-cm uplink and a 70-cm downlink.) Mode B is the more popular combination. Some satellites in the planning stage are also expected to use Mode B.

The TEN-TEC 2510 Mode B Satellite Station is an SSB/CW transmitter and receive converter in one package (see the block diagram in Fig. 1). The 10-W-output, PTO-controlled transmitter covers the 435.0- to 435.5-MHz portion of the 70-cm amateur band. This range covers all present and anticipated Mode-B satellites. (The band switch in the 2510 includes provisions for expanded frequency coverage, should it prove desirable. Additional oscillators are needed to obtain the coverage, however.) Front-panel switches select USB, LSB or CW operation. FM is not used through Amateur Radio satellites because of the 100% duty cycle.

Circuit Description

Several modules comprise the transmitter (see Fig. 1). Signal generation (SSB or CW) starts in the SSB generator module at an approximate frequency of 6.3 MHz. In the transmitter low-frequency mixer module, the SSB signal is mixed with the PTO output (approximately 5 MHz). The sum of these two frequencies (11.5 MHz) is then mixed with the output of a 61.5-MHz crystal oscillator to provide a 50-MHz output. This output is then raised to 435 MHz in the UHF converter module. An MRF641 bipolar transistor in the final-amplifier module increases the output power to 10 W.

Transmitter output power level is controlled by an ALC circuit. The 10-W output limit is factory set. You may wish to operate at a lower power level—particularly if you are driving a separate power amplifier. The operating manual contains a simple, seven-step procedure for setting the ALC level to any desired level below 10 W.

The receiver section is a converter with a few unusual features. Signals in the 145.5- to 146-MHz range enter the converter through an NE41137 GaAsFET preamplifier. Converter output is at 29 MHz, requiring an HF receiver or transceiver to be used as an IF strip. Once the HF receiver is tuned to the proper frequency, all transmitter and receiver tuning (with automatic tracking) is accomplished with the main tuning knob in the 2510. A PIN diode at the converter output is used for muting.

Two features that you might want to add outboard are an inline fuseholder and an ON/OFF switch. If you are using a power supply with current limiting and it only powers the 2510, the switch and fuse are not necessary. For battery operation, the switch and fuse are a must.

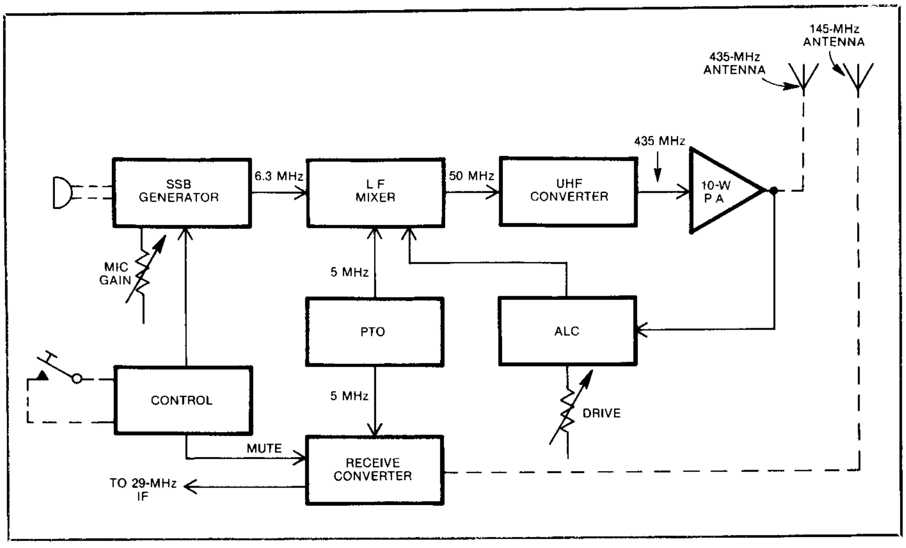


Fig. 1—Block diagram of the TEN-TEC Model 2510 Mode B Satellite Station.

In Operation

I have tried several different radios for OSCAR-10, Mode-B communication. For that reason, it was with great interest and anticipation that I installed the 2510 at K8CH. I connected the equipment as shown in Fig. 2. I use commercial, circularly polarized antennas for the 2-meter and 70-cm bands; both antennas have switchable polarization. My HF transceiver served as the 29-MHz IF receiver. I used the transverter connection to prevent accidentally "cooking" the 2510 receive converter.

When the satellite is in view, I point the antennas and listen for the beacon at 145.810 MHz . . . Yes! There it is, loud and clear. Well S5, but that's loud considering that the beacon (and the strongest signals on the downlink) should be only 22 dB above the

TEN-TEC 2510 Mode B Satellite Station

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Transmitter	
Frequency range: 435.0-435.5 MHz, extendable to 437 MHz with optional oscillator assembly (VFO overrun of approx. 30 kHz on each band edge).	As specified.
Output power: 10 W.	12.8 W at 435.0 MHz, 4.33 W at 435.25 MHz, 0 W at 435.50 MHz (better than 10 W across band).*
Output impedance: 50 ohms, unbalanced.	As specified.
Modes: Upper and lower sideband; CW.	As specified.
Sideband generation: Balanced modulator through 4-pole monolithic filter.	As specified.
Switching mode: Push-to-talk switch on microphone.	As specified.
Automatic level control: Factory set to 10-W output. Can be adjusted downward with internal control.	As specified.
Carrier suppression: 50 dB, min.	−47 dB (−55 dB).*
Unwanted sideband suppression: 30 dB min. @ 1 kHz.	USB, −10 dB; LSB, −28 dB. (−22 dB);* (−28 dB).*
Spurious and harmonic output: Greater than 50 dB below full power rating.	See Figs. 3, 4 and 5.
Microphone input: Low or high impedance with 5-mV level, min.	As specified.
Receiving Converter	
Frequency range: 145.5 to 146.0 MHz input converted to 29-MHz output (VFO overrun approx. 30 kHz on each band edge).	As specified.
Conversion gain: 25 dB, typical.	
Image rejection: Better than 60 dB.	
Noise figure: Less than 2.5 dB.	Noise figure: 2.5 dB (best).*
Dynamic range: 85 dB, typical.	Two-tone 3rd-order intermodulation distortion dynamic range (see Fig. 6).*
	Third-order input intercept, dB: −20.5 dB.*
General	
Power requirements: 12- to 14-V dc, 3 A max., continuous.	
Size: 4-1/2 × 7-9/16 × 11 in (HWD).	
Weight: 6 lb.	

*Measured after unit returned from manufacturer

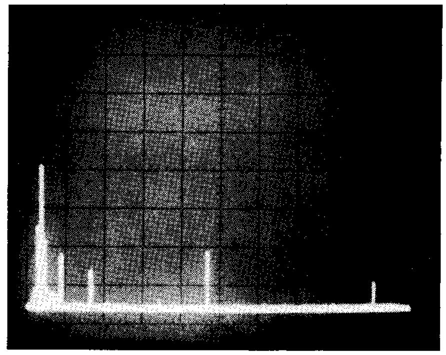


Fig. 3—Spectral display of the TEN-TEC Model 2510. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. Output power is approximately 10 W at a frequency of 435 MHz. All spurious emissions are at least 60 dB below peak fundamental output. The fundamental has been reduced in amplitude approximately 40 dB by means of notch cavities; this prevents analyzer overload. The 2510 meets the manufacturer's specifications for spectral purity.

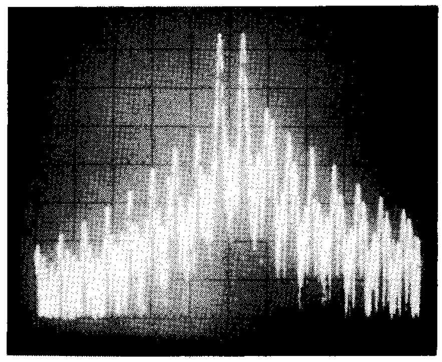


Fig. 4—Spectral display of the 2510 output during transmitter two-tone IMD test. Third-order products are 25 dB below PEP, and fifth-order products are 31 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 2 kHz. The 2510 was being operated at rated input power on the 70-cm band.

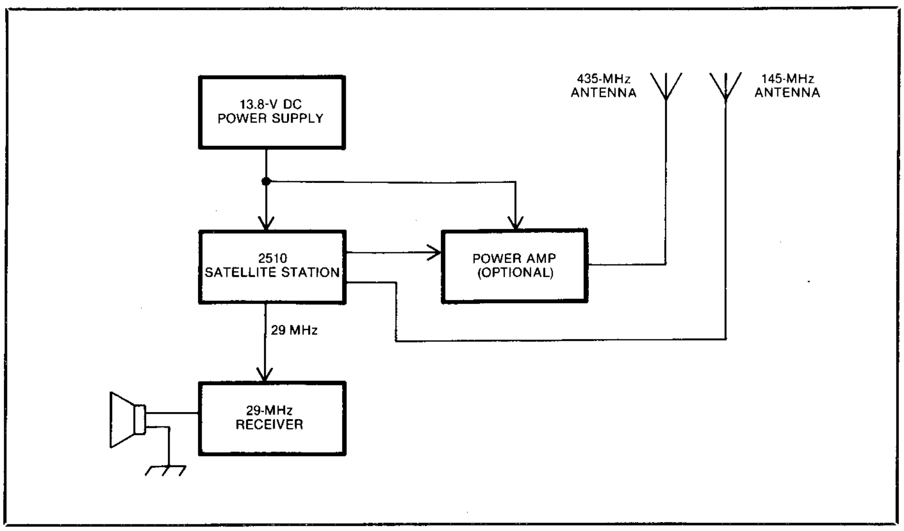


Fig. 2—Equipment interconnections for the installation at K8CH.

noise. I check to see that the antennas are peaked. Doppler shift? As expected. Good! Next tune to a clear area in the CW portion of the downlink. Press the SPOT button and tune the 29-MHz receiver to find the downlink signal. Release the SPOT button and the signal goes away. Great? Well, at least okay. Ten watts on the uplink gives a signal that is just above the noise level on the downlink. I'll connect the amplifier later and try it at 100 watts. Now I can't wait to tune across the passband and ... CQ CQ CQ de SV1DO SV1DO K. Will it work? I call him ... SV1DO de K8CH K8CH K ... K8CH de SV1DO ...

Say, that was easy. No problem placing the transmitter on the right frequency. The PTO in the 2510 takes care of the whole operation. It's as simple as transceive. No need for an uplink/downlink frequency-conversion chart. No on-the-air dots required to find my signals on the downlink. However, as Doppler shift varies, it is necessary to readjust the 29-MHz receiver frequency slightly above or below 29 MHz. (Doppler shift at 435 MHz is triple that for 145 MHz.) Fortunately, that won't keep you very busy.

Later, I found that in my station 100-W output gives a downlink-signal strength approximately equal to that of the 145.810-MHz

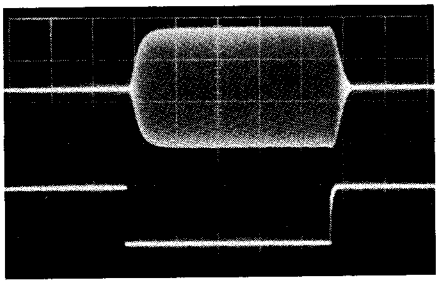


Fig. 5—CW keying waveform of the 2510. Upper trace is the RF envelope; lower trace is the actual key closure. Each horizontal division is 5 ms.

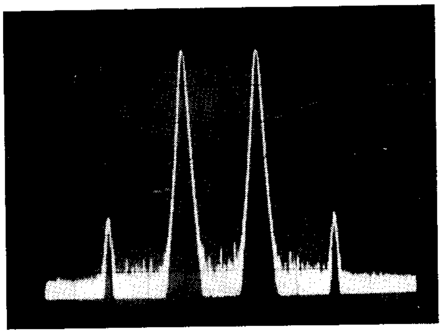


Fig. 6—Two-tone IMD waveform for the receiving converter. Third-order distortion products are down 45 dB. The input signal level was −43 dBm. Vertical divisions are 10 dB.

beacon. That is the maximum level recommended by AMSAT. Satellite transmitter power is limited. The signal strength of each signal it transmits depends on the number of signals in the passband and their relative power. If too many powerful signals are received, then the transponder AGC system reduces all lower-power signals proportionately without actually increasing the strong ones. As a rule of thumb, one should not have a downlink louder than the beacon.

Signals from OSCAR-10 are only a few S units above the noise. Couple that with the power limitation just mentioned and it becomes clear that the most important way to improve station performance is in receive capability. With the 2510 connected as shown in Fig. 2, I can hear the noise coming from the satellite downlink transmitter. I can hear clearly the 3-Hz shift in noise level caused by satellite spin modulation when the antenna is pointed at the satellite. When the antenna is rotated, the noise drops slightly and stays at a constant level. You can't do better than that. That GaAsFET preamp works!

Performance Problems

When the 2510 was tested in the ARRL laboratory, several discrepancies in performance were noted. The power output fell off sharply from 12.8 W at 435.00 MHz to 4.33 W at 435.25 MHz, and showed no output at 435.50 MHz. Sideband suppression was below the manufacturer's specifications: 10 dB in USB, and 28 dB in LSB. Carrier suppression was measured at 47 dB below single-tone peak output. After the unit was returned to the manufacturer for service, TEN-TEC confirmed, by letter, that the performance discrepancies we noted did exist. The unit was returned to us in a few days and, except for USB suppression, our complaints were rectified. [The suppression problem should not be a factor in operation, however, since all operating will be on LSB, and with received signals in the range of 8 dB over the noise, any USB signals will be lost.—Ed.]

Conclusion

If you want a convenient-to-operate station for Mode B, the 2510 belongs in your shack. The 2510 is manufactured by TEN-TEC, Inc., Sevierville, TN 37862. Price class is $490. *—Chuck Hutchinson, K8CH*

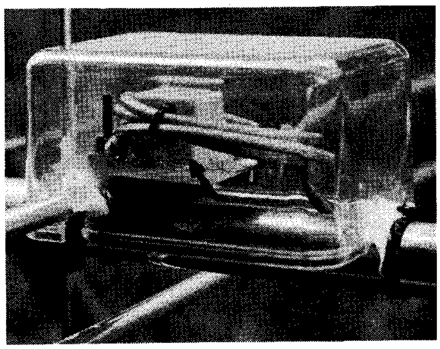


Fig. 7—KLM 2M-22C antenna CP switcher relay with relocated balun and protective cover.

KLM 2M-22C AND KLM 435-40CX YAGI ANTENNAS

☐ One of the really fun operating challenges in the VHF/UHF arena these days is communicating through OSCAR 10. Make no mistake about it—these are weak-signal operations! Getting good signals to and from the satellite is the problem. The answer to the problem is *antennas*. When the opportunity to test KLM's latest offerings in satellite antennas was presented, I nearly fell out of my chair trying to grab that tantalizing brass ring.

Satellite operations demand the use of circularly polarized (CP) antennas for really good performance. Many of us originally used the helical antenna as a logical choice for CP. OSCAR 10 is a different kind of bird, however, and requires that the CP antenna be readily switchable from right- to left-hand circular polarization. KLM's approach uses two long-boom Yagis mounted at right angles to each other on a single boom. One Yagi is mounted ¼ wavelength forward of the other. This design makes the feed-line coupling of the two Yagis somewhat simpler than other arrangements. KLM includes all of the hardware, baluns and relays required for readily switching the circularity of the antennas.

Assembly

Each antenna is well packed in its own compact box and comes with a very complete eight-page illustrated instruction book. Boom sections and elements are well-formed, straight and deburred—a really fine set of antenna hardware. The CP switcher for the '40CX causes a bit of a bulge on the sides of the box, however, exposing it to more risk of damage. The hardware is otherwise well packaged, and spares were included in most cases. Screws and bolts are all stainless steel, with the exception of the mounting U bolts, which are plated steel. One of these years, manufacturers of fine hardware like these antennas will decide to include stainless steel U bolts. Plated-steel hardware just won't make it in Florida.

These antennas use through-boom element mounting with molded button insulators to isolate the element from the boom. I was apprehensive about getting the elements properly centered in the boom. KLM was also concerned and gave explicit instructions in their assembly data. I used a 9/16-inch nut driver to start the button insulators on the 3/16-inch antenna elements. KLM provided a nifty added touch for the '40CX where each element is color coded for easy identification. This idea could well be used for the '22C. Assembly diagrams included a listing of the length of the protruding portion of each element, as well as all the other dimensions, saving some mental gymnastics on my part. I had no problems installing and securing the elements in their button insulators and locking pushnuts, and achieved 1/64-inch centering accuracy (half of KLM's requirement).

Boom assembly is straightforward, and I used three sizes of tubing for the '22C and two for the '40CX. Larger sizes are swaged to fit over the next smaller size. The swaged assemblies on the '22C are snug and close fitting. The '40 CX joints are not quite as close, and I added a third screw to this joint, located perpendicular to and between the two specified screws. This modification adds some lateral stability to the boom joints. There is some boom sag evident on each antenna, and a stiffening brace could have been provided by KLM.

Both antennas use preformed folded-dipole driven elements. Assembly of these elements is well illustrated, and straightforward. Teflon® -cable 4:1 coaxial baluns are supplied. Instructions for installing the CP switchers are complete, with no confusing adjustments required. The switcher for the '22C is identical to that used with KLM's 2M-14C, with a DPDT relay mounted right at the feed point of one of the folded-dipole elements. This relay switches the phase relationships of that element, reversing the CP direction. Two ¼-wavelength, 75-ohm Teflon® coaxial matching sections, preassembled to an SO-239 connector block, are provided with the relay assembly. From prior experience with schemes similar to the '22C switching, I think that the exposed relay will be prone to failure from diurnal pumping. The relay is cased in plastic and sealed to the switching circuit board with RTV—it is not hermetically sealed. As a result, the day/night temperature swings pump air and moisture in and out of the relay case. I protected the relay by relocating the 4:1 balun and placing a clear plastic refrigerator container over the relay (see Fig. 7). I would recommend a similar scheme to anyone installing this antenna. I rotated the antenna to an × position rather than a typical horizontal/vertical position. This allows the condensed moisture in the relay box to drain through two holes drilled in the case. Similar venting of the '40CX relay case is needed.

The relay assembly for the '40CX is a little more elegant because of the higher frequency. The phase reversal is done before the 75-ohm matching sections go to the antenna. The RF path through the relay is balanced, and reversal is accomplished by inserting a ½-wavelength microstrip transmission line in one antenna feed. This neat assembly is housed in an aluminum die-cast box attached to a rearward extension of the boom.

Mounting

KLM has a very good rationale for mounting the antennas on a nonmetallic elevation-axis boom, but doesn't give much assistance in doing it. KLM does market a fine 1½-inch fiberglass tubular boom for the purpose, but not many radio stores stock the item, and few of the sales persons know its purpose. It is very hard to find. KLM might consider including a suitable length of this material with each antenna. One alternative is a length of 1¼-inch, schedule-40 PVC pipe (1¼-inch ID) stiffened with a length of 1¼-inch-OD wooden dowel or clothes rod. Drive the rod into the pipe for a single, stiff assembly. KLM provides for the coaxial cable to exit off the reflector end of these antennas, thus avoiding shunting the antenna pattern and affecting performance.

Installation

My satellite antennas are mounted about five feet above a large Yagi beam. I solved the problem of physical interference by orienting the elevation axis parallel to the boom of the larger antenna. The reflector ends of the long satellite antennas swing down between the director elements of the lower antenna and everything is great—except that I have to remember to add 90° to the beam heading of the lower antenna to get the beam heading of the satellite antennas.

Performance

I have not used switchable antennas previously, so some of my pleasure in these antennas is a result of that change. It is not easy to be very definitive about this type of antenna, but there is no question in my tests—having switchable circularity has improved my performance with OSCAR 10 in certain orbital positions. I hear the satellite very well at all antenna angles with the 'C22, and much better than with the 3.2-wavelength Yagi previously used. For transmitting on 70 cm, my tests show that the gain of the '40CX provides a very satisfactory ERP with only about 6-W RF power at 435.1 MHz. I receive return signals at about 8 dB above noise level, which is quite good copy. Definitely, lower RF power levels can be used with these antennas.

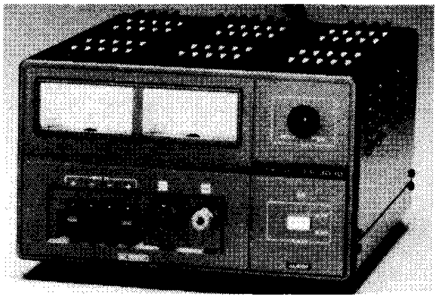
Using these high-gain antennas has put a lot of the fun back into OSCAR 10 operating for me, and I was surprised to find quite a few other operators already using this combination, all with equally good results. Without question, this antenna pair is an asset to the satellite user and provides superior performance capability.

The KLM 2M-22C and 435-40CX antennas are available from KLM Electronics, 17025 Laurel Rd., Morgan Hill, CA 95037, tel. 408-779-7363. Price class: 2M-22C, $120, 435-40CX, $170—*Dick Jansson, WD4FAB, ARRL TA*

New Products

ALINCO DC POWER SUPPLIES

☐ Alinco Electronics Corp. has announced a new line of heavy-duty dc power supplies for Amateur Radio use. The model EP-3030 dc power supply is rated at 25 A continuous and 30 A max (50% duty cycle). Maximum ripple voltage is rated at under 30 mV P-P. Voltage regulation is approximately 0.25%. Output voltage is variable from about 10-15 V by a front-panel control. Separate meters display voltage and current continuously. Two additional front-panel, spring-connect outlets provide up to 7-A output for auxiliary equipment. An automatic current-limiting system shuts down the supply if current is in excess of 30 A. The unit is finished in brown crackle paint, and its styling is designed to complement and blend with current Amateur Radio transceivers. Additional 10-15 V power supplies in the line include the model EP-660, rated at 5.5 A continuous and 6.5 A max (dual-purpose meter), and the model EP-5500, rated at 50 A continuous and 55 A max (two meters).

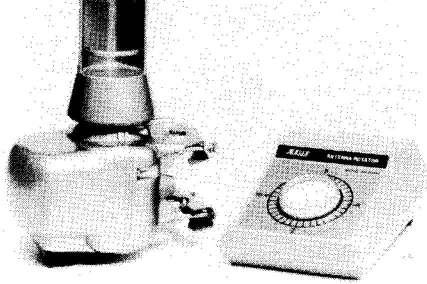


These units also feature automatic current limiting and ripple voltage under 30 mV P-P. Price class: EP-3030, $208; EP-660, $69. Available from dealers or Alinco Electronics Corp., P.O. Box 70007, Reno, NV 89570, tel. 702-359-1414—*Bruce O. Williams, WA6IVC*

AR-200XL ANTENNA ROTOR FROM CMC

☐ The AR-200XL antenna rotor operates from 117-V ac and provides 220 lb-in of motor torque to turn an antenna array. Full 360-degree rotation is achieved in 60 seconds. Motor voltage is kept below 18-V ac for safety, and only three conductors are required between the control unit and the rotor. The control unit includes a demand-heading control and a present-heading indicator presented concentrically on a compass rose.

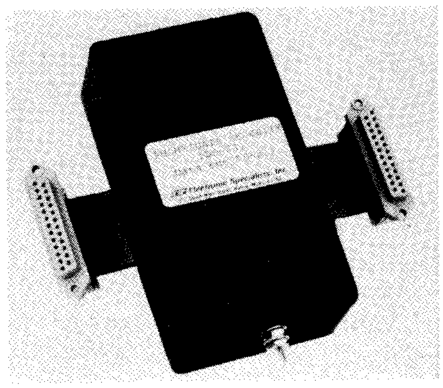
The AX-200XL is designed for medium duty, and will support a vertical load of up to 100 lb



with a wind loading of 5 sq ft. For further information, contact CMC Communications Inc., 5479 Jetport Industrial Blvd., Tampa, FL 33612, tel. 813-885-3996.—*Bruce O. Williams, WA6IVC*

RS-232-C COMPUTER BUS PROTECTION

☐ The Electronic Specialists product line now includes Kleen Line RS-232-C computer bus protection. Models available range from 4-line through 24-line protection. Intended to suppress damaging high-voltage transients and spikes that may occur on LANs (local area networks) or long bus runs, the Kleen Line Security System uses modern semiconductor and gas-discharge suppression techniques, as well as RF interference filtering technology.



The Model PDS-232 (1-3,7) protects lines 1, 2, 3 and 7, and sells for $134. Available from Electronic Specialists, Inc., 171 S. Main St., P.O. Box 389, Natick, MA 01760, tel. 800-225-4876.—*Bruce O. Williams, WA6IVC*

DOWN EAST MICROWAVE ANTENNAS AND ACCESSORIES

☐ Down East Microwave has introduced a new line of loop Yagis, power dividers and stacking frames for the 23- and 13-cm bands. With these products, it is possible to assemble an array of two, four or even more loop Yagis for high gain.

The 23-cm antenna, model 2345LY, covers 1250-1350 MHz. It consists of 45 elements on a 1-inch-OD, 143-inch-long boom; weight is approximately 5 pounds. A Type-N female connector is standard, although other connector types are available on request. The 13-cm antenna (1345LY) for 2200-2350 MHz is also 45 elements, but the boom is ½-inch OD by 81 inches long. The antenna weight is 3 pounds, and a female SMA connector is standard.

Boom material is 6061-T6 tubing. Elements are made from 5052-H32 for strength. All hardware is stainless steel. The antennas are shipped assembled and tested. Booms break in half for shipping.

Two-way and four-way power dividers are available for building multiple-antennas arrays. Available custom stacking frames can be built to specification. Price class: 2345LY, $90; 1345LY, $80; four-way power divider (either band), $50; two-way power divider (either band), $40. Manufacturer: Down East Microwave, Box 1655A, RFD 1, Burnham, ME 04922. —*Mark Wilson, AA2Z*