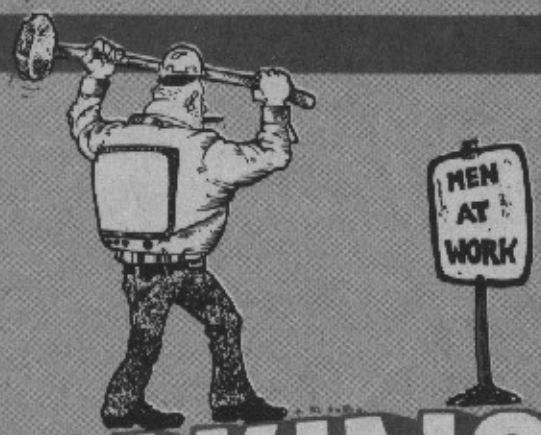
elementary Electronics
May/June 1977



by Morrie S. Goldman

BREAKING THE TV DISTANCE BARRIER

DX techniques add new excitement to your home TV.

In this day of satellite telecasts from all continents, the idea of watching a television program originating from a mere thousand miles distant doesn't sound too exciting. But how about receiving that same TV signal without the aid of a satellite? Sound interesting? Well, that's what TV-DXing is all about.

Even if you're an "old pro" in DXing circles, you're probably not too familiar with TV-DX. Sometimes it seems like many DXers even doubt that TV-DX is possible. What's surprising to many is that TV-DX is actually quite common! TV-DXers around the world regularly pull in distant video signals from 200 to 2000 miles away. As we'll soon see, a station 1000+ miles distant may actually appear with greater clarity than your local stations!

The real key to successful TV-DXing is not massive antenna systems and exotic equipment (though they help!), it is simply tuning in at the times when DX openings are occurring. Unlike the shortwave or broadcast band DXer, the TV-DXer can't just turn on a receiver on most any day and start DXing. The TV-DXer must carefully survey daily and even hourly conditions, watching for a band opening. When openings do occur, the results can be quite rewarding. Instead of just hearing a distant station, you're actually seeing it as well.

You can greatly increase your odds of catching TV-DX by knowing when and on what channels it's most likely to occur. For this introduction, we'll go into a brief description of the most common forms (or modes) of wave propagation that affect television signals. Don't get worried by the sound of that—wave propagation is simply what happens to a signal from the time it leaves the transmitting antenna until it reaches a receiving antenna. A solid understanding of the basics of V-UHF propagation is essential to the TV-DXer.

The television bands are located in the VHF and UHF ranges of the electromagnetic spectrum. Signals in these bands are much higher in frequency than shortwave broadcast signals and as such are not propagated in the same manner. Layers of the earth's ionosphere that regularly reflect shortwave signals to points thousands of miles distant, normally fail to reflect VHF signals. Under "normal conditions," TV signals travel in straight lines and pass through the ionosphere into outer space. This limits the range of broadcast TV stations to line-of-sight. Broadcasters call the area covered under normal conditions, their coverage area. Typically, the coverage area of a VHF TV station

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is between 50 and 75 miles. Under *abnormal* conditions, this coverage area can very greatly increase.

Just what are the "abnormal conditions" that result in TV-DX? They are various changes in the condition of the earth's atmosphere that cause VHF or UHF signals to be bent or reflected beyond the horizon. Different modes of propagation are created by these conditions and they carry signals over varying distances. Certain modes of propagation have very different effects on the range of particular TV channels. Now let's take a close look at each of the common modes of propagation.

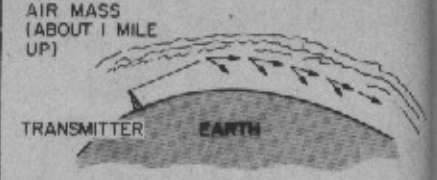
Tropospheric Bending. Tropospheric bending, tropo for short, is the most common mode of VHF-UHF propagaiton. Tropo is the only form of propagation that is *directly* related to weather. Frequently dubbed "extended groundwave," tropo extends the range of VHF and UHF signals by 60 to 1000 miles. Distances up to 350 miles are most common.

Tropo can occur in several ways, but the influence of a high-pressure area is always required. When a temperature inversion occurs (warm air meeting a cool air mass), a low-level barrier to VHF and UHF signals is formed above the earth. Tropo is most common in early morning and evening when rapid warming and cooling of the air takes place. Fall is considered the favorite season for tropo, but openings are common in the spring and summer as well. In northern regions, tropo is uncommon in the spring and summer but it happens during an unseasonably warm weather period.

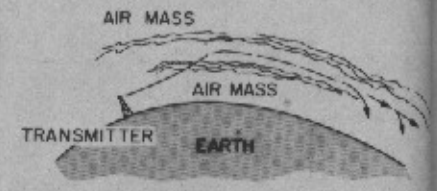
Tropo is characterized by steady signals. It usually affects the *highest* channels most. That is, a good opening on UHF *may* produce fair results on the VHF high band (channels 7-13) and poor results on the low band (channels 2-6). Tropo may also affect only a narrow range of channels. When this type of reception occurs, look for some fantastic catches because it's probably a sign of tropospheric ducting. Ducting is aptly termed, as signals become trapped between two air boundaries of different heights. This condition causes TV signals to behave in much the same manner as if they were being fed into a giant metal duct, following the curvature of the earth. A ducted signal may travel a thousand or more miles above the earth before returning down. Ducts are frequency-selective—they will carry only a limited range of channels. This range may include all of the UHF band or only a few channels. Ducts are very unstable and may last for hours or only minutes. Tropospheric ducting is most common in the UHF channels, but also shows up at the VHF high-band channels. A high-performance antenna system is vital for successfuly DXing tropo ducts.

Sporadic E Skip. Frequently called "short skip" by ham radio operators, sporadic E skip (Es) can produce spectacular TV-DX results. Es commonly brings in TV-DX signals from 450 to 1400 miles distant on a single hop (that's short for the ham bands)—frequently with snow-free pictures. This is the same type of skip that produces the summer skip on CB.

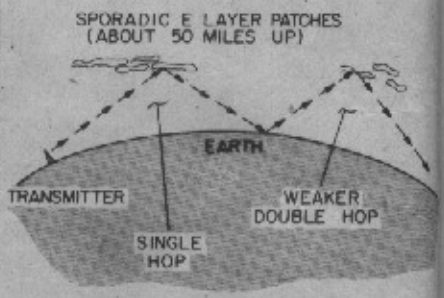
Sporadic E skip occurs when a signal strikes sporadic patches of ionization in the E layer of the ionosphere (about 50 miles above ground). The ionized



Tropospheric Bending causes TV signals on all channels to be "bent" over the horizon

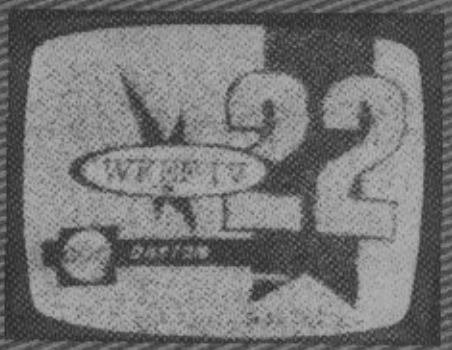


Tropospheric Ducting occurs when a TV signal (usually UHF) is trapped between two air masses and is "ducted" to a distant point several hundred to a thousand miles away



Sporadic E Skip causes signals to be refracted to points 450 to 1400 miles distant on a single hop. On very rare occasions, a signal may bounce off the earth and refract off a second sporadic patch causing "double hop" reception to 2800 miles. Sporadic E normally only affects channels 2-6

TV-DXing can sometimes turn up some real surprises. Like reception of this experimental station operated by Zenith on UHF-TV channel 38.



WKEF-TV, channel 22, in Dayton, Ohio, received by Tropospheric Skip at 260 miles.

990 mile E Skip at a distance of over 1230 miles. Reception of this channel 4 station is common most summers.

patch refracts the signal back toward a distant point on earth, much in the same way that a mirror reflects a beam of light.

The *lowest* TV channels are affected most by Es. Es will normally appear on channel 2 before it hits 3; 4 before 5, and so on, but is very rarely found above channel 6. Openings frequently occur on channels 2 or 3 that never reach the higher channels. Even more frequently, Es produces activity on CB and the 10 meter ham band without reaching the TV channels. Generally, the stronger openings effect the greatest number of channels. A weak opening may only bring in distant stations on channels 2 and 3. If signals on 2 and 3 are quite strong, skip is likely to also be in on channels 4 and 5.

The best seasons for Es are late spring and early summer, with a lesser peak occuring from mid-December to early January. Best times to look for Es signals are from mid morning to early afternoon and again from early evening to about 10:30 PM, local time.

Strong signals and deep fading characterize Es. Signals are commonly strong enough to be received on indoor "rabbit ears" style antennas! Best results will still be obtained with an outdoor rotatable antenna, but it needn't be very high. Es reception can last for minutes, hours or even days. A typical opening lasts for a few hours and may bring in a half dozen or more distant stations. It's even common for two or three different DX stations to be received on the same channel at the same time.

A good way to look for Es openings is to frequently check channel 2. Even if you have a local station on channel 2, DX stations on the same channel will produce an interference pattern of horizontal black bars. More about this later. If you're using a rotatable antenna, this check should be made with the antenna pointed away from your local station.

Outside of the seasonal variations, Es is very unpredictable. It is *not* directly related to local weather conditions, the sunspot cycle or the phases of the moon. Little is really known about the causes of Es, but it does make TV-DXing a lot more exciting!

F2 Skip. Every eleven years, sunspot activity reaches a peak. When this occurs, the radiation projected from the sun builds up the density of the F2 layer of the ionosphere. This layer is about 200 miles up, much higher than the E layer. If sunspot activity is great enough, the F2 layer becomes dense enough to refract signals on the lowest TV channels. Because the F2 layer is so high, distances covered are seldom less than 1700 miles. The world's TV-DX record was set by F2 skip in 1957 when George Palmer of Williamstown, Victoria, Australia, received BBC-TV from England over a 10,400 mile distance.

TYPE 828 EXPOSURES - KODAK

EXPOSURE TABLE

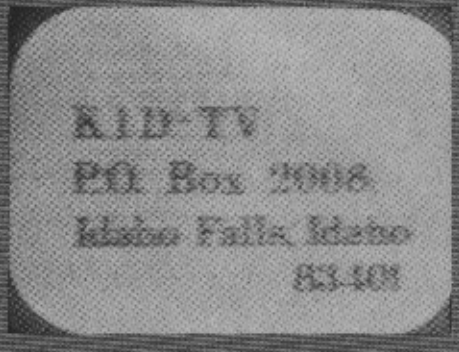
(Suggested Camera Settings for Pictures of Television Images)

Film (Use)	Black-and-White Television Set		Color Television Set	
	Leaf-Type Shutter	Focal-Plane Shutter	Leaf-Type Shutter	Focal-Plane Shutter
Verichrome Pan Plus-X Pan (Black-and-White)	1/30 sec f/4	1/8 sec f/8	1/30 sec f/2.8	1/8 sec f/5.6
Tri-X Pan (Black-and-White)	1/30 sec f/5.6-8	1/8 sec f/11-16	1/30 sec f/4-5.6	1/8 sec f/8-11
Kodacolor-X (1) (Color Prints) Kodachrome-X (1) Ektachrome X (1) (Color Slides)	1/8 sec f/2.8 or 1/15 sec f/2	1/8 sec f/2.8	1/4 sec f/2.8 or 1/8 sec f/2	1/4 sec f/2.8 or 1/8 sec f/2
High Speed Ektachrome (1) (Daylight)—with Normal Processing ASA 160 (Color Slides)	1/15 sec f/2.8-4	1/8 sec f/4-5.6	1/8 sec f/2.8-4	1/8 sec f/2.8-4
High Speed Ektachrome (1) (Daylight)—with ESP-1 Processing for a Speed of ASA 400 (Color Slides)	1/30 sec f/4	1/8 sec f/8	1/30 sec f/2.8	1/8 sec f/5.6

NOTE: When two lens openings are given, such as f/4-5.8, lens setting is midway between these stops.

(1) Pictures of color television taken without a filter will look blue-green. With the color films in the table, you can use a Kodak color compensating filter, CC40R, over your camera lens to help bring out the reds in your pictures. Increase the exposure suggested in the table by 1 stop.

830 mile E Skip reception of KTVS-TV, channel 3, Sterling, Colorado. Both zero and 20 kHz offsets appear in this picture.



KID-TV received by E Skip at a distance of over 1250 miles. Reception of this channel 3 station is common most summers.

Meteor Scatter reception of WMAR-TV, Channel 2, Baltimore, Maryland, 725 miles.

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The next sunspot maximum will be reached around 1979-1980. As the intensity of sunspot cycles varies, we can't yet predict whether activity will again be great enough to produce transcontinental TV-DX. During the most recent cycle, I received the audio of TV transmitters in France and England. The video signals for these channels are on slightly higher frequencies and were not received. The last cycle was no where near as intense as the previous cycle which produced George Palmer's record catch. In the late fifties, several US TV-DXers received almost daily reception from European TV stations on modified TV receivers.

Meteor Trails, Lightning and the Northern Lights. The ionization produced when a meteor burns up from friction as it enters the atmosphere, does a good job of reflecting TV signals. Meteor trails last only a short time, so they produce very brief "bursts" of TV-DX. Meteor bursts commonly last from a fraction of a second to four or five seconds. Bursts may also appear in clusters, permitting reception for thirty seconds or more.

If you watch for meteor scatter when TV stations are running their test patterns (typically 4 to 8 AM local time), a second or two of reception can be long enough to identify (ID) your DX catch. With a good outdoor antenna, a great many meteor bursts can be seen on channels 2-6. For results on channel 7 or above, a very elaborate antenna system must be used. As most meteors burn in the E region of the ionosphere, distances are somewhat similar to Es, but somewhat shorter—500-900 miles. Meteor scatter occurs literally every day, but results are best during meteor showers. A list of major meteor showers can be found in most almanacs or *The Radio Amateur's VHF Manual*, published by the American Radio Relay League.

Sometimes, when an intense lightning storm is between a DXer and a UHF TV station (200-500 miles away), signals can be reflected by the lightning strokes to produce TV-DX. Signals burst in much as if propagated by meteor scatter. NEVER attempt to DX while a storm is in your area—wait until the storm has passed. When the storm is safely out of your area, point your antenna at the storm and tune around the UHF dial. Results will be best if you are looking for a particular station that appears to be within range.

The Northern Lights (aurora) can also produce TV-DX results. TV signals are sometimes scattered by the auroral curtain to produce very fluttery reception. Distances covered can extend to several thousand miles. Most often however, signals are so garbled by auroral flutter that they are impossible to identify. Auroral scatter is most common in the years close to and following a sunspot maximum. This form of DX is most common in Northern areas and is rarely observed south of the Mason-Dixon Line. All of the low- and high-band channels are affected, but chances for IDs are best on the low channels.

What Equipment Is Necessary For TV-DXing? A surprising amount of TV-DX can be observed on a simple antenna system, however the serious DXer must employ a high-performance installation. Of prime importance is that a TV set in top working order be used. The set should be sensitive and selective (eliminating low-end budget sets with only two video IF stages), and should be capable of locking sync on a weak signal. In other words, a weak signal should not roll vertically or lose horizontal sync. Many DXers have found that sets with screen sizes of 19" or smaller are easiest to DX with. Either a color or a monochrome set will do fine.

Most active TV-DXers use separate VHF and UHF antennas. The antennas must be rotated by an accurately calibrated antenna rotor. The best consumer UHF TV antennas are of the 7' parabolic dish variety. The best such antenna is probably still the Finco P-7. If a large dish antenna cannot be used, other "fringe area" designs can still provide good results. A talk with your local distributor or antenna service should probably provide some helpful advice.

A UHF antenna should always be mounted as high as possible. In metropolitan areas, a minimum of fifty feet above ground may be necessary to provide acceptable results. A good quality low-noise UHF preamp will also be quite helpful. A preamp of this type is mast mounted at the antenna and fed by a remote power supply indoors. Two excellent UHF preamps are the Blonder-Tongue CMA-Ub and the Winegard AC-4990. The Winegard unit is less likely to "overload" in a strong signal area, but has less gain than the Blonder-Tongue CMA-Ub. Again, consult a local expert for your best choice.

For VHF, a large fringe area broadband Yagi or log-periodic design antenna should do the job well. Channel Master VHF antennas have long been popular with TV-DXers, but all of the major antenna manufacturers make antennas of this type. Height is somewhat less important for the VHF antenna,

(Continued on page 92)

CLUES TO IDENTIFYING AN UNKNOWN STATION

- Channel
- Network
- Local Commercials
- Local Public Service Announcements
- Antenna Direction
- Offset Frequency
- Propagation
- Other Stations Received About the Same Time
- Recognition of Local Weather Map, Announcer, Logo, etc.
- Time Zone (Caution: Some stations delay broadcasts, causing them to appear to be in a different time zone.)

QSL Information Card

WQLN-TV

Channel 54 **Erie, Pa.**

Effective Radiated Power: **915 kw**

Carrier Frequency: Visual **711.26 mc** Aural **715.76 mc**

RECEPTION CONFIRMATION

Date	Program	Time
1/20/67	Test Pattern	1:58 EST

DX with your TV

(Continued from page 48)

though it should be clear of surrounding obstacles. Unless you live way out in the sticks and away from strong local stations, don't use a mast mounted VHF preamp. Most tend to overload badly when used in strong signal areas.

As we said a bit earlier, a good antenna rotor is essential. An outdoor antenna that cannot be rotated is of almost no value to a DXer. Make sure that you use a rotor that's strong enough to handle a large TV antenna array. It's a nasty feeling to have a rotor fail during a DX opening!

If you're one of those unfortunate DXers that can't use an outdoor antenna, don't despair when the bands are open, there'll still be plenty for you to see. You can improve your results by using adequate antennas. For VHF, stick with the old reliable rabbit ears. Expensive and elaborate looking rabbit ears usually don't work any better than the $3 or $4 kind. Some DXers have found it convenient to use a small outdoor style antenna, indoors. Mounting such an antenna on a pole lamp is a handy trick.

For UHF, forget about that little loop that came with your TV set and buy a small outdoor UHF antenna. The Blonder-Tongue Golden Dart would be an excellent choice. The same UHF preamps we recommended for outdoor use should be useful here as well. If you live on an upper floor of a high-rise building, you can most likely pull in excellent UHF DX with a modest indoor antenna system.

Now on to DXing. TV-DXing, especially for beginners, requires a good deal of patience. It's strange, but a beginner frequently watches carefully for a long while before catching a good opening, then suddenly starts seeing many openings. This usually means that

the DXer is getting accustomed to spotting signs of an opening. You'll also get used to quickly recognizing what mode of propagation you're receiving. After a bit of DXing, you'll recognize the characteristics of each mode.

While DXing, you should have on hand an accurate listing of US, Canadian and Mexican TV stations. If you live in the South, a list of Central American stations will also likely be helpful. White's Radio Log in *Communicaitons World* is a good start for US and Canadian stations, but an even more detailed list is best. One of the most useful references available is the *WTFDA TV Station Guide* ($5 pp from the Worldwide TV-FM DX Association, PO Box 163E, Deerfield, IL 60015). The *Guide* is a comprehensive reference of North and Central American television station data. Features include maps (by channel) showing the call letters, location, network and offset frequency (more about this latter) for almost every TV station in the Western Hemisphere. The respective station lists provide additional data including city of license, state of transmitter location (if other than state of license), whether or not the station is a "satellite" of (rebroadcasts) another station, originating station for the satellite, antenna height, effective radiated power, and even what edition of *TV Guide* lists the station's program schedule. When trying to identify a DX station, there is no substitute for detailed station information. Information of this type will also help you spot what other stations are in the same region as a DX station you've identified. This will help you make the most of the opening.

Identifying DX Signals. As in other areas of DXing, identifying a DX signal is not always as easy as we might like. Signals may fade before a station break, or be buried under another station's signal. Frequently however, enough bits of information can be observed that will help you identify the mystery signal without actually seeing an ID slide.

The Table illustrates some of the common clues that can help you ID an unknown station. If enough clues point to one station, you *may* have solved the mystery. One of those clues is called "offset frequency." This frequency indicates whether a station is assigned to operate exactly on channel, 10 kHz high in frequency or 10 kHz low. Stations around the country are staggered in offset frequency to minimize interference between them. When one station does interfere with another on the same channel, an offset pattern of horizontal black bars is created on the receiver's TV screen. When a station with a +10 kHz offset frequency interferes with a 0 offset station, a 10 kHz offset pattern appears (about 10-15 black bars). If a +10 kHz offset station interferes with a −10 kHz offset station, the difference is 20 kHz, producing a pattern of many fine horizontal lines. Two stations of exactly the same offset produce a zero offset pattern of 5 or 6 thick black bars.

As long as you definitely know the identity of one of two stations being received on the same channel, you can refer to your station list and determine its offset frequency. If that frequency is + or −10 kHz, you can readily determine the offset frequency of the unknown station. If your known station is a zero offset and a 10 kHz offset pattern is observed, the unknown station may have either a + or −10 kHz offset frequency. Unfortunatley no offset list is 100% accurate, so offset patterns alone won't identify an unknown station.

Only you can decide whether you have enough data to identify an unknown station. Carefully analyze the information you know about the station. If all else fails, write to the station's chief engineer or program director and ask whether they think you received their signal.

Photographing your DX. You can get an "instant QSL" by photographing the ID slides and test patterns of the TV-DX stations you receive. It's not too difficult to get results comparable to the photos in this article. Many DXers get by with simple box cameras, but you'll need a camera with adjustable exposure and speed settings for best results. Your camera should be mounted on a tripod or steadied on a firm surface. For starters, try a setting of 1/30th second at F/5.6 using Kodak Tri-X film. Never a flash! Be sure to properly sight the camera so that the entire screen is in the frame.

Kodak has prepared an excellent 8-page booklet entitled, "Photographing Television Images," and it's available free of charge by writing to the Eastman Kodak Company, Consumer Products Division, Rochester, NY 14650. Ask for Customer Service Pamphlet AC-10. This booklet covers the use of color and black and white film, and even describes how to take movies of your DX.

QSL Cards and Letters. Most TV stations will verify your reception by letter or QSL card. Reports should be addressed to the Chief Engineer and include full details of the programming, commercials, and announcements you received. Response will be best if you include a self-addressed stamped envelope.

TV-DXing in England. If you'd like to see what TV-DXing is like in England, a new third edition of *Long Distance Television* is now available from

Weston Publishing, 33 Cherville Street, Romsey, Hants S05 8FB England, for $3 postpaid.

TV-DX Club. For almost ten years, one non-profit organization has been serving TV, FM and public service band DXers—The Worldwide TV-FM DX Association (WTFDA). WTFDA publishes station guides, booklets, log pages, and other supplies for DXers. Most importantly, WTFDA publishes the monthly *VHF-UHF Digest,* featuring columns reporting DX received by members, new station news, and theory, construction and feature articles.

A sample copy of the *VHF-UHF Digest* and full information about the club is available for 75¢ or information only, for a self-addressed stamped envelope. A one year membership is $11 in the US and Canada and $18 overseas. A booklet entitled, "*Beyond Shortwave. . . . An Introduction to TV, FM and V-UHF Radio DX,*" is $1.25. You can write to WTFDA at PO Box 163E, Deerfield, IL 60015.

So now that you've been introduced to the world of video DX, start watching those channels you always thought were blank. And the next time you hear someone say that TV reception is only line of sight, make a good size bet—then pull out your new TV-DX photo album! ■